Behavioural responses to lung cancer screening

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Abstract

Background

Lung cancer causes more deaths than any other type of cancer. Detecting lung cancer at an early stage through screening can reduce mortality but the benefits of screening must outweigh the harms. A trial to evaluate a biomarker screening test for lung cancer is the context for the research reported in the thesis.

In order for screening to be effective, uptake should be high. A significant proportion of individuals invited to cancer screening in the UK do not attend and qualitative methods are suited to developing knowledge of factors influencing this decision. However, qualitative research on the topic exists in a fragmented state because it tends to be confined to particular types of cancer screening. There is a need to synthesise evidence from primary qualitative studies to allow it to contribute to policy and practice.

Tobacco use is the leading behavioural cause of premature death and awareness is high that smoking causes lung cancer. Lung cancer screening might therefore have a behavioural impact by either promoting or discouraging smoking abstinence. The effectiveness of lung cancer screening programmes may greatly depend on their impact on smoking behaviour. Existing evidence of this relationship is conflicting and the behavioural impact of

biomarker lung cancer screening is unknown. There is a need for greater certainty about the direction and size of the effect of lung cancer screening on smoking and to better understand how screening influences individual decision-making about smoking.

The objectives of the thesis are:

1. To systematically search for and synthesise qualitative research evidence that can explain cancer screening attendance decisions in the UK.
2. To measure and explore smoking behaviour and related social cognitive variables over a 12 month period in individuals screened and unscreened for lung cancer.
3. To explore decisions about smoking in smokers screened for lung cancer.

Methods

Methods used are systematic review and meta-synthesis, a longitudinal questionnaire study nested within a randomised controlled lung cancer screening trial (n = 1,032) and a qualitative sub-study (n = 31).

Questionnaire study participants were aged 50-75 years, 51.0% female, 55.2% current smokers and 41.7% lived in the most deprived quintile of the Tayside or Greater Glasgow and Clyde areas of the UK. Of the 1,032 individuals included in the analysis,

321 were sampled from those randomised to screening who subsequently received a positive screening test result, 361 randomised to screening who received a negative result and 350 randomised to the unscreened arm.

Qualitative sub-study participants were screened individuals who had been current smokers at baseline and returned follow-up questionnaires. A quota sampling approach was adopted to include individuals with positive and negative screening test results and those reporting different post-screening smoking behaviours.

Results

There was no impact of randomisation to lung cancer screening on 7-day point prevalence of smoking at any time point or across all time points, OR 0.73 (95% CI 0.38-1.42). There was also no impact on any other smoking behaviour (cigarettes per day; nicotine dependence; quit attempts; attempts to cut down) or related social cognitive variables over a 12 month period.

When comparing test result groups there was no significant difference in smoking 7-day point prevalence between the positive test group and unscreened arm across all time points, OR 0.55 (95% CI 0.25-1.19), or at any single time point. Similarly, there was no significant difference in smoking 7-day point prevalence between the negative test group and unscreened arm across all time points, OR 0.95 (95% CI 0.45-2.01), or at any time point.

Positive test group smokers were significantly less likely to report smoking 20 or more cigarettes per day than unscreened arm smokers across all time points, OR 0.32 (95% CI 0.14-0.69), a difference that endured at 12 months. Significantly more smokers in the positive test group had attempted to quit at three months compared to unscreened arm smokers, OR 2.29 (95% CI 1.04-5.04).

Compared to unscreened arm smokers at three months, negative test group smokers were significantly less likely to have attempted to cut down, OR 0.47 (95% CI 0.23-0.98), or to perceive health benefits of quitting, OR 0.33 (95% CI 0.11-0.93). Negative test group smokers were significantly less likely at one and three months, and positive test group smokers significantly more likely at six months, to be thinking about or trying to quit compared to unscreened arm smokers.

The positive test group reported behavioural change that generally suggested a beneficial effect of lung cancer screening. The negative test group, who represent the vast majority of those screened, reported behavioural change suggestive of a harmful effect of screening but most differences were not statistically significant.

Analysis of qualitative data showed that smokers who were screened made decisions about smoking influenced by their test results, interpretations of which were sometimes inaccurate,

emotional responses to those interpretations and changes in motivation and urgency to quit smoking. Family members were influential, along with a number of non-screening factors and sometimes an accumulation of factors for which screening became a 'tipping point' for change.

Evidence from the meta-synthesis suggests that the context of cancer screening invitations is fundamental in decision-making about whether to attend: individuals' relationship with the health service was the most important factor, with underlying dynamics of trust, power, control and authority. Some people were compliant with screening requests, particularly when received from a known source. However, there can be scepticism of the requirement to adhere to a screening regime and official information about risk can be rejected, influenced by themes of disease beliefs, current health and previous experiences of cancer. Fear was both a motivator and barrier to screening attendance, including fear of the threat of cancer in the absence of screening, fear of the threat of abnormal test results, and fear of screening methods.

Conclusions

The results provide evidence that lung cancer screening does not have a harmful behavioural effect in terms of an impact on tobacco use. There was also no evidence that allocation to lung cancer screening had a beneficial effect on smoking behaviour but in

practice this may depend on the proportions who receive positive and negative screening test results. This is because the positive test group appeared more likely, and the negative test group less likely, to report 'beneficial' changes in their smoking behaviour.

Smoking cessation support integrated with lung cancer screening should be tailored to individuals' emotional response to their understanding of their test result and take account of screening-related and wider contextual factors that influence decisions about smoking after both a positive and a negative test result.

To promote uptake of a future lung cancer screening programme in the UK, strategies to promote greater trust, familiarity and a personal connection with the health service should be considered.

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Abbreviations

CASP	Critical Appraisal Skills Programme
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
CPD	Cigarettes per day
CT	Low dose computed tomography
DCIS	Ductal carcinoma in situ
DLCST	Danish Lung Cancer Screening Trial
EarlyCDT-Lung	Early Cancer Detection Test - Lung
ECLS	Early Cancer Detection Test - Lung Cancer Scotland study
ELCAP	Early Lung Cancer Action Project
EPPM	Extended parallel process model
FS	Flexible sigmoidoscopy
FTCD	Fagerström Test for Cigarette Dependence
GGC	Greater Glasgow and Clyde
HBM	Health belief model
HSI	Heaviness of Smoking Index
IBD	Inflammatory bowel disease
NELSON	Dutch-Belgian Lung Cancer Screening Trial
NHS	National Health Service
NLST	National Lung Screening Trial
OR	Odds ratio
PMT	Protection motivation theory
PO	Prophylactic oophorectomy
PSA	Prostate-specific antigen
RCT	Randomised controlled trial
SIMD	Scottish Index of Multiple Deprivation
TPB	Theory of planned behaviour
TTFC	Time to first cigarette of the day
TTM	Transtheoretical model
UKLS	UK Lung Cancer Screening pilot trial

1 Clinical context

1.1 Chapter summary

Most individuals will develop cancer in their lifetime but the disease can be preventable. Lung cancer accounts for the most cancer deaths and the vast majority of lung cancers are caused by smoking. Older age and a family history of lung cancer are other risk factors for the disease. It is usually detected at a late stage when it is symptomatic and when the prognosis is very poor, so detection at an earlier stage can reduce lung cancer mortality. Medical screening programmes play an important role in primary care but they must meet a number of criteria and their benefits must outweigh their harms. In order for current screening to be effective, uptake must be high. Implementation of lung cancer screening is not widespread presently but its use is set to increase. Despite robust evidence from the USA showing CT lung cancer screening reduces mortality, the results of European trials are yet to be published and there is still some debate about the optimal approach to screening implementation in the UK and Europe. The use of biomarker tests could enable a more favourable benefit-harm balance for a lung cancer screening programme. A study aiming to evaluate one such test is the context for the research reported in the thesis.

1.2 Cancer

Cancer is a generic term for a group of diseases involving the growth of abnormal cells that can affect any part of the body. Cancer is a major cause of morbidity and mortality in all countries and regions, with 14 million new cases of cancer and 8.8 million cancer-related deaths annually worldwide.[1] This represents 15.6% of deaths globally, making cancer the second leading cause of death, behind cardiovascular disease.[2] Lifetime risk of cancer in men and women born in 1960 in Great Britain is 53.5% and 47.5% respectively.[3] The lifetime risk is thought to be higher than this in those born after 1960 due to increases in life expectancy. The implication is that more than half of individuals born since 1960 in Great Britain will develop cancer in their lifetime.[3] As we benefit from increases in longevity, cancer is becoming a proportionately greater threat to continued health.

It is estimated that health care contributes to as little as 10% of a person's health.[4] To influence factors outside the health and care system that define the other 90%, we must look to opportunities for prevention. Cancer is a preventable disease because it can be caused by modifiable environmental factors as well as internal factors. The proportion of UK cancer cases that are preventable is 42%.[5] Tobacco smoking is the greatest modifiable risk factor for cancer because it significantly increases the risk of a large number

of cancer types.[6] Overweight and obesity are the second greatest modifiable population-level risk factor because they are highly prevalent in the UK population and also associated with many cancer types.[6] Reducing prevalence of tobacco smoking and overweight and obesity are therefore key strategies to reduce the cancer burden. Beyond prevention, other target areas include earlier and faster diagnosis, improving quality of care and treatment and achieving a better quality of life in cancer patients.[7, 8]

1.3 Lung cancer

Lung cancer is a malignant tumour in the lung characterised by uncontrolled cell growth. The lung is the most common site of cancer leading to death, accounting for approximately 1.6 million deaths a year globally.[1] This is ahead of cancer of the liver at approximately 745,000 deaths, meaning lung cancer causes more than twice the number of deaths than any other site of cancer. Lung cancer is the most common type of cancer in men and the third most common in women. In the UK there are approximately 46,400 new cases of lung cancer and 35,900 lung cancer deaths a year.[9] It is the most common cause of cancer-related mortality in the UK, responsible for more than a fifth of all cancer deaths.[10] In Scotland, unlike other parts of the UK, lung cancer is the most common type of cancer across the population as a whole, with

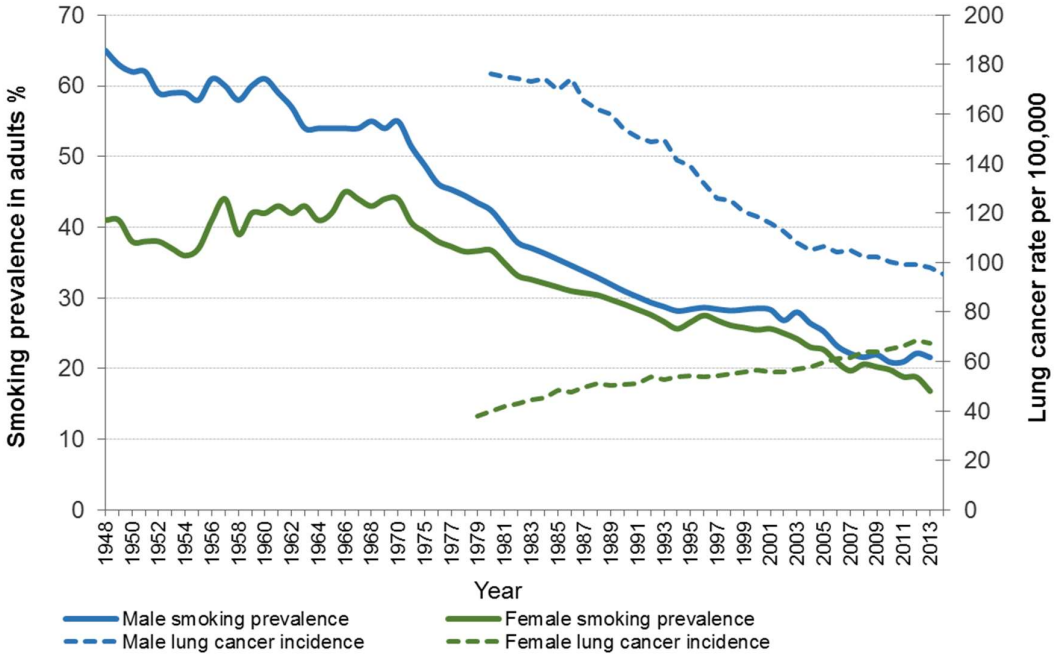
5,045 diagnoses in 2016.[11] The estimated annual cost of lung cancer to the UK economy is £2.4 billion.[12]

Lung cancer is distinct from other cancers in that a much higher proportion of cases (89%) are known to be caused by lifestyle factors.[5] The single biggest risk factor for lung cancer is tobacco smoking, which causes 83% of all cases.[13] Rates of lung cancer in Scotland are among the highest in the world, reflecting a history of high smoking prevalence.[11] Smoking, and therefore lung cancer, tends to be strongly associated in the UK with greater socioeconomic deprivation.[9, 14] In Scotland lung cancer incidence and mortality are three times higher in the most deprived areas than the least deprived.[15] Other risk factors for lung cancer are chronic obstructive pulmonary disease (COPD) and exposure to second-hand smoke, radon gas, asbestos and other carcinogens. Risk of lung cancer increases with age: approximately two thirds of people diagnosed with the disease are over 65 years old, while under-45 year olds account for less than 2% of cases.[16] There is a genetic component to the disease and people with a first degree relative (parent, sibling or child) with lung cancer are at increased risk.[17]

Trends in lung cancer incidence track historical trends in smoking prevalence.[18] Because historical smoking prevalence peaked earlier in men than in women, lung cancer incidence in men has

subsequently been decreasing for several decades, but has been increasing over the same period in women (Figure 1.1). In 2016 more women than men in Scotland were diagnosed with lung cancer, the first time this has been observed.[11]

Figure 1.1 Trends in lung cancer incidence and smoking prevalence by sex in Great Britain 1948-2013



Source: Cancer Research UK[9]

Approximately 15% of lung cancers are small cell lung cancer and 85% are non-small cell lung cancer. The distinction refers to the size of the cancer cells and has implications for how the cancer behaves and is best treated. Small cell lung cancer is rare in individuals who have never smoked, whereas non-small cell lung

cancer is often caused by smoking. 'Staging' refers to the categorisation of a lung cancer case based on the advancement of the cancer, i.e. its size and location. At stage 1 the cancer is small and has not spread, whereas at stage 4 the cancer is in both lungs or has spread to other organs.

Despite advances in lung cancer treatment over the last decade, the prognosis for lung cancer patients is very poor. Approximately 32% of people diagnosed with lung cancer in England and Wales survive the disease for one year or more, 10% for five years or more and 5% for ten years or more.[9] This is because it is typically diagnosed at an advanced stage, often because it is asymptomatic during earlier stages, or its symptoms (persistent cough, persistent chest infections, coughing up blood, ache or pain when breathing or coughing, persistent breathlessness, persistent tiredness or lack of energy, loss of appetite or unexplained weight loss)[19] can be overlooked as a less serious complaint. Consequently, the best prognosis for lung cancer is related to early diagnosis. One year survival rates are 83% when diagnosed at stage 1 and 17% when diagnosed at stage 4.[20] Five-year survival rates are 35% when diagnosed at stage 1, 6% at stage 3, with no reliable figures for stage 4 because the numbers surviving are small.[9] Achieving improvements in the early detection and diagnosis of lung cancer is therefore a priority in public health.

At the time of diagnosis more than 90% of lung cancer patients are symptomatic, experiencing two to three symptoms on average,[21] and are often symptomatic for several months before presenting for medical attention.[22-24] This has been partly attributed to a lack of awareness of the significance of the symptoms.[22, 24] One strategy in this area is therefore to raise awareness of the symptoms of lung cancer and encourage symptomatic individuals to seek medical help.[25]

There can also be service-related delays in lung cancer diagnosis. Many patients will visit their general practitioner more than once before referral for further investigation.[23]

Another strategy, screening, seeks to detect lung cancer in individuals at an earlier stage before it is symptomatic.

1.4 Medical screening

1.4.1 Definition of screening

The term 'screening' in a medical context refers to an organised programme of testing for a disease. The purpose of screening is to reduce risk of the disease or provide information about risk. Screening aims to detect the disease at an early stage before the development of symptoms. An initial test is offered systematically to a group of people who are asymptomatic but often at increased risk of the disease. The test provides a positive or negative result,

although screening test results can sometimes be inconclusive. In those testing positive there are usually subsequent investigations and diagnostic testing.[26]

The UK National Screening Committee is the co-ordinating body of screening in the UK, overseeing policy and supporting implementation. Their definition of screening is:

> "A public health service in which members of a defined population who do not necessarily perceive they are at risk of or already affected by a disease or complications are asked a question or offered a test, to identify those individuals who are more likely to be helped than harmed by further tests or treatments to reduce the risk of a disease or its complications."[27]

1.4.2 Role of screening

Screening is a secondary prevention strategy, in that it usually aims to detect a disease early and improve prognosis, rather than prevent the disease occurring. It should be thought about and delivered as an organised system rather than application of an ad hoc test.[26] It is commonly targeted at groups with known risk factors, which can include non-modifiable factors such as age or family history of the disease, and modifiable risk factors such as one's behaviour and environment. By raising awareness of

particular types of cancers and their symptoms, cancer screening can complement symptom awareness initiatives.[28]

1.4.3 Screening programme criteria

A number of criteria must be met by a screening programme. They relate to the condition being screened for, the screening test, the treatment, and the screening programme.[29] Importantly, there must be high quality evidence from randomised controlled trials (RCTs) that the screening programme is effective at reducing mortality or morbidity. The programme should offer benefits which outweigh the harms. The opportunity cost of the screening programme should be balanced in relation to financial expenditure on other medical care. This can include an assessment that the screening programme is cost-effective. Individuals should be allowed to make an informed choice about whether or not to participate by the provision of information explaining the potential consequences. It must be demonstrated that cases detected by screening would have developed serious adverse consequences, that earlier detection improves the outcome, and that the programme can be organised to a standard of consistent high quality.[26] It is the balance of the above factors that lead to a decision to implement a population-based screening programme. For example, mammography screening for breast cancer is estimated to reduce breast cancer mortality by 20% based on high quality evidence from RCTs and it is estimated the benefits

outweigh the harms.[30] Individuals invited to breast cancer screening in the UK are provided with balanced information about the potential benefits and harms and are encouraged to make an informed choice about whether or not to be screened.[31]

Screening programme outcomes include measures of test performance: sensitivity, or the ability of the test to identify cases as cases, and specificity, or the ability of the test to identify non-cases as non-cases.

In general, for maximum benefit from a screening programme there must be high uptake of screening, high test sensitivity, the test method must be acceptable to the population and high uptake rates for subsequent intervention. For minimum harm from a screening programme there must be high specificity and informed choice about participation. In practice there is commonly a trade-off between maximising benefits and minimising harms.

1.5 Lung cancer screening

1.5.1 Benefits and harms of lung cancer screening

Potential benefits of lung cancer screening are a reduction in lung cancer mortality, a reduction in overall mortality, greater awareness of the disease and its symptoms, lower costs to the health service, emotional reassurance, smoking abstinence and less heavy smoking. Potential harms of lung cancer screening are

overdiagnosis (diagnosis of lung cancer that would not have caused a problem during the patient's lifetime e.g. slow growing tumours), overtreatment (leading to greater costs, associated risks and complications of diagnostic procedures), emotional distress and continued and/or heavier smoking.[32-35] A potential effect which cannot as easily be categorised as a benefit or harm is an increase or decrease in health care utilisation following screening, including a change in attendance at future screening.[34, 36]

1.5.2 Lung cancer screening studies

Evaluation studies of the relative benefits and harms of different methods of screening for lung cancer have been conducted over a period of several decades, primarily in terms of their effectiveness at detecting the disease early and reducing lung cancer mortality.

1.5.2.1 Chest X-ray

The first large prospective trial using chest X-ray (6-monthly) as a screening tool was conducted in the UK in the 1960's. Detection at an early stage was significantly more likely in the screened group than the unscreened group but there was no significant difference in lung cancer mortality between groups at five years.[37] More recently, the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial was conducted in the USA with 154,901 participants. It reported no reduction in lung cancer mortality after

13 years with annual chest X-ray screening for four years compared to usual care.[38]

Four RCTs combined chest X-ray with sputum cytology (the examination under a microscope of mucus from the lungs to check for abnormal cells) as a screening method. For example, the Mayo Lung Project randomised individuals to 4-monthly screening with this method or usual care.[39] The studies found no reduction in lung cancer mortality in the screened arms compared to the unscreened arms over periods of up to 20 years.[40-43] A systematic review and meta-analysis of screening methods to reduce lung cancer mortality concluded the available evidence does not support the use of chest X-ray or sputum cytology.[44]

1.5.2.2 Low dose computed tomography

Pilot studies of low dose computed tomography (CT) scans of the chest as a lung cancer screening method were conducted in Japan and the USA.[45, 46] Although not designed to demonstrate mortality reduction, they established the feasibility of CT screening and its relative superiority to chest X-ray in terms of greater sensitivity and ability to detect smaller lung tumours. There were subsequently a number of other studies of CT screening to detect lung cancer: in Japan,[47] The New York Early Lung Cancer Action Project (ELCAP),[45] the International ELCAP,[48] and the Mayo Clinic

study.[49] In these studies, 61-90% of lung cancers detected were stage 1.

In 2002 the USA National Lung Screening Trial (NLST) began, randomising individuals to three annual screens by either chest CT or chest X-ray. There were 53,454 participants, aged 55-74 with at least a 30 pack-year smoking history. A pack-year is defined as the equivalent of smoking 20 cigarettes (1 pack) per day for one year. Twenty pack-years is thus the equivalent of having smoked 20 cigarettes per day for 20 years, or 40 cigarettes per day for 10 years, and so on. As a large RCT, a design that overcomes important biases when evaluating outcomes from screening,[26] it was designed to provide a definitive conclusion about the effectiveness of CT screening for lung cancer. The NLST reported 247 lung cancer deaths per 100,000 person-years in the CT arm and 309 deaths per 100,000 person-years in the chest X-ray arm. This is a relative reduction in lung cancer mortality of 20% (95% confidence interval (CI) 6.8-26.7), and reduction in all-cause mortality of 6.7% (95% CI 1.2-13.6), with CT compared to chest X-ray.[50]

In Europe a number of RCTs have evaluated CT lung cancer screening. Two, in France (DEPISCAN) and Germany (LUSI), compared CT to chest X-ray,[51, 52] and others in Denmark (Danish Lung Cancer Screening Trial (DLCST)), the UK (UK Lung Cancer

Screening pilot trial (UKLS)), Italy (DANTE; MILD; ITALUNG), and the largest in the Netherlands and Belgium (Dutch-Belgian Lung Cancer Screening Trial (NELSON)), compared CT to usual care.[53-58] Two of these studies (DLCST; DANTE) were synthesised with the NLST in a meta-analysis.[32] It reported a statistically significant reduction in lung cancer mortality, odds ratio (OR) 0.82 (95% CI 0.72-0.94), and no significant reduction in overall mortality, OR 0.99 (95% CI 0.92-1.06).

Smoking history eligibility criteria for studies varied: ≥15 pack-years for DEPISCAN and LUSI; 15-18.75 pack-years for NELSON (>15 cigarettes a day for >25 years or >10 cigarettes a day for >30 years); UKLS used a risk model that included smoking years but not pack-years; and for other European studies it was ≥20 pack-years.

Despite robust findings of effectiveness from the NLST and synthesis of its findings with some European trials, a national CT lung cancer screening programme has significant cost implications for a publicly funded health service. Results from other studies are awaited before decisions are made about lung cancer screening in European countries. Pooled analysis of European trials is planned to generate European mortality data for a better informed cost benefit analysis.[56, 59] Meanwhile, RCTs of CT screening for lung cancer are

being conducted in other parts of the world, including China and Australia.[60, 61]

Unanswered questions about CT lung cancer screening include how best to define and identify those at increased risk of the disease, the screening interval (time between screening rounds) to achieve an optimal balance between mortality reduction and cost-effectiveness, and how to minimise overdiagnosis, overtreatment and other potential harms of screening.[62, 63] The sensitivity of CT lung cancer screening was >90% across the three NLST screening rounds and the specificity ranged from 73% to 84%.[50] In the NLST CT arm 39% of participants had at least one positive screening result from the three screening rounds, 96% of which were false positives.[50] This caused radiation exposure from additional imaging, harmful diagnostic follow-up, increased costs and may have resulted in short-term adverse psychological outcomes, although the NLST reported no change in anxiety or health related quality of life one month after a false positive result.[64] Of lung cancers diagnosed in the NLST CT arm, the proportion estimated to represent overdiagnosis was 18.5%,[65] a significant harm of this screening method which co-exists with the reported benefits.

1.5.3 Lung cancer screening programmes

Subsequent to the NLST, in December 2013 CT screening for lung cancer received a 'B' rating from the U.S. Preventive Services Task

Force indicating a high certainty that the net benefit is moderate or a moderate certainty that the net benefit is moderate to substantial. Lung cancer screening is recommended in the USA for individuals aged 55-80 years with a 30 pack-year smoking history who currently smoke or quit less than 15 years ago.[66] This led to a decision by the Centers for Medicare and Medicaid Services in the USA to provide coverage for screening under the Medicare health insurance program.[67] The American College of Chest Physicians and the American Thoracic Society issued a policy statement to ensure quality, effectiveness, and safety are maintained in lung cancer screening.[68] CT screening for lung cancer is also recommended in Canada for individuals aged 55-74 years with a 30 pack-year smoking history who currently smoke or quit less than 15 years ago.[69] It is recommended in China for 50-74 year-olds with a 20 pack-year history who currently smoke or quit less than five years ago.[70]

1.5.4 Lung cancer screening uptake

Uptake of CT lung cancer screening has been low in the USA since it was recommended. Figures indicate its usage was unchanged from 2010-2015 and in 2015 only 262,700 were screened of 6.8 million smokers eligible.[71] Another study reported that there had been a small increase in its use over a similar period, but that this increase was observed in both those who were eligible and ineligible for screening (e.g. due to age or smoking history).[72]

Preliminary analysis suggests 141,000 were screened in 2016.[73] Consequently, there are concerns about overuse of CT lung cancer screening as well as concerns about slow uptake in those who are eligible. Quantitative and qualitative research has identified modifiable barriers to implementation of lung cancer screening in the USA, including issues of workload management and education of primary care providers.[74, 75] Uptake of cancer screening in a UK context is considered further in Chapter 3.

1.5.5 Lung cancer screening implementation in UK and Europe

At the time of writing, population-based lung cancer screening is not recommended in the UK[76] but the UK National Screening Committee is re-evaluating policy on CT lung cancer screening. Meanwhile, following a pilot project in Manchester in which 46 cases of lung cancer were detected, 80% of which were stage 1 or 2, a programme of CT lung cancer screening delivered in supermarket car parks is being expanded in the north of England.[77] The European Society of Radiology and the European Respiratory Society have recommended CT lung cancer screening in certain medical settings.[78] European position statements have suggested national CT lung cancer screening programmes are unavoidable and that there is sufficient evidence to start planning for them while the NELSON trial results are awaited.[79-81] However, there is a need to optimise screening by improving the selection of participants, the quality of imaging and its interpretation, the

management of screening findings and promoting smoking cessation. Without this work the balance of benefits and harms of CT lung cancer screening has been described as 'tenuous'.[82]

1.5.6 Biomarker screening tests

With development of new technologies and improvement in understanding of the cellular characteristics of cancer, recent approaches to screening have focused on biomarker tests. Such tests might offer the opportunity to detect cancer earlier than other screening methods, they could have higher sensitivity and specificity in detecting cancer and they could be quicker and cheaper to perform. Biomarker tests could complement a CT screening programme for lung cancer by permitting risk stratification for better targeting of CT, enabling a more favourable benefit-harm balance for a screening programme.[83] Biomarkers can be generated by cancer cells, the tumour microenvironment or the body's immune response to cancer (autoantibodies).[84] Potential biomarkers are tissue samples from the respiratory tract such as sputum, saliva and nasal/bronchial airway cells, while others are exhaled breath, urine, serum and blood.[85-88]

The LungSEARCH trial aims to assess whether a shift to early stage diagnosis of lung cancer can be demonstrated by annual screening of sputum samples for five years, or annual CT scans and autofluorescence bronchoscopy for those with an abnormal sputum

result, compared to a single chest X-ray at five years.[89] The trial recruited and randomised 1,568 current or former smokers with >20 pack-year history and mild or moderate COPD from ten centres in the UK. It was reported that 17% of sputum screens were abnormal in the initial round of screening.[90] Depending on the final results a larger trial could follow, designed to demonstrate a reduction in mortality through the use of this biomarker screening strategy.

Serum and blood tests for biomarkers appear another relatively simple and inexpensive method to assess risk of cancer. For example, a blood test to detect eight types of cancer, 'CancerSEEK', identifies DNA mutations and proteins released into the bloodstream by tumours. It can detect the disease with 70% specificity in patients already diagnosed with one of those types of cancer.[91] In five cancer types for which there are no screening tests available (ovary, liver, stomach, pancreas, oesophagus) specificity was 99% and sensitivity ranged from 69% to 98%. Sensitivity for lung cancer was 39% and for stage 1 lung cancer it was 43%.[91] This demonstrates the potential of biomarker blood tests to improve the way cancer is detected but its efficacy as a screening tool in asymptomatic groups has yet to be assessed.

Research at the University of Nottingham by Robertson and colleagues has led to the development and validation of a

biomarker blood test for the early detection of lung cancer.[92, 93] Early Cancer Detection Test - Lung (EarlyCDT-Lung) identifies the presence in blood of a panel of seven autoantibodies to tumour proteins. They are present at lower levels in healthy individuals and at higher levels in those who are at increased lung cancer risk or who have early stage lung cancer. They exist at all stages of lung cancer, and in both non-small cell and small cell lung cancers, providing an opportunity to detect the disease early. Screening of blood samples with EarlyCDT-Lung allows individuals to be stratified based on their risk, enabling subsequent diagnostic tests to be targeted to those at highest risk. The test has 41% sensitivity and 93% specificity,[92] and is owned and sold commercially by Oncimmune Limited.[94] The test could potentially form part of a more cost-effective and less harmful programme of population-based lung cancer screening than through the use of CT as a primary screening method.

1.6 Early Cancer Detection Test - Lung Cancer Scotland Study

A RCT commenced in 2012 to evaluate the effectiveness of EarlyCDT-Lung. The trial is called Early Cancer Detection Test - Lung Cancer Scotland (ECLS).[95] The primary research question addressed by ECLS is:

Does using EarlyCDT-Lung to identify those at high risk of lung cancer and any subsequent CT scanning reduce the incidence of stage 3 and 4 lung cancer or unclassified presentation at diagnosis compared with standard practice?

Secondary research questions include:

Is the use of EarlyCDT-Lung cost-effective compared to standard clinical practice?

What is the emotional impact of EarlyCDT-Lung?

What is the behavioural impact of EarlyCDT-Lung?

Does EarlyCDT-Lung improve clinical outcomes including cardiovascular disease, COPD and hospital stays?

ECLS provides the context for the research reported in the thesis and its methods are described further in Chapter 4.

In summary, there is high quality evidence that CT lung cancer screening can reduce lung cancer mortality but it can also cause harm. Work is needed to optimise approaches to lung cancer screening uptake and implementation to improve the balance of benefits and harms. The use of biomarker screening tests could allow cheaper and earlier detection of lung cancer. The effectiveness of such tests should be evaluated using RCTs in asymptomatic groups.

2 Behavioural background

2.1 Chapter summary

Smoking is the major cause of preventable mortality and morbidity. It is thought lung cancer screening might have a behavioural effect on subsequent tobacco use. This phenomenon is often described in terms of a teachable moment or false reassurance but more highly developed and defined models of health behaviour are best used to attempt to explain how this might happen.

Lung cancer screening could promote smoking cessation and continued abstinence, or conversely, could lead to fewer cessation attempts and heavier continued tobacco use. Controlled studies nested within RCTs of CT lung cancer screening have thus far reported either higher quit rates in screened groups or no effect of allocation to screening on smoking.[96-100] No studies to date have shown greater tobacco use after screening[96-100] but behavioural response to lung cancer screening methods other than CT have not been studied and negative test groups have often not been examined in detail.

The objectives of the thesis are to investigate (1) factors influencing individual decisions to attend cancer screening in the UK, (2) the impact of lung cancer screening on tobacco use and (3)

how lung cancer screening experiences affect individual decision-making about smoking.

2.2 Smoking

Smoking (the inhalation of smoke from tobacco leaves burnt in a cigarette or cigar) is the leading behavioural cause of premature death, directly causing more than 6 million deaths per year worldwide.[101] Tobacco smoke contains more than 7,000 chemicals, including hundreds that are toxic, about 70 that cause cancer and one, nicotine, that is highly addictive.[102] Smoking is causally linked to diseases of nearly all organs of the body. It causes cancer of the mouth, lips, throat, larynx, oesophagus, bladder, kidney, liver, stomach, pancreas, increases risk of cardiovascular disease and causes lung damage leading to COPD and pneumonia.[103] As highlighted in section 1.3, smoking is the greatest risk factor for lung cancer and reducing rates of smoking is a primary strategy to prevent the disease. Smoking causes inflammation, impairs the immune system and damages quality of life.[104] Exposure to second-hand smoke is causally linked to cancer and respiratory and cardiovascular diseases.[104] Most people who smoke want to stop[a] but this can be very difficult because smoking is both physically and psychologically addictive.[105] For many years tobacco

[a] The terms stopping smoking, smoking cessation and quitting are used interchangeably in the thesis.

companies were allowed relative freedom to exploit the addictive nature of tobacco for commercial gain. However, following decades of public health campaigns about the adverse effects of smoking, awareness of the health risks associated with the behaviour is high.[106] Comprehensive national tobacco control policies, such as tobacco duty increases, smoke-free legislation, mass media campaigns, combined with availability of National Health Service (NHS) smoking cessation support, all aim to reduce smoking prevalence and improve public health.[107, 108] The number of people making a quit attempt in Scottish NHS smoking cessation services more than halved in the five year period to 2017,[109] although this may be partly explained by rapid growth in the use of e-cigarettes during this time.[110] In 2016-7 £134,000 was spent on smoking cessation campaigns in Scotland compared to £588,000 in the previous year. Meanwhile, treatment of smoking-related disease is estimated to cost NHS Scotland up to £780 million a year.[111]

2.2.1 Smoking prevalence

The number of tobacco smokers worldwide in 2015 was more than 1.1 billion.[106] Smoking prevalence is declining in some regions of the world and increasing in others. In the UK the number of adult smokers in 2016 was approximately 7.6 million, representing 15.8% of the population.[112] Smoking rates have significantly declined in the UK over time and may still be declining according to the UK Annual Population Survey. For example, in Scotland 17.7%

of the adult population (aged 18 and over) were smokers in 2016, compared to 19.1% in the previous year.[112] There are disparities in smoking prevalence across groups characterised by ethnicity, education level, socioeconomic status, region of the UK and in those with or without mental health problems.[14, 113] For example, retail sales data show a consistently greater number of cigarettes consumed in Scotland than England and Wales.[114] Life expectancy can vary by 10.5 years depending on the deprivation level of the area of Scotland a baby is born in[115] and smoking prevalence in the most and least deprived areas is 35% and 11% respectively.[110] Smoking is the greatest behavioural contributor to continued socioeconomic health inequality.[116] The Scottish Government aims to create a 'tobacco-free generation' by 2034, defined as smoking prevalence in adults of 5% or less.[108] However, Scottish Health Survey figures differ to those of the Annual Population Survey, suggesting smoking prevalence (in those aged 16 and over) is unchanged at 21% since 2013.[110]

2.2.2 Smoking cessation

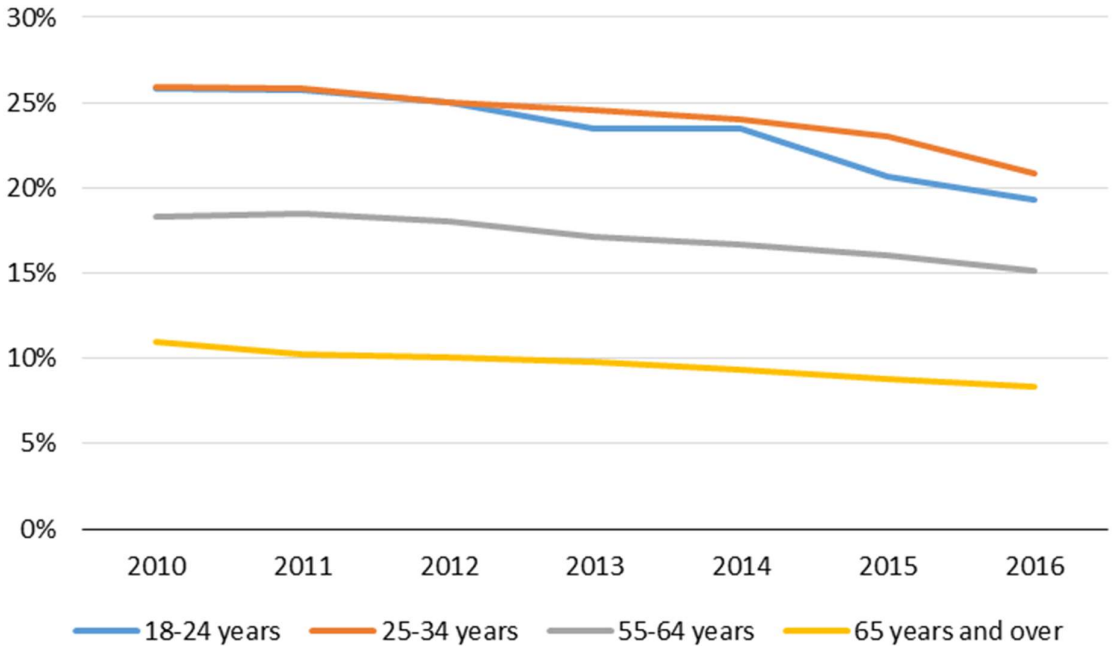
Abstinence from smoking usually follows an intention not to smoke any more cigarettes from a given point in time (quit attempt), cessation of smoking and subsequent resistance of urges to smoke.[105] Effective methods for promoting smoking cessation include brief physician advice,[117] behavioural support[118] and pharmacotherapy, such as nicotine replacement therapy and

varenicline (Champix/Chantix).[119] Cessation attempts that involve stopping completely, rather than reducing the number of cigarettes smoked, are more likely to be successful.[120] Number of cigarettes smoked per day, time to the first cigarette of the day and pre-attempt strength of urges to smoke have been found to predict success of quit attempts.[121] Belief in the harm caused by smoking predicts quit attempts but does not predict whether or not they are successful.[121]

2.2.3 Smoking in age groups eligible for lung cancer screening

Individuals eligible for lung cancer screening are typically in the age range 50-75 years. A proportion of this population group are considered middle-aged adults and others are older adults, usually defined as those aged 65 or over. Smoking prevalence in those aged 55-64 in the UK is 15.1% and in the over 65s it is 8.3%.[112] Although smoking prevalence has decreased in the UK in recent years, there have been steeper declines in younger than older adult age groups (Figure 2.1).

Figure 2.1 UK smoking prevalence in younger and older adult age groups, 2010-2016



Source: Annual Population Survey - Office for National Statistics[112]

There can be a perception that older adult smokers are 'hardened' smokers who are resistant to information about the risks of smoking and are unwilling to attempt to stop.[122] This can, however, risk conflating motivation to stop and ability to stop,[123] and there is evidence that older age is not associated with fewer quit attempts.[121] Predictors of smoking cessation in older adult smokers were found in one study to be older age, never being married, fewer cigarettes smoked per day, fewer years of smoking, and no history of myocardial infarction, stroke or cancer. Predictors of

smoking relapse were younger age, heavier smoking history and less time since quitting.[124]

The use of resources to promote smoking cessation in middle-aged and older age groups might appear logically to offer fewer long-term health benefits and less cost-effectiveness than their use to target younger age groups. However, there is strong evidence of health benefits of smoking cessation in older age.[125] Cessation in older smokers can lead to reduced mortality (2-4 additional years of life in adults over 65 years),[126] additional healthy life years[127] and reduced morbidity.[128] Being an ex-smoker or non-smoker is associated with slower decline in cognitive function and in ability to perform activities of daily living.[129, 130] Although the relative health risks associated with smoking status decline with older age, the absolute risk differences increase.[128]

The number of people in the UK population aged 65 years and over is projected to grow by 10.7 million from 2016-2046, an increase from 18% to 25% as a proportion of the population.[131] With an ageing population, the absolute number of smokers in older age groups may therefore rise over time even if smoking prevalence decreases. However, smoking behaviour may be strongly connected to specific life experiences, which may in older adults be increasingly influenced by secular smoking trends such as knowledge of associated health risks and changing social attitudes

to smoking.[132] Because trends in lung cancer incidence track historical smoking trends, it is unclear whether there will be future changes, and if so in which direction, in lung cancer incidence and in the number considered at increased risk due to smoking history. Regardless, smoking prevalence in older age groups is, in an ageing population, set to have an increasing influence on morbidity, quality of life and demand for health care services in the UK.

2.3 The relationship between lung cancer screening and smoking

Smoking history is the major risk factor for lung cancer and thus one of the eligibility criteria for screening. In the literature medical screening, and in particular lung cancer screening, is often described as having a potential impact on the smoking behaviour of participants.[133, 134]

2.3.1 Evidence of the impact of risk information on health behaviour

In 2003 a systematic review was published by Bankhead et al. of the impact of cholesterol, breast cancer and cervical cancer screening on health beliefs and health-promoting behaviours.[135] It was a comprehensive review with 561 included studies and it reported a narrative synthesis of results. There was inconsistent

evidence that cholesterol screening had an impact on smoking. However, the authors concluded that cholesterol screening had a positive impact on health behaviours: most studies reported an increase in healthier diet and exercise, and a reduction in weight and cholesterol levels, for those diagnosed with high or moderately high cholesterol levels. The review therefore provides evidence, mainly from studies of a cohort design, that screening results can promote health behaviour change, with an impact on objectively measured health outcomes directly relevant to the condition for which the individual is being screened. Breast cancer screening appeared to be associated with regular cervical screening, dental check-ups, seatbelt use, healthier diet, more exercise, less alcohol consumption and less smoking. However, study designs were weak and the review authors concluded the findings could have been a result of different health behaviours and beliefs in those who do and do not undergo screening. There was a complex association between cervical screening and health beliefs, based again on weak quality evidence, however the review reported greater perceived risk of cervical cancer in screening attenders compared to non-attenders. The strongest behavioural finding was that breast and cervical screening attenders are more likely to re-attend screening in the future than non-attenders.[135]

In 2011, RCTs reporting the effects of screening on health behaviour were systematically reviewed using a narrative

synthesis.[136] Outcomes considered were smoking, diet, exercise, alcohol consumption and adherence to healthy living guidelines. There were seven included studies: five on screening for risk factors (4 cardiovascular; 1 oesophageal cancer), one on screening for colorectal cancer and one on screening for hearing loss. In the hearing loss study, healthy living guidelines related to avoiding exposure to noise and using hearing protection. The review authors concluded screening for risk factors positively influences health behaviour but there were too few trials to draw conclusions about screening for health conditions.[136] The single cancer screening trial converted number of cigarettes smoked to a 6-point scale and found a reduction on the scale in both groups. However, there was a significantly greater reduction on the scale in unscreened individuals compared to those randomised to screening.[137] This indicates that randomisation to cancer screening may lead to false reassurance about the risks of smoking.

A 2017 overview of systematic reviews concluded there was some evidence personalised disease risk communication can promote smoking behaviour change.[138] This was based on nine systematic reviews, three of which reported effects on cessation in the short-term. However, there was no support for long-term cessation. The findings were based predominantly on reviews of the effects of testing for genetic vulnerability to smoking-related disease and visual feedback of medical imaging results.

Overall, there is very little high quality evidence that can tell us about the impact of screening on subsequent health behaviour.

2.3.2 Evidence of the impact of lung cancer screening on smoking

2.3.2.1 Randomisation to screening vs. no screening

Several of the lung cancer screening studies described in Chapter 1 have published smoking outcomes. This section summarises the evidence published to date in systematic reviews and primary studies. It then focuses in greater detail on controlled studies nested in RCTs to outline evidence of the causal effect of randomisation to lung cancer screening on smoking.

The most comprehensive review of evidence of the impact of lung cancer screening on smoking is available in a 2012 systematic review by Bach et al.[32] As part of an evaluation of the benefits and harms of CT screening for lung cancer they identified two RCTs (DLCST; NELSON) and five cohort studies (published 2001-2006) that assessed smoking outcomes. Based on the two RCTs they reported the relative effect of annual low-dose CT on smoking cessation compared to usual care was OR 0.95 (95% CI 0.79-1.14). The forest plot is reproduced in Figure 2.2. The quality of this evidence was classed as very low. This was due to risk of bias (absence of blinding and unclear concealment of allocation sequence), imprecision (statistically significant heterogeneity in results) and inconsistency. Another systematic review identified the

same seven studies.[139] The evidence identified by these two reviews leaves open the possibility of either a beneficial or harmful effect of screening on smoking behaviour. The confidence intervals are not wide but an effect size within these intervals in either direction, extrapolated to large groups in population-based lung cancer screening, could represent a substantial effect of screening.

In evidence available subsequent to the systematic review, the DLCST published five-year follow-up smoking data, reporting no statistically significant differences in annual smoking status.[97] In 2017 the UKLS, a third RCT after NELSON and DLCST, published smoking cessation outcomes. It reported significantly greater rates of cessation in the CT screened group than the unscreened control group. This effect was observed at two weeks (9.9% vs. 4.6%; OR 2.38, 95% CI 1.56 to 3.64) and at two years (15.4% vs. 10.2%; OR 1.60, 95% CI 1.17 to 2.18).[100]

Characteristics and findings of these three RCTs are presented in Table 2.1. There are important differences in study characteristics to consider. NELSON and UKLS only included baseline smokers whereas DLCST also included ex-smokers. NELSON only included males. DLCST reported quit rates, relapse rates and proportions of ex-smokers, NELSON reported smoking prevalence, whilst UKLS reported quit rates. NELSON reported the widest range of smoking variables including prolonged abstinence, increase or decrease in

smoking intensity and number of quit attempts. DLCST was the only study that biochemically verified smoking status. Length of follow-ups varied, the shortest being the UKLS 2-week follow-up and the longest the DLCST 5-year follow-up.

Findings presented in Table 2.1 are from analyses that used a 'worst-case approach', i.e. methods that assign a status of current smoker to non-responders instead of treating such data as missing. The merits of this approach are discussed later in the chapter.

Figure 2.2 Forest plot for smoking cessation following annual low dose CT screening for lung cancer (Bach et al. 2012).

Reproduced from Bach et al.[32]
Does not include UKLS[100]

Table 2.1 Characteristics and findings of RCTs reporting the impact of lung cancer screening on smoking

Study & screening	**Methods**	**Findings** *Screened vs. unscreened*	*Screening test result groups*
DLCST[96, 97] (Copenhagen, Denmark) CT at baseline then 4 annual CT scans. Positive (clinically significant findings) = follow-up CT scan 3 months later	**Participants** n = 4104 All trial participants eligible i.e. current and ex-smokers; positive and negative result 55% male **Measures** Quit smoking (yes/no) at least 4 weeks ago Verified using exhaled carbon monoxide levels T_1 = 1 year CT T_2 = 5 year CT Screened vs. control: Non-responders at T_1 treated as current smokers even if they were a non-smoker at baseline; non responders at T_2 treated as last known smoking status Positive vs. negative: Unclear how non-responders were treated	**Quit smoking** (of baseline smokers) T_1 Screened = 11.3% (of baseline smokers) Control = 10.4% p = 0.47 T_2 Not reported	T_1 Positive = 17.7% (of baseline smokers) Negative = 11.4% p=0.04 Positive = 4.7% (of baseline ex-smokers i.e. relapsed and quit) Negative = 10.6% p < 0.01 T_2 Not reported
		Ex-smokers T_1 Not reported T_2 Screened = 42.1% Control = 39.4% p = 0.075	Not reported
		Relapsed T_1 Screened = 16.7% Control = 20.7% p = 0.11 T_2 Not reported	Not reported

NELSON[98, 99] (7 districts in the Netherlands + 14 municipalities around Leuven, Belgium) CT at baseline, 1 year + 3 years vs. no screening Indeterminate baseline result = follow-up scan at 3 months Positive result = referral to chest physician for workup and diagnosis	**Participants** n = 1084 (random subgroup of NELSON first recruitment period) n = 838 for test result comparison Baseline smokers (smoked in last 7 days) Negative or indeterminate result 100% male 46% 'low' education level **Measures** Self-report Smoked in last 7 days (yes/no) Average no. cigarettes smoked per day (categorised and recoded at follow-up as increase/decrease/ stable) Smoked during last 24hrs (yes/no) Smoked during last 7days (yes/no) Currently attempting to quit (yes/no) Smoked since quit date (not at all/1-5 cigarettes/>5 cigarettes)	**Smoking 7-day abstinence** Screened = 13.7% Control = 15.5% p = 0.38	Negative = 10.4% Indeterminate = 12.2% p = 0.39
		Prolonged smoking abstinence (smoked <5 cigarettes since 2 weeks after a quit date) Screened = 13.1% Control = 14.9% p = 0.35	Negative = 8.9% Indeterminate = 11.5% p = 0.19
		Continued smoking abstinence (smoked <5 cigarettes since a quit date) Screened = 12.6% Control = 14.6% p = 0.30	Negative = 8.9% Indeterminate = 11.2% p = 0.23
		Cigarettes per day Not reported	(mean, SD) Negative = 20, 13 Indeterminate = 20, 12 p = 0.37
		Reduced smoking intensity Screened = 53.1% Control = 53.8% p = 0.23	Negative = 51.8% Indeterminate = 55.0% p value not reported
		Increased smoking intensity Screened = 17.7% Control = 13.8% p value not reported	Negative = 18.4% Indeterminate = 14.7% p value not reported

	Smoked since 2 weeks after quit date (not at all/1-5 cigarettes/>5 cigarettes) T_1 = single mailshot ~2.2yrs Non-responders at follow-up treated as current smokers	**Stable smoking intensity** Screened = 29.2% Control = 32.4% p value not reported	 Negative = 29.7% Indeterminate = 30.3% p value not reported
		Number of quit attempts (median, IQR) Screened = 1, 2 Control = 1, 2 p = 0.47	 (mean, SD) Negative = 1.5, 2.0 Indeterminate = 1.9, 2.7 p = 0.016
UKLS[100] **(Liverpool and Cambridge, UK)** Single low-dose CT vs. no screening. Abnormal scan = repeat scan in 3 or 12 months, or referral due to a major lung abnormality and significant incidental findings.	**Participants** n = 1546 Baseline smokers 70% male 47% from 2 most deprived quintiles **Measures** Self-report Quit smoking since joining trial (yes/no) T_1 = 2 weeks after test result letter or assignment to control group T_2 = single mailshot ~2yrs Non-responders at follow-up treated as current smokers	**Quit smoking** (OR, (95% CI)) *Screened vs. unscreened:* T_1 = 2.38 (1.56 to 3.64) T_2 = 1.60 (1.17 to 2.18)	 *Negative vs. control:* T_1 = 1.78 (1.04 to 3.05) T_2 = 0.90 (0.58 to 1.40) *Abnormal vs. control:* T_1 = 2.85 (1.79 to 4.53) T_2 = 2.29 (1.62 to 3.22)

As there are currently only three RCTs contributing to the evidence base it is useful to consider whether studies of a cohort design can tell us anything further about the impact of lung cancer screening on smoking.

Smoking outcomes from two NLST cohorts have been published. NLST arms were each screened using different methods and these cohorts both included participants from both arms. In the first study, 430 participants reported their smoking status at baseline and at one year ("Do you smoke cigarettes now?").[140] Approximately 51% of the cohort were smokers at baseline. At the 1-year follow-up 9.7% of participants had quit and 6.6% had relapsed. In the second study, 8,358 current smokers at baseline reported their smoking status every six months for five years.[141] The proportions not smoking (7-day point prevalent abstinence) were 11.6% at one year, 13.4% at two years and 11.9% at five years.

Two other large cohort studies to be considered were part of the ELCAP and Mayo CT study (Mayo). ELCAP found 35% of baseline smokers reported 30-day smoking point abstinence at at least one follow-up over a six year period, and 29% reported prolonged abstinence (abstinent for at least one year and in all subsequent reports).[142] Mayo showed a single CT screen for lung cancer in

baseline smokers was associated with a 14% abstinence rate at one year.[143]

These cohort studies show us the range of abstinence rates that have been observed after CT lung screening but they cannot imply causality and their quit rates have not been compared with age-sex specific national background quit rates.

Smokers who participate in screening trials, including control group smokers, are thought to be a more motivated group who may be more likely than smokers in the general population to be planning to quit.[96, 144] Consequently, behavioural studies nested in screening trials probably underestimate the effect of screening participation on smoking. Such studies can tell us about the behavioural effect of randomisation to screening or control groups but not necessarily the behavioural effect of screening participation or implementation.

The evidence outlined thus far can be summarised as follows:

1. Lung cancer screening using CT scans may promote smoking cessation but the evidence appears to be conflicting, based on 3 RCTs (DLCST; NELSON; UKLS) supplemented by large cohort studies (e.g. NLST).
2. Lung cancer screening using CT scans in the UK may promote smoking cessation and long-term abstinence, based on a single RCT (UKLS).

3. There is no published evidence about the impact on smoking of screening for early lung cancer detection using biomarkers.

2.3.2.2 Lung cancer screening test results

Slatore et al. conducted a systematic review in 2013 that included a synthesis of evidence of the effect of CT lung cancer screening test result on smoking rates.[139] They identified two RCTs (DLCST; NELSON) and three cohort studies (ELCAP; Mayo; Pittsburgh Lung Screening Study). Reports of two separate ELCAP cohorts contributed to the review. Studies considered the effect of CT scan results that were concerning but not diagnostic for lung cancer (positive; abnormal; indeterminate) compared to normal or negative results. Test results indicating concern for lung cancer were associated with increased abstinence from smoking. A meta-analysis was not possible due to heterogeneity of the measures of smoking behaviour. Findings from DLCST and NELSON test result groups are shown in Table 2.1.

Further evidence is provided by UKLS findings published since the Slatore review (Table 2.1).[100] It compared screening test result groups to the unscreened arm, allowing an assessment of the impact of CT screening test results compared to no screening. Test results requiring additional clinical investigation had a significant effect on smoking cessation compared to controls in the short-

term, OR 2.85 (95% CI 1.79-4.53), and long-term, OR 2.29 (95% CI 1.62-3.22). Negative test results were not associated with significantly greater likelihood of smoking cessation in the short-term, p = 0.09, or long-term, p = 0.07. This finding is important because it addresses the question of potential harm caused in negative test groups. It suggests such harm is not experienced, however the authors advise caution because those who volunteered to participate in the trial may have already been more motivated to quit.[100] There is also the problem in utilising smoking status as an outcome that benefits may be easier to detect than harms in individuals who currently smoke. For example, a smoker who experiences a benefit may change their smoking status by quitting. A smoker who experiences harm may not change their smoking status but could change more subtly by smoking more heavily. This highlights the importance of measuring dimensions of tobacco use other than smoking status, that are sensitive to adverse smoking behaviour change in existing smokers.

Other evidence suggests that specific CT findings, such as nodules >4mm or presence of emphysema, may be associated with greater likelihood of smoking cessation compared to scan results without these findings.[145]

In summary, there is evidence that positive lung cancer screening test results are associated with greater quit rates. The limited

available evidence indicates that negative test results do not lead to lower likelihood of quitting. There is an absence of evidence of the association between negative test results and heavier continued smoking.

2.3.3 Evidence of the impact of lung cancer screening on other psychological outcomes

NLST reported perceived risk of lung cancer and smoking-related disease, knowledge of smoking risks, self-efficacy to quit or remain abstinent, perceived benefits of quitting, perceived severity, and worry about lung cancer and smoking-related disease.[140] Questionnaires were based on constructs from different health behaviour theories.[146] Risk perceptions and other intermediary determinants of smoking behaviour did not change significantly from baseline to the 12-month follow-up and did not differ significantly by screening test result. Changes in perceived risk of smoking-related disease were not associated with changes in smoking status at the 12-month follow-up. Risk perceptions were associated with intention to quit or remain abstinent at baseline but not at follow-up.[140] The authors concluded that there was no sustained impact on psychological outcomes but acknowledged that their study could not have detected short-term post-screening changes.

Motivation or readiness to quit was reported by three studies. In baseline smokers in DLCST motivation to quit was a significant predictor of smoking status at the 1-year follow-up.[96] Readiness to quit smoking was measured in a NLST participant sample both before screening and one month after receipt of test result. It found that in one sample of smokers there was a significant change with 32% becoming more ready to quit and 11% less ready.[147] Becoming more ready to quit was significantly more likely among those with abnormal test results. It appears that individuals who undergo CT screening for lung cancer experience increased motivation or readiness to quit.

Most research on psychological responses to screening has focused on emotional outcomes. UKLS reported a small but significant post-screening effect of lung cancer screening on Cancer Worry Scale scores in those whose scores had been low at baseline.[148] There was no significant short-term effect of screening on cancer worry in those whose scores had been high at baseline, or on short-term general anxiety or depression. At a longer-term follow-up (up to two years) there was a small but significant beneficial effect of screening on anxiety and depression scores but no effect on lung cancer worry. DLCST and NELSON both found no effect of screening on a number of psychosocial outcomes at one and two years respectively.[149-151] Short-term adverse effects have been reported in those who receive an abnormal screening test

result.[152-154] The NELSON trial reported poorer quality of life and increased anxiety and cancer distress at two months in recipients of an indeterminate scan result.[154] The NLST reported no significant differences between those receiving abnormal and normal test results in anxiety and health-related quality of life at one and six months.[64] Studies have shown lung cancer screening can have a short-term effect on emotional outcomes but no effect in the long-term. A preliminary examination of ECLS positive and negative test result groups found statistically significant differences in lung cancer worry, affect, avoidance, intrusion and health anxiety at different time points in the six months after screening.[155]

2.3.4 Knowledge gap

There has been only one previous UK study of the impact of lung cancer screening on smoking and there is currently a limited body of evidence from other countries. Most studies have not measured short-term changes in tobacco use in the weeks and months immediately after screening. There is no evidence of the impact of a biomarker lung cancer screening test, or of biomarker screening test results, on subsequent tobacco use.

It is unclear whether negative lung cancer screening test results lead to adverse and potentially harmful behaviour change. Most studies have not compared negative test groups to unscreened control groups to explore this. They have usually measured a

limited range of outcomes that might be insensitive to adverse smoking behaviour change in existing smokers. In practice, most screening test results are negative so it is important to address this evidence gap.

The behavioural impact of lung cancer screening should be studied in order to evaluate the overall benefits and harms of screening. The effectiveness of future lung cancer screening programmes may greatly depend on their ability to promote smoking cessation.[133, 156, 157] If lung cancer screening promotes smoking cessation it can provide both primary prevention of smoking-related disease and secondary prevention of lung cancer, meaning screening could be more effective at reducing mortality than otherwise estimated. Conversely, if lung cancer screening promotes smoking it might do more harm than good. As EarlyCDT-Lung is a novel test and has not previously been evaluated in large patient groups, behavioural responses to undergoing the test are unknown.

It is important to not just measure this relationship but to attempt to fully understand it. Whatever the impact may be, lung cancer screening in practice is becoming more widespread and there is an urgent need to understand what it is like for smokers who are screened. Smoking cessation interventions integrated in lung cancer screening programmes are widely advocated but as yet there is little evidence on how these should be delivered.[158-160]

2.3.5 Teachable moment

An impact of lung cancer screening on smoking that increases motivation to quit smoking is usually described in terms of a teachable moment.[133, 143, 144, 147, 161] An impact that has the opposite effect on smoking, i.e. reduces motivation to quit and promotes continued heavier smoking or relapse, has been described in terms of false reassurance,[140] optimistic bias,[162] a certificate of health effect[163] and a license to smoke.[133, 144]

The term 'teachable moment' is usually used to describe a naturally occurring life transition or health event thought to motivate individuals to spontaneously adopt risk-reducing health behaviour.[164] There are a number of health events that are likely to represent a teachable moment for health behaviour change, such as health care visits, hospitalisation, pregnancy, illness, diagnosis of a disease, or notification of test results.[164] For example, in smokers undergoing a coronary artery bypass graft, 51% were abstinent from smoking after one year and 44% after five years, indicating quit rates substantially higher than in the background population.[165] The idea that such events can provide an opportunity for more effective health promotion, at a time when motivation to change one's behaviour may be temporarily increased, holds much appeal. However, the teachable moment is poorly developed conceptually and there is no consensus about its essential components.[166] It is usually used in literature to refer simply to an

opportunity, sometimes as a result of a behavioural cue. Furthermore, contexts that promote behaviour change are sometimes retrospectively labelled a teachable moment.[166]

Rather than the use of loosely defined concepts such as teachable moments and false reassurance, theoretical understanding of the relationship between lung cancer screening and smoking behaviour should consider established and well-defined models of health behaviour, some of which incorporate a cue to action that can represent screening participation or receipt of a screening test result. Health behaviour models can also be useful in understanding cancer screening uptake behaviour.

2.4 Health behaviour theories

In this section models of health behaviour are presented that can provide a theoretical grounding for the study of behavioural responses to lung cancer screening. The mechanisms involved in overcoming a psychological and physical addiction, as is usually required in smoking cessation, involve cognitive, emotional and physiological processes to achieve sustained behaviour change.[167] Similarly, behavioural responses to a screening invitation can involve a complex process involving cognitive, social, emotional, cultural, environmental and economic factors. It is worthwhile then to consider social cognition models of health behaviour, meaning

those that identify intermediary social and cognitive determinants of behaviour. These factors and their relationships can help explain individual differences in behavioural response and, unlike sociodemographic characteristics that can influence behaviour, are amenable to change.

Five models are presented below and were chosen because they were developed, and are commonly used, in relation to either screening uptake, tobacco use or behavioural responses to risk information. In combination they provide a comprehensive theoretical grounding for understanding behavioural responses to lung cancer screening.

2.4.1 Health belief model

The health belief model (HBM) was originally developed in the context of explaining screening uptake behaviour.{Rosenstock, 1988 #687}{Rosenstock, 1974 #237} The key components and constructs of the HBM that are said to contribute to behaviour are:

- Perceived susceptibility - subjective evaluation of the risk the individual is at from an event or condition;
- Perceived severity - subjective evaluation of the significance of the consequences associated with the event or condition;
- Perceived threat - the product of severity and susceptibility;

- Perceived benefits - subjective evaluation of the positive outcomes of a health behaviour to compensate for a perceived threat;
- Perceived barriers - subjective evaluation of negatively valued attributes of performing the health behaviour, or overcoming anticipated barriers to performing it;
- Self-efficacy - belief in one's ability to perform the behaviour;
- Expectations - the product of perceived benefits, barriers and self-efficacy;
- Cues to action - reminders or prompts to take actions consistent with intentions to perform a behaviour.

Conceptualisations of the teachable moment and false reassurance described in section 2.3 often rely heavily on the HBM.[146] This is because the model emphasises cues to action, which are said to influence the perceived threat of an adverse outcome and may prompt a change in behaviour. For example, a cue to action such as lung cancer screening could prompt a behaviour in an individual, such as a smoking cessation attempt, particularly if they perceive that the threat of smoking-related disease is serious, that they are at risk, they are confident that they could attempt to quit and they believe that attempting to quit would be beneficial. Systematic reviews and meta-analyses suggest HBM components have small to medium correlations with behaviour.[168, 169] For preventive behaviour such as attending screening, percentages of variance in

behaviour explained by HBM components are: severity 18%; susceptibility 33%; benefits 34%; barriers 13%.[170] There does not appear to be any published research that has used the model as a basis for smoking cessation.[167] Common criticisms of this model include a lack of ability to explain habitual behaviour, an absence of perceived benefits of not adopting the healthy behaviour (e.g. enjoyment of continued smoking) and a lack of clarity about the hypothesised relationships between components.[171, 172]

2.4.2 Theory of planned behaviour

The theory of planned behaviour (TPB) assumes that behaviour is the result of intentions to perform that behaviour. Intentions result from:

- Attitudes;
- Subjective norms;
- Perceived behavioural control.

Each of these respective components is influenced by specific beliefs:

- Behavioural beliefs - a) the likelihood that a behaviour will promote a given outcome and b) evaluating the desirability or undesirability of the outcome;
- Normative beliefs - a) whether important others are believed to think the behaviour should be performed and b) the

degree to which the individual wants to comply with the important other;

- Control beliefs - a) beliefs about external factors facilitating or inhibiting the behaviour and b) self-efficacy, the individual's self-confidence to perform the behaviour.

Evidence suggests that the TPB can predict 27% of variance in behaviour, and 39% of variance in intentions.[173] A meta-analysis of TPB constructs in relation to screening attendance found attitudes (0.51), subjective norms (0.41) and perceived behavioural control (0.46) had medium to large-sized correlations with intention, while perceived behavioural control (0.19) and intention (0.42) had small to medium-sized relationships with attendance.[174] The TPB is also considered useful in understanding smoking behaviour: smoking intentions have a medium-sized correlation with behaviour (0.30), perceived behavioural control has a smaller but important association with behaviour (-0.20), and attitudes (0.16), subjective norms (0.20) and perceived behavioural control (-0.24) have small but important correlations with intentions.[175] The TPB is not considered useful as a basis for intervention design to promote smoking cessation.[167, 176] It is valuable, however, in explaining and understanding intermediary influences on smoking behaviour, such as attitudes, subjective norms, perceived behavioural control and intentions in relation to smoking. These components can be measured to observe and explore social cognitive variables that

form a framework within which health behaviour is generally understood and they may be useful in identifying areas to target for intervention.

2.4.3 Protection motivation theory

Protection motivation theory (PMT) states there are six perceptions that influence motivation to engage in a protective behaviour: (1) severity of an event (with fear as an indirect influence on severity); (2) probability of the event occurring or vulnerability to it; (3) rewards of the harmful behaviour; (4) efficacy of the protective behaviour; (5) self-efficacy to carry out the protective behaviour; (6) response costs.[177] For example, these components can be mapped onto smoking behaviour in the context of lung cancer screening: (1) perceived severity of lung cancer; (2) perceived risk of lung cancer; (3) perceived benefits of smoking, (4) perceived risk reduction associated with smoking abstinence; (5) self-efficacy for abstinence; (6) beliefs about physical or psychological costs of abstinence. PMT proposes factors 1-3 contribute to a process of 'threat appraisal' (the sum of perceived severity and vulnerability minus rewards). Factors 4-6 are said to contribute to a process of 'coping appraisal' (the sum of efficacy and self-efficacy minus response costs). These lead to protection motivation, best measured by behavioural intentions. It is theorised there is a threat appraisal x coping appraisal interaction, whereby high coping appraisals lead to greater motivation as threat appraisal increases,

and low coping appraisals lead to lower motivation as threat appraisals increase.[178] A meta-analysis showed intentions have the strongest association with subsequent behaviour (mean correlation 0.40). Self-efficacy (0.33) and response costs (-0.34) have the strongest associations with intentions.[179] There are small to medium associations between threat appraisal constructs and intentions (mean correlations: severity 0.10; vulnerability 0.16; fear 0.20), and subsequent behaviour (severity 0.07; vulnerability 0.12; fear -0.04), and between coping appraisal constructs and intentions (efficacy 0.29; self-efficacy 0.33; response costs -0.34), and subsequent behaviour (efficacy 0.09; self-efficacy 0.22; response costs -0.25).[179] Combining the findings of six smoking studies, a meta-analysis showed coping appraisal variables had stronger associations (mean 0.56, 95% CI 0.48-0.64) with either smoking intentions or behaviour than threat appraisal variables (mean 0.25, 95% CI 0.12-0.38).[177]

2.4.4 Extended parallel process model

The extended parallel process model (EPPM) can be described as a fear appeal theory. It proposes that threat is appraised first, in terms of perceived vulnerability and severity.[180] If both are low, there is no fear arousal and low motivation for protective behaviour. If perceived threat is high there is fear arousal, prompting an efficacy appraisal similar to that of PMT. The outcome of the process is either danger control (e.g. quit attempt) or fear

control (e.g. avoidance). The EPPM is similar to PMT, except it states threat appraisal occurs before efficacy appraisal, gives a greater role to fear arousal and explains both successes and failures of fear appeals. A meta-analysis found support for the EPPM's competing fear control and danger control outcomes. Fear control responses were inversely correlated with danger control responses (r = –0.18, 95% CI -0.28 — -0.08).[181] Pictorial cigarette pack warnings are an example of fear appeals intended to promote smoking cessation and abstinence. They are supported as being more effective than text-only warnings at increasing behavioural intentions to quit (standardised mean difference 0.54, 95% CI 0.29 - 0.79)[182] but there has been a lack of assessment of the effect of such fear appeals on smoking behaviour outcomes.

2.4.5 Transtheoretical model

The transtheoretical model (TTM) uses a framework of qualitatively different sequential stages to explain how behaviour change may occur.[183] In addition, there are ten experiential and behavioural processes that facilitate transition between stages. The model was first developed in relation to smoking behaviour and is where much of its research has been carried out. The stages are:

- Pre-contemplation – the individual has no intention of changing behaviour in the foreseeable future;

- Contemplation - the individual is considering changing behaviour in the next six months;
- Preparation - change is planned in the next month;
- Action - the behaviour was changed within the last six months;
- Maintenance - the behaviour has been sustained for at least six months.

Smoking cessation can be explained by the model in terms of the processes of 'self-re-evaluation' and 'self-liberation'. Self-re-evaluation is an emotional and cognitive reappraisal of values in relation to smoking. Self-liberation involves commitment to change and belief in the ability to change. These can facilitate progression to a more advanced stage of smoking behaviour change. Smoking relapse can be conceptualised similarly, leading to regression to an earlier stage. The model has been criticised for its focus on conscious planning and failing to explain spontaneous quit attempts.[184] The idea that smokers can be assigned to groups and supported differently according to certain behavioural observations has intuitive appeal. However, it is argued there is no convincing evidence that moving somebody from one stage to the next results in sustained smoking behaviour change.[184] A review of cessation interventions found no benefit for stage-based approaches compared with non-tailored interventions.[185]

In summary, the HBM, TPB, PMT, EPPM and TTM share similarities but each take a slightly different approach to explaining health behaviour. The models allow identification of intermediary components that may be important in behavioural responses to screening. There are commonly a range of cognitions, which can lead to intentions, which in turn can result in behaviour.

The HBM, TPB and TTM may be most relevant to understanding behavioural responses to cancer screening invitations because they incorporate a range of components that are known to be important proximal determinants of health behaviour, including beliefs, perceptions, attitudes, norms and self-efficacy. The HBM includes a cue to action which can take the form of a screening invitation, and the TPB places importance on prior planning and intentions to perform the behaviour, as required with a screening invitation and a scheduled screening appointment.

The PMT and EPPM may be most relevant to understanding behavioural responses to lung cancer screening test results because they attempt to explain how new risk information can motivate protective health behaviour.

There are other health behaviour theories that it could be argued are relevant to the topic under investigation, and there have been efforts to develop integrated models of behaviour and behaviour change by distilling core components of existing models. However,

the theories outlined above provide ample relevant theoretical structure within which to understand behavioural responses to lung cancer screening. Furthermore, because smoking behaviour is poorly explained by health behaviour theories, the thesis also utilises qualitative research methods to explore smoking behaviour change at the individual level.

2.5 Objectives of thesis

The thesis explores behavioural responses to lung cancer screening. Behaviours of interest are responses to screening invitations and tobacco use after undergoing screening. It is outlined in this chapter why these behaviours are of importance in the detection of lung cancer and prevention of smoking-related disease. The specific research questions addressed in the thesis, the rationale for those questions (some of which are expanded upon in later chapers) and the objectives of the thesis are summarised below.

Research question: Why do a significant proportion of individuals eligible for cancer screening programmes decide not to be screened?

Rationale: A better understanding is needed of factors involved in the decision to attend cancer screening. This knowledge can help

promote uptake which, despite much research on the subject, is currently suboptimal. Higher uptake can improve the effectiveness of screening programmes, increase the early detection of cancer and reduce cancer mortality.

Objective 1: To systematically search for and synthesise qualitative research evidence that explains cancer screening attendance decisions in the UK (Chapter 3).

Research question: What impact does lung cancer screening have on the smoking behaviour of those screened?

Rationale: Changes in smoking are a potential benefit or harm resulting from lung cancer screening and must be taken into account when assessing the overall effect of a screening programme. Screening could impact smoking prevalence via quit attempts, relapse, change in heaviness of smoking and smoking-related cognitions such as motivations and intentions. There are a limited number of previous studies conducted on this topic and the overall relationship is currently unclear.

Objective 2: To measure and explore smoking behaviour over a 12-month period in individuals screened for lung cancer (Chapter 4).

Research question: How and why does lung cancer screening affect smoking behaviour?

Rationale: A nuanced understanding is needed of the thoughts and experiences of smokers about their smoking in the context of lung cancer screening. This could help explain the findings of Chapter 4 and identify aspects of the screening experience that might be associated with a beneficial or harmful behavioural effect. The findings could be used to develop strategies for smoking cessation interventions in the lung cancer screening context. Research on this topic is sparse and, with integrated lung cancer screening and smoking cessation programmes being advocated, this addresses an important and urgent evidence gap.

Objective 3: To explore in-depth using qualitative methods decisions about smoking in smokers screened for lung cancer (Chapter 5).

3 Factors influencing the decision to attend screening for cancer in the UK: a meta-synthesis of qualitative research

3.1 Chapter summary

In the UK a significant proportion of those invited to be screened for cancer do not attend. For screening to be effective at reducing cancer mortality it is important that uptake is high. A systematic review was conducted to identify and synthesise qualitative evidence explaining individual cancer screening attendance decisions amongst UK samples. Thirty four studies were included in the review and their findings were synthesised using the principles of meta-ethnography. Reciprocal translation established themes clustered around three main constructs: relationship with the health service, fear, and risk. They provide a comprehensive interpretation of the cancer screening uptake decision. By attempting to bring together all qualitative UK studies on this topic for the first time, the chapter builds on existing evidence of factors associated with uptake and the previous application of health behaviour theory in interventions to improve uptake. With this new knowledge, issues are discussed relating to informed choice in cancer screening, strategies proposed to improve uptake of cancer screening in the UK, and the relevance of the findings to lung cancer screening discussed.

3.2 Background

As described in chapter 1, the incidence of cancer is increasing and population-based screening programmes can reduce cancer mortality by detecting the disease early. In this chapter a behavioural response to screening is explored that is key to its effectiveness: the decision of whether or not to attend screening.

3.2.1 UK cancer screening programmes

There are established UK population-based screening programmes for breast, cervical and colorectal cancer. Prostate cancer screening is available on request to men over 50 years old but there is no population-based screening for that group of men. Studies of the effectiveness of screening for lung and ovarian cancer provide opportunities to investigate uptake in the absence of implemented screening programmes.

The NHS Breast Screening Programme invites women aged 50-70 years for mammography screening every 3 years.[186] The NHS Bowel Cancer Screening Programme invites men and women aged 60-74 years (50-74 in Scotland) for colorectal cancer screening using a faecal occult blood test every two years.[187] Colorectal cancer screening involves the collection of samples at home using a postal kit and so is distinct in that it takes place outside of a medical setting. The NHS Cervical Screening Programme invites women aged 25-64 years for screening (liquid based cytology and

HPV testing) every three years (ages 25-49) or five years (ages 50-64).[188] Cervical screening aims to detect 'pre-cancers' when it is preventative. Individuals must be registered with a GP to be invited to participate in the screening programmes. Women are likely to gain more experience than men of being invited to cancer screening since cervical cancer is a disease solely affecting women and breast cancer primarily affecting women. Men in England, Wales and Northern Ireland receive their first cancer screening invitation at aged 60 years. In comparison, women aged 60 years are eligible for all three programmes and may already have many years of experience of being invited to two of them. Women aged over 65 years are invited to cervical screening if they have not been screened since age 50 or have recently had abnormal tests. Those who are too old to be eligible for colorectal (England and Scotland only) or breast cancer screening can be screened on request but do not receive an invitation. Individuals can opt-out of UK cancer screening programmes.[189]

Those eligible are sent a postal invitation letter, typically from a regional hub but sometimes appearing to be from a GP, with an appointment to attend for screening (breast cancer screening) or instructions about how to make a screening appointment (cervical screening). Information is provided about the benefits and risks of screening. For example, the breast cancer screening information describes the benefit in terms of saving lives from breast cancer,

and the risks of unnecessary treatment, false positive results and associated worry and distress, increase in lifetime risk of cancer associated with mammograms, and false negative results. It also says that mammograms can be uncomfortable or painful. The information emphasises that it is the individual's decision whether or not to be screened.[31] For colorectal cancer screening, 'at-risk' individuals are sent information through the post, followed a week later by a test kit with instructions. A reminder may be sent after a further 28 days.

3.2.2 Cancer screening uptake

Screening uptake is defined in England as the proportion of invited individuals who receive an adequate screen (definitive positive/negative result) within six months of their invitation. In order for screening to be effective in reducing cancer mortality it is important for several reasons that uptake is high. Firstly, high uptake ensures that given the current screening modalities sufficient cancers can be detected early, with significant reduction in cancer-specific mortality, to make the programme cost-effective. Secondly, there are currently disparities in uptake between different socioeconomic and ethnic groups meaning low uptake of screening could contribute to health inequality.[190, 191] High uptake across the whole 'at-risk' population to be invited for screening should mean a reduction in such disparities. Thirdly, those least likely to attend screening may be those most at risk of cancer due

in part to a positive relationship between health literacy and preventative health behaviours, especially in older adults.[192] This has been termed 'reverse targeting' of screening, potentially compromising its effectiveness.[193] A potential issue is that if increased resources are required to engage harder-to-reach individuals in screening this could generate decreasing return in the cost-effectiveness of detecting cancers.

Uptake has been described as the most important factor in determining the success of a screening programme.[194] Uptake of breast, cervical and colorectal cancer screening in England is 71% (2016-17),[195] 72% (2016-17)[196] and 58% (2012-15)[197] respectively.

However, screening must be cost-effective in economic and health care terms and the need for uptake to be high is not an absolute need but rather relates to the effectiveness of the screening method. For example, breast cancer screening reduces breast cancer mortality by 20% but a screening test that reduces mortality by 100% could be cost-effective with low uptake. Screening is about reducing cancer mortality in a cost-effective manner which, for currently available screening methods, requires high uptake.

3.2.3 Sociodemographic factors

Ethnicity, social deprivation, gender and age are key determinants of cancer screening uptake in the UK.[194] Lower uptake has been consistently observed in minority ethnic groups, especially South Asians.[198, 199] Uptake of colorectal cancer screening is lower in more ethnically diverse areas, areas of higher deprivation[200, 201] and in men.[197] Uptake of lung cancer screening may be lower in poorer socioeconomic groups and in women.[202] Socioeconomically deprived and single women are less likely to have ever been screened for colorectal, cervical or breast cancer.[203] Younger age is associated with lower uptake of colorectal cancer screening[198, 199] and cervical screening[204] and higher uptake of lung cancer screening.[202]

3.2.4 Practical factors

Barriers to cancer screening identified in quantitative research are predominantly practical ones, such as difficulty making an appointment, forgetting to do so and dependency on others to carry out the activities of daily living.[205, 206]

3.2.5 Psychosocial factors

Studies have reported psychological motivators and barriers to screening including embarrassment, worry, anxiety, fear, fatalistic beliefs and self-efficacy.[207-209] Other factors include social support and a lack of awareness of cancer as a disease and of the role of

screening.[210] A survey of individuals eligible for cancer screening in England found cancer stigma was associated with irregular or non-participation in all three national screening programmes.[211] Stigma around lung cancer as a perceived self-inflicted disease is a particular barrier to lung cancer screening.[212] Smokers in the USA were less likely to be willing to consider lung cancer screening compared to never-smokers[213] and in the UK were less likely to attend colorectal screening.[214] Avoidance of cancer risk information was associated with lower participation in colorectal cancer screening.[215] There are higher participation rates in colorectal cancer screening using less invasive screening methods.[216] Dislike of the screening test appears to be a stronger barrier to colorectal cancer screening than breast cancer or cervical screening.[203]

3.2.5.1 Attitudes to cancer screening

Most individuals report enthusiasm for cancer screening. A survey of 50-80 year-olds conducted in 2012 in Great Britain asked 'Do you think routine cancer screening tests for healthy people are almost always a good idea?' with 89% responding 'yes'.[217] A USA focus group study of smokers found many participants expressed a strong desire to pursue lung cancer screening despite being unfamiliar with it.[218] Positive attitudes to cancer screening are reported even where individuals have been presented with information about overdiagnosis.[219] Women in the USA who had previously received a false positive mammography result were

slightly more tolerant of the harm caused by false positive results than other women.[220] 'Popularity paradox' is a term used to describe the tendency for those who have been misdiagnosed and overtreated due to screening to believe that they owe their health to screening.[26] The implication is that the more overtreatment resulting from screening, the more popular screening becomes.

Despite positive social attitudes to screening, there could be changes in attitudes as a result of the pursuit of informed uptake (see section 3.2.8). This highlights the importance of using an exploratory approach to investigate thoughts and experiences about screening that can vary over time in a changing social context.

3.2.6 Publicity and the media

The use of mass media campaigns can lead to increases in cancer screening uptake in areas where there is good availability of organised screening.[221] High profile cancer deaths can impact screening uptake, such as the death in 2009 of 27 year old UK television personality Jade Goody from cervical cancer. In the month of her death cervical screening attendances in England were 67% higher than expected and there were 480,000 extra attendances after her diagnosis was made public and around the time she died.[222]

3.2.7 Structural, organisational and other factors

It is likely that a proportion of those who do not attend cancer screening do not receive the invitation,[223] perhaps because they have moved house. Some patients do not attend because they are already undergoing treatment for the cancer of interest or have other medical reasons that would make participation inappropriate.[224] Research in a wide range of contexts has consistently found that past behaviour is the best predictor of future behaviour.[225, 226] It is unsurprising then that previous screening attendance is the largest single predictor of future attendance.[205]

3.2.8 Informed choice

A recent focus on what constitutes informed consent in cancer screening has taken place alongside increased public debate about the benefits and harms of screening. It is no longer the goal simply to achieve greater uptake but to achieve uptake based on informed decisions that involve understanding and consideration of the potential costs and benefits of taking part.[227] Participant information now balances both the benefits and harms and emphasises the importance of choice. There is some evidence that interventions promoting informed choice may have little effect on screening uptake[228] but they have been shown to impact intentions to attend breast cancer screening.[229] Screening invitations may lack the information necessary for informed choice.[230] It is unclear

to what extent screening participants understand the information they are given.[231]

3.2.9 Theory of screening uptake behaviour

The purpose of this chapter is not to test theory or establish 'truth', but it is useful to outline theory in which current understanding of screening uptake behaviour is grounded. Two of the health behaviour models outlined in Chapter 2 are briefly considered in relation to cancer screening uptake.

3.2.9.1 Health belief model

Theoretical understanding of screening uptake behaviour most commonly draws on the health belief model.[232] This can explain how perceptions of susceptibility, benefits, severity, barriers, cues to action and self-efficacy contribute to screening attendance decisions. Health belief model constructs explained 47% of variation in interest in colorectal cancer screening, which was highly predictive of uptake.[233] Interventions using health belief model constructs were associated with more than twice the likelihood of mammography screening uptake.[234, 235]

3.2.9.2 Transtheoretical model

According to the transtheoretical model, individuals who are not aware of a cancer screening programme or have not thought about taking part can be conceptualised as 'pre-contemplators'. Other stages of the model can describe those who have thought about

taking part (contemplators), have taken part (actors) and have taken part more than once (maintainers). Studies of mammography uptake have shown that interventions tailored to individuals' stage of mammography adoption are effective at improving uptake.[235-239]

3.2.10 Interventions to improve uptake

Interventions to improve uptake have mainly used modifications of invitations, such as adding GP endorsement,[240] the use of education materials[241] and reminders.[242] These have been found to be effective in systematic reviews[243-245] but associated with only modest absolute increases in screening uptake of typically 1-6%.[246] The offer of out-of-hours appointments to improve access to screening may slightly improve attendance.[247]

3.2.11 Qualitative syntheses

Despite knowledge of theoretical models and sociodemographic, practical, psychosocial, structural and organisational factors associated with uptake, efforts to increase uptake have had limited effectiveness. There is a need to examine alternative interpretations of screening uptake behaviour using qualitative methods, to achieve a broader, more nuanced, and deeper understanding of the experiences of those invited to be screened. There is a need to thoroughly understand *why* some people do not attend screening, in order to effectively engage non-attenders.

Qualitative research in health care gives the patient a voice through the documentation of their priorities, preferences and experiences. Qualitative inquiry can enrich knowledge about individual cancer screening decision-making, which takes place in a social context, mediated by roles and relationships and through lenses of personal values and psychological processes.[248] Qualitative studies of factors influencing cancer screening uptake have usually examined a single type of cancer, or method of cancer screening, in isolation. In recent years three syntheses of such studies have been published.

A synthesis of women's barriers to breast cancer screening published in 2015 used search terms in English and Persian, finding 21 studies (1 from the UK).[249] The method of analysis was described as thematic analysis: barriers identified were categorised into groups and their frequencies reported. The most important barriers were lack of knowledge about screening services and how to use them, lack of access, fear of a positive result and of pain, professionals' attitudes and advice that screening is not needed, women's beliefs about screening (e.g. fatalism, screening has no efficacy), procrastination, embarrassment (especially with male professionals), long wait for an appointment, language, and previous negative experiences such as pain or perceived inappropriate services.[249]

A synthesis of barriers and facilitators to the uptake of colorectal cancer screening published in 2016 included 94 reports (11 from the UK).[250] It used a two-stage synthesis that included a thematic analysis and a meta-synthesis (defined in section 3.2.13). Themes from the thematic analysis stage reported as barriers were lack of awareness of screening and its purpose, cancer fear and fatalism, negative attitudes towards colorectal cancer screening tests (including dealing with faecal matter and related hygiene concerns and social taboos), lack of motivation in the context of competing health concerns and life demands, cultural barriers (e.g. the belief that natural remedies can prevent cancer), gender barriers (e.g. the belief that screening is a threat to masculinity) and socioeconomic barriers (e.g. the need to take time off work to be screened). Conversely, facilitators were awareness of screening, positive attitudes towards colorectal cancer screening tests and motivation for screening. The meta-synthesis stage produced a conceptual framework that included the main barriers and facilitators, with 'awareness' as the key central component influencing the other factors. This was described as awareness of: colorectal cancer as a disease; the aetiology and progression of colorectal cancer; screening modalities and their risks and benefits; the need to screen in the asymptomatic state; the role of screening in prevention of colorectal cancer incidence, morbidity, and mortality.[250]

A synthesis of barriers to cervical cancer screening in countries with an established call-recall programme, restricted to English-language reports, included 39 papers (20 from the UK).[251] The method of analysis was described as thematic synthesis, involving inductive coding of data and arrangement of codes into hierarchical groupings that described emergent themes. This produced a coding frame that represented concepts across all included studies. The first overarching theme was 'should I go for screening?' which it reported women considered in terms of the relevance (causal beliefs; life stage; current health state; family history) and value (screening has value; screening does not have value; no opinion of the value) of screening. The second overarching theme was 'screening is a big deal'. This described perceptions of cervical screening as posing a threat physically and emotionally (potential for screening to reveal cancer; screening causes physical harm; screening causes anxiety; screening causes a social threat) and negative experiences of the procedure (physical experiences; emotional experiences; interaction with health professionals; smear taker preferences – trusting relationship/anonymity). The authors reported further minor themes relating to previous experiences and practical barriers.

These syntheses reveal a complex interplay of screening awareness, perceptions, beliefs, emotions and motivations. They demonstrate that the decision about whether to attend cancer

screening requires investigation and understanding beyond that achieved by quantitative methods or conceptualised within health behaviour theories. They also show that some factors vary by type of cancer and hence a need to synthesise evidence across all types of cancer screening. Qualitative evidence synthesised and incorporated into the hierarchy of evidence could offer a deeper knowledge that can be used to improve uptake of cancer screening.

Whilst the response of medical practice to the threat of cancer is dictated by the site or organ in which the disease occurs, the word 'cancer' often carries a more general meaning to people.[252] Different cancer screening tests may share common barriers to uptake and those who do not attend more than one programme may have more global barriers such as cancer fatalism.[203] A meta-synthesis of patients' experiences of recognising cancer symptoms and help-seeking found common themes across cancer types including cancer fear.[253] An invitation to screening in an asymptomatic population has similarities in that it can increase the perceived threat of cancer and requires help-seeking behaviour to negotiate the threat. Receipt of invitations to different types of cancer screening may therefore prompt common thoughts, emotions and experiences, despite differences in screening methods and disease characteristics.

Cancer screening in the UK differs to some other developed countries, such as the USA, in that it is organised and delivered via the public NHS. Individuals are automatically invited when they become eligible for screening, which is free at the point of use. Responsibility for screening in the USA falls more on the individual and their private health care provider, suggesting that different barriers to screening may exist. Weller and colleagues recommend that strategies to increase cancer screening uptake consider health service context and cultural and societal norms.[254] It is therefore worthwhile to focus attention on cancer screening attendance specifically in the UK.

3.2.12 Knowledge gap

No review to date has synthesised qualitative evidence explaining uptake of all types of cancer screening, or has focused on evidence from UK screening programmes. A comprehensive synthesis of evidence which explores reactions to invitations to any type of cancer screening could provide new insight into experiences of deciding whether to engage with cancer screening. This in turn may provide a basis for deciding what new research studies, research methodology and/or interventions might be most appropriate to improve screening programmes.

Within the wider investigation of behavioural responses to lung cancer screening in the thesis, this approach will identify any

qualitative research into UK lung screening trial participation. As the number of such studies is likely to be very small, it will provide higher level evidence relating to all UK cancer screening which may be generalisable to a UK lung cancer screening programme.

3.2.13 Meta-synthesis

As the number of published qualitative studies grows, the use of meta-synthesis to generate new understanding and insights in health care is increasing. Meta-synthesis is an approach that uses rigorous methods to identify and synthesise qualitative studies. Similar to the meta-analysis approach to synthesising quantitative studies, it is 'research of research' that uses existing data to address a specific research question. However, in contrast to meta-analysis, the aim of meta-synthesis is not to aggregate the findings of studies but to construct greater meaning through an interpretative (rather than integrative) process and to enlarge and enrich discourse.[255] It achieves this through an explicit critical re-interpretation of existing studies using an interpretivist rather than a positivist approach to knowledge generation. Meta-synthesis provides a level of conceptual development beyond that of any individual study. It addresses the issue of fragmentation of qualitative evidence and allows the findings of qualitative studies to be brought together in a way that can inform further research and practice. It has the potential to adapt existing concepts, develop new theoretical frameworks and develop interventions.

A meta-synthesis of evidence explaining cancer screening attendance decisions can create a more comprehensive and valuable understanding of study findings. In other words, it can develop the findings of individual studies into more thickly descriptive and comprehensive understandings of individuals' decision-making processes which in conceptual terms are greater than the sum of their parts.

3.3 Objective

The objective of the work reported in this chapter is to conduct a meta-synthesis to systematically identify and synthesise qualitative evidence that can help to explain individual cancer screening attendance decisions in the UK.

3.4 Methods

3.4.1 Eligibility criteria

Studies were eligible for inclusion in the meta-synthesis if they utilised qualitative methodology (e.g. interviews, focus groups) and reported evidence of factors influencing decisions to attend screening for cancer in the UK. Quantitative studies reporting a relevant qualitative component were eligible. Eligible screening included organised population-based screening programmes and research trials of screening methods. Opportunistic screening, self-examination, second stage screening (a diagnostic test following an

initial screen), genetic testing and family history counselling were all ineligible. This is because the phenomenon of interest is the specific type of decision-making that occurs after being invited to screening, usually via a postal invitation received at home while asymptomatic for the disease.

To be eligible for inclusion, at least one factor must have been associated with a participant's screening attendance decision. This association could be made either by the participant or the author of the research study. Studies were therefore excluded if they reported views or experiences of screening with no explicit link to a screening participation decision. Research participants must have had experience of being invited to cancer screening, meaning that studies reporting evidence solely relating to hypothetical screening invitations, including vignette studies, or originating solely from individuals who have never been eligible for screening (e.g. due to age) were excluded. Reports solely of the views of people other than the screening invitation recipient (e.g. health care practitioners) were ineligible. Research which specifically aimed to recruit individuals with symptoms of the disease, a previous cancer diagnosis, physical or learning disabilities, or who had experienced sexual abuse were ineligible. The decision to attend screening in these groups is likely to be dominated by specific factors which are unlikely to be generalisable to the wider population, and are the

subject of existing evidence syntheses about engagement with health care services.[253, 256, 257]

3.4.2 Information sources

Databases searched were MEDLINE, Embase, CINAHL, PsycINFO, ASSIA and Web of Science. Journals Social Science & Medicine (Jan 1982 – Oct 2016) and Journal of Medical Screening (Jan 1994 – Oct 2016) were hand-searched online. The following additional online sources were hand-searched: Cancer Research UK; National Cancer Research Institute; International Cancer Research Partnership Database; NHS Cancer Screening Literature Database; HealthTalkOnline. Reference lists of included studies were searched for further relevant references and Web of Science was used to search for papers citing the included studies.

3.4.3 Search

Databases were searched from date of inception to September 2013 and updated with searches from 2013 to October 2016 (see 3.4.9). The MEDLINE search strategy is shown in Box 3.1. These search terms were adapted to suit each database.

Box 3.1 MEDLINE search strategy

1	exp qualitative research/
2	exp interview/
3	exp focus groups/
4	(qualitative or interview$ or focus group$).tw.
5	(themes or thematic or content analys$ or framework analys$ or template analys$ or IPA or grounded theory or discourse analys$ or phenomenolog$ or $ethnograph$ or interpre??tiv$ or inductiv$ or reflexiv$ or triangulat$).tw.
6	or/1-5
7	(cancer$ or sigmoidoscopy or colonoscopy or faecal occult blood test or bowel or colorectal or PSA or digital rectal examination or prostate$ or pap$ or smear or liquid based cytology or cervical or mammogra$ or breast or sputum or bronchoscopy or chest radiography or chest x-ray or computed tomography or CT or lung).tw.
8	exp Mass Screening/ut [Utilization]
9	screening.tw.
10	8 or 9
11	(uptake or utili#ation or participat$ or $respond$ or respons$ or experience$ or decision$ or choice$ or decline$ or $attend$ or factor$ or motivat$ or predictor$ or reason$ or influence$ or barrier$ or acceptability).tw.
12	6 and 7 and 10 and 11

3.4.4 Study selection

Search results from each database were combined and duplicates removed. Two researchers independently assessed titles and abstracts. A third senior researcher was available to resolve any disagreements. Full text papers were retrieved and, where the title appeared relevant but no abstract was available, the full text was

retrieved. A standardised form was completed independently by two researchers to assess eligibility for inclusion (Appendix A) and a consensus reached on any disagreements.

Papers assessed as eligible were classified by both researchers according to a typology of findings in qualitative research.[258] This addressed the problem that methodology stated by qualitative study authors in approximately half of reports does not accurately reflect that which was used.[258] The typology outlines five categories (Table 3.1) that form a continuum indicating degree of transformation of data, from findings that remain very close to source data (category 1) to findings representing several transformative moves away from data (category 5). This can be used to classify a study as qualitative research (categories 3-5) or not (categories 1-2). Studies not classified as qualitative research according to the typology were excluded. The typology classification was not used to make judgements about study quality.

To summarise, the review aimed to focus on evidence of high relevance and value in relation to the research question, namely from studies that:

i) Reported using qualitative methodology
ii) Displayed adequate transformation of findings to be classified as qualitative research

iii) Explained actual real-life UK cancer screening attendance decision-making with data sourced from the person invited

iv) Could be generalised to a wider screening-eligible population

Table 3.1 Sandelowski and Barroso's typology of findings in qualitative research[258]

Category	Degree of transformation of data	Defining feature	Action for this review
1. No finding	**Lowest**	Presentation of data as if they were the findings	**Exclude study - not qualitative findings**
2. Topical survey		Reduction of data to nominal or categorical data, or lists and inventories of topics	
3. Thematic survey		Data more transformed than 2, e.g. a move toward describing themes or patterned responses, but less transformed than 4 or 5	**Include study - qualitative findings**
4. Conceptual/thematic description		A move beyond surveying the topical or thematic landscape of events, phenomena, or cases toward interpretively integrating portions of data	
5. Interpretive explanation	**Highest**	Transformation of data to produce grounded theories, ethnographies, or otherwise fully integrated explanations of a phenomenon, event, or case	

3.4.5 Summary measures

In meta-synthesis the construction of research findings occurs at three levels. Firstly, participants in the primary qualitative studies construct meaning and understanding of the phenomenon of interest, termed 'first-order constructs'.[259] Secondly, the study authors construct their own understanding and interpretation of the data participants reported, termed 'second-order constructs'. These are influenced by the authors' own lived experiences and the epistemological assumptions of the methodology undertaken.[259] Thirdly, the investigators conducting the meta-synthesis add their own epistemological approach in the bringing together of the already-complex second-order constructs. Meta-synthesis has been described as reconstructions of reconstructions of constructions. The current meta-synthesis used second-order constructs in combination with the available first-order constructs to develop the higher level reconstruction.

First-order constructs (direct quotes from participants) and second-order constructs (study authors' interpretations of participants' accounts) were further categorised as primary or secondary data (Table 3.2). Primary data were first- or second-order constructs explicitly reported as having contributed to a screening attendance decision. Secondary data were first or second-order constructs not reported as having contributed but interpreted by the current author as potentially influencing the decision. So although the

study inclusion criteria required an explicit link to a real-life screening attendance decision, the criteria for eligible data in included papers were wider. Data interpreted as potentially influencing a future screening attendance decision but not a previous one (e.g. experiences of a recent involvement in screening post-invitation) were not considered relevant unless expectations held prior to screening were also mentioned, which could have influenced the attendance decision.

Table 3.2 Categories of relevant data extracted from included studies

	First-order construct	Second-order construct
Primary data	Direct participant quote Described by a participant or the study author as having influenced the participant's screening attendance decision	Study author commentary Described by the study author as having influenced a participant's screening attendance decision
Secondary data	Direct participant quote Not primary data but interpreted by the current author as having potentially influenced a participant's screening attendance decision	Study author commentary Not primary data but interpreted by the current author as having potentially influenced a participant's screening attendance decision

3.4.6 Data collection process

Study characteristics were extracted from included papers into a table by one researcher. Quotes and text from papers which met the criteria for primary or secondary data were systematically identified and extracted into a spreadsheet by one researcher, coded as first or second-order constructs and as primary or secondary data.

3.4.7 Appraisal of included studies

Included papers were assessed independently by two researchers using the Critical Appraisal Skills Programme (CASP) tool for appraising qualitative research.[260] This has ten questions which help the user to understand the value of the research and to form a judgement of the validity and relevance of the reports. Questions address the appropriateness of the research design, recruitment strategy, data collection methods, whether the relationship between the researcher and participants been adequately considered, whether ethical issues have been taken into consideration, whether the data analysis was sufficiently rigorous and whether there is a clear statement of findings. It was not used to score papers numerically on their quality, or to exclude papers. By taking into account the CASP tool, typology of findings, conceptual richness and relevance and contribution to the review question, papers were categorised as a 'key paper', 'satisfactory paper', or 'fatally flawed'.[261] This was used to assess the

contribution of papers and guide the synthesis, allowing more emphasis to be placed on key papers.

3.4.8 Synthesis of results

The synthesis of findings involved interpretative analysis following the principles of meta-ethnography (Box 3.2).[262]

Box 3.2 Seven phases of Noblit & Hare's meta-ethnography[262]

1. Getting started
2. Deciding what is relevant to the initial interest
3. Reading the studies
4. Determining how the studies are related
5. Translating the studies into one another
6. Synthesising translations
7. Expressing the synthesis

The included reports were carefully read and the relationships between the concepts arising were considered in relation to others in the original study and across studies. This is comparable to the method of constant comparison used in qualitative data analysis. Noblit and Hare suggest synthesis is achieved through 'reciprocal translation' when the concepts of one study can be easily encompassed by those of another.[262] When concepts are contested across studies 'refutational translational synthesis' can be used, a method of exploring and explaining contradictions between studies. When studies investigate different aspects of the same phenomenon a 'lines of argument synthesis' can be used to build

up a more complete picture of the phenomenon. These three approaches to synthesis can be used in series or ad hoc.[262] The concepts in studies included in this review were deemed homogeneous enough to allow a reciprocal translation synthesis.

Thematic coding was undertaken, firstly with data extracted from key papers and continued through all included studies. When a new theme was identified the other papers were reviewed to check for the presence of the theme, forming a cyclical process. The studies were translated into one another via an interpretative reading of meaning of the data for each theme and using a matrix of shared themes. This was then used to synthesise the translations through the identification and development of 'third-order constructs' by taking the first- and second-order constructs and analysing them thematically.

3.4.9 Update of searches

The synthesis was conducted initially with 28 papers identified from the searches run in 2013 (Figure 3.1). The decision to update a meta-ethnography can be made for reasons different to those for updating a meta-analysis or quantitative systematic review. There is no fixed time period after which a meta-ethnography becomes out-of-date.[263] Key factors in deciding to update a meta-ethnography have been summarised as the purpose, quality and time-dependency of the original meta-ethnography and the volume

and content of new, relevant qualitative studies.[263] In 2016 a scoping search was conducted to explore the volume of new relevant published studies and their content. A number of new potentially eligible studies were identified but they did not report sufficiently novel findings to warrant an update. In fact, their findings were highly consistent with the synthesis produced and provided validation of the work already undertaken. It was noted, however, that the new studies extended the findings to population groups that had not been represented in the original synthesis (regions of the UK; ethnic groups; vulnerable population subgroups). It was therefore decided that the searches would be updated to include new studies, their data would be extracted and incorporated in the review, but that the synthesis would not be rerun from the beginning. The searches were updated in 2016, applying the same eligibility criteria and typology of qualitative findings, resulting in the inclusion of a further eight papers[264-271] (Figure 3.1).

3.5 Results

3.5.1 Summary of included studies

Thirty six papers reporting 34 different studies were included in the meta-synthesis (Figure 3.1). Three papers originated from the same study.[272-274] Characteristics of included studies are shown in Table 3.3. Twenty one papers had cancer screening uptake as the

main focus of the reports. The primary focus of other reports included wider knowledge and attitudes to cancer and prevention,[271, 272, 275-279] responses to information about screening,[273, 280-282] experiences of screening test results[264, 283] and risk management options which included screening.[269, 284] Cervical, breast and colorectal cancer screening accounted for 29 of the 34 studies. Two related to prostate cancer, two to ovarian and one to lung cancer. Five papers were categorised as key papers,[273, 285-288] and all others as satisfactory. None were categorised as fatally flawed. Cervical, breast and colorectal cancer screening were all represented within the key papers.

Figure 3.1 PRISMA flowchart

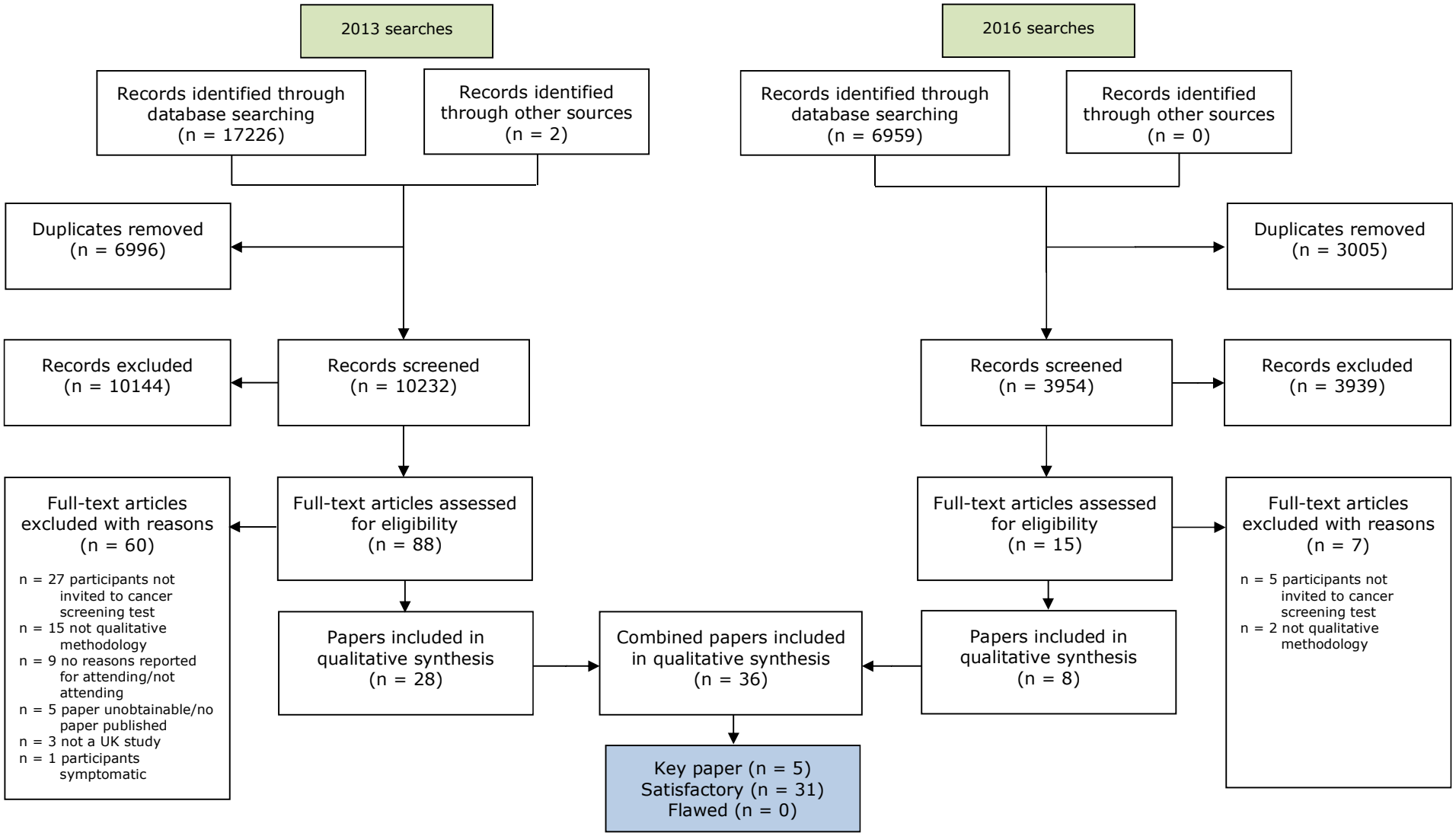


Table 3.3 Characteristics and relevant findings of included studies

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
Abdullahi et al. 2009 Satisfactory paper	Explore understanding of the purpose of cervical screening, risk factors for cervical cancer, opinions on barriers to screening and suggestions for overcoming those barriers	Cervical cancer Liquid-based cytology Community setting	n = 42 (focus groups), n = 8 (interviews) Never been screened = 19; Screened status not reported = 31 25–64 years; women; Somali; Camden, London Purposive sampling	Focus groups and interviews Thematic analysis informed by an interpretivist approach	**Barriers to uptake of screening** -Lack of knowledge -Language difficulties -Fear of the test -Embarrassment -Negative past experiences -Male practitioners -Practical difficulties	**Proposed solutions to the barriers** *Provision of education and information about cervical screening in Somali by Somali community workers; training for staff about Somali culture, particularly female circumcision; more proactive encouragement for Somali women to attend from GPs*
Archer & Hayter 2006 Satisfactory paper	Describe the experiences of men who received equivocal prostate-specific antigen test results	Prostate cancer Prostate-specific antigen test Prostate Testing for Cancer and Treatment (ProtecT) trial	n = 7 All received inconclusive screen and participating in ongoing monitoring of blood tests or biopsies or both 50-59 years; men; ethnic group not reported; all were from one general practice in the north of England Purposive sampling	Semi-structured interviews Phenomenological approach - seven stage reductive process	**Pre-conceptions** *Their beliefs about prostate cancer before screening* **Responsibility** *Their sense of obligation to their own health, to the future health of men generally and to their family*	
Armstrong 2005 Satisfactory paper	Explore ways that women think about and understand cervical cancer risk factors and how these are, or are not, relevant to them as individuals	Cervical cancer Papanicolaou test NHS Cervical Screening Programme	n = 35 All previously invited 1 never attended 26 regular attenders 20-64 years; women; white British, South Asian and African Caribbean; east midlands, England	Lightly structured interviews Analysis of the material was approached inductively and explored the kinds of discourses and themes that women drew upon	**Bodily risks** -Genetics -Menopause **Behavioural risks** -Sexual behaviour -General health status	

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
			Quota sampling by age and ethnic group	when talking about their views, understandings and experience.		
Armstrong 2007 [a] Key paper	Explore how women interpret, negotiate and make sense of the information material they receive when called to attend cervical screening in the context of their personal circumstances, experiences and characteristics; therefore producing alternative conceptualisations of, and discourses upon, cervical screening	As for Armstrong 2005	As for Armstrong 2005	In-depth interviews Analysis of the material was approached inductively with emergent themes being identified from the interview transcripts and explored for the kinds of discourses and themes that women drew upon.	**Emotional experiences** *Explanations of what it is about individuals that mean their experiences are more troublesome than those of others* **The changing body** *How changes in women's bodies, e.g. the menopause, influenced thoughts about screening*	
Armstrong & Murphy 2008 [a] Satisfactory paper	Examine the complex interplay between lay and professional understandings of cervical cancer risk and causation	As for Armstrong 2005	As for Armstrong 2005	Semi-structured interviews Thematic analysis	**Childbirth: the extension of explanations based on trauma** *The role of childbirth in lay understandings of cervical screening*	
Austin et al. 2009	Explore perceived barriers to flexible sigmoidoscopy screening among	Colorectal cancer	n = 53 Screened status not reported	Focus groups Framework analysis	**Lack of awareness about bowel cancer** *Lack of knowledge as a barrier to attending*	**Recommendations to increase attendance to the FS test - Message**

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
Satisfactory paper	UK ethnic minority groups	Flexible sigmoidoscopy (FS) Community group	49-78 years; 20 men, 33 women; 18 Gujarati Indian, 14 Pakistani, 12 African Caribbean, 9 White British; London Opportunistic sampling		**Perceived benefits of FS screening** - a 'definitive' test - peace of mind - reduction of invasive treatment **Perceived barriers to FS screening** -Procedural barriers ~ invasiveness of the test and the area of the body under investigation ~ bowel preparation (enema) at home -Psychosocial barriers ~ fear of test results ~ attitudes to cancer treatment -Lack of symptoms -Culturally influenced barriers ~ attitudes of staff to religious beliefs e.g. female endoscopist necessary ~ biomedical view of healthcare system ~ language difficulty ~ threat to masculinity -Gender -Lack of awareness about screening	**dissemination and screening location** -General practitioner involvement -Group discussions within communities -Use ethnic community media -Use celebrities and community leaders as role models **Recommendations to increase attendance to the FS test - Message content** -Increase awareness -Emphasize severity -Emphasize preventive nature of the test
Avery et al. 2008 Satisfactory paper	Increase understanding of men's decision-making about prostate-specific	Prostate cancer Prostate-specific antigen (PSA) test	n = 21 14 screened 7 unscreened	Semi-structured interviews Constant comparison	**Accepting PSA test** -Nothing to lose -Opportunity for reassurance -Lack of symptoms -Perceived good health	**Not responding to PSA test** -Belief that the PSA test is unwarranted due to:

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
	antigen (PSA) testing and subsequent biopsy	Prostate Testing for Cancer and Treatment (ProtecT) trial	51-55 years; men; ethnic group not reported; screened participants were from Bristol, Newcastle, Sheffield, Birmingham, Cardiff, Edinburgh, Cambridge, Leicester and Leeds. Unscreened participants were from just one of these locations (unspecified) Purposive sampling	methods derived from grounded theory		~ Perceived low risk of prostate cancer ~ Lack of symptoms/perceived good health ~ Belief that prostate cancer is not severe/life-threatening ~ Advice of medical practitioner/other -Belief that the PSA test/result is inaccurate
Bond et al. 2015 Satisfactory paper	Understand what it is like to have a false-positive screening mammogram	Breast cancer Mammography NHS breast screening programme (participant recruitment via GP practices and university staff newsletter)	n = 21 All screened with a false positive result between 0.5-12 years ago, for 6 of whom it had been their first screen 42-69 years; women; ethnic group not reported; location not reported Purposive sampling	Semi-structured interviews Interpretive Phenomenological Analysis	**Believing in the healthy self** *Going for mammography every 3 years had become part of their health care routine, it was welcomed, and there was a sense of handing responsibility for their health, in some measure, over to the NHS; screening gave peace of mind*	
Box 1998 Satisfactory paper	Ascertain the views and knowledge of cervical cancer and the cervical screening programme held by black and minority ethnic women and by	Cervical cancer Papanicolaou test 'ScanLink' - project to raise awareness and uptake of breast and	n = 17 eligible for this meta-synthesis. Study also included interviews with facilitators of cancer awareness sessions and focus groups with health advocates ineligible for this meta-synthesis Screened status unclear	Interviews Method of analysis not reported	Themes may be derived partly from ineligible data from facilitators and health advocates or due to age of interviewee meaning they are ineligible for screening **Ethnicity** *Beliefs and attitudes thought to be culturally specific e.g.*	**Language** *Failure of information to reach women, fears that they will be unable to communicate adequately, letters ignored or considered alien, irrelevant, or frightening* **Advocacy**

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	health advocates and facilitators	cervical cancer among black and minority ethnic women in the North Thames region	16-46+ years; women; "Black and minority ethnic" speaking either Cantonese, English, Hindi, Gujerati, Punjabi, Somali, Tamil or Urdu; Newham, London Sampled from those completing a questionnaire evaluation form as part of a cancer awareness session, to represent the range of ethnic groups in the area		*cervical cancer associated with promiscuity, inflicted as a punishment from God, a disease of the West, nothing could be done to avoid cervical cancer* **Racism and other problems** Being treated coldly because of race, being treated like a piece of meat, being too intimidated to ask questions	*Women who had made use of advocates appeared to be better informed. Many were unaware that health advocates could be booked*
Bradley et al. 2015 Satisfactory paper	Identify the reasons why some people do not participate in bowel cancer screening so that steps can be taken to improve informed decision-making	Colorectal cancer Faecal occult blood test Northern Ireland Bowel Cancer Screening Programme	n = 28 All unscreened. 27 had received but not completed a screening kit and 1 had not yet received a screening kit Age not reported (60-71 years were eligible); 18 men, 10 women; White; Northern Ireland (focus groups conducted in Belfast and Armagh Purposive sampling	Focus groups Thematic analysis	**Fear of cancer** *Fear and anxiety provoked by different aspects of screening, especially among men. Responses to suddenly being considered 'old'* **The test procedure** *Repugnance at idea of having to handle own faeces, mixed views about how difficult the test was to use, e.g. having to take samples three times* **Social norms** *Test is embarrassing, encouraged to participate by others who had done so*	**Past experience of cancer and screening** *Knowing people who had cancer, futility of treatment, early treatment more successful* **Lack of knowledge or understanding about bowel cancer screening** *Surprise at receipt of test, difficult to distinguish from private advertising, misunderstanding of test instructions, lack of symptoms* **Resulting behaviour towards the test** *Test put aside then either left indefinitely or binned*

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Brain et al. 2004 Satisfactory paper	Explore perceptions of ovarian cancer screening and prophylactic oophorectomy (PO) in women newly identified as being at increased risk of familial ovarian cancer	Ovarian cancer Ultrasound scan and blood test UK Familial Ovarian Cancer Screening Study	n = 10 Identified by screening as high-risk and facing a treatment decision (ongoing screening or prophylactic surgery) 27-62 years; women; ethnic group not reported; Wales Sampling method not reported	Semi-structured interviews Thematic analysis	**Reactions to ovarian cancer screening** *Expectations for the appointment, waiting for the scan, the experience of undergoing transvaginal ultrasound, the impact of screening results, attitudes to screening and the idea of benefiting others through screening*	**Reactions to the option of prophylactic oophorectomy** *Reactions to the option of undergoing prophylactic oophorectomy and factors that helped to decide whether to go ahead with surgery or remain on ovarian screening including the practicalities of surgery, issues regarding the onset of surgical menopause, views on surgery as a risk-reducing strategy and the uncertainties associated with screening and genetic testing*
Bush 2000 Satisfactory paper	Explore the importance of cervical screening discourses in framing women's perceptions of femininity	Cervical cancer Papanicolaou test Community setting	n = 35 Range of screening histories. All had been screened at least once 20-64 years; women; white; South Yorkshire Purposive sampling (cervical screening experiences, age and socioeconomic criteria)	Semi-structured interviews and open ended questions in a questionnaire Analytical process inscribing a movement from the particular to the general. Constant comparison of emergent conceptual categories	**Smear tests are a normal part of being a woman** *Feelings of normalcy associated with having a smear test* **Deviance associated with not attending for a smear test** *Having a smear test as a 'correct' form of behaviour and notions of deviance associated with non-attendance*	**Regulatory discourses and cervical screening** -Regulatory discourses embedded within the call and re-call programme -Regulatory pressure exerted by opportunistic screening **Fear** *Fear was reflected in the interview transcripts in different ways*
Chapple et al. 2008	Why some people decided to take part in screening	Colorectal cancer	n = 44 Screened = 35	Semi-structured interviews	**Factors affecting the decision to accept screening**	**Factors that made people feel reluctant or**

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Satisfactory paper	while others felt reluctant to participate or declined to take part	Faecal occult blood test NHS Bowel Cancer Screening Programme & pilot	Screened after delay = 6 Invited but not screened = 3 58–64 years = 14, 65 years or over = 30; 22 men, 22 women; White British = 42, Black Caribbean = 2; location not reported Maximum variation sampling	Thematic analysis with constant comparison	-Close relatives or friends had cancer -Past experience with other forms of screening -Convincing information in the leaflets -General practitioner involvement -A sense of obligation - a civic duty	**decline to accept screening** -Perception of low risk -Busy lifestyle -A sense of denial and fear of unpleasant results -Dealing with faecal matter -Issues about confidentiality -Confused about the instructions -Fear of colonoscopy and scepticism about treatment for bowel cancer
Clements et al. 2008 Satisfactory paper	Explore the value that women at increased risk (with a family history of breast cancer) placed on screening, both pre- and post-cancer diagnosis and the impact of the diagnosis	Breast cancer Mammography PIMMS Study (evaluating the psychological impact of mammography screening in women with a family history of breast cancer)	n = 12 All diagnosed with screen-detected breast cancer 37-50 years; women; ethnic group not reported; location not reported - from one of 21 centres in the UK 6 sampled from questionnaire study of 2321 women (sampling method not reported); 6 identified as eligible by clinics in study	Semi-structured interviews Framework approach	**Reasons for being on the early screening programme** -greater perceived chance of survival by early diagnosis -greater faith in mammography than self-examination	
Clifton et al. 2016 Satisfactory paper	Identify barriers and facilitators for breast, cervical and bowel cancer screening uptake by people with mental illness in order to inform interventions to	Breast, cervical, and colorectal cancer Mammography, liquid-based cytology &	n = 45 eligible for this meta-synthesis. Study also included interviews with NHS professionals ineligible for this meta-synthesis Some screened, some had missed, declined, ignored, or delayed screening, 1 not registered with a GP	In-depth interview Framework analysis	**Knowledge of screening programmes and processes** -Barriers: Not knowing what to expect or what to do; unsure of need for screening; difficult to process information **-**Facilitators: Wanting to be informed; understanding the	**Beliefs and concerns** -Barriers: Additional burden; mental health symptoms reduce motivation for self-care; past negative experience; embarrassment; traumatising; fear of bad news; poor relationship

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	promote equal access	faecal occult blood test NHS Breast, Bowel and Cervical Cancer Screening Programmes	26-73 years; 39 women, 6 men; 31 white, 5 black Caribbean, 4 mixed, 3 black African, 2 other; 29 London, 16 Dorset Purposive sampling		benefits of screening; feeling health conscious; encouragement **Knowledge of, and attitudes towards mental illness** -Barriers: Lack of understanding of mental illness in screening professionals; made to feel like a burden on health service; stigma of mental illness **-**Facilitators: Staff being understanding; staff knowledge of mental illness **Health service delivery factors** -Barriers: Screening environment aggravates mental health symptoms; staff can be rushed; staff can be rough; exclusion from GP registers **-**Facilitators: Continuity of care	with GP; diagnostic overshadowing **-**Facilitators: Feeling health conscious; being anxious to avoid further health problems; physical symptoms (e.g. finding a lump); past positive experience; good relationship with GP; good relationship with practice nurse **Practicalities** -Barriers: Appointment booking; transport difficulties; difficulty remembering appointments; difficulty leaving the house due to mental health problems; taking time off **-**Facilitators: Familiar location; reminders
Dharni et al. 2016 Satisfactory paper	Explore the factors affecting screening participation in an ethnically and socio-economically diverse inner city population	Colorectal cancer Faecal occult blood test NHS Bowel Cancer	n = 50 19 not invited, 18 screened, 7 declined, 5 invited but not yet completed, 1 tested as part of medical investigation	Semi-structured interviews Framework analysis	**Benefits of screening** -Helping oneself *Belief that taking part in screening is a way of protecting one's own interests and keeping healthy. Susceptibility due to age, belief that cancer is a hidden*	**Fear of cancer** *Fear of colorectal cancer, of the potential outcomes of screening, of stigma of cancer, lack of fear or embarrassment* **Religious faith**

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		Screening Programme, recruitment and interviews done in GP practices	55-74 years; 29 men, 21 women; 17 white British, 15 black Caribbean, 13 black African, 3 white other, 2 black other; London Purposive sampling		*disease, that early detection would be beneficial and offers the opportunity for reassurance* -Helping others *Helping others intertwined with beliefs about the purpose of screening, e.g. that it is a form of medical research which benefits society* **Awareness of screening** *Knowing a close family member or friend who had died of cancer, feeling susceptible, surprise at screening invitation due to low awareness*	*Belief that God would help them, the word 'occult' having demonic connotations* **Civic duty** *Not participating would be a waste of NHS time and money* **Barriers to faecal occult blood test completion** -Everyday pressures -Faecal sample -Misunderstanding of instructions -Planning test completion
Ekberg et al. 2014 Satisfactory paper	Identify and understand the factors that encourage or discourage individuals from participating in the Bowel Cancer Screening Programme	Colorectal cancer Faecal occult blood test NHS Bowel Cancer Screening Programme	n = 33 All eligible for screening 60-69 years; 15 men, 18 women; ethnic group not reported; 3 towns in the East Midlands of England Purposive sampling	Focus groups Analysis method not reported	**Association of screening with entry into 'old age'** *Avoiding the association of older age with illness, turning 60 as a social stigma* **Exposure to health screening** *More frequent exposure likely to result in an increase in body awareness and greater acceptability of medical screening, women who have been through pregnancy and childbirth more likely to participate* **Significant others**	**Fear of cancer** *Fear of the result, fear of cancer* **Lack of symptoms** *Especially for older people familiar with consulting a doctor only when symptomatic* **Embarrassment** *Embarrassed to discuss with others, threats to dignity and privacy, decision to be screened becomes a very private and personal decision* **Paternalistic healthcare**

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					The presence or absence of support and encouragement from significant others **Perception of risk** *Subjective assessment of risk, influenced by unique biographical past*	*Resistance to paternalism, preventative healthcare and the 'nanny state', interpreted as being a threat to individual freedom and autonomy and as being overly broad and repetitive*
Hall et al. 2015 Key paper	Explore the beliefs and experiences of individuals who had not responded either to their screening invitation or reminder to colorectal cancer screening	Colorectal cancer Faecal occult blood test NHS Bowel Cancer Screening Programme	n = 27 Non-responders to screening invitation 60-72 years; 13 men, 14 women; none from an ethnic minority group; north east England Purposive; maximum variation	In-depth interviews Grounded theory approach, with an emphasis on the constant comparison method	**Knowledge, beliefs and awareness** -Lack of awareness of others who have taken part (social norms difficult to assess) -Perceived low awareness of bowel cancer generally and screening programme specifically -Preference to go to GP with symptoms/belief that screening more necessary if symptoms apparent -Belief that treatment is likely to be unsuccessful or that bowel cancer is untreatable -Perception that screening is not personally needed (e.g. lack of symptoms, feeling well) -Unrealistic optimism/low perceptions of risk -Age-related beliefs (e.g. decreased ability to fight off illness with age) -Perception that it is better not to know (e.g. when there is no interest in receiving treatment)	**Circumstances** -Other more pressing priorities, (stressful life events, health concerns and illness, caring for others) or not prioritising own health -Not wanting to waste resources by completing kit unnecessarily -Previous negative experiences of health care and health-care system **Recent GI medical intervention** -Recent colonoscopy or other surveillance procedure -Recent bowel cancer diagnosis -Ongoing monitoring or medical review for bowel condition (e.g. IBD) **Practicalities of completing kit** -Perceived complexity of sampling procedures

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					-Traditional male gender roles and beliefs regarding health care and related activities -Bowels are private and not discussed -Belief that rectal bleeding (haemorrhoids or inflammatory bowel disease (IBD)) will affect test results **Emotional reactions to invitation** -Disgust/distaste at dealing with faeces -Avoidance of decision-making (put at back of mind or ignored) -Anxiety and fear about susceptibility, potential cancer diagnosis, further testing and hospitals -Unable to 'cope' with additional demands (e.g. due to depression, illness, stressful life events) -Embarrassment/difficult topic to discuss -Lack of need for reassurance	-Disgust/distaste at dealing with faeces -Lack of understanding of information provided -Unfamiliarity of taking own samples -Inability to take sample due to disability -Need for contemplation, planning and organization -Lack of confidence in being able to carry out sampling procedures -Lack of understanding of whether/when screening is appropriate when under medical review, or recent endoscopy investigations taken place -Not having read the information thoroughly or at all -Practicalities associated with going to the toilet, for example where and when bowel movements take place, regularity of bowel movements -Test seen as unable to provide definitive answer re: cancer diagnosis -Concerns about hygiene (storage, disposal of equipment and posting)
Jackowska et al. 2012	Identify patterns of screening attendance,	Cervical cancer	*Focus groups* n = 32 *Interviews*	Focus groups and semi-structured interviews	**Language**	**Time pressures** *Pragmatic reasons for not participating in screening*

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Satisfactory paper	awareness about, attitudes to, and barriers to participation in the NHS Cervical Screening Programme in migrant women from Central and Eastern Europe living in London	Liquid-based cytology NHS Cervical Screening Programme	n = 20 Screened status not reported 20-53 years; women; country of origin *Focus groups* Poland = 18, Romania = 9, Slovakia = 5, *Interviews* Poland = 11, Romania = 2, Slovakia = 7; London Opportunistic sampling via local advertisements and snowballing	Framework analysis	*Ease of communication as a reason for not attending screening* **Negative attitudes to the NHS** *Lack of confidence in NHS health professionals* **Lack of awareness of entitlements** *A belief that some migrant women might not know what their rights to health care in Britain are*	**Lack of acculturation** -'Fractured living' in two countries
Jepson et al. 2007 Satisfactory paper	Explore what people know about cancer screening, the information they want to make an informed choice (as to whether or not to participate), and factors affecting the choices and decisions they made	Breast, cervical, and colorectal cancer Screening methods not reported NHS national cancer screening programmes	n = 68 Normal screen result = 30 Abnormal screen result = 29 Did not attend screen = 9 *Cervical* 19-55 years, *Breast* 50-65 years, *Colorectal* 50-60 years; 11 men, 57 women; ethnic group not reported; Tayside and Lothian Purposive sampling	Focus groups and semi-structured interviews Constant comparative method	**How information is used when making a decision about whether to be screened or not** *Whether information was used to make the decision depended on what the information was related to (e.g. symptoms, risk factors or limitations)*	**Relationships between information provision and knowledge, choice and behaviour** *Whether they felt they had made an 'informed choice' to participate in screening or not and how concerned they were about this*
Karbani et al. 2011 Satisfactory paper	Explore attitudes, knowledge and understanding of breast cancer and preventive measures	Breast cancer Mammography Breast cancer units	n = 24 Screened status not reported 39-69 years; women; South Asian; West Yorkshire	Interviews guided by topic list Framework analysis	**Awareness and knowledge of breast self-examination and breast screening**	**Cultural practices and beliefs about cancer** -Cancer was a taboo subject -Cancer was contagious -Cancer was a stigma

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	amongst South Asian breast cancer patients		Purposively sampled breast cancer patients (but screening attendance decisions were pre-diagnosis) from three hospitals. Unclear how participants were sampled from this group			-Cancer in the family had ramification on children's marriage prospects
Lifford et al. 2013 Satisfactory paper	Examine how women felt about screening and what contributed to these feelings	Ovarian cancer Ultrasound scan and blood test UK Familial Ovarian Cancer Screening Study	n = 48 24 undergoing screening, 24 screened but withdrawn from programme 38-76 years; women; 47 white, 1 Indian; different (unspecified) geographical areas Purposive sampling; maximum variation	Semi-structured interviews Framework approach	**Positive experiences of ovarian cancer screening** -Benefit for self *Privilege to be able to be screened, peace of mind, reassurance, being proactive about their risk, taking responsibility for their health* -Benefit for research/others *Wanting to help the medical community deal with the disease*	**Negative experiences of ovarian cancer screening** *Inconvenience of having to be screened on particular days*
Logan et al. 2011 Satisfactory paper	Explore the experiences and perceptions of cervical screening among women from a socially deprived area	Cervical cancer Liquid-based cytology Community setting	n = 48 All attended a mobile cervical smear unit and had a cervical smear test taken within the last 12 months 35-55 years; women; ethnic group not reported; Northern Ireland Purposive sampling	Focus groups Thematic content analysis	**Women's perceptions of cervical cancer and screening** *knowledge and awareness of cervical cancer risk factors and the need for screening* **Women's experiences of cervical screening** *Negative attitudes and feelings of fear, embarrassment and stigma*	**Barriers to attending for cervical screening** *Practical factors: timing of appointments, issues of time and having to find child care* **Perceived solutions to barriers** -Flexibility of appointments -Use of peer support -Opportunistic screening -Education and empowerment
Marlow et al. 2015	Explore self-perceived barriers to cervical screening	Cervical cancer Liquid-based cytology	n = 54 35 regularly screened, 8 screened but had missed or delayed screening	Semi-structured interviews	**Lack of knowledge or misunderstanding** *Misunderstandings in the ethnic minority sample about*	**Emotional barriers** -Fear of pain -Embarrassment -Fear of cancer

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Satisfactory paper	attendance among ethnic minority women compared to white British women	Community setting	in the past, 6 screened but >3/5 years since last test, 1 regularly screened outside the UK, 1 never screened, 1 had a hysterectomy, 1 unknown 28-63 years; women; 24 Indian, 11 white British, 6 Caribbean/mixed white & black Caribbean, 4 black other, 3 white other, 2 Pakistani, 2 Bangladeshi 2 African; London boroughs of Brent, Barnet, Hounslow, Hillingdon, Newham, Lewisham and Camden Convenience sampling	Framework analysis	*cervical cancer, its causes and screening* **The procedure** -The health professional -Location	-Shame **Practical barriers** *Screening as an inconvenience* **Cognitive barriers** -Perceived risk -Absence of symptoms
McCaffery et al. 2001 Key paper	Explore and interpret the accounts given by people who declined FS screening	Colorectal cancer Flexible sigmoidoscopy Within a bowel cancer screening trial	n = 60 non-responders = 20 'definitely not interested' = 20 'probably not interested' = 20 Age not reported - participants sampled from group aged 55-64; 30 men, 30 women; ethnic group not reported; Leicester Purposive sampling	Semi-structured interviews (telephone) Method of analysis not named	**Reactions to the letter** *Little memory of the letter; negative feelings; neutral responses* **Social influences** *Whether they had discussed the test with anyone else and whether this had influenced their decision about screening* **Attitudes to screening** *Positive attitudes; few overtly negative attitudes* **Susceptibility** - Not necessary - Cancer: experience and attitudes	**Avoidance - 'leave well alone'** - Avoid thinking about illness when well to prevent psychological harm - The sense that the test could cause physical harm **Emotional responses** - Embarrassment - Pain and discomfort **Practical barriers** *Had little influence on decisions to decline screening*

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Michie et al. 1996 Satisfactory paper	Describe how members of families affected by familial adenomatous polyposis perceive this health threat and how they perceive predictive genetic testing (and subsequent bowel screening)	Familial adenomatous polyposis which leads to colorectal cancer if untreated. Regular bowel screening from adolescence if at risk of inheriting gene Colonoscopy A single polyposis clinic	n = 20 All from families in which a predictive blood test had been offered or carried out Affected individuals = 6 High risk result on genetic test = 1 Low risk result on genetic test = 3 Waiting for genetic test result = 10 15-46 years; 12 women, 8 men; ethnic group not reported; location not reported Purposive sampling from the polyposis register of a specialist hospital	Semi-structured interviews Grounded theory approach	**Relief and the hospital visit** *The hospital visit is associated with relief from anxiety* **Social reinforcement and the hospital visit** *Further reinforcement may come from the social and emotional contact with the hospital staff*	**Bowel screening: a necessary evil** *Bowel screening is regarded as aversive* **Genetic testing: reluctance to relinquish bowel screening in the face of low risk** *A desire for bowel screening to continue, even when the result of genetic testing indicates very low risk results*
Palmer et al. 2014 Key paper	Explore reasons for non-uptake of bowel cancer screening, and examines reasons for subsequent uptake among participants who had initially not taken part in screening	Colorectal cancer Faecal occult blood test NHS Bowel Cancer Screening Programme	n = 128 Included those who had and had not attended screening. 100 participants (78%) reported non-uptake on at least one occasion Age not reported; 67 men, 61 women; two focus groups were specifically for people of African-Caribbean origin; London and South Yorkshire Purposive sampling for 16 focus groups; opportunistic sampling from community settings for 2 focus groups	Focus groups Analysed inductively using techniques originating in grounded theory	Themes common across non-professional and professional occupational groups: **Risks posed by faeces** *Aversion to complete a test kit by reference to the perceived risks that collecting, storing, and posting samples of faeces posed to hygiene* **Detachment from familiar health-care settings** *Discomfort with the detachment and a preference to attend a health setting*	**Judgements of good health and low relevance of screening** *Test was irrelevant because they were certain that they did not have and were unlikely to get bowel cancer* Professional occupational groups only: **Delaying uptake, leading to non-uptake** *Non-uptake in terms of delay, rather than outright rejection* **The power of talk: a key 'tipping point'**

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					Implications of knowing screening results *Participants preferred not to be in possession of this information for several reasons*	*Being influenced by discussions with family members, friends, and health professionals*
Patel et al. 2012 Satisfactory paper	1. Are the screening methods offered acceptable to patients? 2. Why do some people take part and others decline?	Lung cancer Sputum cytology Lung-SEARCH trial	n = 60 Screened = 16 Abnormal screen plus annual bronchoscopy and CT scanning = 20 Declined screening = 24 52-81 years; 29 men, 31 women; ethnic group not reported - "limited numbers of ethnic minority patients"; location not reported Purposive sampling	Interviews (24 face-to-face; 36 telephone) Thematic analysis	**Acceptability of the screening methods** -Providing sputum samples -Views of bronchoscopy -Experiences and perceptions of CT scans **Taking part** -Altruism -Personal benefit -Reassurance -Knowing other people with lung cancer	**Perception of risk of lung cancer** -Influence of family history on risk -Influence of current health and medical care on risk **Barriers to participation** -Travelling for screening tests -Bad experiences of hospitals and doctors -Perception of bronchoscopy
Pfeffer 2004 Key paper	Why do some women accept their invitation for free screening mammography and others do not?	Breast cancer Mammography Community setting	n = 70 (of eligible screening age) Screened status not reported 50-64 years; women; white = 12, white Jewish = 9, Gujarati speakers = 9, Punjabi speakers = 9, Black Afro-Caribbean = 5, Somali speakers = 9, Sylheti speakers = 8, Cantonese speakers = 5, Turkish speakers = 4; Hackney, London "Sampling sought to capture the diversity of Hackney women and the groups were organised around a	Focus groups The transcripts were analysed both deductively and inductively. They were read and coded to test assumptions about compliance. The transcripts were then read for in vivo categories and coded accordingly. A	**Compliance** *How ideas of personal candidacy (women's assessment of their risk of disease) influence compliance*	

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			mixture of language, faith, skin colour, and social status."	notable theme emerging from the inductive analysis .. lead to a second reading…		
Prinjha et al. 2006 Satisfactory paper	Explore the attitudes of women with screen-detected ductal carcinoma in situ (DCIS) towards information provision for mammographic screening	Breast cancer Mammography DIPEx project/NHS Breast Screening Programme	n = 10 All screened and diagnosed with DCIS 52-69 years; women; ethnic group not reported; locations throughout the UK Maximum variation sampling to include younger and older women from various social backgrounds	Semi-structured interviews Framework analysis	**Women's knowledge of mammographic screening and DCIS before diagnosis** *Reasons for attending screening* **Information about screening mammograms after diagnosis** *Women searched for information at different stages and from various sources*	**Screening mammography and informed choice** *Women now felt more able to make an informed choice about whether to have mammograms in future.*
Shang et al. 2015 Satisfactory paper	Explore views on breast cancer and breast health among Chinese women in the UK and the potential influence of social and cultural context on views and screening behaviour	Breast cancer Mammography Community setting	n = 22 18 regular attenders, 1 irregular attender, 3 did not attend when invited 50-70 years; women; Chinese; Manchester and Liverpool Purposive sampling	Semi-structured interviews Grounded theory approach	**Breast screening practice** *Belief that screening is effective and beneficial, time constraints and distance to screening centre, invitation letter key to encouraging attendance, some view screening as mandatory*	
Szarewski et al. 2009 Satisfactory paper	1. Identify barriers to attendance at conventional cervical screening among Muslim women	Cervical cancer Liquid-based cytology Community setting	n = 28 Screened status not reported. "Only one woman in the screening age range reported never having had a smear test"	Focus groups Thematic analysis/ framework analysis	**Barriers to attendance for screening** -Embarrassment -Concern that the doctor might be male -Fear of pain and discomfort -Time pressures	

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
	2. Assess the acceptability of self-sampling for HPV using a new cervico-vaginal lavage self-sampling device (the Pantarhei Sampler) and to compare attitudes to this new device with women's feelings about the Qiagen kit		21-65 years; women; Pakistani = 15, Indian = 9, not reported = 4; Leyton, north-east London Purposive sampling		-Not prioritising one's own health -Language	
Thomas et al. 2005 Satisfactory paper	Describe some of the factors that act as barriers to effective uptake of breast and cervical cancer screening services among black minority ethnic groups living in Brent and Harrow	Cancer screening in general but predominantly breast and cervical cancer Mammography and Papanicolaou test Community setting	n = 135 "Only three females reported actually going for breast screening at regular intervals" 20-75 years; 85 women, 50 men; Indian = 26, Pakistani = 16, Blind Asian group (largely from Indian subcontinent) = 9, West African = 22, African Caribbean = 26, Arabic = 14, Greek = 20; Brent and Harrow, London Purposive sampling	Focus groups and 'a few' telephone interviews Content analysis and a coding method based on frequency of ideas	**Accessing the screening services** *Knowledge and uptake of screening with reasons for not attending* **Barriers to screening services** - Language barrier - Cultural beliefs - Lack of confidence in screening and outcome - Relationship with health professionals - Religious beliefs **Improving uptake of screening** *Strategies included community-based cancer awareness education*	**Inclined abstainers** (believing in the importance of screening but not translating positive screening intentions into action) -Service provision issues -The test itself -Apathy -Competing time demands -Low-risk perceptions **Uncertainty about reasons for nonattendance** *Identification of barriers without being sure whether they really played a role* **Age differences** *Age-related trends in responses*

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme	
Waller et al. 2012 Satisfactory paper	Explore differences in barriers to attendance at cervical screening across age groups	Cervical cancer Liquid-based cytology Participants recruited via a market research company - context appears to be NHS Cervical Screening Programme	n = 27 (focus groups) n = 19 (interviews) Never screened = 26 Currently overdue = 17 Up to date but has delayed in the past = 3 25–50+ years; women; white = 29, Asian/Asian British = 7, black/black British = 5, mixed race = 3, Chinese = 1, unknown = 1; London Purposive sampling	Focus groups and interviews (face-to-face and telephone) Framework analysis	**Disinclined abstainers** -Not being sexually active -An informed choice not to attend **Inclined abstainers** -Service provision issues -The test itself -Apathy -Competing time demands -Low risk perceptions	**Uncertainty about reasons for nonattendance** **Age differences**
Waller et al. 2013 Satisfactory paper	Explore the influence of overdiagnosis information on women's decisions about mammography	Breast cancer Mammography NHS Breast Screening Programme (participant recruitment via an agency and other methods)	n = 40 Time since last mammogram <=3 years = 29, 4–9 years = 4, >=10 years = 3, screened but time missing = 2, never screened = 2 50-71 years; women; white = 27, black = 6, Asian = 5, mixed = 1, other = 1; London Purposive sampling	Focus groups Thematic analysis	**Making sense of the concept of overdiagnosis** *In a few cases ... women were put off by the information*	**Implications of overdiagnosis information** -Erring on the side of caution -Impact on screening decisions
Woodrow et al. 2008 Satisfactory paper	Explore public perceptions regarding the communication of information designed to facilitate informed choice in relation	Colorectal cancer Faecal occult blood test NHS Bowel Screening	n = 86 Screened = 38, lives outside screening area = 48 60-69 years; 42 women, 44 men ; 83 white British, 2 Asian origin, 1 European origin; screened	Focus groups Transcripts were coded within a framework developed by the authors	**General perceptions of screening and information provision** *Positive and negative views about bowel screening*	

Study Key paper/ satisfactory /fatally flawed	**Aim/research question(s)**	**Screening** Disease Screening method Study context	**Participants** No. of participants Screened status Age; sex; ethnic group; location Sampling method	**Data** Collection method Analysis method (as described by authors)	**Second-order constructs: Themes and subthemes explicitly linked to screening attendance** **Theme** -Subtheme or *theme summary* ~Further subtheme
	to the new NHS Bowel Cancer Screening Programme	Programme pilot	participants from Coventry and Rugby, unscreened participants from other unspecified locations Random sample stratified by screening result		

[a] Same study as Armstrong 2005

3.5.2 Evidence synthesis

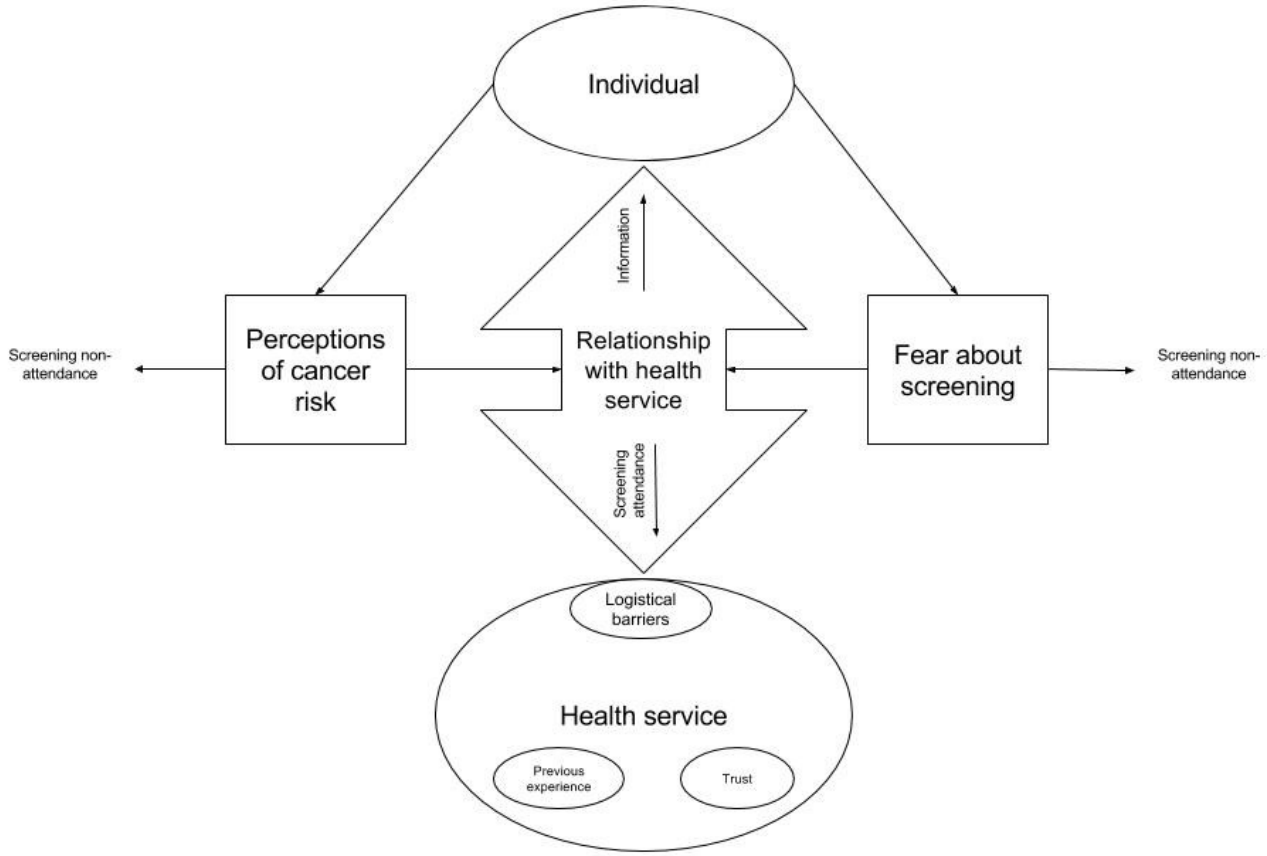
The interpretation of the findings identified key themes clustered around three main third-order constructs: First, screening attendance decisions were shaped by individuals' relationship with the health service. Second, fear was an influence on both decisions to attend and to not attend. Third, experiences of risk were expressed throughout the data. The distribution of themes across the 36 papers is shown in Table 3.4. Illustrative quotes from study participants (P) and authors (A) are provided below. A diagram of third-order constructs and their relationships is shown in Figure 3.2.

Table 3.4 Types of cancer screening studied and identification of themes from extracted data

Study	Breast cancer screening	Cervical cancer screening	Colorectal cancer screening	Prostate cancer screening	Ovarian cancer screening	Lung cancer screening	Relationship with health service	Fear of cancer screening	Risk/ uncertainty	Beliefs about early detection	Beliefs about the disease	Other emotions e.g. embarrassment	Individual responsibility	Privacy/taboo/ disgust	Information/ knowledge (or lack of)	Social influences	Moral/altruism	Surveillance/ control/ regulation	Specific population needs	Gender	Life-cycle needs	Avoidance	Current health/ wellness	Previous experiences of screening	Experiences of cancer e.g. family	Practical factors	Screening invitation/ materials
Bond et al. 2015	✓						✓	✓		✓		✓	✓			✓		✓					✓	✓	✓		✓
Clements et al. 2008	✓							✓		✓		✓															
Karbani et al. 2011	✓										✓			✓	✓	✓			✓	✓		✓		✓			
Pfeffer 2004	✓						✓	✓		✓	✓	✓		✓		✓			✓	✓				✓	✓	✓	
Prinjha et al. 2006	✓						✓		✓	✓		✓	✓		✓									✓			✓
Shang et al. 2015	✓						✓			✓																✓	✓
Waller et al. 2013	✓						✓			✓		✓			✓												✓
Clifton et al. 2016	✓	✓	✓				✓	✓		✓	✓	✓	✓		✓	✓			✓					✓		✓	
Jepson et al. 2007	✓	✓	✓				✓	✓	✓			✓			✓												
Thomas et al. 2005	✓	✓					✓		✓		✓				✓				✓	✓	✓			✓			
Abdullahi et al. 2009		✓					✓	✓	✓		✓	✓			✓	✓			✓	✓				✓		✓	✓
Armstrong 2005		✓							✓				✓				✓	✓	✓		✓			✓			
Armstrong 2007		✓									✓	✓		✓				✓			✓			✓			
Armstrong & Murphy 2008		✓									✓							✓			✓						
Box 1998		✓					✓	✓	✓			✓			✓				✓								
Bush 2000		✓					✓	✓					✓	✓		✓		✓		✓							
Jackowska et al. 2012		✓					✓			✓		✓			✓				✓							✓	✓
Logan et al. 2011		✓					✓	✓				✓			✓					✓						✓	

Study	Breast cancer screening	Cervical cancer screening	Colorectal cancer screening	Prostate cancer screening	Ovarian cancer screening	Lung cancer screening	Relationship with health service	Fear of cancer screening	Risk/ uncertainty	Beliefs about early detection	Beliefs about the disease	Other emotions e.g. embarrassment	Individual responsibility	Privacy/taboo/ disgust	Information/ knowledge (or lack of)	Social influences	Moral/altruism	Surveillance/ control/ regulation	Specific population needs	Gender	Life-cycle needs	Avoidance	Current health/ wellness	Previous experiences of screening	Experiences of cancer e.g. family	Practical factors	Screening invitation/ materials
Marlow et al. 2015		✓					✓	✓	✓	✓	✓	✓		✓	✓					✓			✓	✓		✓	
Szarewski et al. 2009		✓						✓				✓							✓	✓						✓	
Waller et al. 2012		✓							✓	✓					✓						✓					✓	
Austin et al. 2009			✓				✓	✓	✓	✓	✓	✓		✓	✓				✓	✓							
Bradley et al. 2015			✓				✓	✓				✓		✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓
Chapple et al. 2008			✓				✓	✓	✓	✓				✓			✓							✓	✓	✓	✓
Dharni et al. 2016			✓					✓	✓	✓	✓	✓		✓	✓		✓				✓		✓		✓		
Ekberg et al. 2014			✓				✓	✓	✓			✓				✓					✓		✓	✓			
Hall et al. 2015			✓					✓		✓		✓				✓	✓					✓	✓		✓	✓	✓
McCaffery et al. 2001			✓					✓		✓						✓						✓	✓		✓	✓	
Michie et al. 1996			✓				✓			✓		✓				✓											
Palmer et al. 2014			✓				✓	✓				✓		✓		✓						✓	✓	✓		✓	✓
Woodrow et al. 2008			✓					✓		✓		✓			✓	✓								✓			✓
Archer & Hayter 2006				✓			✓		✓	✓	✓	✓	✓		✓	✓	✓							✓			
Avery et al. 2008				✓			✓	✓	✓	✓	✓			✓									✓			✓	✓
Brain et al. 2004					✓				✓	✓																	✓
Lifford et al. 2013					✓					✓		✓	✓				✓									✓	
Patel et al. 2012						✓			✓	✓		✓		✓			✓						✓	✓	✓	✓	

Figure 3.2 Diagram of third-order constructs



3.5.3 Relationship with health service

Reciprocal translation established 'relationship with the health service' as a recurrent theme explaining responses to screening invitations. Participants displayed varying levels of trust, ranging from those who perceived the screening invitation as a command to be obeyed, to those who saw it as an attempt at control to be resisted. Between these two extremes there were other aspects of the relationship with the health service that influenced decisions about attending screening.

There was evidence that the NHS is seen as a higher power in the relationship, with attendance explained in terms of compliance and non-attendance in terms of deviance.

> "A Sylheti-speaker had gone along to the screening unit because she understood her letter of invitation, emblazoned with official logos, as a command, not a request."(A)[288]

> "Many interviewees referred to having a smear test as a 'correct' form of behaviour: as the right/correct/proper thing for women to do. Notions of deviance were associated with non-attendance."(A)[276]

> "Most men passively accepted the [PSA test] invitation."(A)[289]

One author noted that failure to attend screening was sometimes an act of scepticism and purposeful resistance:

> "There was some evidence that women who had not had smear tests when invited were doing so, not because they were 'irresponsible' … but because they were actively resisting the system."(A)[276]

Resistance to screening invitations was expressed, in this example, as a desire to maintain control over decisions about one's health:

> "I was annoyed to find that because I hadn't had a smear test my medical record card had been emblazoned with a sticker. I feel as though I should be the one taking responsibility for my own health - so a reminder would be sufficient. To a certain extent whether I have a smear or not is my business and nobody else's."(P)[288]

> "...more attention should be paid to increasing the level of trust between the individual and the national health system ... the participants in this study viewed these messages as a form of medical paternalism, which lowered their weight and value when deciding whether or not to participate in the [NHS Bowel Cancer Screening] programme."(A)[268]

In contrast, others felt they had been allowed the autonomy to make the attendance decision themselves:

> "Generally, a sense of feeling coerced was not a major issue for people invited for breast and colorectal screening. As people received invitations at home, most saw it as their choice whether they went or not. Even those people who did not participate felt that the choice was respected."(A)[290]

Some felt privileged to be invited to screening[282] and viewed it as the offer of a valuable service at no financial cost to them.[288] Others felt obliged to comply with the 'system' in order to help maintain a good relationship:

> "I was very reluctant to go along and have [a smear] and I felt in the end I'd better because it would affect my relationship with my GP which isn't … Umm I felt I was under pressure to do it…"(P)[290]

Infrequent use of the health service can mean that a screening appointment is experienced as an ordeal due to a limited history to the relationship:

> "I'm not a sick sort of person, in fact I can honestly say the last time I went to the doctor's was three years ago for my last screening, so I think going to the doctor's for me is quite an ordeal you know."(P)[273]

Immigrant populations with limited experience of the NHS lacked trust in its services and employees, sometimes opting to be screened in their home country where a stronger relationship existed with the health care provider:

> "Lack of confidence in NHS professionals was a pervasive theme."(A) "I decided not to go for this test in Britain anymore and refused the last invitation from my GP. I travel home regularly … to have it done over there."(P)[291]

Language problems inhibited them from asking questions and forming a trusting relationship.[292] There was distrust of interpreters provided by the NHS who were described as unqualified to translate using medical terminology.[293] There were perceptions from ethnic minority groups that screening services did not (or would not) meet their cultural and religious needs. This participant experienced a lack of sensitivity to religious beliefs which dictated that women could only be seen by a female practitioner:

> "They just make you feel uncomfortable [for requesting a female nurse]. So that is why I don't go, if I got the test I would say no I don't want to go because of this thing."(P)[294]

Associations of cervical screening with promiscuity raised concerns about confidentiality in women who did not trust clinicians and receptionists to meet these needs.[295]

Another aspect of the relationship which influenced decisions is the communication from the health service to the invited patient. Firstly, interpersonal communication was a key component of the relationship:

> "All of the participants identified unhelpful GPs' attitudes as a factor that affected their desire to take up screening."(A)[292]
>
> "My GP, he sits like he is getting impatient that I am there … and I'm thinking don't worry about it — I'm just wasting your time."(P)[292]

Secondly, screening-specific communication flowed from the health service to the individual containing information about the potential harms and benefits. Different levels of knowledge about screening resulted from this communication, but in those who did not attend there was often a deficit in knowledge and understanding about screening, which they were not motivated to overcome:

> "Throughout the focus groups the women expressed a lack of awareness about the need for cervical screening, resulting in the women ignoring an invite for cervical screening."(A)[296]
>
> "Expressions such as 'never knew anything about cancer before'; 'I never knew'; 'I didn't know what is cancer' were common."(A)[278]

In contrast, the information had influenced some to take part in screening:

> "I think when the booklet came through, that actually made up my mind really. If I hadn't of thought about it before, once I'd read that booklet, after reading it I would think, yes, after reading this information I would definitely want to do it."(P)[297]

There were expectations that screening should take place in a clinical setting and that patients are the passive recipient of care from the screening provider.[287] The receipt of home testing kits for colorectal cancer, for example, was interpreted as unusual and impersonal. The detachment of screening from clinical settings was linked to non-uptake:

> "Self-testing at home … undermined the value and relevance of screening."(A)[287]

Invitations endorsed by general practitioners were revered and carried additional weight, especially in those holding a biomedical view of the health service relationship in which the medical profession were seen as the sole decision-makers:

> "I don't think breast screening is beneficial. I do it only because it is requested by a doctor."(P)[271]

> "It is up to the medical profession what they do, it is not up to the public to tell them what to do."(P)[294]

For women, the relationship with the health service was sometimes not perceived to be strong enough to entertain the prospect of attending screening, during which they would be required to reveal private parts of their body to a stranger.[295] There was a theme of control and surveillance experienced by women, within a discourse from the provider of the female body being a site of risk in need of medical observation,[276] or feelings their bodies were being used to fulfil quotas[295] or achieve other objectives. Some felt doctors might be inclined to overtreat or undertreat cancer:

> "Because doctors aren't infallible are they? … Some will be more cautious than others, some will want to err on the side of not doing very much surgery and only doing as little as they can get away with until there is an indication that more is needed."(P)[281]

3.5.4 Fear

Fear was the second primary theme explaining decisions about cancer screening and was both a motivator and barrier to screening attendance. Four key sources of fear were screening invitations, the threat of cancer in the absence of screening, the threat of abnormal test results, and screening methods.

Varying levels of fear were experienced as a result of cancer screening invitations. Non-attenders described being 'terrified' and 'frightened to death' by the invitation,[286] leading to a quick decision to not respond.

> "I don't want to do it voluntarily. I suppose I'm scared of cancer."(P)[267]

Fear was often associated with displeasure or concern at being identified as being 'old', leading to avoidance or delay in participation.

> "You're coming up to the age and you're afraid."(P)[265]

> "Our participants appeared to associate the screening test with entry into the socially constructed category of 'old age' and wanted to avoid the stereotypical image that associates older age with chronic illness."(A)[268]

More moderate levels of fear were negotiated by talking to others and seeking more information about screening:

> "I remember the first invitation, I threw it out….I just thought it was – I didn't want to know about it. I more or less got frightened and thought what I don't know won't bother me. Then I spoke to a few people and they said if you go early you've got more of a chance. I phoned up and got another one sent."(P)[282]

Fear of developing cancer in the absence of screening was a powerful motivator to attend which facilitated the overcoming of other perceived barriers to screening:

> "When it's something like discovering whether you've got cancer or not, which is life or death, it is very important that you do the test."(P)[297]

> "Fear appeared to be the main driving force behind the decision to have smear tests."(A)[276]

Implications of an abnormal screening test result were a principal source of fear. This was described as 'fear of the unknown' and fear of an inability to cope with a diagnosis and 'the word cancer' itself.[286]

> "It's kind of scary and it's all leading up to the result."(P)[265]

Fears about screening methods were commonly cited, either from previous experience or from anecdotes. These were anticipated as leading to other negative emotions including pain, discomfort and embarrassment:

> "For some women ... fear of the test being painful had acted as a barrier to screening in the past."(A)[270]

> "Fear of the test was cited as a hindrance to some women, even if they appreciated the need for screening. The metal

> speculum was perceived as a painful instrument and some did not trust the sterilisation process."(A)[293]

Fear was both a barrier and motivator to cancer screening attendance:

> "Many individuals seemed inhibited from acting by their fear. Avoidance of thinking about cancer, and a preference for 'not knowing' were expressed several times. However, this was balanced by numerous statements in favour of knowing."(A)[265]

> Woman: "It doesn't make sense [non-participation] if everybody is so scared about it why don't they do something about it?" Man: "Yeah, but ignorance is bliss, you know."(P)[268]

Another aspect of screening feared was the performance of an unfamiliar event under professional scrutiny:

> "Women lacking in social and educational capital attribute some of the obstacles to personal failings. They fear looking foolish in new and unfamiliar situations."(A)[288]

The importance of the social role of screening patient that must be 'played' in order to successfully navigate the screening process is highlighted here. A low level of confidence in one's ability to fulfil this role without social inadequacy can mean fear of failure and

lead to avoidance.[288] Anticipation of having to wait for screening results also generated fear. Other sources included a general fear of hospitals and medical procedures[286] and fear of stigma associated with cancer or cancer risk.[278]

3.5.5 Experiences of risk

The third concept explaining screening attendance decisions was risk. The third-order interpretation was that those invited to cancer screening were subject to external discourses of risk and in response to this created their own 'game of chance'.[288] The 'official discourse' from the health service labels individuals as 'at risk', non-attenders as at even higher risk and attenders as at lower risk.[272] There was resistance to this discourse, influenced by themes of disease beliefs, current health and previous experiences of cancer. One author described the understanding of risk as occurring through 'candidacy':

> "Women distance or align themselves with breast cancer candidacy by strategically amplifying or submerging differences and similarities between their own beliefs and behaviours and those of idealized others."(A)[288]

In other words there are benchmarks, or 'candidates' against which people measure their personal risk, which influences screening attendance decisions. For example, the belief that an absence of symptoms and perceived wellness meant low risk of the disease

was cited as a reason for either attending or not attending screening:

> "I'd almost be surprised if I did get it, I don't feel anything."(P)[298]

Another author highlighted that participants inaccurately perceived a genetic component to cervical cancer risk:

> "Many ... tended to combine cervical cancer with other cancers as if to suggest that cancer was simply one disease that could develop in different locations around the body."(A)[272]

The same author describes how beliefs about the disease and previous experiences of cancer can influence experiences of risk and therefore screening attendance:

> "The idea that there is 'cancer in the family', or that the family has 'cancerous genes', can heavily influence an individual woman's views on screening and her perceived level of risk."(A)[272]

Beliefs were expressed that risk of cancer was reduced by participation in screening. This shows how screening offered as secondary prevention (e.g. breast cancer screening) can be experienced as primary prevention. This may be a coping strategy to gain protection from the risk and uncertainty of the threat of

cancer. Beliefs about cancer also influenced risk in minority ethnic groups, for example beliefs that talking about cancer or being in close proximity to someone with cancer can put one at risk.[278]

3.5.6 Other factors influencing the decision

3.5.6.1 Altruism

Altruistic reasons for attending cancer screening were sometimes cited. This was described as a sense of obligation, a civic duty, and good citizenship.[297] Underlying reasons for this were beliefs that taking part in a preventative programme such as screening would save the NHS money,[297] screening was a good use of NHS resources[285] and screening was a form of medical research that could advance science.[267] There were also altruistic reasons for taking part in screening as part of a research trial, such as helping future generations, including relatives,[298] and 'giving something back to society'.[269]

3.5.6.2 Practical factors

Many studies identified practical factors, such as travel, as influencing the screening attendance decision:

> "The only drawback I would say [is] the fact that I had to travel which meant that I had to have days off work and my husband had to have days off work to take me because it is not the kind of thing that you want to go to by yourself."(P)[269]

3.5.6.3 Uncertainty about factors

Some people were unable to offer a reason for not attending screening. This was highlighted by one author as a limitation of quantitative research on the topic:

> "Survey studies that ask women to choose reasons for nonattendance from a check-list … assumes that women have well-articulated reasons for nonattendance that can be accessed by a simple question. It appears that this is not always the case."(A)[299]

3.6 Discussion

3.6.1 Main findings

This meta-synthesis aimed to explore factors influencing the decision of whether or not to attend cancer screening in the UK. The objective was to create a higher level interpretation that includes all cancer screening, rather than identify factors specific to different types of cancer screening. In doing so, it has generated new knowledge that adds to existing evidence of sociodemographic, psychosocial and practical factors associated with cancer screening uptake.

The finding that individuals' relationship with the health service was the most important factor suggests that the context of the screening invitation is fundamental in their decision. The decision

takes place with underlying dynamics of trust, power, control and authority. Some people were compliant with screening requests, particularly when received from a known source. This is consistent with research demonstrating that general practitioner endorsement promotes higher uptake.[240] However, in a society where many areas of people's lives are under routine surveillance, there can be scepticism of the requirement to adhere to a screening regime. A general distrust of those in power is a social dynamic that can include health services. For example, a qualitative study found that smokers reported distrust of the medical system in perceptions of lung cancer screening.[218] Resistance from those invited to screening, described in the data in terms of deviance, may be an attempt to maintain control over their own bodies and their right to decide when they need medical attention.

A component of the relationship with the screening provider is the information received and the knowledge and understanding that results. In screening, this communication typically occurs in writing and many of the nuances of communication that could contribute to a trusting relationship are lost. Home visits combined with an educational video were shown to be particularly effective in promoting screening uptake in a group of Asian women who were not recorded as having previously attended, whilst written translated materials were ineffective.[300] Interventions to modify invitation materials may have limited potential to promote uptake

beyond that which has already been achieved.[243, 244, 301] Improving screening uptake may require strategies that promote a personal connection with prospective screening patients.

It is known that social deprivation, gender and ethnicity are associated with cancer screening uptake. The meta-synthesis did not aim to identify and compare barriers across socioeconomic, gender or ethnic groups so it has limited ability to explain sociodemographic patterned uptake of cancer screening. An interpretive synthesis of access to healthcare by socio-economically disadvantaged people identified candidacy as the key concept.[302] This was defined as 'the ways in which people's eligibility for medical attention and intervention is jointly negotiated between individuals and health services'.[302] This concept can be continually redefined based on the changing relationship with the health service, demonstrating how investment in the relationship can promote screening uptake over time. Attending screening may have a further impact on this changing relationship, leading attendees to perceive greater importance of the role of the health service in maintaining their health.[303] Socioeconomic status may impact screening uptake via different pathways. Such groups may experience more frequent life stressors and have fewer resources to cope with them.[304] A study of intentions and action in colorectal cancer screening reported that social cognition variables were strongly associated with intention but only weakly with action. In

contrast, life difficulties (deprivation, poor health) were better predictors of action than intention.[305] This indicates poorer socioeconomic groups may experience non-screening specific barriers related to poor health literacy and higher life stress. A UK study found informal caregiving responsibilities did not explain the socio-economic gradient in breast cancer screening attendance[306] but further research is needed to explore other life stressors.

Several studies included in this review investigated minority ethnic groups, which suggested that cultural barriers were of importance when considering screening decisions. There was evidence that in some cultures cancer was a taboo subject that should be avoided, and that cervical screening carried particular stigma. There appeared to be a poorer relationship with the health service in immigrant populations, who had greater cultural and language needs that were seen as being unmet. They experienced further barriers due to a lack of familiarity with the NHS and limited knowledge of services. A study in Norway showed immigrant women are less likely to attend breast screening, even after adjusting for sociodemographic factors.[307] It was found in that study that screening attendance increased with duration of residency in the country, perhaps because the relationship with the health service strengthened over time and they may have been less likely to return to their country of origin as time progressed.

The finding that fears about cancer screening were an influential factor is consistent with a body of previous research. A Canadian focus group study of how affect influences breast and prostate cancer screening decisions found that participants reported fear of the particular cancer or of cancer in general, and fear of screening harms including discomfort, radiation exposure, false-positive results and unnecessary treatment.[308] Lack of fear was the strongest predictor of cervical screening uptake in a UK survey.[309] In the UK Flexible Sigmoidoscopy Trial desire for screening was higher in people who worried about cancer, but participants were less likely to attend if they felt uncomfortable at the thought of cancer.[310] The fear finding is also consistent with evidence of barriers to help-seeking for cancer symptoms. A meta-ethnography of patients' experiences found that fear of consultation was one of two key concepts.[253] This manifested as a fear of embarrassment and fear of cancer.

The relationship between fear and cancer screening attendance is complex and the findings of the current meta-synthesis show the different ways fear is experienced and interpreted in this context. There were individual differences in fear responses to the perceived threat that a cancer screening invitation presents. It has been suggested by reviewers of the fear appeal literature that fear combined with high-efficacy messages promotes health behaviour change and fear with low-efficacy messages creates defensive

responses.[181] This synthesis supports the premise that very high levels of fear about cancer screening can promote avoidance and demonstrates the importance of the relationship with the health service in enabling the negotiation of moderate levels of fear in deciding to attend screening. Some overcame their fear having been persuaded by another person to attend, presumably someone they knew and trusted. Increasing familiarity and trust in relation to the health service might have a similar effect in moderating fear.

The role of fear and its link with cancer worry and perceived susceptibility in cancer screening uptake has received much attention.[310-312] However, the role of emotions has been underplayed in the past by health behaviour models and quantitative survey research on this topic.[174, 254] It might be difficult to reconcile emotionally-driven thoughts about cancer screening with information about the benefits and harms of screening. Faced with such a complex and uncertain situation people may revert to emotionally-driven factors over rational ones.[313] Efforts to improve screening uptake should consider the role of fear in individual decision-making, methods for overcoming such fear, the potential for emotional factors to inhibit informed decisions and strategies for addressing this.

The meta-synthesis showed how the experience of being identified as 'at risk' by the health service led to some resistance and the

creation of alternative explanations based on a range of beliefs about the disease. According to the health belief model, feelings of susceptibility and concern about serious consequences are two reasons why asymptomatic people might undergo screening tests.[132, 133] Evidence shows that a moderate level of perceived risk optimises screening uptake, with high levels leading to avoidance and low levels a lack of motivation.[252] The interpretation in this meta-synthesis was one of individuals creating their own perceptions of risk irrespective of the 'official discourse', sometimes by comparing themselves to others through 'candidacy'. Risk perceptions were influenced by beliefs about cancer, current health and previous experiences of cancer. Attending screening was a strategy to cope with risk, amongst the other interacting factors identified in the synthesis. There may be optimum ranges of both fear and risk that motivate screening attendance.

The findings of this meta-synthesis go beyond those of the three previous qualitative syntheses on this topic described in section 3.2.11. There was overlap in their inclusion of some of the same UK studies but there were different approaches to analysis. They reported barriers to screening uptake that fit within the conceptual framework developed in this meta-synthesis. For example, *professionals' attitude to the need for screening, embarrassment, language, interaction with health professionals; smear taker preferences – trusting relationship/anonymity*[249] all fit within the

overarching *relationship with the health service*. One synthesis identified *awareness* as the central component influencing the others.[250] In comparison, the current meta-synthesis identified *information/knowledge (or lack of)* as a recurring theme (Table 3.4) but did not conceptualise it as a central component influencing the others. Instead, knowledge or awareness about cancer screening was a component of the relationship with the health service and the information that flowed to the individual within that relationship. This difference in the importance and positioning of awareness or knowledge could indicate that knowledge of cancer screening programmes is high among those eligible for screening in the UK. Perhaps a lack of awareness is a greater barrier in other countries where different screening systems exist, although awareness may not necessarily equate to accurate understanding of the benefits and harms of screening.[314] Accurate knowledge is essential for informed decision-making about participating in screening. Due to the enduring effect of communication in the past about the benefits of screening, it could be difficult to 'un-ring the bell' and promote awareness that screening harms may sometimes outweigh the benefits.[308] It has been demonstrated by a population-based survey that knowledge is associated with sociodemographic status, ethnicity and previous screening attendance[210] but the direction of the associations is unclear and is an area for further investigation.

The findings of this meta-synthesis may be generalisable to other health screening in the UK. For example, factors influencing decisions to take up the offer of a NHS Health Check were found to include a lack of awareness of the programme, beliefs about susceptibility to cardiovascular disease, beliefs about civic responsibility, issues concerning access to appointments, and beliefs about the consequences of having a check.[315] The NHS Health Check is a relatively new screening programme, which could help explain why awareness was a barrier. There were, however, findings consistent with risk (barriers *maintains healthy lifestyle, believes risk is low*) and perceptions of the health service (facilitator *moral responsibility to attend if asked*).

Cancer screening should be contextualised in public health and the findings may aid understanding of engagement with other health processes. Poorer socio-economic groups with the greatest morbidity and need for preventive services have the lowest rates of uptake across a range of services including cancer screening,[316] so factors may be generalisable beyond screening. It has been argued that if public health consistently and reliably meets the most pressing needs of vulnerable communities, cancer screening may come to have more relevance to them.[317] It is therefore important that the evidence on cancer screening uptake is not examined in isolation but is considered within a wide-ranging assessment of the needs of underserved groups.

3.6.2 Strengths of the meta-synthesis

The meta-synthesis provides an insight into the thoughts and experiences of a diverse range of people from around the UK. A particular strength is the focus on data that explained participants' own real life screening attendance decisions. A range of databases, journals and online sources were searched in an attempt to identify most, if not all, relevant evidence, not just that from medically focused sources. Hand-searching and citation searching were used to overcome the known difficulty in relying on descriptive titles and indexing of studies to identifying qualitative research.[318]

The inclusion of data on all types of cancer screening, including from research trials using screening that is not routinely available, provides a wide ranging examination of the topic. It is necessary to incorporate, at the earliest opportunity, experiences of new types of cancer screening where the evidence exists, including prostate, ovarian and lung cancer screening. An included key paper found that a discussion about the causes of breast cancer 'dissolved' into a debate about the causes of all types of cancer.[288] There was also evidence that people tend to combine different types of cancer as one disease.[272] This shows the value in consideration of factors influencing uptake of all types of cancer screening, rather than one type in isolation.

3.6.3 Limitations of the meta-synthesis

Reasons for participation in cancer screening research studies may differ to those for NHS screening programmes, however the vast majority of included studies related to NHS cervical, breast and colorectal screening. The studies were published over a wide timeframe (1994-2016) and so the experiences of participants may not necessarily reflect the current or future state of screening in the UK. For example, it is estimated the future introduction of a faecal immunochemical test as a simpler colorectal cancer screening test method will lead to a substantial increase in uptake.[319] A further limitation is the potential for recall bias to have influenced the data because the inclusion criteria required studies to report past experiences of screening attendance decisions. A major limitation is that those who are least likely to engage in screening (e.g. socioeconomically deprived groups and those who cannot speak English) were probably underrepresented in the data since they might be less likely to take part in a research study on the topic. There may be factors that qualitative research on this topic has limited ability to identify. For example, health literacy is thought to be associated with cancer screening uptake[320] but was not an influencing factor in the meta-synthesis. Finally, the experiences of men may be underrepresented because most UK cancer screening is provided for women.

Debate exists about some aspects of meta-synthesis as a method for combining qualitative findings. Firstly, synthesis of findings originating from different contexts and research traditions has been questioned. There are, however, examples of meta-ethnographies which have successfully synthesised papers rooted in different qualitative research traditions and made a valuable contribution to the extension of qualitative research.[321] Secondly, given the importance of explanatory context in the analysis and interpretation of qualitative data, there are concerns about a loss of context when combining studies. Thirdly, meta-synthesis is inherently restrictive in terms of the proportion of data (participant quotes) which are presented by study authors and which can therefore be extracted for inclusion in the analysis. Finally, quality appraisal is a contentious exercise for qualitative research. There is debate about whether studies should be assessed for quality and how such judgements should be used. It has been argued that this can become an exercise in judging the quality of reports rather than the quality of research, particularly those published in journals which are not qualitative-focussed.[322] In this meta-synthesis appraisals of reports were only used to distinguish 'key' papers and 'fatally flawed' papers (of which there were none) from others ('satisfactory' papers), to guide the synthesis.

3.6.4 Implications for practice

The pursuit of informed choice means cancer screening uptake decisions should be made by the invited individual, with an understanding of the benefits and risks involved. This chapter indicates that such an approach is somewhat detached from the reality of people's experiences of making the cancer screening decision. The evidence shows that individuals are influenced by a number of wider factors and tend not to make rational judgments by weighing up the benefits and risks of screening, which may not even be read or understood. Increases in screening uptake might be achieved as a result of interventions targeting the population or clinicians to improve the relationship between the screening provider and non-attending patients. This could involve utilising existing trusted relationships, such as extension of general practitioner involvement[323] subject to general practice time constraints and other priorities. Effective communication strategies about cancer screening should be in place, using advocacy groups and the media.[324] Reliance on printed materials should be reduced. Cancer screening could be reframed by the NHS within an 'us versus cancer' battle, exploiting perceptions of cancer as the greatest health problem we face and positive attitudes to the NHS.[325] For certain groups there may be a benefit in including key community figures (e.g. local religious leaders) in communicating the health agenda, or offering different screening arrangements in

tandem with existing screening, for those with specific cultural needs.[317] Interventions should provide personalised care from a trusted source, to detract emphasis from the "anonymous" systematic nature of computerised call-recall screening processes. If cancer screening is more personalised then invitation recipients may be less likely to resist the official discourse on risk. There could be tailored responses to individual levels of fear and perceived risk, perhaps using interactive methods. This could help prevent avoidance or lack of motivation to attend cancer screening.

3.6.4.1 Lung cancer screening

This meta-synthesis can aid in understanding factors that might influence uptake of a future UK lung cancer screening programme. Only one lung cancer screening study was included in the review (from the LungSEARCH trial)[298] but there are indications that fear and perceived risk could be particularly influential in lung cancer screening decisions. This could be due to the high mortality rate, the strong association of lung cancer with smoking and possible stigma associated with perceptions of the disease as being self-inflicted. Because social deprivation is associated with both smoking and cancer screening non-attendance, lung cancer screening faces unique challenges which may require significant efforts to overcome. The UKLS found practical and medical reasons were the most commonly cited barriers to participation, followed by emotional barriers, particularly in smokers. These included fear and

avoidance of lung cancer information. Low perceived risk was a barrier and was cited in relation to either no longer smoking or smoking too few cigarettes to warrant screening.[202] In the NLST, themes identified in data from those who opted out of screening were knowledge avoidance, perceived low value, false-positive worry, practical barriers and patient misunderstanding.[326] Another USA study reported that fear of a lung cancer diagnosis and perceived lung cancer risk were the most influential factors for patients making decisions about lung cancer screening.[327] A USA study aims to evaluate communication processes being used in lung cancer screening and to identify best practices that can be scaled up. It hypothesises that higher quality of patient–clinician communication will be associated with less decisional conflict in lung cancer screening participation.[328] In the USA there is a requirement for shared decision-making about lung cancer screening. This is to ensure patients are eligible for screening (and the risk-benefit ratio of screening is maintained) and to provide them with individualised information to make an informed choice about screening.[67] This is a different type of decision-making to that prompted by postal invitations in UK cancer screening programmes and places greater emphasis on the interpersonal communication aspect of the provider-patient relationship. There has been work on the development of a conceptual model to guide research on uptake of lung cancer screening. It links key variables

(stigma, medical mistrust, fatalism, worry, and fear) with theoretical models and can be refined by future research.[329] It is important that this includes both qualitative and quantitative research, and that the applicability of the model to lung cancer screening in the UK is assessed in the future. If lung cancer screening is implemented in the UK, awareness will initially be low and information will need to be communicated very carefully to target groups. Improving awareness of screening will be crucial and could have additional indirect benefits by raising awareness of the disease and promoting earlier help-seeking for its symptoms.

3.6.5 Implications for research

Findings highlight the limitations of theoretical models in explaining screening uptake behaviour. Such approaches do not fully take account of factors such as trust, compliance/deviance, religious and cultural beliefs, civic duty, fear, embarrassment, resistance to risk and practical aspects of attending and completing a screening test. Further research should use quantitative methods to explore in which groups the barriers identified are prevalent and the extent to which they are experienced. This evidence would allow the targeting of interventions which could contribute to increases in cancer screening uptake. The meta-synthesis was not able to adequately explore why uptake is lower in poorer socio-economic groups and so qualitative research is needed into their experiences. There is a need for research on factors associated with compliance

with the cancer screening pathway beyond the initial screen. There is also a need for interpretative research to improve other components of UK early cancer detection strategies, such as delays in help-seeking for cancer symptoms. New screening methods may be developed in the future and strategies may be undertaken to improve understanding of the benefits and harms of screening, rather than the current situation where information is provided but often poorly understood. This creates a continuing need to investigate experiences of being invited for cancer screening.

3.7 Conclusion

This chapter highlights important factors that influence individual decision-making about uptake of cancer screening programmes in the UK. Strategies to improve uptake should target perceptions of the wider health service, rather than modifications to screening invitation materials or methods alone. They should consider how fear can be an overarching barrier to cancer screening and how high levels of fear could be prevented and moderate levels negotiated. Individuals' decisions often relate closely to perceptions of risk but official information about risk can be rejected and replaced by their own assessments. This is perhaps because UK cancer screening lacks a personal touch and its information can be seen to carry low personal relevance, so promoting personalised care from a trusted source could be beneficial. If a lung cancer

screening programme is implemented in the UK there may be other unique barriers in addition to those identified in this chapter.

Decisions about cancer screening are shaped by a multitude of psychological factors and lived experiences, which vary between individuals. More people may participate in cancer screening if it becomes more personalised and sensitive to these psychosocial and contextual factors that influence decisions to be screened.

4 The impact of lung cancer screening on tobacco use

4.1 Chapter summary

In this chapter is reported a behavioural study nested in the ECLS study: a RCT of a biomarker blood test for early lung cancer detection.

A cohort of smokers and ex-smokers from the screened and unscreened trial arms (n = 1,032) completed questionnaires before screening, at one month (after receipt of blood test results) and at three, six and 12 months. They self-reported smoking 7-day point prevalence, number of cigarettes smoked per day, nicotine dependence, attempts to quit and cut down, and smoking-related social cognitive variables, including motivation, intentions and norms. Multi-level regression analyses, using an interim dataset and adjusted for confounders, explored differences in smoking variables over time between screened and unscreened arms and between the positive test group, negative test group and unscreened arm.

There were no statistically significant differences in smoking 7-day point prevalence between the screened and unscreened arms at any time point or across all time points, OR 0.73 (95% CI 0.38-

1.42). There were no significant differences on any other outcomes between screening arms.

When comparing test result groups, there was no significant difference in smoking 7-day point prevalence between the positive test group and unscreened arm across all time points, OR 0.55 (95% CI 0.25-1.19), or at any single time point. Similarly, there was no significant difference in smoking 7-day point prevalence between the negative test group and unscreened arm across all time points, OR 0.95 (95% CI 0.45-2.01), or at any time point. Positive test group smokers were significantly less likely to report smoking 20 or more cigarettes a day than the unscreened arm across all time points, OR 0.32 (95% CI 0.14-0.69), a difference that endured at 12 months. Significantly more smokers in the positive test group had attempted to quit at three months compared to the unscreened arm, OR 2.29 (95% CI 1.04-5.04). Compared to unscreened arm smokers at three months, negative test group smokers were significantly less likely to have attempted to cut down, OR 0.47 (95% CI 0.23-0.98), or to perceive health benefits of quitting, OR 0.33 (95% CI 0.11-0.93). Negative test group smokers were significantly less likely at one and three months, and positive test group smokers significantly more likely at six months, to be thinking about or trying to quit compared to unscreened arm smokers.

The results suggest randomisation to a biomarker blood test for early lung cancer detection does not result in overall benefit or harm via changes in smoking behaviour. However, test result subgroups displayed contrasting behavioural responses to screening, indicating potential benefits and harms. Findings show a positive lung cancer screening test result can promote quit attempts and they highlight the short-term risk of adverse behavioural response after a negative test result.

Results are compared with existing evidence and evaluated in light of several key strengths and limitations of the study. Conclusions drawn are: (1) there is probably no impact of allocation to lung cancer screening on tobacco use but this may depend heavily on the proportion receiving positive test results; (2) this is because positive lung cancer screening test results can lead to significant benefits via changes in smoking-related motivation and behaviour; (3) evidence remains unclear of harm resulting from changes in behaviour following negative test results; (4) differences in social cognitive variables provide considerations for smoking cessation interventions, however they do not adequately explain pathways by which smoking behaviour change may occur and further work is needed to better understand screening participants' experiences.

4.2 Background

4.2.1 Benefits and harms of lung cancer screening

Three annual CT screens for the detection of lung cancer have been shown in the USA to reduce lung cancer mortality by 20% compared to chest X-ray.[50] CT screening for lung cancer can also cause harm through overdiagnosis, false positive test results, overtreatment and adverse emotions.[32] Alternative screening strategies, such as a simple biomarker test, may enable more effective detection of early stage lung cancers, the targeting of diagnostic scans at those at greatest risk of the disease and fewer false-positive results.[84] This could lead to more cost-effective screening and less associated harm.

It has been suggested that one of the key benefits or harms of lung cancer screening is the impact it might have on smoking behaviour.[156] This is because awareness is high that smoking is the greatest risk factor for lung cancer, due in part to decades of public health campaigns.[106] Smoking is the leading behavioural cause of premature death,[101] a major contributor to health inequalities[106] and there are clear health benefits of cessation in adults of all ages.[128] Most individuals screened are eligible because of their smoking history, amongst other criteria. Screening could promote smoking cessation and continued abstinence, or conversely, could lead to fewer cessation attempts and heavier continued smoking.[147]

The beneficial effect of smoking cessation on overall mortality may be three to five times greater than the effect achieved by CT lung cancer screening alone,[156] so the overall success of lung cancer screening programmes may be heavily influenced by any effect of screening on subsequent smoking behaviour of participants. It is therefore important to know the direction and size of effect of lung cancer screening on smoking behaviour in screened groups, to comprehensively assess the benefits and harms of lung cancer screening.

Past studies have reported either higher quit rates in screened groups or no effect of allocation to screening on smoking.[96-100] No studies to date have shown greater tobacco use after screening[96-100] but behavioural response to lung cancer screening methods other than CT have not been studied and negative test groups have often not been examined in detail.

Hereinafter, outcomes associated with greater chance of smoking cessation or abstinence are referred to as 'beneficial' and those associated with continued or heavier smoking as 'harmful'.

4.2.2 Health behaviour theories

Theories of health behaviour that are useful in understanding and explaining behavioural responses to lung cancer screening are outlined in Chapter 2. In general, smoking behaviour is not very well explained by models of health behaviour. Whilst there is a

consensus about the most effective strategies to promote cessation, the theoretical underpinning of behavioural cessation support is debated.[330] With that said, this section considers the application of behavioural theory to smoking behaviour change in response to lung cancer screening. It focuses firstly on two social cognition models chosen as the most relevant to the research question under investigation in this chapter. They were developed specifically to explain the impact of health risk information on risk-reducing behaviour. It is hypothesised lung cancer screening can provide new lung cancer risk information that might influence smoking behaviour.[32] Other models can be applied to the behaviour and context under investigation but they organise variables differently and do not give as great an emphasis to risk perceptions. The models use distinct processes to more thoroughly explain how changes in perceived risk can lead to different outcomes for a behaviour that is known to be directly related to that risk.

4.2.2.1 Protection motivation theory

PMT was developed specifically to explain the impact of health risk information on risk-reducing behaviour. It states that there are six perceptions that influence motivation to engage in a protective behaviour, and these can be applied to responses to health risk information received via a screening test result.[177] The model is described in Chapter 2, section 2.4.4.

4.2.2.2 Extended parallel process model

The EPPM is another model that demonstrates how health risk information, or fear appeals, can lead to a change in motivation to perform a protective behaviour.[180] It also describes how fear appeals (e.g. pictorial cigarette pack warnings) can lead to avoidance. The model is described in Chapter 2, section 2.4.4.

4.2.2.3 Intention-behaviour gap

The models above explain behavioural intentions but more than half of intentions do not result in behaviour.[331] For example, in a UK study of cervical screening attendance, PMT constructs predicted intentions and behaviour but only 43% of those who intended to attend screening were later found to have done so.[332] Strategies to reduce the intention-behaviour gap include the formation of implementation intentions, or 'if-then' plans.[333] Smokers who formed implementation intentions were significantly more likely to quit, smoke fewer cigarettes a day and have lower nicotine dependence.[334]

4.2.2.4 Addictive behaviour

There are a range of behaviour change theories that can be applied to tobacco use, each giving emphasis to a different set of modifiable factors and/or behaviour change techniques.[167] But they can be criticised for failing to explain irrational, habitual behaviour that is characteristic of addiction. Theories of addictive behaviour

should be considered to ensure the current study is grounded in theoretical approaches that are most relevant to the type of behaviour under investigation, as well as the context of the behaviour. West (2006) stated 'the theory of addiction is in fact a theory of motivation and how the motivational system is distorted in the case of addiction.'[335] West outlined 'PRIME theory', a 'synthetic theory' that attempts to unify existing theories of addiction such as those of rational choice, irrational choice, personality and disease models of addiction. It argues three types of abnormality lead to addiction: abnormalities in the motivational system independent of the addictive behaviour such as anxiety, depression and impulsiveness; abnormalities in the motivational system caused by the addictive behaviour such as development of habits, withdrawal symptoms and acquired drives; abnormalities in the physical and social environment that contribute to the behaviour having an high priority. There is a 5-level motivational system: plans, evaluations, motives, impulses and simple responses. Higher level motivations (plans and evaluations) can only influence behaviour through motives, and motives can only influence behaviour through impulses. This gives priority in behaviour to the immediate situation over prior planning, and to feelings over beliefs.[335] This can help explain behaviour that is poorly explained by theories of health behaviour, such as spontaneous smoking quit attempts that involve no prior planning.

There is support for this multilevel approach to motivation in explaining smoking cessation behaviour. A scale that included different levels of wanting and planning was predictive of quit attempts at six months.[336] Enjoyment of smoking and strength of urges to smoke were associated with significantly lower likelihood of quit attempts and successful quit attempts respectively at six months.[337]

4.2.2.5 Summary of theories

PMT and EPPM describe how risk information resulting from lung cancer screening might lead to smoking behaviour change. Intentions to change one's behaviour are associated with threat appraisals (perceptions of severity and susceptibility) and coping appraisals (efficacy and self-efficacy). Low-threat fear appeals appear to produce little, if any, persuasive effects. Social cognitive models of health behaviour such as these can be applied to smoking behaviour but theories of addictive behaviour should also be considered to take account of distortions in the motivational system. This gives priority to simple responses and impulses over beliefs and intentions.

This knowledge can be used to identify relevant cognitive and motivational components that precede behaviour. However, it is inappropriate to base the approach of the current study on any single behavioural theory because no single construct has been

shown to be most suited to the behaviour and context under examination. Rather, this chapter adopts an approach informed by theory, using knowledge of PMT, EPPM and addictive behaviour, in combination with components of other models outlined in Chapter 2 (HBM, TPB, TTM). These identify commonly acknowledged intermediary behavioural variables that can be measured to explore the impact of a health event that produces new risk information, such as screening, on subsequent behaviour. Smoking-related social cognitive variables considered in the study are:

- Perceived risk of lung cancer
- Motivation to quit
- Perceived health benefits of quitting
- Self-efficacy to quit
- Subjective norms about quitting
- Readiness to quit
- Intention to quit

4.3 Objective

The objective of this chapter is to report a study measuring the impact of screening for the early detection of lung cancer on tobacco use over a 12 month period. This was investigated with a questionnaire study nested in a UK screening trial that used a

biomarker blood test as the screening method. It aimed to examine:

i. The effect of randomisation to screening on tobacco use and smoking-related social cognitive variables;
ii. The effect of screening test result on the same outcomes.

4.4 Methods

4.4.1 ECLS methods

4.4.1.1 Aims

ECLS is a RCT evaluating the effectiveness of a biomarker blood test (EarlyCDT-Lung) to detect lung cancer early.[95] This chapter considers the impact of the test on smoking behaviour.

4.4.1.2 Recruitment

ECLS recruited 12,210 participants primarily through general practices serving patients in the most deprived areas of Scotland. The regions were NHS Greater Glasgow and Clyde (GGC), NHS Tayside and NHS Lanarkshire. Other recruitment was conducted in the same regions through adverts, posters, flyers and other community based strategies. ECLS inclusion criteria were:

- Aged 50–75 years
- Current or former cigarette smoker with at least 20 pack-years, or less than 20 pack-years plus an immediate family

history (parent/sibling/child) of lung cancer giving an equivalent personal risk to 20 pack-years

- Healthy enough to undergo radical treatment either by pulmonary resection or stereotactic radiotherapy

Exclusion criteria were:

- History of any cancer other than non-melanomatous skin cancer and/or cervical cancer in situ
- Lung cancer symptoms in the past six months, e.g. coughing of blood or weight loss
- Patients for whom the GP considered invitation to ECLS would cause undue distress
- Patients with terminal disease
- Patients on prolonged/continuous use (>3 months) of Cyclophosphamide (chemotherapy)

The ECLS invitation letter included a slip for individuals to express interest in taking part. Those returning a slip were telephoned by a member of the local ECLS research team. The researcher discussed the study, answered any questions, conducted a preliminary eligibility assessment and, if eligible, made an appointment for a baseline clinic visit. Non-responders to the invitation letter were contacted by a reminder letter or a message on a repeat prescription.

4.4.1.3 Baseline clinic visit

Baseline visits took place at local clinical research facilities. At this 30-45 minute visit, research nurses confirmed eligibility and obtained written informed consent, including an option to consent to further research. Nurses took a blood sample from all consented participants, asked them to complete a baseline questionnaire and, after completing the questionnaire randomised them to either a screening ('screened arm') or control ('unscreened arm') condition. This was conducted using the web-based Tayside Randomisation System (TRuST) provided by Tayside Clinical Trials Unit. Randomisation was stratified by GP practice and minimised by gender, age group (50-54; 55-59; 60-64; 65-69; 70-75) and smoker/ex-smoker.

It should at this stage be emphasised that the unscreened arm underwent an experience that is different to a situation in which screening is unavailable. They were identified as at increased risk of lung cancer, invited to a screening study, confirmed as at increased risk, visited the clinic, provided a blood sample, and then informed the blood sample will not be screened. ECLS evaluates the physical act of screening, communication of test results and the subsequent imaging pathway but not necessarily the effect of implementing the overall programme of screening.

4.4.1.4 Screening arm

Blood samples were sent to a USA laboratory for screening with the EarlyCDT-Lung test.[92] Within four weeks screening test results were available to research nurses through a secure portal. A negative test result was communicated to participants via a mailed letter. It stated:

> We now have your results and your test is NEGATIVE. This means it is very unlikely you have lung cancer at the moment. Between 98 and 99 out of 100 people with a negative test do not have lung cancer at the time of the test. [...] This test is expected to pick up about 40 in 100 cases of lung cancer and detect the cancer at an early stage. However this means it doesn't pick up all cases of lung cancer. So even though your test is negative it is important that you see your GP if you are unwell in any way that could be due to lung cancer. This includes persistent cough, coughing up blood, shortness of breath, weight loss or loss of appetite.

The letter invited participants to telephone the study centre if they wanted to discuss the result with a research nurse. The negative test group received no further study screening or imaging. A positive test result was communicated to participants via a mailed letter inviting them to telephone the clinic to arrange a second visit:

We now have the results from your blood test and would like to discuss the result with you. You may remember that this blood test does not tell us whether or not you have lung cancer; it just tells us whether we need to ask you to have further tests. So this next appointment is to discuss any further tests that might be needed.

4.4.1.5 Diagnostic imaging and serial CT

At the second visit the positive test group received a chest X-ray and, if it was negative, a study CT scan. If the chest X-ray was positive or suspicious for lung cancer, or a CT scan showed clinically significant findings, the participant was diverted to NHS routine clinical care. If the NHS pathway CT scan was negative the participant remained in the ECLS trial. The positive test group received three further study CT scans at six month intervals.

4.4.2 Participant eligibility

Eligibility criteria for the nested questionnaire study were:

- Consented to further research
- Completed the baseline questionnaire (as recorded by research nurses)
- From study regions (1) NHS GGC or (2) NHS Tayside (NHS Lanarkshire did not recruit during the questionnaire study recruitment period)

- Sent EarlyCDT-Lung test result letter (or reached 1-month time point if unscreened) at least seven days ago but less than six weeks ago and within the questionnaire study recruitment period of January 2014 - May 2015

All eligible individuals who were randomised to the screened arm and subsequently received a positive test result were invited to the questionnaire study. Random samples of 21 eligible individuals per week were invited from (1) the negative test group and (2) the unscreened arm. If there were 21 or less eligible from those groups in a week, all eligible were invited. The personal data of individuals to be invited were transferred securely on a weekly basis from the ECLS participant database to a separate database partitioned for the questionnaire study.

4.4.3 Data collection

On the same day of each weekly data transfer of participants to be invited, the researchers (BY and LB) mailed the first follow-up questionnaire ('1-month questionnaire'). It was accompanied by a letter inviting participation in the questionnaire study (Appendix B), personalised with the individual's name and hand-signed by BY and LB. The letter stated 'When you gave your blood sample the nurse said we might send you some more surveys to fill in. […] Please complete the enclosed survey and return it to us in the freepost

envelope provided within the next 7 days.' A £5 monetary incentive was offered for completing the questionnaire.[b]

One week after sending the 1-month questionnaire, if it had not already been returned BY or LB made a 1-week follow-up telephone call to the participant. It was a brief semi-scripted call with the purpose of checking safe receipt of the questionnaire, answering any questions and encouraging its return by emphasising the importance of the research. If telephone contact was not made after two attempts, a voicemail was left where possible.

If the questionnaire was not returned two weeks after mailing, an identical copy was sent with a reminder letter (Appendix C). If either of the questionnaire copies were not returned three weeks after first mailing (one week after mailing the reminder copy) a 3-week reminder telephone call was attempted. Two reminder call attempts were made and, if unsuccessful, a voicemail was left where possible.

On receipt of a questionnaire it was checked for completeness. If more than 50% of responses in at least one section of the

[b] As part of a separate evaluation of data collection methods not reported in the thesis, individuals were randomised 1:1 to receive a £5 monetary incentive either with the questionnaire or after returning the questionnaire.

questionnaire were missing, a telephone call was attempted up to five times over five separate days to collect missing data.

Participants were mailed further follow-up questionnaires three, six and 12 months after their baseline date (3-month questionnaire; 6-month questionnaire; 12-month questionnaire). These were mailed in weekly batches, accompanied by follow-up cover letters (Appendix D). There were no 1-week follow-up calls for these questionnaires, however the procedures for monetary incentives, reminder copies, 3-week reminder calls and the collection of missing data were the same as the 1-month questionnaire.

The methods described above were informed by systematic review-level evidence of strategies to promote returned of mailed questionnaires. Effective strategies include monetary incentives (OR 1.87, 95% CI 1.73-2.04), follow-up contact (OR 1.35, 95% CI 1.18-1.55), providing a second copy of the questionnaire (OR 1.46, 95% CI 1.13-1.90), mentioning an obligation to respond (OR 1.61, 95% CI 1.16-2.22), university sponsorship (OR 1.32, 95% CI 1.13-1.54), and an assurance of confidentiality (OR 1.33, 95% CI 1.24-1.42).[338]

Recruitment in each of the positive test group, negative test group and unscreened arm stopped when 300 had been recruited in each group. Due to the time taken in receiving returned questionnaires, this meant there were more than 300 recruited in each group and

more in the negative-test and unscreened arm than the positive test group because they were recruited at a relatively faster rate.

Exclusion criteria for the questionnaire study cohort were:

- Cancer diagnosis
- Non-response to two consecutive follow-up questionnaires
- Request of participant to withdraw (e.g. during telephone contact or written on a returned questionnaire)
- Withdrawal of consent from ECLS study

Individuals who returned a 1-month and/or 3-month questionnaire were considered participants in the questionnaire study. At the 1-month questionnaire, positive test participants may not yet have had their diagnostic CT scan and chest X-ray but they are likely to have had this by the time they received the 3-month questionnaire.

Before any contact with participants their ECLS trial status was checked. Participants whose status was 'further investigations' were assigned reduced contact but not excluded. This status indicated suspicious findings that could be lung cancer. They still received postal contact regarding the questionnaire study but did not receive any telephone calls until they reverted to the usual study status. If any individual was diagnosed with lung cancer they were excluded from that point onward. Participants withdrawing consent from the questionnaire study or from ECLS could request

that their data submitted up to that point were not used (but none did so).

Every contact with a participant was recorded in the participant database. This included yes/no fields recording whether each questionnaire, reminder, voucher and telephone call had been sent/made/received at each follow-up, and free text fields for recording telephone call attempts and brief notes of telephone conversations. Reports were created within the database to generate refreshable lists of participants requiring each type of mailing or telephone contact. The database was also used to record and manage the data entry and filing of individual questionnaires.

4.4.4 Measures

4.4.4.1 Sociodemographic and baseline variables

Sociodemographic characteristics were sourced from the ECLS participant database. Some had in turn been sourced from primary care patient records: date of birth, sex, source region (GGC/Tayside) and Scottish Index of Multiple Deprivation (SIMD) quintile. Others had been recorded in the database by researchers at participant eligibility assessment: family history of lung cancer, smoking pack-years and baseline smoker/ex-smoker. Other sociodemographic characteristics were completed by participants in baseline questionnaires including the EQ-5D-3L and ethnic group (Appendix E).

SIMD is the Scottish Government's official tool to identify areas of relative multiple deprivation.[339] For 6505 'data zones' it gives a weighted rank for each of seven domains: income (28%), employment (28%), health (14%), education, skills and training (14%), geographical access to facilities (9%), crime (5%), and housing (2%). Each data zone represents a small geographical area containing around 750 people identified by postcode. Individuals can therefore be assigned to a relative deprivation quintile based on their postcode, the first quintile representing the most deprived and the fifth quintile the least deprived.

The EQ-5D-3L is a standardised measure that can produce a descriptive generic health profile based on five domains: mobility; self-care; usual activities; pain/discomfort; anxiety/depression.[340] The respondent is asked to indicate a current health state by indicating for each domain: no problems, some problems, or extreme problems. Each combination of responses can produce one of 243 possible health states which can be converted to a single summary index. The measure includes a visual analogue scale where health is self-rated from 0-100. The EQ-5D-3L is shown to be a reliable and valid measure in disease-specific and general populations.[341] In a UK general population smokers reported significantly worse health state than non-smokers on all dimensions.[342] The descriptive system and the visual analogue scale were both included in baseline and follow-up questionnaires

except at three months. The descriptive system is reported in the thesis as a baseline characteristic.

4.4.4.2 Risk perception pilot work

The risk of lung cancer among smokers varies greatly[343] and smokers' perceptions of risk of the disease are not well understood. Belief in the harm caused by smoking is predictive of quit attempts but not the success of those attempts.[121] Studies have found that smokers in the general population can both underestimate and overestimate their risk of harm. A contributing factor to the uncertainty about how smokers perceive risk is the variability in how such perceptions are measured in studies. For example, questions about risk can be worded in terms of absolute risk (e.g. what is the chance that you will get lung cancer?), relative risk (e.g. compared to other people, what is the chance that you will get lung cancer?) or smoking attributable risk (e.g. by how much does being a smoker affect the chance that you will get lung cancer?). USA national survey data showed smokers' perceptions of relative risk were related to quit attempts but perceptions of attributable risk were not.[344]

In lung cancer screening, NLST researchers developed a ten-item measure of perceived lifetime risk of lung cancer and other smoking-related diseases.[146] The baseline survey of NLST participants showed smokers overestimated their own risk and the

population-based risk of lung cancer but underestimated their risk relative to other smokers.[146]

A brief measure of perceived risk of lung cancer was needed for the current study, so pilot work was undertaken to test the feasibility of three questions measuring the distinct dimensions of perceived lung cancer risk used by the NLST. The questions were intended to measure perceived average lung cancer risk for someone of the same age and sex, perceived risk relative to others and perceived objective risk (Appendix F). Two questions used a 0-100% scale and one question used tick box options. BY and LB piloted these with smokers, who were asked to self-complete the three items. Six males and five females completed the questions, with an average age of over 55 years. Of the eleven, nine stated they preferred the tick box design and, comparing their responses, ten indicated a much larger risk when using the 0-100 scale compared to the tick boxes. When asked, six people were unable to articulate the distinct aspect of lung cancer risk that each question was targeting. It was concluded from this pilot that tick boxes should be used in the questionnaires and, for simplification, two questions should be asked: objective risk and relative risk. A 'don't know' response option was added to the final version. The 'don't know' response to questions about personal cancer risk is usually prevalent in populations affected by health disparities[345] and so to not include this option could affect the validity of the resulting

data. The risk perception questions included in ECLS questionnaires are shown in Appendix G. Only the perceived relative risk question is used in the thesis. This is because there is no valid and reliable way to combine single-item perceptions of absolute and relative risk of lung cancer into a single score but it is known that relative perceived risk can predict smoking behaviour change.[344]

4.4.4.3 Social cognitive variables

Measuring determinants of behaviour change is important because it can allow a causal explanation of the impact of screening on smoking. However, in general the most important predictor of smoking behaviour is nicotine dependence and in addictive behaviours impulsive responses tend to override plans and motivations.[121, 335] Smoking behaviour is thus not very well explained by cognitive variables. It is therefore justified to explore social cognitive variables as outcomes of interest and discussion points, as they provide a framework within which health behaviour is generally understood, but not consider them as predictors of smoking behaviour. Knowledge of effects on intermediary variables can allow discussion about why participants behave in the way they do. It can identify psychological constructs for the targeting of behavioural interventions, for example to promote the conversion of behavioural intentions into performed behaviour.

All questionnaires in this study included six social cognition variables, informed by the theoretical background outline in section 4.2.2. Each variable was measured using a 5-point Likert scale. The questions and response options are shown in Table 4.1. Their presentation in the baseline questionnaire is shown in Appendix H.

Table 4.1 Social cognitive questions and Likert scale response options

Outcome	Motivation to quit	Perceived health benefits of quitting	Self-efficacy to quit	Subjective norms of quitting	Readiness to quit	Intention to quit
Question	*Which one of these statements do you most strongly agree with?*	*How strongly do you agree or disagree with the statement "My health will improve if I stop smoking."*	*How sure or confident are you that if you tried, you could give up smoking for good?*	*How strongly do you agree or disagree with the statement "People who are important to me want me to stop smoking."*	*Which one of these statements do you most strongly agree with?*	*Do you have any intention of giving up smoking in the next four weeks?*
Response options	I would like to keep on smoking	Disagree strongly	Very certain	Disagree strongly	I never think about stopping smoking	Yes, definitely
	I don't really want to stop smoking	Disagree	Fairly certain	Disagree	One day I will need to think about stopping smoking	Yes, probably
	I don't know whether I want to stop smoking or not	Don't know	Don't know	Don't know	I should stop smoking but I don't think I'm ready	Don't know
	I don't really want to carry on smoking	Agree	Fairly uncertain	Agree	I am starting to think about how I can smoke less	Probably not
	I would like to stop smoking	Agree strongly	Very uncertain	Agree strongly	I am trying to stop smoking	Definitely not

4.4.4.4 Tobacco use variables

Tobacco use questions are shown in Appendix H.

4.4.4.4.1 Smoking point prevalence

There is no agreed definition of having 'stopped smoking', so when measuring abstinence (or its opposite prevalence) the length of the abstinence period should be made clear.[105] Smoking 7-day point prevalence (also known as period prevalence) was measured as a yes/no response to the question: '*Have you smoked any cigarettes or tobacco in the last seven days/week?*' Point prevalence is one of two common outcome measures in smoking cessation trials, the other being prolonged abstinence that usually considers a period of several months. The two measures are highly correlated and produce similar effect sizes in studies measuring smoking status outcomes.[346, 347] The definition of abstinence sometimes allows a small relapse (e.g. less than five cigarettes) and other times is defined as having smoked no cigarettes at all. In the current study the latter approach was used, meaning somebody reporting having smoked any cigarettes or tobacco whatsoever in the last seven days was treated as a current smoker.

Smoking point prevalence was self-reported. The need for biochemical verification of self-reported smoking status is a debated issue. The practice is often seen as a gold standard in smoking cessation trial outcome methods[348] but the current study

was not a smoking cessation trial and participants could be ex-smokers, or current smokers who did not want to quit. Some experts acknowledge that biochemical validation methods should not always be used when measuring smoking status.[349] Three factors are thought to affect the accuracy of smoking self-report: type of population, type of intervention and demand characteristics (the extent to which behaviour changes due to the perceived purpose of the study).[350] Lung cancer screening involves population groups at increased disease risk, an intervention that could influence risk perceptions, and could represent a high-demand situation because lung cancer stigma has been reported of what is commonly perceived to be a self-inflicted disease.[351] However, ECLS did not include a smoking cessation intervention and cessation advice was not routinely offered. The ECLS participant information leaflet did not include any information or advice about smoking, other than to state as an explanation of the inclusion criteria that the risk of lung cancer is higher in those who have smoked. Furthermore, the smoking behaviour section of the questionnaires stated: "*This study is not about trying to encourage people to stop smoking but we are still interested in your smoking behaviour and your views about smoking.*" Follow-up questionnaires were sent and received by post rather than completed at the study clinic. Demand characteristics are likely to have been minimised by these methods. Pre-trial focus groups

indicated that perceived coercion to stop smoking could be a deterrent to ECLS participation.[352] Biochemical verification could therefore have had a detrimental impact on continued participation in the questionnaire study because it could have been seen as an application of pressure to stop smoking.

Because of uncertainty about the need for biochemical validation of questionnaire-based responses about smoking in this context, previous behavioural lung cancer screening studies can provide an indication of whether it is warranted. A USA lung cancer screening study biochemically verified smoking status using exhaled carbon monoxide levels in 710 participants. Of 314 who self-reported abstinence, 98% were biochemically confirmed.[161] The USA Jewish Hospital Lung Cancer Screening and Early Detection Study verified self-reported smoking status with urinary cotinine levels in 55 consecutive participants. It found sensitivity of self-report was 100% and specificity 95%.[353] The DLCST routinely biochemically verified smoking status at baseline and at one follow-up using exhaled carbon monoxide levels. It reported five (0.5%) of 980 'ex-smokers' had carbon monoxide levels indicating current smoking.[96, 97] NELSON validated self-reported smoking in a random sample of 475 men using blood cotinine levels. It reported both sensitivity and specificity were 98%.[354] It can be concluded from these four studies that the validity of self-reported smoking status is high amongst individuals at increased of lung cancer who

participate in lung cancer screening trials. It includes evidence from individuals who were randomly selected for biochemical verification and who would not necessarily have anticipated the procedure when self-reporting smoking.

Based on this evidence and the characteristics of ECLS outlined above, smoking point prevalence was not biochemically verified in the current study. Only those participants who reported current 7-day smoking were asked to complete further questions. Prolonged abstinence was measured but its assessment is not an aim of this study and the variable is not considered as an outcome within the thesis.

4.4.4.4.2 Cigarettes per day

It was asked: '*On average, how many cigarettes do you smoke each day*?'

Abstinence should be the ultimate goal to reduce risk of smoking related disease, however reducing tobacco consumption can also reduce risk.[355] For that reason it is important to measure the number of cigarettes smoked per day (CPD) as a clinically relevant dimension of smoking behaviour. It was hypothesised this outcome could be more sensitive to change than smoking point prevalence, which could be advantageous in two respects. Firstly, the study aims to detect beneficial change in smoking behaviour but a high pack-year smoking history could be a barrier to quitting in the

ECLS population group. A reduction in cigarettes per day could be an alternative indicator of beneficial change. Secondly, the study aims to detect harmful change in smoking behaviour in current smokers, which cannot be measured through a change in smoking point prevalence but could be detected by an increase in cigarettes per day. Fewer cigarettes per day is predictive of quit attempts and the success of quit attempts.[121]

4.4.4.4.3 Nicotine dependence

Nicotine dependence can be thought of as an indicator of ability to quit. Several different measures can be used to assess nicotine dependence and there is no consensus about which should be used. The most common is the 6-item Fagerström Test for Cigarette Dependence (FTCD).[356, 357] In the DLCST low FTCD scores in baseline smokers were a predictor of smoking status at the 1-year follow-up.[96] An abbreviated two-item version of the FTCD, the Heaviness of Smoking Index (HSI),[358] is also used widely. Evidence suggests the HSI predicts cessation outcomes almost as well as the FTCD,[359, 360] however both have been criticised for internal consistency below normally acceptable levels.[361] HSI scores are a significant predictor of quit attempts (OR 0.83, 95% CI 0.81–0.86) and of maintenance of quit attempts after one month (OR 0.78, 95% CI 0.74–0.82).[362]

It was asked: '*How soon after you wake up do you smoke your first cigarette or tobacco?*' Options were: after 60 minutes; 31 to 60 minutes; 6 to 30 minutes; within 5 minutes.

Time to the first cigarette of the day (TTFC) as a single-item measure can predict smoking cessation[363, 364] and lung cancer risk.[365] TTFC combined with CPD forms the HSI as a validated measure of nicotine dependence for this study.[362] CPD scores are 0: 1–10 CPD; 1: 11–20 CPD; 2: 21–30 CPD; and 3: 31+ CPD. TTFC scores are 0: 61+ min; 1: 31–60 min; 2: 6–30 min; and 3: ≤5 min. When summed, CPD and TTFC give a nicotine dependence (HSI) score with the range 0–6. Score categorisations are: low dependence (0-1), moderate dependence (2-4), and high dependence (5-6).

4.4.4.4.4 Quit attempt

Motivational factors predict quit attempts but not the success of quit attempts.[121] This is therefore an important outcome for smoking behaviour change, especially in the current study where no smoking cessation support is provided and no quit date is set.

It was asked: '*In the last X months have you tried to stop smoking?*' (Yes/No). The number of months stated in the question varied at each time point to refer only to the period since the last questionnaire (Appendix I).

4.4.4.4.5 Attempt to cut down

The rationale for this outcome was the same as for quit attempts.

It was asked: '*In the last X months have you tried to cut down the number of cigarettes you smoke?*' (Yes/No).

4.4.4.5 Scope of chapter

ECLS questionnaires included measures to address other project aims that are not reported in the thesis. These included measures of affect, health anxiety, beliefs about lung cancer, lung cancer worry, lung cancer risk perceptions and health care utilisation. The study reported in this chapter was focused on smoking behaviour outcomes which, in the aims of ECLS stated in section 1.6, were distinct from emotional outcomes and risk perceptions. The analysis reported in the thesis does not utilise the emotional outcome data as they form the basis of another individual's PhD research (LB). Similarly, the thesis does not report change in perceived risk of lung cancer as an outcome but instead incorporates baseline perceived risk as a potentially confounding variable for smoking outcomes.

Questions about tobacco use formed the penultimate section of the baseline questionnaire and final section of follow-up questionnaires.

4.4.5 Data entry

Data were entered to the database on an 'as-seen' basis, i.e. judgements about how to deal with discrepancies were made post-

hoc. Validation rules were implemented in the database to ensure the format of data was valid and to reduce likelihood of input errors. This included the use of drop-down boxes for entering multiple choice/Likert scale responses. Explanatory notes written by participants, and any responses that did not meet the validation requirements of the data field in the database, could be entered as discrepancies for later review.

4.4.6 Data quality verification

Quality and accuracy of data were verified against a sample of paper questionnaires in September 2015 while data collection was ongoing. All one to 12 month questionnaires entered to the database as at 19 August 2015 were eligible for verification. The following steps were taken:

1. A list of questionnaires entered was obtained in Excel format. This contained the cohort ID, follow-up and name of the researcher who entered the data. There were multiples lines for a participant each representing different questionnaires.
2. Eligible questionnaires were numbered sequentially and a random number generator was used to randomly select 10% of numbered questionnaires. The selection was of questionnaires, not participants and every questionnaire had an equal chance of being selected, meaning more than one questionnaire from the same participant could be selected.

3. Within the questionnaires sampled, 100% of items (1 item = 1 database field) were checked for accuracy against the paper questionnaire to ensure no errors had been made in data entry. The responsibility for checking was allocated between researchers to ensure that no individual checked a questionnaire that they had entered themselves. Free text data fields (not reported in the thesis e.g. beliefs about the causes of lung cancer) were checked for the presence of data but not for the accuracy of every keystroke. Each free text field was therefore included in the error rate calculation as one item regardless of how many words or keystrokes the data item contained.
4. Errors identified were amended directly in the questionnaire database and recorded in detail on a spreadsheet in order to identify any recurring errors and prevent repetition in subsequent data entry. No data were amended on the paper questionnaires.
5. The number of items found to be inaccurate in each questionnaire was recorded in the spreadsheet (numerator), along with the number of items in the whole questionnaire (denominator) allowing the error rate to be calculated. The denominator varied for each questionnaire depending on follow-up, test group and the participant's smoking status. An

error rate of >0.5% at any time point would have resulted in further review and corrective action.

Of 3,702 questionnaires eligible, 370 were sampled and verified. Results showed 68 errors detected of 28,193 items checked, an error rate of 0.2%.

4.4.7 Interim dataset

For the purpose of the analysis of data for the thesis an interim dataset was obtained. There were fewer positive test participants eligible for the questionnaire study per week of the recruitment period, compared to the availability of negative test and unscreened arm participants. This resulted in a comparatively longer period over which positive test group individuals were recruited to the questionnaire study. At the time of the data extract some positive test participants had not yet reached 12 months from baseline. The dataset included all follow-up data from unscreened arm and negative test participants, and all positive test group data up to six months, but did not include 12 month data from a proportion of positive test participants. Furthermore, the interim dataset had not undergone validation checks that were to be carried out by the ECLS data managers when all follow-up data were collected. It was, however, subject to a number of cross-validation checks by BY. The dataset used for the thesis was

extracted on 29 January 2016. Twelve month data collection finished in April 2016.

4.4.8 Software

Administration of questionnaires was managed using a browser-based recruitment database provided and supported by the Health Informatics Centre, University of Dundee. For entry and storage of questionnaire data Tayside Clinical Trials Unit provided a browser-based database using OpenClinica (openclinica.com), its standard GCP-compliant data management system. Data manipulation, cleaning and analysis were undertaken using Stata 14 SE. Some participant data were exported from the recruitment database to Stata and other participant data (including all questionnaire responses) were exported from OpenClinica to Stata.

4.4.9 Analysis considerations

4.4.9.1 Sample size

A sample size calculation showed 200 participants in each screening test result group would provide 80% power at 5% significance level, assuming 80% of participants are current smokers, to detect a 13% reduction in smoking prevalence. Previous lung cancer screening RCTs observed quit rates of 12%,[96] 17%[98] and 22%.[100] It was estimated that 300 participants should be recruited in each group to allow for attrition at 12 months.

4.4.9.2 Data cleaning

Stata syntax files (.do format) were developed in order to produce the dataset for analysis. The data cleaning process involved validation and cross checking of data values to identify any errors, and dealing with lists of data discrepancies logged during data entry.

4.4.9.3 Data manipulation

The *eq5d* command was used in Stata to generate an index value from the five domain responses using UK value sets.[366] This produced summary index scores in the range -0.594 (worst health) to 1.000 (best health).

Age was calculated in days using participants' date of randomisation minus the date of birth, then converted to years as a decimal. This value was converted to age groups as per ECLS minimisation groupings: 50-54, 55-59, 60-64, 65-69 and 70-75 years.

Discrepancies in cigarettes per day which did not fit the response options of the question (e.g. 2 cigars per day; 0.5oz loose tobacco per week) were converted to an equivalent number of cigarettes smoked per day using ratios: 1 cigar = 2 cigarettes; 0.25oz loose tobacco = 11 cigarettes.[367, 368] For simplicity, the cigarettes per day question only referred to 'cigarettes' and responses could have

included pre-rolled or hand-rolled cigarettes (which tend to be smaller and therefore contain less tobacco).

Ordinal and continuous tobacco use variables were dichotomised for analysis after exploring distributions of responses. HSI scores (range 0-6) were dichotomised into a low (0-3) or high (4-6) nicotine dependence value. Cigarettes per day were dichotomised as less than 20 and 20 or more. Social cognitive variables were all dichotomised with a two/three split representing the two most 'desirable' responses and the three 'least desirable' of the five options for each question. Relevant dichotomised values are indicated for each outcome in the frequency tables in the results section and can be viewed in combination with the response options shown in Table 4.1.

4.4.9.4 Missing data

If more than one response option to the same question was ticked by a participant the item was entered to the database as missing. This is recommended practice for the EQ-5D-3L.[369] Missing data were included in the analysis as missing only if a questionnaire had actually been sent to the participant (except the worst case approach described below).

4.4.9.4.1 Smoking point prevalence

Some missing data for this outcome were imputed to assume current smoking. The approach was based on a recommended and

widely used method to reduce bias in missing outcome data of smoking cessation studies.[348] It addresses the tendency for non-responders to be more likely to be current smokers and for smoking prevalence to be underestimated as a consequence. There are drawbacks to adopting such an approach because there may be other reasons for non-response to questionnaires. The approach may overestimate smoking prevalence, particularly at later follow-ups where the proportion of missing data is usually greater due to attrition.

In considering which approach to adopt, important differences were identified between the current study and other smoking behaviour studies. Firstly, unlike smoking cessation trials, the aim of the current study is not to promote smoking cessation, meaning any social desirability bias should be inherently lower. Secondly, the current study includes ex-smokers as well as current smokers. A very cautious approach could be to assume all non-responders are smoking (i.e. all non-responding ex-smokers relapsed). Alternatively it could be argued that simply carrying forward the most recently reported status is the most appropriate strategy to minimise bias. However, ex-smokers with missing smoking data are likely to behave differently to smokers with missing smoking data. For example, the weekly risk of relapse in ex-smokers over time resembles an 'L'-shaped curve, where the risk is approximately 75% in the week after quitting but reduces to

approximately 2% in those still abstinent at 12 weeks.[370] In UKLS the quit rates across all smoking study participants were 7% at 2 weeks and 13% at approximately two years (figures using a worst case approach).[100] Ignoring for a moment ex-smokers who have recently quit, relapse and quitting are both relatively unlikely events within their respective groups of ex-smokers and current smokers. The very cautious approach of assuming all non-responders are current smokers was therefore rejected. It was also felt that carrying forward the previous response would not adequately address the smoking non-response bias. However, the bar was set high for missing ex-smokers' data to be treated as missing rather than imputed as currently smoking. He/she must have consistently reported abstinence in all other available responses. To be eligible for and having participated in the questionnaire study, this covered as a minimum the six month period prior to baseline and either the one month period after baseline (1-month questionnaire) or the two month period following that (3-month questionnaire). Responses to point prevalence and prolonged abstinence questions at all time points were examined and participants with any report of smoking were eligible for imputation of missing follow-up smoking point prevalence data. This included participants who had withdrawn or been excluded from ECLS or the questionnaire study for any reason

other than lung cancer. It did not include 12-month data in participants who had not yet reached 12 months.

To summarise, the worst case approach assumed participants with missing smoking point prevalence values had smoked in the last seven days if they had reported smoking at any time during the study or the six months before baseline. This approach attempted to achieve a balance to minimise risk of bias by either underestimating or overestimating smoking rates. Analyses with and without the worst case approach were performed and both are reported in the thesis.

4.4.9.4.2 Cigarettes per day

In keeping with a worst case approach, if a range was entered by a participant for number of cigarettes smoked per day then the upper number of the range was used.

4.4.10 Data analysis

Baseline characteristics were compared between arms (screened/unscreened) and test groups (positive/negative) using independent t-tests for normally distributed or Mann-Whitney U tests for non-normally distributed continuous variables and chi-squared tests for categorical variables. Fisher's exact test was used if more than 20% of the tabulated frequencies for a variable were <5, meaning the assumptions of a chi-squared test were not met. Histograms were plotted to assess normality. For outcome

variables a series of multilevel models were computed to examine differences between the following groups over time:

1. Screened arm vs. unscreened arm
2. Positive test group vs. unscreened arm; negative test group vs. unscreened arm
3. Positive test group vs. negative test group

Random effects logistic regression was used with repeated measures nested within participants. Models did not converge adding the ECLS minimisation variable GP practice as a random effect; therefore models were adjusted for study centre as a fixed effect (GP practice is contained within study centre). All models included ECLS minimisation variables (age group; sex) as fixed effects plus time. The baseline value of the outcome variable was included in all models, except smoking point prevalence where the ECLS minimisation smoker/ex-smoker variable was included instead. All models were run with and without confounders. Smoking pack-years, SIMD and baseline perceived relative risk of lung cancer were included as *a priori* confounder variables for all outcomes. In previous lung cancer screening trials smoking abstinence at follow-up has been associated with fewer pack-years,[97] higher socioeconomic group,[371] and greater anxiety about perceived risk of lung cancer.[144] The NLST reported changes in perceived risk were not associated with changes in smoking,[140] however perceived risk is a well-established predictor of smoking

cessation.[372] In the general population, smoking behaviour is strongly associated with socioeconomic status.[330]

Pack-year history and baseline cigarettes smoked per day were checked for a linear relationship with the outcome variable by adding higher order terms to the model and assessing using likelihood ratio tests. The relationship was found to be non-linear so a histogram was plotted to assess the distribution and the covariate categorised appropriately before being added to the model. A p-value of <0.05 was taken as significant. Differences in outcomes over time between groups were assessed by adding time x group interaction terms to models with significance assessed using likelihood ratio tests with a p-value of <0.01.

4.4.11 Ethical approval

The study was reviewed and approved by East of Scotland Research Ethics Service REC 1 (reference 13/ES/0024, amendment AM05). The approval letter is shown in Appendix J.

4.5 Results

In this section, results for all outcomes are summarised and then for each outcome the following group comparisons are presented:

1. Screened vs. unscreened;
2. Positive test vs. unscreened; negative test vs. unscreened;
3. Positive test vs. negative test.

Findings from analyses run with and without confounders in general did not differ. Tables of findings from models adjusted for confounders are presented. For smoking point prevalence the frequencies and findings with and without using the worst case approach are presented but only the group comparisons using the worst case approach are presented in table form.

Participant flow is shown in Figure 4.1. Of 1,082 individuals eligible (and sampled if applicable), two negative-test individuals were not invited to take part due to a database reporting error. Of the 1,082, 1,032 (95.4%) returned at least one follow-up questionnaire and were included as questionnaire study participants in the analysis. At the time of the data extract, 43 (13%) in the positive test group had not yet reached 12 months. Of those in the 1,082 who had reached 12 months, more than 80% in each group returned a 12 month questionnaire.

Baseline participant characteristics are shown in Table 4.2. The median participant age was 60 years, 97.1% were of white British ethnic origin, 41.7% lived in the most deprived SIMD quintile and 55.2% were current smokers. All characteristics were balanced between the screened and unscreened arm. The negative test group were more likely than the positive test group to be male and a current smoker.

Figure 4.1 Questionnaire study participant flowchart

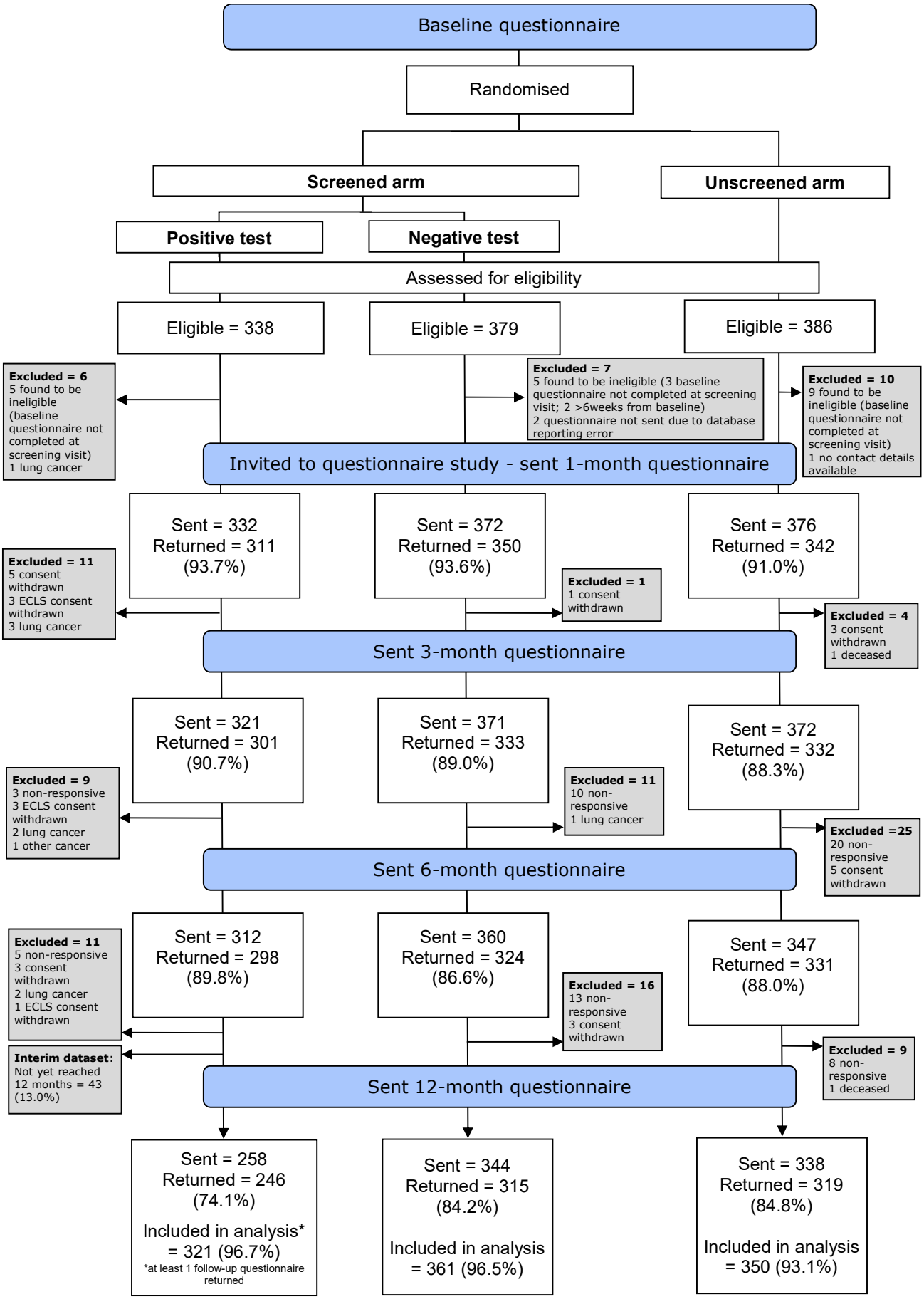


Table 4.2 Participant characteristics at baseline

	Positive test grp n = 321 (%) [missing]	Negative test grp n = 361 (%) [missing]	p value	Screened arm n = 682 (%) [missing]	Unscreened arm n = 350 (%) [missing]	p value
Age (years)						
Median	61	60	0.055	60	60	0.784
Range	50-75	50-75		50-75	50-75	
IQR	56-66	55-66		55-66	55-66	
	[0]	[0]		[0]	[0]	
Sex						
Male	139 (43.3)	198 (54.9)	0.003	337 (49.4)	169 (48.3)	0.732
Female	182 (56.7)	163 (45.2)		345 (50.6)	181 (51.7)	
	[0]	[0]		[0]	[0]	
Ethnicity						
White Scottish/White British/Other white	310 (98.1)	352 (98.9)	0.689	662 (98.5)	344 (98.9)	1.000
Other	6 (1.9)	4 (1.1)		10 (1.5)	4 (1.1)	
	[5]	[5]		[10]	[2]	
Work status						
In paid employment	119 (37.8)	144 (40.6)	0.433	263 (39.3)	115 (33.5)	0.588
Unable to work illness/disability	46 (14.6)	52 (14.7)		98 (14.6)	54 (15.7)	
Unemployed and looking for work	10 (3.2)	18 (5.1)		28 (4.2)	16 (4.7)	
At home and not looking for work	5 (1.6)	10 (2.8)		15 (2.2)	6 (1.8)	
Retired	118 (37.5)	118 (33.2)		236 (35.2)	135 (39.4)	
Other	17 (5.4)	13 (3.7)		30 (4.5)	17 (5.0)	
	[6]	[6]		[12]	[7]	
Home ownership						
Rented	116 (36.8)	138 (39.0)	0.709	254 (38.0)	128 (37.3)	0.083
Owned/ mortgaged	196 (62.2)	211 (59.6)		407 (60.8)	204 (59.5)	
Other	3 (1.0)	5 (1.4)		8 (1.2)	11 (3.2)	
	[6]	[7]		[13]	[7]	

	Positive test grp n = 321 (%) [missing]	Negative test grp n = 361 (%) [missing]	p value	Screened arm n = 682 (%) [missing]	Unscreened arm n = 350 (%) [missing]	p value
SIMD						
1 (most deprived)	124 (38.9)	155 (43.1)	0.208	279 (41.1)	151 (43.6)	0.832
2	80 (25.1)	63 (17.5)		143 (21.1)	63 (18.2)	
3	46 (14.4)	57 (15.8)		103 (15.2)	50 (14.5)	
4	40 (12.5)	48 (13.3)		88 (13.0)	47 (13.6)	
5 (least deprived)	29 (9.1) [2]	37 (10.3) [1]		66 (9.7) [3]	35 (10.1) [4]	
Smoker/ex-smoker[a]						
Smoker	165 (51.4)	218 (60.4)	0.018	383 (56.2)	187 (53.4)	0.404
Ex-smoker	156 (48.6) [0]	143 (39.6) [0]		299 (43.8) [0]	163 (46.6) [0]	
Smoking pack-years						
Median	33	35	0.228	35	35	0.958
Range	2-113	2-175		2-175	3-350	
IQR	25-48 [0]	26-47 [0]		25-47 [0]	26-49 [0]	
Cigarettes per day[b]						
Median	15	18	0.848	17	18	0.826
Range	0-60	1-136		0-136	0-120	
IQR	10-20 [0]	10-20 [2]		10-20 [2]	12-20 [3]	
Family history of lung cancer						
Yes	95 (29.6)	92 (25.5)	0.230	187 (27.4)	87 (24.9)	0.378
No	226 (70.4) [0]	269 (74.5) [0]		495 (72.6) [0]	263 (75.1) [0]	
EQ5D utility index						
Median	0.848	0.848	0.999	0.848	0.812	0.996
Range	-0.184 to 1.000	-0.239 to 1.000		-0.239 to 1.000	-0.181 to 1.000	
IQR	0.691 to 1.000 [5]	0.725 to 1.000 [8]		0.710 to 1.000 [13]	0.691 to 1.000 [6]	

	Positive test grp n = 321 (%) [missing]	Negative test grp n = 361 (%) [missing]	p value	Screened arm n = 682 (%) [missing]	Unscreened arm n = 350 (%) [missing]	p value
Perceived absolute risk of lung cancer						
1/1000	50 (15.7)	51 (14.2)	0.535	101 (14.9)	47 (13.5)	0.077
1/500	40 (12.5)	37 (10.3)		77 (11.3)	41 (11.8)	
1/250	25 (7.8)	25 (6.9)		50 (7.4)	17 (4.9)	
1/100	18 (5.6)	20 (5.6)		38 (5.6)	22 (6.3)	
1/20	8 (2.5)	17 (4.7)		25 (3.7)	20 (5.8)	
1/10 or greater	9 (2.8)	17 (4.7)		26 (3.8)	26 (7.5)	
Don't know	169 (53.0) [2]	193 (53.6) [1]		362 (53.3) [3]	175 (50.3) [2]	
Perceived relative risk of lung cancer						
A lot less likely than others	7 (2.2)	14 (3.9)	0.209	21 (3.1)	6 (1.7)	0.429
Less likely than others	16 (5.0)	20 (5.5)		36 (5.3)	15 (4.3)	
About as likely as others	132 (41.4)	117 (32.4)		249 (36.6)	121 (34.7)	
More likely than others	57 (17.9)	73 (20.2)		130 (19.1)	76 (21.8)	
Much more likely than others	23 (7.2)	25 (6.9)		48 (7.1)	33 (9.5)	
Don't know	84 (26.3) [2]	112 (31.0) [0]		196 (28.8) [2]	98 (28.1) [1]	

[a] recorded by research nurses at ECLS eligibility assessment
[b] in those who reported they had smoked cigarettes or tobacco in the last 7 days in the baseline questionnaire

4.5.1 Frequencies of tobacco use outcomes

Frequencies of tobacco use outcomes in the screened and unscreened arms are shown in Table 4.3, Figure 4.2 and Figure 4.4. Frequencies of tobacco use outcomes in the positive test group, negative test group and unscreened arm are shown in Table 4.4 and Figure 4.3 and Figure 4.5.

Table 4.3 Frequencies of tobacco use outcomes: screened arm and unscreened arm

Baseline		1 month		3 months		6 months		12 months	
Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]
Smoking point prevalence - worst case approach[a]									
N = 682	N = 350	N = 674	N = 346	N = 669	N = 347	N = 658	N = 347	N = 602	N = 344
376 55.1 [51]	189 54.0 [27]	366 54.3 [8]	184 53.2 [4]	369 55.2 [11]	186 53.6 [3]	354 53.8 [19]	184 53.0 [3]	327 54.3 [29]	177 51.5 [6]
Smoking point prevalence[b]									
N = 682	N = 350	N = 661	N = 342	N = 634	N = 332	N = 622	N = 331	N = 560	N = 319
376 55.1 [51]	189 54.0 [27]	351 53.3 [2]	179 53.1 [1]	334 52.7 [0]	170 51.2 [1]	315 50.6 [3]	167 50.5 [1]	275 49.1 [10]	151 47.3 [1]
N = 376	N = 189	N = 351	N = 179	N = 334	N = 170	N = 315	N = 167	N = 275	N = 151
Cigarettes per day[c] *Median; range; IQR; [missing]*									
17 0-136 10-20 [2]	18 0-120 12-20 [3]	15 0-100 10-20 [2]	20 0-50 12-20 [0]	15 0-80 10-20 [1]	15 1-50 11-20 [1]	15 1-80 10-20 [2]	16 1-60 10-20 [2]	15 1-80 10-20 [1]	15 2-60 12-20 [1]
Cigarettes per day *20 or more*[c]									
183 48.7 [2]	91 48.2 [3]	162 46.2 [2]	93 51.2 [0]	144 43.1 [1]	78 45.9 [1]	137 43.5 [2]	79 47.3 [2]	126 45.8 [1]	70 46.4 [1]
Nicotine dependence[c] *Moderate/high on Heaviness of Smoking Index*									
132 35.1 [4]	67 35.5 [5]	124 35.3 [5]	62 34.6 [0]	104 31.1 [4]	56 32.9 [2]	97 30.8 [5]	50 29.9 [4]	92 33.5 [2]	49 32.5 [2]
Quit attempt[c]									
95 25.3 [8]	66 34.9 [7]	63 18.0 [1]	37 20.7 [2]	68 20.4 [0]	43 25.3 [0]	72 22.9 [2]	44 26.4 [1]	75 27.3 [2]	49 32.5 [2]
Attempt to cut down[c]									
249 66.2 [10]	123 65.1 [6]	212 60.4 [1]	113 63.1 [1]	216 64.7 [0]	116 68.2 [0]	200 63.5 [1]	109 65.3 [1]	188 68.4 [1]	100 66.2 [2]

[a] Assumes non-responders are current smokers if they reported smoking at any other time point, N = responders without missing data (or all responders at baseline) + imputed missing data (none imputed at baseline), [missing] considers responders plus non-responders eligible for imputed missing data

[b] N = returned questionnaires, [missing] considers responders only

[c] N = responders reporting current smoking

Table 4.4 Frequencies of tobacco use outcomes: positive test group, negative test group and unscreened arm

Baseline			1 month			3 months			6 months			12 months		
Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]
Smoking point prevalence – worst case approach[a]														
N=321	N=361	N=350	N=318	N=356	N=346	N=315	N=354	N=347	N=308	N=350	N=347	N=259	N=343	N=344
164	212	189	157	209	184	154	215	186	147	207	184	124	203	177
51.1	58.7	54.0	49.4	58.7	53.2	48.9	60.7	53.6	47.7	59.1	53.0	47.9	59.2	51.5
[29]	[22]	[27]	[3]	[5]	[4]	[4]	[7]	[3]	[9]	[10]	[3]	[13]	[16]	[6]
Smoking point prevalence[b]														
N=321	N=361	N=350	N=311	N=350	N=342	N=301	N=333	N=332	N=298	N=324	N=331	N=246	N=314	N=319
164	212	189	150	201	179	140	194	170	135	180	167	104	171	151
51.1	58.7	54.0	48.2	57.4	52.3	46.5	58.3	51.2	45.3	55.6	50.5	42.3	54.5	47.3
[29]	[22]	[27]	[0]	[2]	[1]	[0]	[0]	[1]	[2]	[1]	[1]	[7]	[3]	[1]
N=164	N=212	N=189	N=150	N=201	N=179	N=140	N=194	N=170	N=135	N=180	N=167	N=104	N=171	N=151
Cigarettes per day[c] *Median; range; IQR; [missing]*														
15	18	18	15	17	20	15	15	15	15	15	16	17	15	15
0-60	1-136	0-120	0-50	1-100	0-50	2-80	0-80	1-50	1-60	1-80	1-60	1-60	1-60	2-60
10-20	10-20	12-20	10-20	10-20	12-20	10-20	10-23	11-20	10-20	12-20	10-20	10-20	10-20	12-20
[0]	[2]	[3]	[0]	[2]	[0]	[1]	[0]	[1]	[0]	[2]	[2]	[0]	[1]	[1]
Cigarettes per day[c] *20 or more*														
79	104	91	65	97	93	54	90	78	54	83	79	49	77	70
48.2	49.1	48.2	43.3	48.3	52.0	38.6	46.4	45.9	40.0	46.1	47.3	47.1	45.0	46.4
[0]	[2]	[3]	[0]	[2]	[0]	[1]	[0]	[1]	[0]	[2]	[2]	[0]	[1]	[1]
Nicotine dependence[c] *Moderate/high on Heaviness of Smoking Index*														
62	70	67	50	74	62	44	60	56	38	59	50	37	55	49
37.8	33.0	35.5	33.3	36.8	34.6	31.4	31.9	32.9	28.2	32.8	29.9	35.6	32.2	32.5
[2]	[2]	[5]	[1]	[4]	[0]	[1]	[3]	[2]	[1]	[4]	[4]	[0]	[2]	[2]
Quit attempt[c]														
48	47	66	32	31	37	41	27	43	32	40	44	32	43	49
29.3	22.2	34.9	21.3	15.4	20.7	29.3	13.9	25.3	23.7	22.2	26.4	30.8	25.2	32.5
[3]	[5]	[7]	[0]	[1]	[2]	[0]	[0]	[0]	[0]	[2]	[1]	[1]	[1]	[2]
Attempt to cut down[c]														
110	139	123	99	113	113	96	120	116	89	111	109	69	119	100
67.1	65.6	65.1	66.0	56.2	63.1	68.6	61.9	68.2	65.3	61.7	65.3	66.4	69.6	66.2
[5]	[5]	[6]	[0]	[1]	[1]	[0]	[0]	[0]	[0]	[1]	[1]	[1]	[0]	[2]

[a] Assumes non-responders are current smokers if they reported smoking at any other time point, N = responders without missing data (or all responders at baseline) + imputed missing data (none imputed at baseline), [missing] considers responders plus non-responders eligible for imputed missing data

[b] N = returned questionnaires, [missing] considers responders only

[c] N = responders reporting current smoking

Figure 4.2 Smoking point prevalence (worst case approach): screened arm and unscreened arm

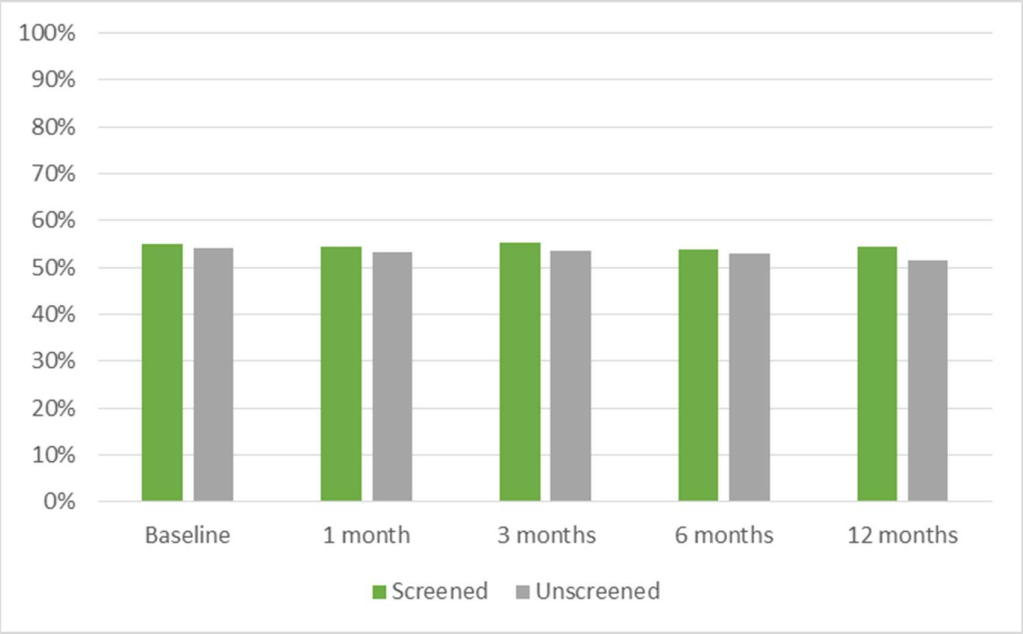


Figure 4.3 Smoking point prevalence (worst case approach): positive test group, negative test group and unscreened arm

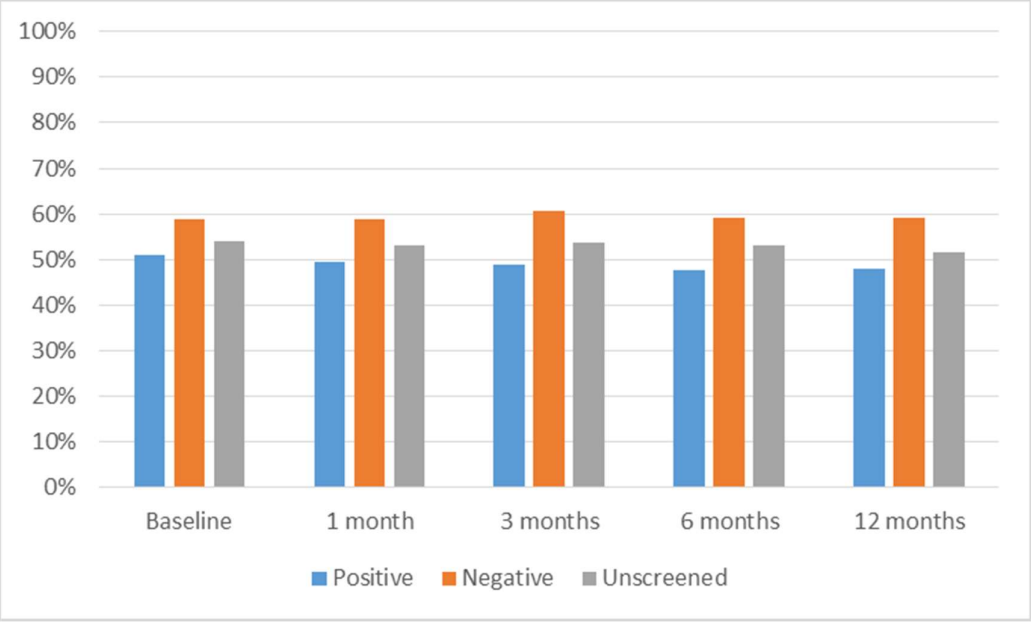


Figure 4.4 Cigarettes per day (20 or more): screened arm and unscreened arm

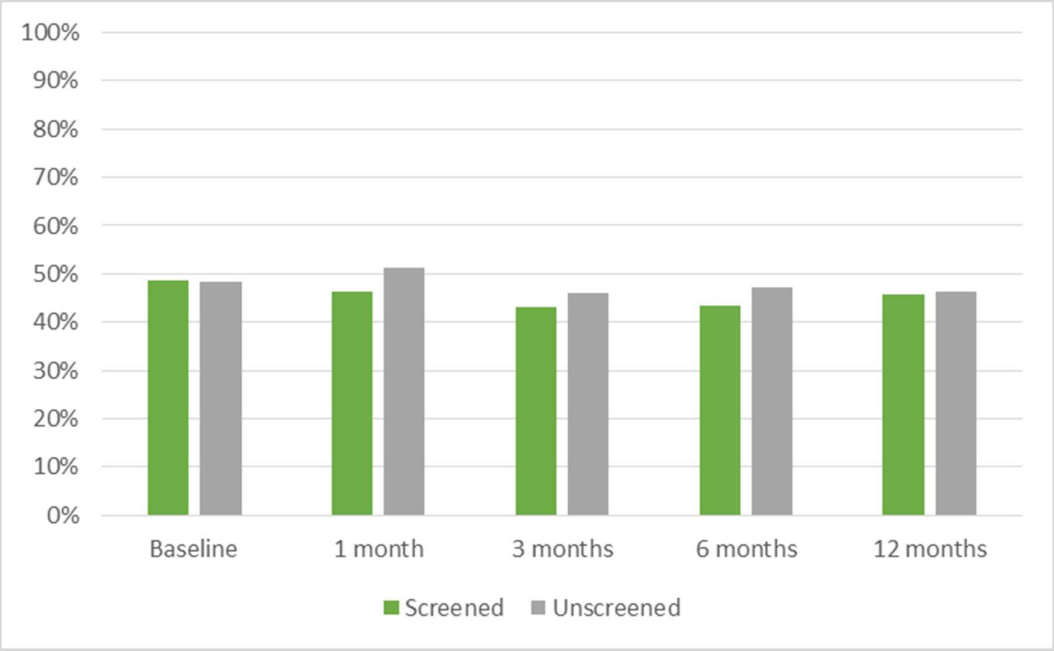


Figure 4.5 Cigarettes per day (20 or more): positive test group, negative test group and unscreened arm

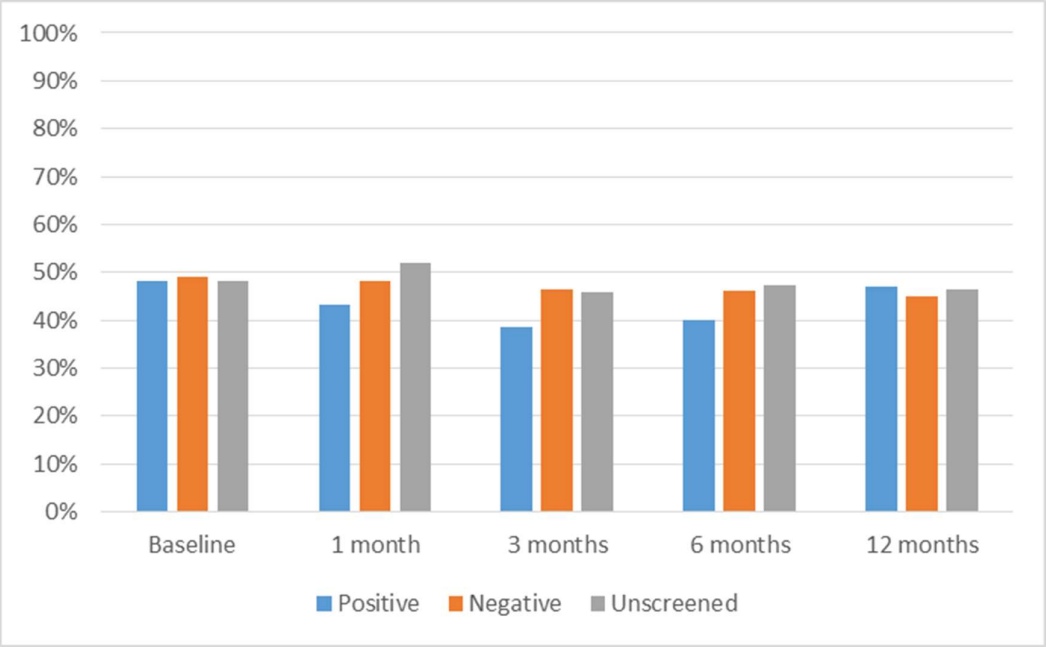


Table 4.5 Frequencies of social cognitive variables in current smokers: screened arm and unscreened arm

Baseline		1 month		3 months		6 months		12 months	
Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]	Screened n % [missing]	Unscreened n % [missing]
N = 376	N = 189	N = 351	N = 179	N = 334	N = 170	N = 315	N = 167	N = 275	N = 151
Motivation to quit *Don't really want to carry on/Would like to stop*									
218 58.0 [6]	117 61.9 [4]	209 59.5 [1]	112 62.6 [0]	200 59.9 [4]	107 62.9 [0]	176 55.9 [4]	101 60.5 [1]	161 58.6 [3]	86 57.0 [0]
Perceived health benefits of quitting *My health will improve if I stop Agree/Agree strongly*									
302 80.3 [4]	154 81.5 [2]	282 80.3 [2]	148 82.7 [0]	271 81.1 [2]	150 88.2 [0]	260 82.5 [0]	135 80.8 [0]	226 82.2 [0]	129 85.4 [0]
Self-efficacy to quit *How sure or confident are you that if you tried, you could give up smoking for good? Very certain/Fairly certain*									
102 27.1 [5]	54 28.6 [2]	93 26.5 [0]	44 24.6 [0]	78 23.4 [0]	32 18.8 [0]	76 24.1 [0]	39 23.4 [0]	70 25.5 [0]	25 16.6 [0]
Subjective norms of quitting *People who are important to me want me to stop Agree/Agree strongly*									
314 83.5 [5]	167 88.4 [2]	291 82.9 [1]	150 83.5 [1]	275 82.3 [0]	148 87.1 [0]	260 82.5 [0]	138 82.6 [1]	225 81.3 [0]	129 85.4 [0]
Readiness to quit *I am starting to think about how I can smoke less/I am trying to stop*									
197 52.4 [5]	111 58.7 [3]	179 51.0 [3]	103 57.5 [0]	169 50.6 [2]	97 57.1 [2]	161 51.1 [2]	82 49.1 [2]	138 50.2 [1]	83 55.0 [1]
Intention to quit *Do you have any intention of giving up smoking in the next four weeks? Yes definitely/Yes probably*									
90 23.9 [4]	50 26.5 [3]	96 27.4 [1]	48 26.8 [0]	84 25.2 [0]	39 22.9 [0]	87 27.6 [2]	43 25.8 [0]	63 22.9 [0]	36 23.8 [1]

Table 4.6 Frequencies of social cognitive variables in current smokers: positive test group, negative test group and unscreened arm

Baseline			1 month			3 months			6 months			12 months		
Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]	Positive n % [missing]	Negative n % [missing]	Unscreened n % [missing]
N=164	N=212	N=189	N=150	N=201	N=179	N=140	N=194	N=170	N=135	N=180	N=167	N=104	N=171	N=151
Motivation to quit *Don't really want to carry on smoking/Would like to stop*														
101 61.6 [2]	117 55.2 [4]	117 61.9 [4]	92 61.3 [0]	117 58.2 [1]	112 62.6 [0]	83 59.3 [1]	117 60.3 [3]	107 62.9 [0]	78 58.8 [2]	98 54.4 [2]	101 60.5 [1]	55 52.9 [2]	106 62.0 [1]	86 57.0 [0]
Perceived health benefits of quitting *My health will improve if I stop Agree/Agree strongly*														
138 84.2 [2]	164 77.4 [2]	154 81.5 [2]	128 85.3 [0]	154 77.6 [2]	148 82.7 [0]	117 83.6 [0]	154 79.4 [2]	150 88.2 [0]	111 82.2 [0]	149 82.8 [0]	135 80.8 [0]	85 81.7 [0]	141 82.5 [0]	129 85.4 [0]
Self-efficacy to quit *How sure or confident are you that if you tried, you could give up smoking for good? Very certain/Fairly certain*														
32 19.5 [2]	70 33.0 [3]	54 28.6 [2]	39 26.0 [0]	54 26.9 [0]	44 24.6 [0]	30 21.4 [0]	48 24.7 [0]	32 18.8 [0]	25 18.5 [0]	51 28.3 [0]	39 23.4 [0]	25 24.0 [0]	45 26.3 [0]	25 16.6 [0]
Subjective norms of quitting *People who are important to me want me to stop Agree/Agree strongly*														
137 83.5 [3]	177 83.5 [2]	167 88.4 [2]	127 84.7 [0]	164 81.6 [1]	150 83.8 [1]	118 84.3 [0]	157 80.9 [0]	148 87.1 [0]	112 83.0 [0]	148 82.2 [0]	138 82.6 [1]	88 84.6 [0]	137 80.1 [0]	129 85.4 [0]
Readiness to quit *I am starting to think about how I can smoke less/I am trying to stop*														
87 53.1 [2]	110 51.9 [3]	111 58.8 [3]	89 59.3 [0]	90 44.8 [3]	103 57.5 [0]	78 55.7 [0]	91 46.9 [2]	97 57.1 [2]	79 58.5 [0]	82 45.6 [2]	82 49.1 [2]	53 51.0 [0]	85 49.7 [1]	83 55.0 [1]
Intention to quit *Do you have any intention of giving up smoking in the next four weeks? Yes definitely/Yes probably*														
40 24.4 [2]	50 23.6 [2]	50 26.5 [3]	50 33.3 [0]	46 22.9 [1]	48 26.8 [0]	40 28.6 [0]	44 22.7 [0]	39 22.9 [0]	41 30.4 [1]	46 25.6 [1]	43 25.8 [0]	22 21.2 [0]	41 24.0 [0]	36 23.8 [1]

4.5.2 Frequencies of social cognitive variables

Frequencies of social cognitive variables in the screened arm and unscreened arm are shown in Table 4.5. Frequencies of social cognitive variables in the positive test group, negative test group and unscreened arm are shown in Table 4.6.

4.5.3 Summary of results

An overview of results is shown in Table 4.7. There were no statistically significant differences on any outcome between the screened and unscreened arms. There were statistically significant 'beneficial' changes in the positive test group compared to the unscreened arm on: cigarettes per day; quit attempts; readiness to quit. Of these, smoking 20 or more cigarettes per day was significantly less likely across all time points. There were statistically significant 'harmful' changes in the negative test group compared to the unscreened arm: attempts to cut down; perceived health benefits; readiness to quit. Of these, readiness to quit was significantly less likely across all time points.

Comparing the negative to the positive test group, there were statistically significant 'harmful' differences across all time points on seven of the eleven outcomes. However, self-efficacy to quit was significantly greater at six months in the negative test group compared to the positive test group.

Table 4.7 Overview of results

Outcome	Screened vs. unscreened	Positive vs. unscreened	Negative vs. unscreened	Negative vs. positive
Outcomes for which a decrease is 'beneficial':				
Smoking point prevalence - worst case approach	O	▽	O	△
Cigarettes per day	▽	▼*	O	▲*
Nicotine dependence	O	▽	O	▲*
Outcomes for which an increase is 'beneficial':				
Quit attempt	O	▲3m	O	▼*
Attempt to cut down	▽	△	▼3m	▼*
Motivation to quit	O	△	O	O
Perceived health benefits	O	O	▼3m	▼*
Self-efficacy	O	O	△	▲6m
Subjective norms	O	O	O	▽
Readiness to quit	O	▲6m	▼*	▼*
Intention to quit	O	△	▽	▼*

▲ statistically significantly higher at at least one time point
▼ statistically significantly lower at at least one time point
* statistically significant across all time points
3m statistically significant difference at 3-month time point
6m statistically significant difference at 6-month time point
△ consistently higher at all time points but not statistically significant at any time point
▽ consistently lower at all time points but not statistically significant at any time point
O none of the above

4.5.4 Smoking point prevalence

Adopting a worst-case approach, there were no statistically significant differences in smoking point prevalence between screening arms across all time points, OR 0.73 (95% CI 0.38-1.42), or at any single time point during the 12 months after screening (Table 4.8).

Similarly, there were no statistically significant differences with a worst case approach when comparing test result groups to the unscreened arm (Table 4.9), or the negative test group to the positive test group (Table 4.10).

Without a worst case approach, there were no statistically significant differences in smoking point prevalence in the screened compared to the unscreened arm across all time points, OR 0.63 (95% CI 0.32-1.25), or at any single time point. There were no significant differences when comparing test result groups to the unscreened arm, or the negative test group to the positive test group without the worst case approach.

Table 4.8 Smoking point prevalence (worst case approach): Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.73 (0.38-1.42)	0.359	
1 month	0.70 (0.27-1.80)	0.454	LR $\chi 2(4)=0.75$
3 months	0.79 (0.30-2.06)	0.625	p=0.95
6 months	0.58 (0.22-1.48)	0.253	
12 months	0.90 (0.36-2.22)	0.819	

*Adjusted for study centre, age group, gender, baseline smoker/ex-smoker, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.9 Smoking point prevalence (worst case approach): Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	0.55 (0.25-1.19)	0.127	0.95 (0.45-2.01)	0.894	
1 month	0.56 (0.18-1.72)	0.312	0.83 (0.28-2.44)	0.731	LR $\chi2(8)=5.39$
3 months	0.46 (0.15-1.41)	0.173	1.27 (0.42-3.82)	0.668	p=0.72
6 months	0.36 (0.12-1.09)	0.070	0.86 (0.29-2.54)	0.790	
12 months	0.63 (0.22-1.84)	0.399	1.20 (0.43-3.38)	0.723	

*Adjusted for study centre, age group, gender, baseline smoker/ex-smoker, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.10 Smoking point prevalence (worst case approach): Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	1.70 (0.80-3.63)	0.170	
1 month	1.45 (0.50-4.20)	0.493	LR $\chi2(4)= 5.02$
3 months	2.70 (0.92-7.93)	0.071	p=0.29
6 months	2.32 (0.82-6.61)	0.114	
12 months	1.87 (0.66-5.30)	0.237	

*Adjusted for study centre, age group, gender, baseline smoker/ex-smoker, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.5 Cigarettes per day

There was no statistically significant difference between the screened and unscreened arms in likelihood of smoking 20 or more cigarettes a day over all time points, OR 0.57 (95% CI 0.30-1.09), or at any single time point (Table 4.11).

The positive test group were significantly less likely to smoke 20 or more cigarettes a day than the unscreened arm across all time

points, OR 0.32 (95% CI 0.14-0.69) (Table 4.12). The greatest difference was observed at six months, OR 0.16 (95% CI 0.05-0.51). There was no significant difference on this outcome at any time between the negative test group and unscreened arm.

The negative test group were significantly more likely than the positive test group to smoke 20 or more cigarettes a day across all time points, OR 2.88 (95% CI 1.30-6.37) (Table 4.13). However, the confidence intervals were wide at each time point.

Table 4.11 Cigarettes per day (20 or more): Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.57 (0.30-1.09)	0.088	
1 month	0.42 (0.16-1.08)	0.072	LR $\chi2(4)=3.75$
3 months	0.57 (0.22-1.47)	0.244	p=0.44
6 months	0.50 (0.19-1.32)	0.163	
12 months	0.43 (0.16-1.16)	0.094	

*Adjusted for study centre, age group, gender, baseline cigarettes per day, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.12 Cigarettes per day (20 or more): Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	0.32 (0.14-0.69)	0.004	0.88 (0.44-1.78)	0.728	
1 month	0.24 (0.07-0.77)	0.017	0.62 (0.21-1.80)	0.375	LR
3 months	0.22 (0.07-0.72)	0.012	1.09 (0.37-3.20)	0.882	$\chi2(8)=$
6 months	0.16 (0.05-0.51)	0.002	1.18 (0.39-3.54)	0.766	15.57
12 months	0.19 (0.06-0.68)	0.010	0.70 (0.23-2.13)	0.535	p=0.05

*Adjusted for study centre, age group, gender, baseline cigarettes per day, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.13 Cigarettes per day (20 or more): Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	2.88 (1.30-6.37)	0.009	
1 month	2.69 (0.81-8.96)	0.107	LR $\chi 2(4)=12.21$
3 months	5.24 (1.57-17.51)	0.007	p=0.02
6 months	8.12 (2.37-27.83)	0.001	
12 months	3.84 (1.08-13.73)	0.038	

*Adjusted for study centre, age group, gender, baseline cigarettes per day, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.6 Nicotine dependence

There was no significant difference in nicotine dependence between screened and unscreened arms across all time points, OR 0.92 (95% CI 0.53-1.62) or at any single time point (Table 4.14).

There were no significant differences between either test group and the unscreened arm (Table 4.15).

The negative test group were significantly more likely to have high nicotine dependence across all time points compared to the positive test group, OR 2.52 (95% CI 1.27-4.99), and there was a significant difference at one, six and 12 months (Table 4.16).

Table 4.14 Nicotine dependence: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.92 (0.53-1.62)	0.782	
1 month	1.22 (0.52-2.85)	0.654	LR $\chi2(4)=1.29$
3 months	0.72 (0.30-1.76)	0.475	p=0.86
6 months	1.07 (0.44-2.63)	0.882	
12 months	0.77 (0.31-1.93)	0.577	

*Adjusted for study centre, age group, gender, baseline nicotine dependence, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.15 Nicotine dependence: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	0.56 (0.28-1.11)	0.096	1.33 (0.72-2.48)	0.363	
1 month	0.58 (0.20-1.71)	0.326	2.03 (0.78-5.30)	0.150	LR
3 months	0.45 (0.15-1.36)	0.158	0.98 (0.36-2.70)	0.969	$\chi2(8)=$
6 months	0.35 (0.11-1.05)	0.060	2.51 (0.90-6.97)	0.078	16.71
12 months	0.32 (0.10-1.03)	0.057	1.36 (0.48-3.85)	0.567	p=0.03

* Adjusted for study centre, age group, gender, baseline nicotine dependence, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.16 Nicotine dependence: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	2.52 (1.27-4.99)	0.008	
1 month	3.76 (1.27-11.15)	0.017	LR $\chi2(4)=16.21$
3 months	2.33 (0.77-7.08)	0.136	p<0.001
6 months	8.04 (2.56-25.25)	<0.001	
12 months	4.70 (1.42-15.55)	0.011	

*Adjusted for study centre, age group, gender, baseline nicotine dependence, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.7 Quit attempts

There were no statistically significant differences in attempts to stop smoking between screened and unscreened arms across all time points or at any single time point (Table 4.17).

At three months the positive test group were significantly more likely to have attempted to stop smoking since the last questionnaire compared to the unscreened arm, OR 2.29 (95% CI 1.04-5.04) (Table 4.18).

The negative test group were significantly less likely to have attempted to stop smoking than the positive test group across all time points, OR 0.54 (95% CI 0.34-0.85), and at three months, OR 0.20 (95% CI 0.09-0.47) (Table 4.19).

Table 4.17 Quit attempts: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.94 (0.65-1.38)	0.766	
1 month	1.16 (0.59-2.29)	0.666	LR $\chi 2(4)= 2.63$
3 months	1.07 (0.54-2.10)	0.854	p=0.62
6 months	1.03 (0.53-2.01)	0.926	
12 months	1.07 (0.55-2.10)	0.841	

*Adjusted for study centre, age group, gender, baseline quit attempt, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.18 Quit attempts: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.26 (0.81-1.97)	0.311	0.74 (0.48-1.15)	0.187	
1 month	1.29 (0.57-2.91)	0.545	1.05 (0.48-2.29)	0.906	LR $\chi2(8)=$
3 months	2.29 (1.04-5.04)	0.040	0.52 (0.23-1.17)	0.134	11.43
6 months	1.07 (0.47-2.41)	0.873	0.98 (0.46-2.09)	0.967	p=0.18
12 months	1.63 (0.70-3.80)	0.258	0.80 (0.38-1.70)	0.565	

* Adjusted for study centre, age group, gender, baseline quit attempt, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.19 Quit attempts: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.54 (0.34-0.85)	0.008	
1 month	0.76 (0.33-1.76)	0.519	LR $\chi2(4)=9.04$
3 months	0.20 (0.09-0.47)	<0.001	p=0.06
6 months	0.84 (0.37-1.93)	0.687	
12 months	0.44 (0.19-1.03)	0.059	

*Adjusted for study centre, age group, gender, baseline quit attempt, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.8 Attempts to cut down

There were no statistically significant differences in attempts to cut down smoking between screened and unscreened arms across all time points, OR 0.85 (95% CI 0.57-1.26) or at any single time point (Table 4.20).

At three months the negative test group were significantly less likely to have attempted to cut down compared to either the unscreened arm, OR 0.47 (95% CI 0.23-0.98) (Table 4.21) and the

positive test group, OR 0.40 (95% CI 0.19-0.86) (Table 4.22). There was no evidence that the positive test group were more likely to attempt to reduce their smoking compared to the unscreened arm (Table 4.21).

Table 4.20 Attempts to cut down: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.85 (0.57-1.26)	0.413	
1 month	0.83 (0.44-1.55)	0.553	LR $\chi2(4)=1.47$
3 months	0.68 (0.35-1.32)	0.253	p=0.83
6 months	0.77 (0.40-1.48)	0.434	
12 months	0.90 (0.44-1.81)	0.765	

*Adjusted for study centre, age group, gender, baseline attempt to cut down, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.21 Attempts to cut down: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.13 (0.70-1.84)	0.620	0.69 (0.44-1.07)	0.100	
1 month	1.19 (0.56-2.53)	0.659	0.64 (0.32-1.28)	0.205	LR $\chi2(8)=4.95$
3 months	1.15 (0.52-2.58)	0.727	0.47 (0.23-0.98)	0.044	p=0.76
6 months	1.10 (0.49-2.44)	0.816	0.60 (0.29-1.24)	0.166	
12 months	0.99 (0.41-2.38)	0.974	0.83 (0.38-1.80)	0.643	

*Adjusted for study centre, age group, gender, baseline attempt to cut down, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.22 Attempts to cut down: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.59 (0.37-0.95)	0.028	
1 month	0.52 (0.25-1.08)	0.080	LR $\chi2(4)=3.38$
3 months	0.40 (0.19-0.86)	0.019	p=0.50
6 months	0.53 (0.25-1.14)	0.104	
12 months	0.81 (0.35-1.90)	0.636	

*Adjusted for study centre, age group, gender, baseline attempt to cut down, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.9 Motivation to quit

There were no statistically significant differences between screening arms or test result groups for motivation to stop smoking across all time points or at any time point.

Table 4.23 Motivation to quit: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	1.12 (0.71-1.75)	0.625	
1 month	1.11 (0.54-2.26)	0.781	LR $\chi2(4)=1.64$
3 months	1.25 (0.60-2.60)	0.552	p=0.80
6 months	0.85 (0.41-1.77)	0.662	
12 months	1.51 (0.70-3.27)	0.291	

*Adjusted for study centre, age group, gender, baseline smoker/ex-smoker, baseline motivation to quit

Table 4.24 Motivation to quit: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.13 (0.66-1.93)	0.667	1.11 (0.67-1.84)	0.676	
1 month	1.10 (0.47-2.58)	0.827	1.12 (0.50-2.49)	0.790	LR $\chi2(8)=6.16$ p=0.63
3 months	1.08 (0.45-2.61)	0.863	1.40 (0.62-3.19)	0.421	
6 months	1.13 (0.46-2.73)	0.791	0.67 (0.29-1.54)	0.350	
12 months	1.07 (0.42-2.78)	0.883	1.92 (0.81-4.55)	0.140	

*Adjusted for study centre, age group, gender, baseline motivation to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.25 Motivation to quit: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.99 (0.57-1.71)	0.973	
1 month	1.03 (0.44-2.40)	0.946	LR $\chi2(4)=4.50$
3 months	1.31 (0.55-3.12)	0.543	p=0.34
6 months	0.59 (0.25-1.44)	0.250	
12 months	1.78 (0.68-4.65)	0.237	

*Adjusted for study centre, age group, gender, baseline motivation to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.10 Perceived health benefits

There were no significant differences between screening arms for perceived health benefits across all time points or at any time point (Table 4.26).

At three months the negative test group were significantly less likely to perceive health benefits of quitting compared to the

unscreened arm, OR 0.33 (95% CI 0.11-0.93) (Table 4.27). The negative test group were significantly less likely than the positive test group to perceive health benefits of quitting across all time points, OR 0.38 (95% CI 0.16-0.90), and at one month, OR 0.22 (95% CI 0.07-0.68) (Table 4.28).

Table 4.26 Perceived health benefits: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.92 (0.49-1.75)	0.808	
1 month	0.96 (0.41-2.27)	0.924	LR $\chi2(4)=4.73$
3 months	0.48 (0.19-1.25)	0.133	p=0.32
6 months	1.39 (0.57-3.39)	0.466	
12 months	0.79 (0.30-2.06)	0.630	

*Adjusted for study centre, age group, gender, baseline perceived health benefits, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.27 Perceived health benefits: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.60 (0.73-3.52)	0.245	0.63 (0.31-1.28)	0.201	
1 month	2.30 (0.78-6.82)	0.133	0.54 (0.21-1.38)	0.197	LR
3 months	0.84 (0.26-2.66)	0.763	0.33 (0.11-0.93)	0.037	$\chi2(8)=$
6 months	1.62 (0.55-4.79)	0.384	1.29 (0.47-3.58)	0.620	10.23
12 months	1.02 (0.31-3.41)	0.972	0.65 (0.22-1.89)	0.429	p=0.25

*Adjusted for study centre, age group, gender, baseline perceived health benefits, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.28 Perceived health benefits: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.38 (0.16-0.90)	0.028	
1 month	0.22 (0.07-0.68)	0.009	LR $\chi 2(4)=5.85$
3 months	0.38 (0.12-1.21)	0.101	p=0.21
6 months	0.80 (0.25-2.59)	0.716	
12 months	0.64 (0.18-2.24)	0.482	

*Adjusted for study centre, age group, gender, baseline perceived health benefits, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.11 Self-efficacy

There were no significant differences between screening arms for self-efficacy to stop smoking across all time points or at any time point (Table 4.29). Similarly, there were no significant differences between test result groups and the unscreened arm (Table 4.30). There was a statistically significant difference when comparing the negative test group to the positive test group at six months, OR 3.20 (95% CI 1.05-9.78) (Table 4.31).

Table 4.29 Self-efficacy: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	1.11 (0.59-2.11)	0.740	
1 month	1.29 (0.55-3.03)	0.560	LR $\chi 2(4)=4.43$
3 months	1.31 (0.53-3.25)	0.563	p=0.35
6 months	0.71 (0.30-1.72)	0.454	
12 months	1.93 (0.73-5.10)	0.186	

*Adjusted for study centre, age group, gender, baseline self-efficacy, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.30 Self-efficacy: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	0.74 (0.34-1.61)	0.450	1.51 (0.74-3.07)	0.254	
1 month	1.21 (0.43-3.36)	0.718	1.33 (0.50-3.52)	0.562	LR $\chi2(8)=15.25$ p=0.05
3 months	1.23 (0.41-3.68)	0.712	1.37 (0.49-3.82)	0.543	
6 months	0.37 (0.12-1.10)	0.073	1.15 (0.43-3.11)	0.778	
12 months	1.53 (0.46-5.14)	0.491	2.32 (0.80-6.78)	0.123	

*Adjusted for study centre, age group, gender, baseline self-efficacy, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.31 Self-efficacy: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	2.01 (0.92-4.41)	0.079	
1 month	1.09 (0.39-3.06)	0.867	LR $\chi2(4)=11.28$ p=0.02
3 months	1.10 (0.37-3.26)	0.861	
6 months	3.20 (1.05-9.78)	0.042	
12 months	1.52 (0.47-4.93)	0.485	

*Adjusted for study centre, age group, gender, baseline self-efficacy, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.12 Subjective norms of quitting

There were no significant differences between screening arms for subjective norms of quitting across all time points or at any time point (Table 4.32). There were no significant differences found on this outcome when comparing test result groups to the unscreened arm (Table 4.33) or to each other (Table 4.34).

Table 4.32 Subjective norms: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.69 (0.30-1.59)	0.386	
1 month	1.17 (0.40-3.38)	0.775	LR $\chi2(4)=5.00$
3 months	0.45 (0.14-1.41)	0.170	p=0.29
6 months	0.99 (0.33-2.93)	0.981	
12 months	0.55 (0.17-1.78)	0.321	

*Adjusted for study centre, age group, gender, baseline subjective norms, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.33 Subjective norms: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	0.89 (0.33-2.42)	0.819	0.58 (0.23-1.45)	0.245	
1 month	1.50 (0.40-5.58)	0.547	0.99 (0.30-3.25)	0.991	LR
3 months	0.80 (0.20-3.26)	0.759	0.31 (0.09-1.08)	0.066	$\chi2(8)=$
6 months	0.95 (0.25-3.54)	0.938	1.03 (0.30-3.51)	0.963	10.73
12 months	1.25 (0.28-5.68)	0.774	0.36 (0.10-1.28)	0.115	p=0.22

*Adjusted for study centre, age group, gender, baseline subjective norms, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.34 Subjective norms: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.59 (0.23-1.56)	0.292	
1 month	0.60 (0.17-2.15)	0.431	LR $\chi2(4)=5.63$
3 months	0.35 (0.09-1.31)	0.118	p=0.23
6 months	0.98 (0.27-3.61)	0.981	
12 months	0.26 (0.06-1.12)	0.071	

*Adjusted for study centre, age group, gender, baseline subjective norms, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.13 Readiness to quit

There were no differences between the screened and unscreened arms in those who were either thinking about quitting or trying to quit across all time points, OR 0.83 (95% CI 0.53-1.30) or at any single time point (Table 4.35).

The negative test group were significantly less likely than the unscreened arm across all time points to be either thinking about quitting or trying to quit, OR 0.57 (95% CI 0.35-0.94), with a significant difference observed at one and three months but not six or 12 months (Table 4.36). At six months the positive test group were significantly more likely than the unscreened arm to be either thinking about quitting or trying to quit, OR 2.93 (95% CI 1.31-6.55) (Table 4.36).

The negative test group were significantly less likely than the positive test group to be either thinking about quitting or trying to quit at one, three, and six months, with the greatest difference observed at six months, OR 0.21 (95% CI 0.09-0.47) (Table 4.37).

Table 4.35 Readiness to quit: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.83 (0.53-1.30)	0.419	
1 month	0.78 (0.41-1.47)	0.436	LR $\chi2(4)=3.10$
3 months	0.69 (0.36-1.32)	0.262	p=0.54
6 months	1.25 (0.65-2.42)	0.503	
12 months	0.83 (0.42-1.65)	0.595	

*Adjusted for study centre, age group, gender, baseline readiness to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.36 Readiness to quit: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.40 (0.81-2.42)	0.225	0.57 (0.35-0.94)	0.028	
1 month	1.54 (0.71-3.35)	0.273	0.48 (0.23-0.97)	0.041	LR
3 months	1.32 (0.59-2.93)	0.496	0.44 (0.21-0.91)	0.026	$\chi2(8)=$
6 months	2.93 (1.31-6.55)	0.009	0.68 (0.32-1.41)	0.298	12.34
12 months	1.15 (0.49-2.74)	0.746	0.65 (0.31-1.39)	0.268	p=0.14

*Adjusted for study centre, age group, gender, baseline readiness to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.37 Readiness to quit: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.37 (0.21-0.65)	0.001	
1 month	0.28 (0.13-0.61)	0.001	LR $\chi2(4)=9.39$
3 months	0.30 (0.14-0.67)	0.003	p=0.05
6 months	0.21 (0.09-0.47)	<0.001	
12 months	0.51 (0.22-1.22)	0.130	

*Adjusted for study centre, age group, gender, baseline readiness to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.14 Intention to quit

There were no significant differences between screening arms on intentions to quit (Table 4.38). There were also no significant differences when comparing test result groups to the unscreened arm (Table 4.39). There was a significant difference when comparing the negative test group with the positive test group across all time points, OR 0.54 (95% CI 0.34-0.88), and at one and six months (Table 4.40).

Table 4.38 Intention to quit: Screened arm vs. unscreened arm

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	1.04 (0.70-1.55)	0.840	
1 month	1.26 (0.65-2.41)	0.494	LR $\chi2(4)=1.15$
3 months	1.22 (0.60-2.47)	0.588	p=0.89
6 months	0.97 (0.49-1.92)	0.924	
12 months	0.98 (0.46-2.07)	0.956	

*Adjusted for study centre, age group, gender, baseline intention to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.39 Intention to quit: Test result groups vs. unscreened arm

	Positive vs. unscreened		Negative vs. unscreened		p value of ORs over time
	Adjusted OR* (95% CI)	p value	Adjusted OR* (95% CI)	p value	
All time points	1.38 (0.87-2.20)	0.174	0.83 (0.53-1.29)	0.407	
1 month	1.94 (0.91-4.15)	0.087	0.86 (0.41-1.82)	0.701	LR
3 months	1.77 (0.77-4.07)	0.178	0.90 (0.40-1.99)	0.792	$\chi2(8)=$
6 months	1.45 (0.65-3.26)	0.367	0.69 (0.32-1.51)	0.355	4.66
12 months	1.14 (0.44-2.93)	0.793	0.87 (0.38-1.97)	0.732	p=0.79

*Adjusted for study centre, age group, gender, baseline intention to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

Table 4.40 Intention to quit: Negative test group vs. positive test group

	Adjusted OR* (95% CI)	p value	p value of ORs over time
All time points	0.54 (0.34-0.88)	0.013	
1 month	0.40 (0.19-0.87)	0.020	LR $\chi 2(4)=3.50$
3 months	0.46 (0.20-1.05)	0.064	p=0.48
6 months	0.43 (0.19-0.98)	0.044	
12 months	0.70 (0.27-1.78)	0.448	

***Adjusted for study centre, age group, gender, baseline intention to quit, deprivation, smoking pack-years, baseline perceived relative risk of lung cancer

4.5.15 Comparison with models unadjusted for confounders

There were few differences in findings between models adjusted for ECLS minimisation variables (sex, age group, source region, baseline smoker/ex-smoker) and baseline values of the outcome variable and models adjusted for the same plus confounders (pack-years, SIMD, baseline perceived relative risk of lung cancer). Three differences observed were:

- Before adjusting for confounders the negative test group were significantly more likely to report high nicotine dependence at six months than the unscreened arm, OR 2.90 (95% CI 1.05-8.06). After adjusting for confounders the difference was not statistically significant.
- Before adjusting for confounders there was no statistically significant difference in attempts to cut down when comparing the negative test group to the positive test group, OR 0.64 (95% CI 0.40-1.03). After adjusting for confounders

the negative test group were significantly less likely to attempt to cut down.

- The negative test group were less likely to perceive that people important to them wanted them to quit (subjective norms) compared to the unscreened arm at three months. Before adjusting for confounders the difference was of borderline statistical significance, OR 0.29 (95% CI 0.08-1.00), but the difference was not significant or of borderline significance after adjusting for confounders.

The results of the study can be interpreted and discussed in terms of the likelihood of benefits or harms arising from changes in smoking behaviour following lung cancer screening.

4.6 Discussion

4.6.1 Main findings

There was no effect of allocation to lung cancer screening on smoking point prevalence or on any other tobacco use or social cognitive variables. However, when examining test result subgroups within the screened arm there was some evidence of a beneficial effect of a positive test result and a harmful effect of a negative test result.

Positive test group smokers were significantly less likely to smoke 20 or more cigarettes a day than either the unscreened arm and

negative test group smokers. These differences were observed across all time points and endured 12 months after screening. Compared to unscreened arm smokers at three months, positive test group smokers were significantly more likely to have attempted to quit and negative test group smokers were significantly less likely to have attempted to cut down. When directly comparing test result groups, the differences on these two outcomes were statistically significant at three months and across all time points.

There was a similar pattern in the social cognitive variables. On readiness to quit, positive test group smokers at six months were significantly more likely, and negative test group smokers at one and three months significantly less likely, to be thinking about or trying to quit compared to unscreened arm smokers. The perceived health benefits of quitting were significantly lower in the negative test group at three months compared to the unscreened arm and at one month compared to the positive test group.

On the nicotine dependence and intention to quit outcomes there were similar divergent patterns in test result groups. These were statistically significant only when directly comparing the two groups: high nicotine dependence was significantly more likely in the negative test group than the positive test group across all time points, with the greatest difference observed at six months;

intentions to quit were significantly less likely in the negative test group compared to the positive test group across all time points and at one and six months.

The exception to the pattern of benefits in the positive and harms in the negative test group was that positive test group smokers reported less self-efficacy to quit. The difference between test result groups at six months was statistically significant.

There were no statistically significant differences between any groups at any time point on two outcomes: motivation to quit and subjective norms.

4.6.2 Tobacco use outcomes

4.6.2.1 Screened vs. unscreened: initial discussion

There was no difference found in smoking prevalence between ECLS participants randomised to lung cancer screening or usual care. This can be compared to the findings of three previous RCTs outlined in Table 2.1, however two of these studies reported smoking in terms of quit rates rather than point prevalence. UKLS, the only previous UK study, found greater quit rates in the screened arm, in contrast with ECLS.[100] A comparison of ECLS and UKLS findings is discussed further in section 4.6.4. DLCST found no difference in quit rates or relapse rates between screened and unscreened arms, consistent with ECLS.[96, 97] NELSON reported smoking 7-day point prevalence, the same primary outcome as

ECLS, also finding no difference between screened and unscreened arms.[98, 99] However, their follow-up measure was at 2.2 years compared to one, three, six and 12 months in ECLS. The NELSON control arm were not invited to the screening site, unlike the ECLS unscreened arm who had a blood sample taken before randomisation. Furthermore, NELSON only included male baseline smokers whereas ECLS included baseline smokers and ex-smokers of any gender.

There were no significant differences between screened and unscreened arms on any other tobacco use outcomes (cigarettes per day; nicotine dependence; quit attempts; attempts to cut down). This is consistent with evidence from NELSON reporting no difference in smoking intensity or quit attempts between screened and control arms.[98] The screened vs. unscreened findings are discussed further after consideration of test result groups.

4.6.2.2 Test result groups

There were no statistically significant differences in smoking point prevalence at any time point when comparing test result groups to the unscreened arm, or when comparing the positive and negative test groups directly. There was a difference that approached statistical significance that may indicate the positive test group were less likely to smoke than the unscreened arm at six months. However, at 12 months this difference was no longer evident. Of

the three previous RCTs, only UKLS compared test result groups to the control arm. It found both the negative and abnormal test groups were significantly more likely to have quit two weeks after their test result compared to controls, with a greater effect in the abnormal group. At two years the effect was observed in the abnormal group but not the negative group.[100] The current study did not observe a beneficial effect in the negative test group compared to the unscreened arm at any time point, a key contrast with the UKLS findings. At six months the ECLS negative test group were significantly less likely to have attempted to cut down than the unscreened arm. Both ECLS and UKLS were UK studies involving a single screen with no further investigations for those with a negative result. Both studies measured smoking behaviour soon after receipt of test results. Perhaps a negative CT screening result lead to greater smoking cessation than a negative EarlyCDT-Lung result. Explained in terms of health psychology theory, there may have been greater perceived vulnerability to lung cancer resulting from a negative CT screen compared to a negative blood screen. It is possible that beliefs about a CT screen for lung cancer are different to beliefs about a blood screen for lung cancer, which could result in different perceptions of vulnerability resulting from each screening method. High perceived vulnerability combined with high perceived severity of lung cancer can lead to fear arousal, efficacy appraisal and a response of danger control (e.g. quit

attempt) or fear control (e.g. avoidance). Alternatively, differences in efficacy appraisals in negative test groups (e.g. greater self-efficacy to quit in UKLS) could have resulted in greater likelihood of danger control response in UKLS and fear control response in ECLS.

Another potential explanation is that ECLS negative test group quitting behaviour could have been offset by ex-smokers who relapsed after screening, whereas the UKLS sample were all baseline smokers so could only change their smoking status in one direction. Until further analyses are undertaken to identify ECLS quit rates and relapse rates the explanation is not entirely clear. However, other differences in ECLS and UKLS study procedures and participant characteristics are discussed later, in section 4.6.4.

The other studies compared test result groups to each other, rather than to controls. NELSON reported no difference in smoking prevalence at one year between indeterminate and negative test groups,[98, 99] consistent with ECLS. DLCST found significantly greater quit rates in the positive than the negative test group at one year. This comparison considered baseline smokers only and there was no analysis of quit rates in ECLS with which to compare the findings. When looking at quit rates in baseline ex-smokers only (i.e. those who relapsed after screening and then quit again), the DLCST found significantly greater quit rates in the negative group than the positive.

In the current study there was a significant difference in smoking 20 or more cigarettes per day between test result groups at three, six and 12 months. This contrasts with NELSON, which found no difference on cigarettes per day between the negative and indeterminate test groups.[98, 99] This could be due to differences in the screening regimes, where an indeterminate NELSON CT result led to a repeat CT at three months, then a scheduled CT at 12 months that was also received by the negative test group. In ECLS a positive blood test result led to an X-ray, CT and serial CTs at six and 12 months that were not received by the negative test group. In other words, a positive screen in ECLS had greater implications in terms of subsequent number of scans received (4 additional) than an indeterminate screen in NELSON (1 additional), which could have influenced differences in number of cigarettes smoked at the long-term follow-ups.

There were significantly greater odds of a quit attempt at three months and of less than 20 cigarettes smoked per day at three, six and 12 months in the positive test group than the unscreened arm. The evidence from ECLS and previous studies is consistent in suggesting that those receiving a positive/abnormal/indeterminate lung cancer screening test result are more likely to respond favourably in their subsequent tobacco use.

4.6.2.3 Screened vs. unscreened: further discussion

Given that the test result groups in this study are subgroups of the screened arm, the findings can help to explain the results of the screened vs. unscreened analysis. It appears that positive test groups are more likely to respond favourably and negative test groups may be more likely to respond in adverse ways. When evaluating the current evidence of the impact of screening on tobacco use it is therefore important to consider the extent to which each of these subgroups are represented in screened study populations. In UKLS allocation to the screening arm was associated with greater odds of quitting and within the screening group, 55% of the sample required further investigations.[100] This can be compared to NELSON, in which 44% of the screened sample had an indeterminate screening result and which found a non-statistically significant increase in smoking abstinence in the screened group compared to controls.[99] In DLCST only 12% of the sample received a positive test result, with no difference in smoking cessation between the screened and control group.[96] In ECLS 47% of screened participants taking part in the questionnaire study received a positive test result and, similar to NELSON, there was a non-statistically significant increase in smoking abstinence in the screened group compared to controls. In other words, studies may be more likely to show an effect of randomisation to screening on tobacco use if a higher proportion of their sample has an

abnormal test result, although absolute differences between ECLS, UKLS and NELSON were not great (range 44-55%). This highlights the importance of considering screening test attributes such as the proportion receiving positive test results, when extrapolating findings from behavioural study samples to predict the impact of screening on tobacco use. It is equally important to consider that the proportion with positive test results in the current study will not be the same if population-based EarlyCDT-Lung screening was introduced because positive test participants were oversampled for the study.

The results are inconsistent with UKLS in that they do not demonstrate beneficial smoking behaviour change in the negative test group compared to controls. This raises the question of whether negative test group participants suffered harm, requiring closer examination of prevalence rates and other dimensions of tobacco use in this group. Smoking point prevalence in the negative test group reduced from 62.8% at baseline to 59.1% at 12 months (worst case approach), a reduction of 3.7%. In the unscreened arm prevalence reduced by 7.3%, from 58.8% to 51.5%. Without the worst case approach the reductions in prevalence were 7.7% and 11.0% in the negative test group and unscreened arm respectively. However, controlling for baseline smoking status, baseline perceived risk of lung cancer and other confounding variables, the difference was not statistically

significant. There was no statistically significant difference in the odds of smoking 20 or more cigarettes per day, of having high nicotine dependence scores, or of making a quit attempt, in the negative test group compared to the unscreened arm at any time point. These findings suggest the negative test group did not experience harm. Nevertheless, they were significantly less likely to have attempted to cut down their smoking at three months compared to the unscreened arm. In general, they tended to respond in adverse ways but usually not to a degree that was statistically significant compared to the unscreened arm.

4.6.3 Social cognitive variables

There were no significant differences between screened and unscreened arms on any social cognitive variables. This is consistent with evidence from NELSON and NLST reporting no impact of screening on motivation to quit,[99] perceived health benefits,[140] and self-efficacy.[140] Randomisation to CT rather than chest X-ray in NLST was associated with greater motivation to quit in those who did not quit but screened individuals were not compared to an unscreened group.[141]

The short-term social cognitive variables highlight factors that may be important in the pathway to the observed behavioural change in the positive test group. They show intentions to quit, which can indicate protection motivation, almost doubled at one month

compared to the unscreened arm (p=0.087) and thinking about or trying to quit was almost three times more likely at six months (p<0.01). They do not, however, explain what social cognitive factors may have led to these changes, because there were no other significant short-term effects found in the positive test group compared to the unscreened arm.

The tobacco use outcomes appear to challenge the idea of false reassurance in negative lung cancer screening test groups. Examination of social cognitive variables, however, indicates changes in some smoking-related variables in an adverse direction. The negative test group were significantly less likely to perceive health benefits of quitting at three months. They were significantly less likely to be thinking about quitting or trying to quit at both one and three months. There was no significant difference in intentions to quit. In summary, these findings provide novel evidence that there may have been short-term false reassurance about the risks of smoking in the negative test group, but that this did not impact intentions or behaviour.

According to PMT and the EPPM, important factors influencing whether health risk information leads to behaviour change include the perceived probability of the event (e.g. as implied by a lung cancer screening test result), perceived rewards of the harmful behaviour, efficacy of the protective behaviour (e.g. perceived

health benefits) and self-efficacy to carry out the protective behaviour. The first two factors form part of a threat appraisal and the last two form part of an efficacy/coping appraisal. These lead to a protection motivation response that can be conceptualised as either danger control or fear control, and is best measured by behavioural intentions. The findings of the current study show that when the threat of lung cancer is increased in the form of a positive screening test result, responses were very different compared to when the threat was decreased via a negative result. After receiving the test result (one month) the positive test group had already adopted a danger control response in being substantially less likely to smoke 20 or more cigarettes a day compared to controls. At three months those who were still smoking were significantly more likely to have made a quit attempt (positives vs. unscreened). At six months those who were still smoking were less likely to have high self-efficacy for quitting, a component of efficacy appraisal that leads to protection motivation. The negative test group perceived fewer health benefits of quitting but their self-efficacy to quit was unchanged. Efficacy appraisals therefore appear to have prohibited danger control responses to threat appraisals caused by lung cancer screening test results. It might be that the threat in the positive test group was short-lived and they experienced reassurance from subsequent diagnostic imaging and repeat CT scans. An alternative explanation is that

more of the positive test group, and those with greatest self-efficacy, had already stopped smoking at six months.

The results indicate outcomes that were most variable over time and, on those outcomes, at what time points the greatest differences between groups were observed. Comparing screened and unscreened arms there were no statistically significant differences in ORs over time on any outcome. Comparing the negative test result group to the positive, difference in nicotine dependence was significant over time at the $p<0.01$ level, however the confidence intervals were wide. The difference was greatest at six months, OR 8.04 (95% CI 2.56-25.25), compared to three months, OR 2.33 (95% CI 0.77-7.08), and 12 months, OR 4.70 (95% CI 1.42-15.55). There were two variables with a statistically significant difference in ORs over time using $p<0.05$ in the negative vs. positive test group comparisons: cigarettes per day and self-efficacy. The greatest difference on both variables was at six months. This suggests that lung cancer screening test results had an effect on smoking outcomes that was greatest during the one to six month period after screening. This is when the positive test group would have most likely discovered their first CT scan did not show lung cancer at that point but would not yet have had their six month scheduled CT scan.

4.6.4 Comparison with UKLS

When comparing the results to other studies, differences in participant characteristics and study experiences should be considered. UKLS methods were similar to other European CT lung cancer screening trials, with the ultimate aim of pooling their data. Compared to UKLS, the ECLS behavioural study participant group was older, more balanced on gender and more likely to return follow-up questionnaires.[100] The UKLS behavioural sample only included smokers whereas only 55% of the ECLS sample were smokers.

ECLS targeted general practice patients in postcodes of greater deprivation, whilst UKLS randomly selected individuals from NHS primary care records. Like ECLS, the UKLS behavioural study participant group were skewed towards the most deprived quintile (34.3% UKLS, 41.7% ECLS), however there was a lower proportion than ECLS in the second most deprived (12.3% UKLS, 20.0% ECLS) and a higher proportion in the least deprived quintile (21.3% UKLS, 9.8% ECLS). UKLS behavioural study participants therefore lived in less deprived areas than ECLS questionnaire study participants, which may increase the relative likelihood of smoking cessation in UKLS. There is a strong socioeconomic gradient in quit attempt success, with the lowest social grade half as likely as the highest to succeed in an attempt, and more deprived smokers can

lack the financial, emotional and environmental resources to achieve smoking abstinence.[373]

UKLS participants at their baseline visit underwent a lung function test and gave blood, buccal swab, nasal, and sputum specimens.[374] They were informed of their randomisation condition within two weeks, and so those in the screening arm had their CT scan at a separate visit. In contrast, ECLS participants gave only a blood sample, were informed of their randomisation condition immediately afterwards and the negative test group had no further visits. All UKLS smokers in both arms were offered smoking cessation advice sheets and a list of local NHS stop smoking services.[100] Such advice was not routinely offered to ECLS participants.

The differences outlined above could have contributed to disparities in findings on smoking behaviour outcomes. For example, the finding of greater smoking cessation in the UKLS negative test group compared to controls, but no replication of such a finding in ECLS.

The impact on the findings of the worst case approach to analysis of smoking point prevalence can be discussed (sensitivity analysis) and compared with UKLS. As might be expected, the worst case approach had a greater influence on the findings as the proportion of missing data increased over time. Outcome frequencies show

that at six months it led to a 3.2% greater smoking point prevalence rate than without the worst case approach in the screened arm and 2.4% greater in the unscreened arm. The worst case approach increased smoking point prevalence at 12 months by 5.8% in the screened arm (7.9% positive test group; 4.3% negative test group) and 4.0% in the unscreened arm. These findings can be compared to UKLS: at two weeks their 'intention to treat' analysis approach reduced quit rates by 4% in the screened arm and by 3% in the unscreened arm compared to a complete case approach. At two years the figures were 9% and 11% respectively.[100] It can therefore be argued that the impact of the worst case approach in the current study was minimised through the achievement of high response rates, low attrition over time and efforts to collect missing data by telephone. At 12 months the proportion of imputed data in the negative test group and unscreened arm was comparable to that at two weeks in UKLS. However, there was no procedure to collect missing data at baseline other than relying on research nurses to check completion of questionnaires before marking them as complete in the participant database. As a result, 6.9% of smoking point prevalence data were missing at baseline.

4.6.5 Study strengths

This is the first behavioural study of biomarker blood screening for lung cancer detection. It is only the second UK behavioural study of

its type across all methods of lung cancer screening. The study achieved a high participation rate and low attrition over time, reducing the chance of bias. It measured short-term as well as long-term outcomes and explored the impact of screening on intermediary social cognitive variables as well as behavioural smoking outcomes. It included smokers and ex-smokers and men and women. For these reasons it may be one of the most comprehensive studies to date of the behavioural impact of lung cancer screening. Unlike previous studies, the analysis took account of repeated observations over time and the correlation between repeated observations, reducing chance of a type I error. Importantly, the study examined the potential for smoking-related harm in the negative test group using a range of social cognitive and behavioural variables.

4.6.6 Study limitations

4.6.6.1 Measures

No attempt was made to biochemically verify smoking point prevalence data. Approximately 40% of hospitalised smokers enrolled in USA smoking cessation trials were reported to have failed biochemical verification,[375] so the validity of self-reported smoking data cannot be assumed. However, the validity of self-reported smoking status in lung cancer screening trial participants and the likely demand characteristics of ECLS were outlined in section 4.4.4.4.1. They suggest self-reported smoking data are

likely to have high validity in this study. Regardless, it is possible that those receiving a positive test result experienced greater demand characteristics and were more likely to falsely report having stopped smoking than the unscreened group. Similarly, it is possible the negative test group were less likely to falsely report having attempted to cut down than the unscreened group. This could have contributed to the differences observed between groups in the study.

The smoking questions referred to different time periods in order to avoid overlap and allow an assessment of continuous abstinence (not reported in the thesis). This limits the ability to compare changes in some outcomes within groups over time, for example quit attempts over a one month period compared to a six month period.

Cigarettes per day can predict quit attempts[121] but a problem with the manipulation of cigarettes per day and nicotine dependence is that categories are imposed on continuous measures and there is no good evidence that the cut-off points are optimal. However, as both measures are highly skewed there are problems with using these as continuous measures.[362] Furthermore, cigarettes per day is prone to bias whereby responses tend to cluster around numbers divisible by ten.[376] Nicotine dependence was, however, determined using a validated measure.[362] Social cognitive measures were not

validated and their data were transformed from Likert scale to binary data for analysis using a pragmatic approach based on distribution of responses, with no evidence that the cut-off points are optimal.

Change in perceived risk of lung cancer was not examined, limiting an explanation of the psychological pathway by which screening may have influenced smoking behaviour change. Health psychology theory states that perceived vulnerability is a key component of threat appraisals, which lead to behavioural intentions. The analysis did, however, control for baseline risk perceptions. In the NLST risk perceptions were reported not to have changed between baseline and 12 months or to differ between test result groups.[140] It is a challenging variable to reliably measure and it is likely that a sizeable proportion of participants responded 'don't know' at follow-up as they had done at baseline. A high proportion of 'don't know' responses limits ability to measure changes in perceived risk and there is also the problem that the underlying reason for such responses is unknown. If it is due to low numeracy then this could introduce bias if numeracy is related to outcomes in any way.

4.6.6.2 Analysis

This study was based on analysis of a dataset in which 13% of the positive test group had not yet reached the 12 month follow-up. The long-term findings need to be confirmed by analysis of a final

study dataset. However, collection of data at other time points was complete.

The study reports smoking point prevalence rather than quit rates, so it cannot quantify participants who quit or relapsed and the findings cannot be directly compared with some other studies.

Caution is needed in the interpretation of findings due to the imputation of missing smoking point prevalence data using a worst case approach. The advantage of this method is that it can avoid underestimating smoking rates caused by non-response but it could also lead to overestimates. An alternative approach could be to treat participant groups differently based on characteristics associated with non-response in previous lung cancer screening trials. For example in UKLS baseline smokers in the unscreened arm were significantly less likely than those in the screening arm to complete 2-week and 2-year questionnaires. Evidence on which to base such an approach is limited, however, and the approach taken in the current study probably minimised overall non-response bias in smoking outcomes.

4.6.6.3 Generalisability of findings

Generalisability of findings to lung cancer screening using methods other than a biomarker test may be limited. Behavioural response might also be different in a screening regime that involves annual screening for those with a negative test result, as was offered in

the NLST, rather than the single one-off screen offered in ECLS and UKLS.

The behaviour of individuals in areas of greater deprivation in GGC and Tayside may not necessarily be generalisable to a national population group of individuals with equivalent lung cancer risk factors. For example, we know that smokers from lower social grades are less likely to succeed in quit attempts,[373] so in a national programme that does not target deprived areas there may be greater smoking cessation in positive test groups than observed in the ECLS positive test group.

4.6.7 Bias

4.6.7.1 Selection bias

Selection bias refers to the risk that participant groups differ on outcomes because of baseline characteristics rather than an intervention or exposure. In the current study this was minimised by (1) a randomised controlled design for the comparison of screened and unscreened arms, (2) random sampling of participants (negative test and unscreened) from ECLS, (3) demonstration that baseline characteristics were similar between groups, (4) high participation rates in all groups in the questionnaire study. The baseline characteristics of the participant sample could have been compared to those of all ECLS participants to demonstrate the sample was representative but these data were

not available. However, more than 90% of ECLS participants from the GGC and Tayside regions completed a baseline questionnaire and consented to further research, the two key eligibility criteria for the questionnaire study.

Non-response bias could have been present because those who did not respond to questionnaires may have been systematically different on outcomes to responders. There is a risk the unscreened arm may have felt they did not benefit from taking part in ECLS and may have been less motivated to complete follow-up questionnaires. There is a risk the negative test group felt less engaged in ECLS over time and were less motivated to complete follow-up questionnaires, compared to the positive test group who re-attended for serial CT scans. Slightly lower response rates were observed in the unscreened arm although the proportion included in the analysis in all groups was still high (93.1% unscreened arm, 96.7% positive test group, 96.5 negative test group). The characteristics of those not responding at 12 months could have been compared on characteristics to those who responded. It is likely that responders were characteristically different to non-responders in ways that were not dealt with by the worst case approach in the analysis of smoking point prevalence. This risk is mitigated by the high response rate to questionnaires and the similarity in response rates over time in the three groups. It is possible that positive test group participants who had not yet

reached 12 months, and therefore participated in ECLS at a later stage, could have been characteristically different to those who participated at an earlier stage of the trial, although there was no obvious rationale for this.

Exclusion bias could have been introduced where participants were excluded for reasons other than non-response. Other reasons for exclusion were withdrawal from the questionnaire study, withdrawal from ECLS, cancer diagnosis and death. It is possible that reasons for withdrawing were associated with outcomes in some way, although numbers were small.

The social cognitive variable questions were only answered by those who reported they had smoked in the last seven days. Over time, bias may have been introduced by the exclusion from these variables of those who had successfully quit, who may have been different on social cognitive characteristics to those who had not quit. An alternative approach could have been for abstinent participants to provide responses on social cognitive variables about remaining abstinent rather than quitting. This could have complicated the questionnaire, however, and the priority was to collect tobacco use data.

4.6.7.2 Information bias

Information bias refers to the risk of participant misclassification on outcomes. This can include recall bias, which could have impacted

the quit attempt and attempt to cut down outcomes, especially where questions referred to six month historical period. It can also include social desirability bias, which may have been limited by the fact that ECLS was not a smoking cessation trial and the smoking questions were presented at the end of questionnaires, of which most of the content was focused on other outcomes. Nevertheless, there is still likely to have been some social desirability bias operating.

4.6.8 Confounding

Confounding was minimised by controlling for baseline values of outcome variables. There may still have been confounding factors post-baseline that influenced outcomes. For example, the Scottish Government's Detect Cancer Early Campaign ran during the study.[377] It included a lung cancer phase with advertising featuring Scottish former football manager Alex Ferguson. It was reported that the campaign increased awareness in Scotland of lung cancer symptoms and that the proportion of patients diagnosed with lung cancer at the earliest stage (stage 1) increased by 24.7 per cent.[378] This may have influenced outcomes in study participants and the strength of this influence may have differed depending on their study group. However, in an implemented lung cancer screening programme, individuals are likely to be exposed to multiple background cancer-related public health campaigns.

The smoking behaviour of the unscreened arm could have been affected by their trial participation. They probably do not form a true control group that represents the population in a scenario in which lung cancer screening is not implemented. They also do not represent non-attenders in a screening programme. It was not feasible to recruit a true usual care group sample for the questionnaire study, i.e. a cohort who did not undergo a clinic visit or have a blood sample taken. This was because at the time the questionnaire study was designed all potentially eligible general practices in the study regions had already been approached for ECLS recruitment. The researchers explored with ECLS trial managers whether an alternative control group could be recruited for the questionnaire study but were advised there were no further general practices from which an alternative background comparison group could be sourced.

4.6.9 Chance

Considering the number of outcomes and time points measured in this study, and the use of a 0.05 significance level, some statistically significant findings would be expected by chance, i.e. type I errors. However, the design of the study allowed relationships to be observed using repeated measures of a range of variables that are known from behavioural theory to be interrelated. This allows the building of a comprehensive picture of the impact of lung cancer screening on smoking. The results show

that even when findings were not statistically significant, there were often similar effects in each test result group, which were directionally opposite in terms of benefit or harm. Across all of the outcomes and time points, this highly consistent overall picture makes it difficult to explain any individual finding as a type I error.

In the power calculation it was estimated 200 individuals in each group could detect a reduction in smoking prevalence from 80% to 67%. It was then estimated that a 300 sample would result in achieving a 200 sample at 12 months after attrition. Results show that only 55% of participants were current smokers at baseline. However, due to effective participant recruitment and retention methods, there were more than 320 included in the analysis in each test result group which greatly exceeded the estimated required sample size. This power reduces the possibility of a type II error.

4.6.10 True effect

There was no evidence of an effect of randomisation to lung cancer screening on any outcome. Smoking prevalence in test result groups did not differ statistically significantly from the unscreened arm. However, of the other ten outcomes, a statistically significant difference was found between groups on eight. This includes comparisons of test result groups either to the unscreened arm or to each other. Of these eight, seven indicated a beneficial response

in the positive test group and/or a harmful response in the negative test group. Effect sizes were generally small, so an effect of lung cancer screening test result on tobacco use is unlikely to have great clinical implications.

4.6.11 Implications for policy

Decisions about implementing population-based screening must follow robust and explicit processes and is usually done at a national level.[26] In the UK and Europe, policy-makers are due to examine the pooled results of European CT lung cancer screening trials to consider the benefits, harms and value for money offered by lung cancer screening.[379] Benefits include earlier detection of lung cancers and reduction in (lung cancer) mortality. Harms include overdiagnosis, overtreatment and psychological distress. The impact of screening on smoking behaviour has the potential to be the primary benefit or harm associated with lung cancer screening.[156] The implications of the findings of the current study and other similar studies are that the impact of screening on tobacco use is likely to represent a benefit to the subgroup receiving a positive test result, and unlikely to represent a harm to screened individuals. Less heavy smoking and more quit attempts may represent a benefit in terms of lower risk of the adverse consequences of smoking described in Chapter 1.

CT is the most common method to screen for lung cancer, however CT is costly, exposes participants to ionising radiation, generates a high proportion of false positive results and causes morbidity with further investigations.[32] If a biomarker test is found to be more effective than CT as a primary lung cancer screening method, policy-makers will need to consider whether the impact on smoking differs between a CT scan and a biomarker test. The findings of this study are generally consistent with those of CT screening, however there was no beneficial effect observed in the negative test group as reported by UKLS.[100] This leaves open the possibility that a biomarker screening test for lung cancer generates fewer benefits in terms of the impact on smoking behaviour.

The decision about whether to implement a national lung cancer screening programme must consider all the expected benefits and harms of implementation and compare this to a situation in which the programme is not implemented. As highlighted earlier, the current study can tell us about the behavioural impact of screening a blood sample, communicating the test result, and any associated diagnostic imaging, but is not designed to assess the impact of implementing a screening programme or of participating in screening. Furthermore, the decision about whether to implement a national screening programme must consider the financial costs of each scenario in the decision. The current study and previous

similar studies are not designed to assess the financial cost or benefit of the behavioural impact of screening.

4.6.12 Implications for practice

If a lung cancer screening programme is implemented, evidence from trials can help design screening programmes with the optimal balance of benefits and harms. Findings should be considered in light of knowledge that participants who receive a positive test result are likely to experience short-term emotional harm, based on evidence from CT lung cancer screening studies.[148] The implication is that any smoking-related benefit of population-based lung cancer screening may come at a short-term psychological cost borne by the individual.

In practice approximately 90% of those undergoing EarlyCDT-Lung screening receive a negative test result so it is important to adequately explore the behavioural effect in that group. There was evidence of a risk of short-term adverse social cognitive response in the negative test group. There was no evidence, however, that this had an impact on tobacco consumption. This can further allay concerns that lung cancer screening might cause any clinically relevant harm via false reassurance. Any short-term adverse changes in motivations and intentions around smoking could be prevented or minimised. This might include integrating smoking cessation interventions into lung cancer screening. The findings of

the current study support this approach because quit attempts were significantly more likely in the positive test group but smoking prevalence was not significantly lower. Appropriate cessation support could increase the success of those quit attempts.[119] In the negative test group, adverse social cognitive responses suggest there may be an opportunity to intervene to prevent such response in a group who may have initially had greater motivation to quit by nature of their participation in screening. Smoking cessation interventions in a lung cancer screening context are discussed further in Chapters 5 and 6, including the emerging evidence of the feasibility of such interventions.

It has been debated whether or not lung cancer screening represents a teachable moment for tobacco use. Findings of higher quit rates in positive test groups are often cited as evidence of a teachable moment.[134] Meanwhile it has been suggested that screening participants may be more interested in quitting than non-participants,[380] and have higher smoking cessation rates compared with smokers in the general population.[100] Motivation to stop smoking in those applying for lung cancer screening in Canada was reported to be 98% and motivation to receive help with their quit attempt 89%.[381] This might indicate participants intentionally seek out screening, rather than screening being a naturally occurring event that prompts change. In our sample 59.8% stated before screening that they would like to stop smoking and 54.7%

stated they were trying to stop or thinking about how to stop. Figures show that 67% of smokers in Scotland in 2014 wanted to quit smoking.[382] This suggests that the smokers in the ECLS sample may have had lower motivation to quit than the background smoking population. The proactive recruitment methods of ECLS may have contributed to this and reasons for participating in ECLS may be different to reasons for participating in an implemented lung cancer screening programme.

4.6.13 Implications for research

Analysis of the final dataset for publication (in preparation) will identify quit rates and relapse rates in this cohort, allowing closer comparison of findings with other lung cancer screening trials. The data should be explored further to identify predictors of perceived risk of lung cancer and explore the role of risk perceptions in subsequent smoking behaviour. It can be examined for differential behavioural response by sociodemographic subgroups, for example sex, age and deprivation quintile. There is already strong justification that all smokers should be offered cessation support as part of lung cancer screening,[156, 157] so developing further knowledge of these was not a priority within the current study as the findings would have limited implications for practice e.g. targeting of interventions.

Future studies should compare negative test groups with unscreened groups as well as with positive test groups, and make use of better control group populations who do not undergo study experiences likely to influence behaviour. This may necessitate recruiting a participant group who are not made aware of the availability of lung cancer screening or of their eligibility for screening as a smoker or ex-smoker. Behavioural differences could be explored in those with and without incidental findings on their diagnostic scans, because in NELSON smoking abstinence was associated with number of indeterminate scans.[99] Because the current study did not fully explain mechanisms of behavioural response in participants, further explorative research is needed to better understand the experience of lung cancer screening in smokers and ex-smokers, and to develop appropriate smoking cessation interventions for this context. Lung cancer screening programmes that deliver smoking cessation interventions will likely produce different behavioural outcomes to those observed here and these need to be evaluated within the context of any screening programmes that are introduced.

4.6.14 Conclusions

The study advances knowledge of the direction and size of effect of lung cancer screening on smoking prevalence within the context of understanding the benefits and harms of screening.

There was no difference in smoking behaviour over a 12 month period between individuals randomised to screening with the EarlyCDT-Lung test and the unscreened arm. In the positive test group there was evidence of fewer cigarettes smoked and more quit attempts, consistent with previous studies. There appeared to be some evidence of a short-term risk of adverse social cognitive response in the negative test group, a finding not observed in previous studies. However, lung cancer screening trial participants who smoke may be characteristically different from eligible non-participants who smoke. The behavioural response of the unscreened arm may have been further influenced by study experiences.

Social cognitive variables do not satisfactorily explain psychological pathways by which smoking behaviour change occurs and this requires further exploration. Predictors of smoking behaviour response to lung cancer screening, including emotions and perceptions of risk, should be examined in further work.

To conclude, allocation to screening for lung cancer in this study was not associated with changes in smoking behaviour but there were changes in test result subgroups of the screened arm. Considering all the available evidence there is little impact of lung cancer screening on tobacco use but this may depend heavily on the proportion of positive and negative test results produced by the

screening test. This is because positive lung cancer screening test results are associated with greater likelihood of quit attempts and smoking cessation. Those receiving a negative test result could be susceptible to harm via behavioural responses to screening but this evidence is less clear.

5 Decisions about tobacco use in smokers screened for lung cancer: a qualitative study

5.1 Chapter summary

Evidence suggests that positive test results appear to promote smoking abstinence in individuals screened for lung cancer but little is known about how screening influences individual decision-making about smoking. Integrated lung cancer screening and smoking cessation programmes have been advocated and piloted but there is a need for them to consider target users' experiences, motivations and needs. To explore this I conducted an in-depth qualitative investigation with 31 ECLS study participants who were all smokers before screening, eleven of whom had stopped smoking since screening. I used thematic analysis of transcripts of semi-structured interviews.

Themes showed that individuals created their own *interpretation of screening test results* that sometimes involved an inaccurate perception of risk, to which they *responded emotionally*, and this impacted decisions about smoking. Two distinct aspects of the so-called teachable moment of screening were identified, representing *a wake-up call* and a feeling that *now is the time to stop smoking*. The social context of smoking decisions was also found to be influential, as were several factors unrelated to screening, and sometimes an

accumulation of multiple factors that allowed screening to be a final tipping point for change.

Smokers responded to lung cancer screening in individualistic and unpredictable ways, which can help to explain the questionnaire study results in Chapter 4. Specifically, the themes describe a process of cognitive understanding and response, where smoking behaviour change can result from both increases and decreases in perceived lung cancer risk. They emphasise the important role of emotional responses in this context and therefore why positive test groups might respond differently to groups receiving a negative test. Different key dimensions to teachable moments are suggested by the findings, which can improve our understanding of the potential for behaviour change in smokers screened for lung cancer.

In the discussion of these findings I consider whether better risk communication can improve understanding of lung cancer risk and what impact this might have on smoking. I then discuss how the findings relate to the problem that some lung cancer screening participants benefit from screening via factors that influence smoking, while others may be harmed. The study suggests that the extent to which any such effect can be attributed to the type of test result, or other individual characteristics, needs to be explored further.

The themes derived from the data should be taken into account in the delivery of smoking cessation interventions in the lung cancer

screening context. Such programmes should provide tailored support that seeks to 'exploit' individual emotional responses, capitalise on increased motivation and urgency to quit, and involve family members and other factors that influence smoking decision-making. In this way lung cancer screening can be best equipped to both detect lung cancer and prevent smoking-related disease by reducing tobacco use in those at increased risk.

5.2 Background

5.2.1 Lung cancer screening and smoking

In assessing the relative benefits and harms of a lung cancer screening programme it is important to consider any impact on the smoking behaviour of participants. Such behavioural responses could be indicative of either a preventative health effect of screening via smoking behaviour, leading to benefits for smoking-related disease, or of harm associated with screening via continued and/or heavier smoking. The best evidence currently available is provided by lung cancer screening RCTs. They indicate that there are likely to be behavioural benefits, particularly in those who receive a positive test result. [97, 98, 100]

In Chapter 4 I report a behavioural study that adds to the evidence on this topic, nested in a RCT of a biomarker blood test (EarlyCDT-Lung) for early lung cancer detection. Analysis of questionnaire data showed

no statistically significant difference in smoking prevalence between the screened and unscreened arms over a 12 month period after screening. The positive test group were significantly more likely to have attempted to stop smoking at three months and significantly less likely to report smoking 20 or more cigarettes a day across all time points compared to the unscreened arm. The negative test group at three months were significantly less likely to have attempted to cut down or to perceive health benefits of quitting than the unscreened arm.

To summarise the available evidence, lung cancer screening in itself does not appear to impact smoking but there are beneficial effects associated with abnormal or positive screening test results.

There is a growing body of work that has quantified the relationship between lung cancer screening and smoking behaviour but little is known about how screening influences individual decision-making about smoking. Teachable moments for smoking cessation as described by McBride et al. (2003) are a precursor to change resulting from the extent of three responses to a health event: (1) a perception of increased risk; (2) a strong emotional response to the event; and (3) a re-examination of the person's self-concept caused by the event. The key to understanding the potency of the teachable moment and for designing intervention components is said to be the extent to which an event impacts each of the three domains.[164]

An investigation into how and why screening impacts thoughts, feelings and motivations about smoking can enable a better understanding of the behavioural impact of screening. It could add explanatory value to evidence that smoking behaviour change is associated with the type of test result received.

Lung cancer screening targets those at increased risk of the disease due to older age, smoking history and family history of lung cancer, many of whom are current smokers. It is thought that smokers who undergo lung cancer screening may be more motivated to stop smoking and more interested in smoking cessation interventions than those who are eligible who do not undergo screening.[147] Lung cancer screening provides an opportunity for intervention to promote quitting and abstinence in older adults with potential benefits for smoking-related disease.

5.2.2 Smoking cessation interventions

The nature of population-based cancer screening is that some recipients benefit through earlier detection of cancer while others are harmed.[26] When considering the potential health-related benefits and harms of screening resulting from changes in tobacco use, such a trade-off is not necessary. This is because there is the opportunity to provide appropriate behavioural support to promote smoking cessation and prevent heavier smoking. The integration of smoking cessation interventions (‘primary prevention’) into lung cancer screening

programmes ('secondary prevention') is widely recommended.[158, 159] For example in the USA the National Comprehensive Cancer Network explicitly recommends smoking cessation counselling as an integral component of screening[160] and Centers for Medicare and Medicaid Services require that all smokers undergoing screening must receive cessation support.[67] Simulation models indicate that such support can improve the cost-effectiveness of lung cancer screening by 20–50%.[158, 383] There is currently a lack of evidence on how such support should be provided to most effectively promote smoking cessation.[384-386] It is important that the experiences of screening participants who smoke are explored in order for the potential health benefits of this opportunity to be fully realised.

Smokers that undergo lung cancer screening may have different needs and motivations relating to cessation attempts compared to the general smoking population. These could be further influenced by specific screening experiences. In Chapter 4 I examine smoking point prevalence rates in an ECLS study participant sample that included 45% ex-smokers at baseline. Prevalence declined by 5.6% from baseline to after receipt of test results and was 4.4% lower than baseline at 12 months post-screening in the screened arm, who received no smoking cessation intervention as part of the study.

Pilot studies of strategies to combine smoking cessation support and lung cancer screening programmes report abstinence rates in screened

groups of smokers in the range of 15-17%.[387-389] Background quit rates are considered to lie in the range of 5-10% per year[390] although a proportion of ex-smokers may also relapse in any period. Rather than situating existing smoking cessation interventions within lung cancer screening programmes, the integration of such support requires careful consideration of the target users' experiences, motivations and needs. A deeper understanding of how lung cancer screening influences decisions about smoking could enable such interventions to be better adapted to this population and setting.

5.2.3 Qualitative studies of smoking in lung cancer screening

Due to some conflicting findings about the impact of lung cancer screening on smoking and because little is known about how the experience might influence smokers' thoughts and motivations, it is appropriate to investigate this using qualitative methods. Such an approach allows an in-depth interrogation of interviewees' thoughts, feelings and motivations. It also allows the social environment to be considered and the positioning of smoking behaviour within a context of multiple other personal goals.[391]

Two studies have used qualitative methods to explore smoking in the lung cancer screening context. The first recruited 35 smokers and ex-smokers from the NLST.[392] The focus of the study was on examining risk perceptions and whether screening was a cue to smoking behaviour change. Structured telephone interviews were used one to

two years after screening and data were analysed using content analysis, with data split by smoking status and screening result. Some participants had reduced their smoking but none had stopped smoking. The authors reported that most participants had high perceived risk of lung cancer and other smoking-related diseases but concern about risk was not a motivator for seeking screening. They stated that screening experiences were not described as particularly stressful and screening was seen rather as 'an opportunity to check-in'. Despite this conclusion, they reported that, of those who received a positive test result, 'half were affected, describing the experience as "severe"'. One participant said about their result: 'Oh, that meant a great deal to me … so evidently I need to quit smoking cigarettes.'[392] The authors did not expand on this finding and factors influencing decisions about smoking were not explored in depth. The study is limited in what it can tell us about how lung cancer screening impacts smoking behaviour due to the structured nature of the interviews, the time elapsed between screening and data collection, and the absence of any participants who had stopped smoking.

The second study took place in the context of the Veterans Health Administration Lung Cancer Screening Clinical Demonstration Project, a pilot study of primary care clinical reminders for lung cancer screening in USA medical centres.[393] In-depth semi-structured telephone interviews were used to explore experiences of being offered lung cancer screening and receiving test results, including attitudes and

perceptions about smoking cessation. Interviews were conducted after receipt of test results, although it is unclear how soon after. Eight of the 37 participants were also interviewed before screening. Seven participants had not been screened and four of these had declined screening. Data were analysed using inductive and deductive content analysis, finding that screening prompted many current smokers to reflect on their health. Three participants had stopped smoking for at least 30 days since being offered screening. Of these, one said the offer of screening had changed their thoughts about smoking and another said the finding of nodules had motivated them to quit. About half of the participants are reported to have described ways that screening had lowered their motivation to quit. Reasons for this included the perception that undergoing screening offers the same health benefits as smoking cessation and reassurance from the monitoring of CT findings.[393] This study indicates some ways in which lung cancer screening increased and decreased smokers' level of motivation to quit but the explanations of how this happened lack depth and explanatory context.

5.2.4 Knowledge gap

Lung cancer screening appears to be associated with a beneficial effect on smoking behaviour in some who are screened but it is not fully clear whether others experience a harmful effect on smoking behaviour. There has been very little exploratory research into how smokers respond to lung cancer screening. Of studies conducted to date, none

has focused on *decisions* about smoking to explore what screening factors and experiences may influence decisions to attempt to stop smoking or to continue smoking. Furthermore, no study has purposively recruited those who have stopped smoking after screening to explore factors influencing successful post-screening quit attempts.

5.3 Objective

My objective in this chapter is to report a qualitative study of smokers screened for the early detection of lung cancer, to explore decisions about smoking post-screening, including decisions to attempt to stop smoking and decisions to continue smoking. My first aim is to help explain the findings of Chapter 4 and thus achieve a more comprehensive understanding of the nature of the relationship between lung cancer screening participation and smoking. My second aim is to generate findings that can be used to adapt and improve smoking cessation interventions for the lung cancer screening context.

5.4 Ontology and epistemology

It is important to acknowledge my own theoretical position and values in relation to qualitative methods and this topic of research. It is also important that the theoretical framework and methods are suitable for the aims of the research. Ontology deals with the nature of reality and is a system of beliefs that reflects an individual's interpretation of what constitutes a fact. Epistemology deals with theory of knowledge and is

concerned with the question of what constitutes valid knowledge. I used a phenomenological approach to qualitative inquiry in this study to explore how people make sense of and attach meaning to their experiences.[394] I adopted the theoretical position that 'reality' is best understood when seen through the eyes of those who have experienced it at first hand. Such experience is therefore best accessed by explaining its unique nature and meanings from those individuals' perspectives.[395] I used an interpretive approach to phenomenology to achieve this,[396] in a way that can inform clinical practice. The interpretivist view can be historically linked to the sociologist and philosopher Max Weber's concept of 'Verstehen', or understanding something in its context. In this study the aim is to understand the experiences of individuals in the context of lung cancer screening, with the assumption that those who are screened may have experiences that influence their subsequent decision-making.

5.5 Methods

5.5.1 Study design

I conducted a qualitative investigation as a sub-study to the ECLS questionnaire study exploring behavioural responses to screening, the methods of which I report in Chapter 4. My objectives of the qualitative study at its conceptualisation were to explore in a screened group of smokers (1) decisions about smoking, reasons for those decisions, and barriers and facilitators to smoking abstinence and (2) differences

between groups. The original analysis plan involved a 2x3 comparative analysis of barriers and facilitators between two test result groups (positive/negative) and three smoking behaviour groups (stopped smoking/tried to stop/did not try to stop). During the data coding stage I identified a need to distinguish more clearly between 'decisions' and subsequent barriers and facilitators to action, which led to a modification of this plan. Given the complexity of the two aspects I was investigating, I chose to focus on one (i.e. decision-making) and will analyse the other (barriers and facilitators) separately and I do not report it in the thesis.

5.5.2 Sampling

I sampled individuals from the subset of 1,032 ECLS questionnaire study participants. Questionnaire respondents self-reported their current smoking status and recent attempts to stop smoking before screening, after receipt of screening test results and at three, six and 12 months after screening. My aim was to recruit approximately ten people who reported having stopped smoking since screening, ten who reported having attempted to stop but were still smoking, and ten who reported having not attempted to stop. I also aimed to recruit an approximately equal number who had received positive and negative EarlyCDT-Lung results and participants from across the Tayside and GGC ECLS study regions (the third region Lanarkshire had not yet begun recruiting). I adopted a quota sampling approach using these characteristics, intending to achieve a diverse range of screening

experiences and behavioural responses represented in the sample and to allow a comparison of findings between groups as described above. The definitions for each category of this sampling frame and other eligibility criteria are shown in Figure 5.1. Within each quota I took a convenience sampling approach by inviting eligible individuals who had most recently returned a questionnaire in advance of my scheduled visits to the respective study regions.

5.5.3 Recruitment

I mailed sampled individuals a letter (Appendix K), information leaflet (Appendix L) and a contact form to return in a prepaid envelope to express interest in taking part. In the letter and leaflet I explained that the purpose of the study was to investigate what people think about smoking after lung cancer screening and emphasised that the purpose was not to try to stop them smoking. With this I aimed to encourage participation by those who did not want to stop smoking. On receipt of a completed contact form I telephoned the potential participant to explain the study, answer any questions and arrange a convenient time for an interview. I suggested that the interview take place in the participant's home for their convenience but offered the alternative option of meeting me at the Glasgow or Dundee clinical research facilities being used for the ECLS study.

5.5.4 Data collection

I conducted face-to-face interviews using a question guide (Appendix M), developed and structured to address the distinct aims of the study. The first section of the guide contained questions about general ECLS study experiences designed to help establish a rapport, ease the participants into the topic, whilst generating useful contextual information about their experience in the ECLS study. The next section enquired about participants' smoking history, again intended to provide context to aid understanding of their responses to later questions about smoking. The third section focused on decisions about smoking along with barriers and facilitators to action. Questions were worded slightly differently depending on whether the participant had stopped smoking, attempted to stop smoking but not stopped, or not attempted to stop smoking. The final section covered attitudes and preferences for smoking cessation support available as part of a lung cancer screening programme. Interviews were semi-structured and the exact formulation of questions was influenced by responses to previous questions during the interview and other participants' responses in preceding interviews. This meant that discussions could stray from the question guide and any new relevant topic that came up could be explored. Participants completed and signed a consent form before the interview. I advised them that I held no strong feelings about smoking and was simply interested in their thoughts and feelings. I offered all

interviewees a £5 multi-store gift voucher to thank them for participating.

I approached the first two interviews as pilot interviews in anticipation of potential changes needed to the interview schedule, however I made no major revisions and these interview transcripts were included in the data. After each interview, or at the end of each day of interviewing, I made some brief unstructured reflective notes about each interview. These contained whatever I felt was important to record at the time, such as how I felt the interview had gone (including ideas for improving future interviews), the non-verbal communication of participants, relevant things participants had said before or after the interview, and any other thoughts I had about the interview which would not necessarily be evident to me from the transcript at a later date. I digitally audio recorded the interviews and transcribed the recordings (anonymised) verbatim.

5.5.5 Data analysis

I analysed transcripts using thematic analysis, a method for identifying, analysing and reporting patterns (themes) within data,[397] with regular discussions around the analysis with my supervisors. I chose to use thematic analysis because it can provide a rich and detailed account of data, offers flexibility (e.g. inductive and deductive analysis), and is useful as a foundational method that can provide core skills to novice qualitative researchers.[397] I used this as an experiential

method, which reports experiences, meanings and the 'reality' of participants. I used a hybrid approach of both inductive and deductive thematic analysis.[398, 399] Inductive analysis consisted of open, unstructured coding and allowed for the identification of unexpected or previously unidentified themes. I undertook deductive analysis through the use of *a priori* codes that related to the study objectives and the questions used in the interviews, which were influenced by knowledge of theories of health behaviour and addiction, but not structured to reflect any theoretical models or their components.

5.5.5.1 Coding and theme development

I began coding after all data were collected and transcribed. I imported transcripts to NVivo 10 software[400] for coding. Reflective notes were used as an aid to remembering and understanding the data but were not used as source data. The coding process involved familiarisation with the data, systematic coding of data, generation of a set of initial codes, sorting of codes into structures containing overarching themes and their subthemes (using separate structures to address distinct aims of the research), reviewing and refining themes and finally, defining and further refining themes to create a coherent and internally consistent account of the data.[397]

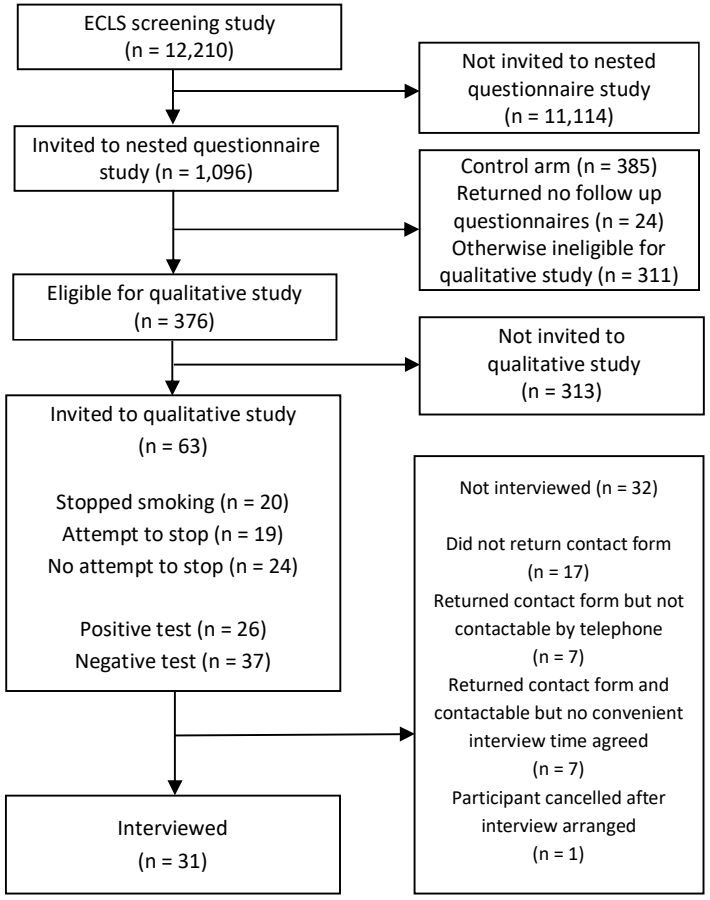
The modification of study objectives described in section 5.5.1 led me to adapt the coding structure. Initially, I coded all data broadly as either a barrier or facilitator to smoking abstinence, with branches of

sub-codes under each of these overarching categories. Through regular reviews of the coding process with the primary supervisor of this study RdN., and further discussion between all of my PhD supervisors (RdN, KV, DK, JR), we decided the coding structure should reflect the modified aims of the research. I created a distinct coding structure to encompass all data relating to smoking decision-making. I recoded data to either the *decisions about smoking* structure or kept it within the barriers and facilitators structure, renamed *action and maintenance* (Table 5.1). For the purpose of coding data explaining factors influencing successful or unsuccessful decisions about smoking, we identified uncertainty in how 'success' should be defined. We decided it was more important and relevant to the study aims to group codes by whether the individual *wanted* to stop smoking. So, within the revised *decisions about smoking* code group there were branches of sub-codes organised according to whether the individual wanted to stop smoking or continue smoking (as described by them in their interview). This is shown in Appendix N.

Table 5.1 Revised broad coding categories and their definitions

Broadest level code ('node' in NVivo)	**Definition**
1. Decisions about smoking	Any text about reasons for wanting to stop, cut down or continue smoking, or any thoughts or feelings that have influenced this decision, but not barriers or facilitators to taking action or maintaining the behaviour.
2. Action and maintenance	Any text about barriers, facilitators, thoughts or feelings about the action or maintenance of smoking or non-smoking behaviour, but not reasons for deciding to change or continue the behaviour.

Figure 5.1 Participant flowchart with eligibility criteria and smoker sampling frame definitions



Eligibility criteria for qualitative study

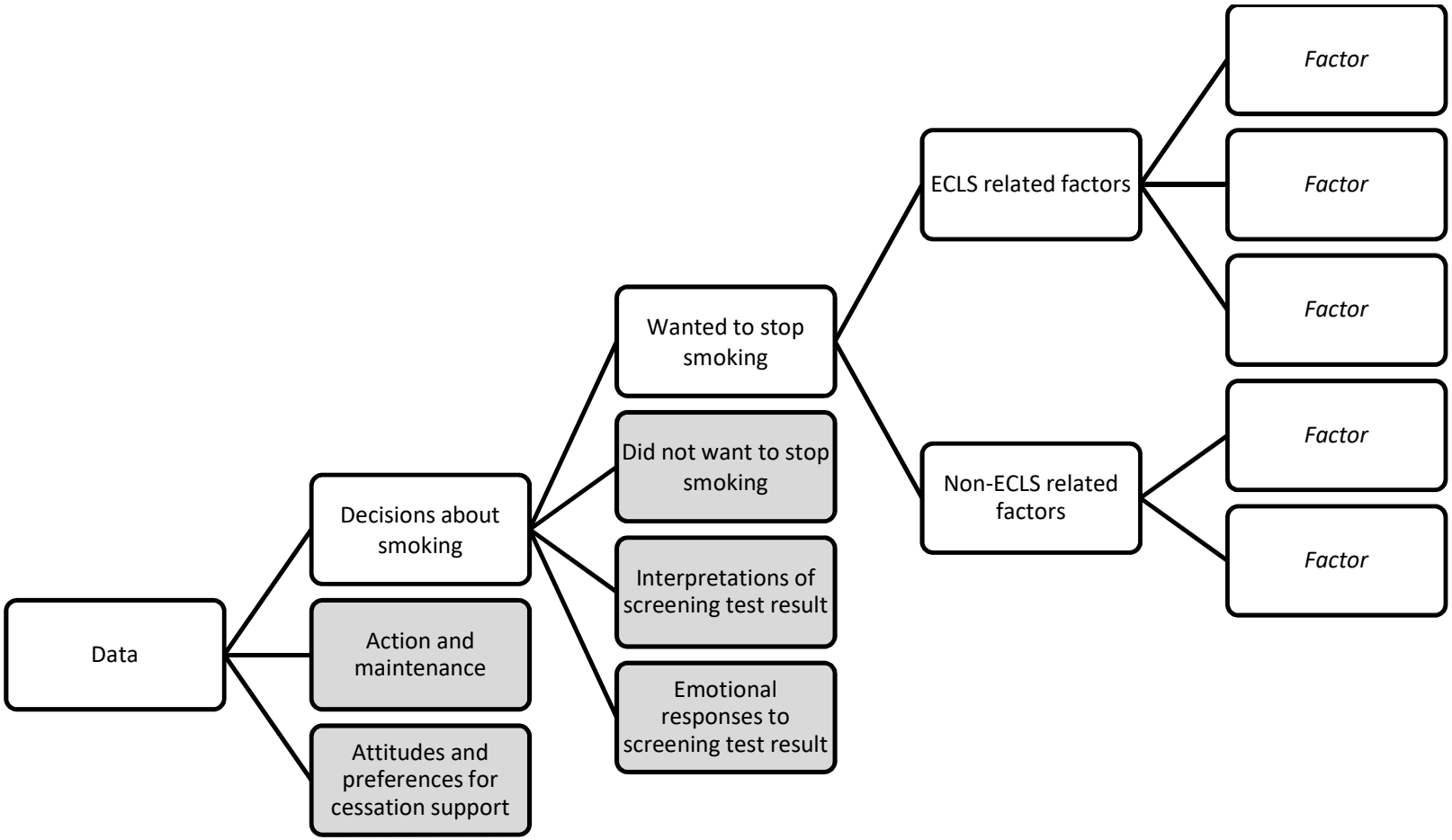
- Randomised to screening arm at ECLS enrolment
- Consented to further research at ECLS enrolment
- Completed a baseline questionnaire and at least one follow up questionnaire
- Smoker at ECLS enrolment (reported having smoked cigarettes or tobacco within last 7 days)
- Not diagnosed with lung cancer
- Not invited to participate in a separate ECLS qualitative study on a different topic
- Greater Glasgow & Clyde or Tayside study centre
- Met 1 of our 3 smoker sampling frame definitions:

Stopped smoking = reported a continuous 7 day period of abstinence at the time of completing a follow up questionnaire

Attempt to stop smoking (but not stopped) = reported having attempted to stop smoking + having smoked cigarettes or tobacco within last 7 days on a follow up questionnaire

No attempt to stop smoking = reported no attempt to stop smoking + having smoked cigarettes or tobacco within last 7 days on a follow up questionnaire

Figure 5.2 Overview of higher-level coding structure for decision-making data from participants who wanted to stop smoking



5.5.6 Trustworthiness

There are several different perspectives on ensuring quality in qualitative research. In this report I place an emphasis on demonstrating 'trustworthiness' of the research. This involves taking the broad concepts of validity and relevance common in quantitative research and operationalising them differently. More specifically, I considered characteristics of 'good' qualitative research suggested by Yardley (2000): sensitivity to context, commitment and rigour, transparency and coherence, and impact and importance.[401] I demonstrate sensitivity to context, commitment and rigour of the research by the methodology outlined in Table 5.2.

I also consulted the more detailed criteria of Seale et al. (2013) to ensure quality in the analysis and write up. These are 21 guidelines for 'good' qualitative research that include, for example, explaining rationale for a number of different aspects of the study, demonstrating openness to emergent issues, and paying attention to deviant cases or alternative explanations.[402] Furthermore, I had detailed knowledge of the CASP qualitative research checklist questions (having applied this to studies in the meta-synthesis reported in Chapter 3) which helped me to further improve the trustworthiness by, for example, being clear about how and why the methods were modified during the study.

Table 5.2 Characteristics of good qualitative research (Yardley, 2000)[401]

Essential qualities	Examples of the form each can take	Examples of essential characteristics in this study
Sensitivity to context	• Theoretical • Relevant literature • Empirical data • Sociocultural setting • Participants' perspectives • Ethical issues	• Positioning of the research within the wider ECLS study • 'Neutral', non-judgmental language in approaching the topic of smoking in the recruitment materials and interviews • Interviewing in participants' homes – naturalistic context
Commitment and rigour	• In-depth engagement with topic • Methodological competence/skill • Thorough data collection • Depth/breadth of analysis	• Inclusion of participants who had received positive and negative test results and those who had and had not tried to stop smoking • Inductive and deductive approach to analysis • Digital recording and verbatim transcription of interviews • Systematic coding aided by the use of software • Discussion between two researchers during the sorting of codes into structures to generate overarching themes

5.5.7 Ethical approval

East of Scotland Research Ethics Service REC 1 approved the research (reference 13/ES/0024, amendment AM05). The approval letter is in Appendix J (ECLS sub study 3).

5.6 Findings

Of 12,210 ECLS study participants, 376 were eligible for this study as screened participants completing follow-up questionnaires who smoked at enrolment. I invited 63 of them to the qualitative study, 46 (73%) responded and I interviewed 31 (49%) (Figure 5.1). Twenty seven interviews took place in participants' homes and four at participants' regional ECLS study clinical research centre. Participant characteristics are shown and compared to those of the source population in Table 5.4. On most characteristics the interviewees were comparable to the source population. They were, however, less likely to live in the most deprived areas and were more likely to have been intending to stop smoking at enrolment in the ECLS study. Interviews took place between May and September 2014. The timing of interviews in relation to participants' ECLS study clinical events are shown in Table 5.5. Most interviews took place within five months of EarlyCDT-Lung screening and, for those with a positive result, most took place after their chest X-ray and first study CT scan and before their 6-month study scheduled CT scan. In addition to the interview audio recordings, one participant

sent an email to me after their interview which I included as source data in the analysis because it contained further thoughts on topics discussed during the interview. During their interviews eleven participants reported having stopped smoking (as defined by them) since lung cancer screening. I transcribed 26 interview recordings and the other 5 were transcribed using external support. Table 5.3 shows a worked example of each step of the analysis. The complete coding structure addressing decisions about smoking (before development of themes) is shown in Appendix N. The quotes presented below were selected for presentation as the most representative data extract(s) of each theme. I identify whether each quoted participant described themselves as having stopped or not stopped smoking since screening. I did not conduct a structured comparative analyses of these groups but this information allows the reader to understand more of the participant's personal narrative or screening 'journey' and thus understand the impact of the evidence I am presenting in terms of the potential health outcomes.

Table 5.3 Example of analysis steps

Coding and theme development stage	Example
Raw data	"this trial kinda gives me another wake up call, do you know what I mean?"
Initial data categorisation of coding	Facilitators to cessation > Study specific factors
Initial data coding	i) participation in ECLS study ii) perceptions of risk
Revised data categorisation of coding	Decisions about smoking > Wanted to stop >>ECLS related
Revised data coding	Health of self and perceptions of risk
Generation of themes	Teachable moment
Review and refine themes	A wake-up call
Define and further refine themes	'A wake-up call' *ECLS experiences providing a reminder of the already-known risks of smoking, prompting realisation that action is needed (does not include data about increased urgency to take action or a sense that action should be taken 'now')*

Table 5.4 Participant and source population characteristics at ECLS study enrolment

	Interviewed (n=31)		Source population (n=376) (screened ECLS study participants completing follow-up questionnaires who smoked at enrolment)	
	n (%) [missing]	Median Range [missing]	n (%) [missing]	Median Range [missing]
Age (years)		58 51-74 [0]		59 50-75 [0]
Gender				
Man	15 (48.4)		198 (52.7)	
Woman	16 (51.6)		178 (47.3)	
	[0]		[0]	
UK region				
GGC	21 (67.7)		268 (71.3)	
Tayside	10 (32.3)		108 (28.7)	
	[0]		[0]	
Ethnicity				
White Scottish or White British	30 (100)		366 (98.4)	
	[1]		[4]	
Scottish Index of Multiple Deprivation (most deprived quintile = 1)				
1	10 (32.3)		164 (43.7)	
2	8 (25.8)		86 (22.9)	
3	6 (19.4)		50 (13.3)	
4	5 (16.1)		44 (11.7)	
5	2 (6.5)		31 (8.3)	
	[0]		[1]	
At least one parent or sibling with a lung cancer diagnosis				
Yes	6 (19.6)		90 (23.9)	
No	25 (80.7)		286 (76.1)	
	[0]		[0]	
Smoking pack-year history		40 20-175 [0]		37 2-175 [0]

Average no. cigarettes smoked a day	15 2-60 [0]	17 0-136 [2]
Attempted to stop smoking in last six months		
Yes	9 (31.0)	95 (25.8)
No	20 (69.0)	273 (74.2)
	[2]	[8]
Intend to stop smoking in next four weeks		
Yes	10 (32.3)	90 (24.2)
Don't know	10 (32.3)	100 (26.9)
No	11 (35.5)	182 (48.9)
	[0]	[4]
EarlyCDT-Lung result		
Positive	13 (41.9)	164 (43.6)*
Negative	18 (58.1)	212 (56.4)
	[0]	[0]

*EarlyCDT-Lung results in source population not representative of all ECLS study participants due to higher sampling rate of positive test vs. negative test participants for questionnaire study

Table 5.5 Interview timings relative to ECLS study clinical events

	Median **Range**
Days since EarlyCDT-Lung screening	146 110-254
Days since EarlyCDT-Lung result letter sent	126 79-228
Positive test participants (n = 13):	
Days since ECLS first CT scan	123 72-209
Days before ECLS scheduled 6-month CT scan (n = 11 [85%])	58 12-116
Days after ECLS scheduled 6-month CT scan (n = 2 [15%])	n/a 14; 28

The two overarching themes I extracted relating to decisions about smoking were *interpretations of screening test results* and *emotional responses* to those interpretations.

5.6.1 Theme 1: Interpretations of screening test results

Participants' interpretations of test results were a perceptual filter through which screening influenced decisions about smoking. The most important aspect of this theme was that levels of understanding of the degree of lung cancer risk implied by the type of test result were variable. ECLS participants had been advised that the test is not completely accurate and that it can detect lung cancer in only about 40% of cases of the disease. However, in the example below a negative result was interpreted as being an 'all

clear' from lung cancer, which represented to the participant a good time to stop smoking:

> P20[a]: And you say 'well I've got a chance, I've not got it so this would be a good time to stop, I've just been given the all-clear'. (Man,[b] 56,[c] negative,[d] not stopped smoking[e])
>
> [a]unique identifier [b]gender [c]age (years) [d]EarlyCDT-Lung test result [e]post-screening smoking cessation as described by participants in interviews (stopped smoking/not stopped smoking)

At the other extreme of perceived lung cancer risk, a positive result was interpreted in the following quote as meaning the disease will definitely develop in the future:

> P27: I thought when it was positive that it was there and it was 'you'll get lung cancer,' I thought that's the way it worked. (Woman, 63, positive, stopped smoking)

Some other recipients of a positive test result demonstrated a more informed understanding of the associated lung cancer risk:

> P7: The positive markers were coming up in my blood and look I read everything and it explained about it could be a false positive. (Woman, 53, positive, stopped smoking)
>
> P6: It's a one in nine chance over the next two years ... I thought well one in nine, that's roughly the same risk of one in eight smokers getting lung cancer anyway, it's just a pretty short timescale they've given me but it's pretty good odds. (Woman, 71, positive, stopped smoking)

Other interpretations displayed confusion about the presence or absence of lung cancer:

> P12: I mean to be honest I couldnae [could not] sit and tell you right now whether I've got cancer or whether I'm getting it. I know I tested positive for it, so what does that mean? Have I got it, or am I going to get it? ... But through my own fault it's confusing, cause I don't want to know. So you just get up every day and continue to smoke cause you think to yourself, 'well I've probably left it too late anyway,' and I'll just wait and see what happens next. (Woman, 53, positive, not stopped smoking)

Some interpretations of test results demonstrated a polarised understanding of lung cancer risk (e.g. a definitive 'all clear' or a diagnosis of certain future lung cancer), some showed a more balanced understanding and others involved a noticeable lack of understanding or confusion about what their test result meant.

5.6.2 Theme 2: Emotional responses to interpretations of screening test results

Participants responded emotionally to the interpretations described above and these responses were central to their decisions about smoking. Adverse emotional responses were generally (but not exclusively) described by those who received and interpreted a positive test result. They included fear, shock, upset, worry, anxiety and guilt:

> P7: You don't think there is emotions and fears and anxieties that come up, you think oh it's a study... you're facing something that could be

possibly detrimental to you, it can be worrying. For me I think it really reinforces trying to stop smoking. (Woman, 53, positive, stopped smoking)

P12: Shocked … shocked but in a roundabout way … I remember when I got the letter I was crying. I thought 'oh my God' … but then when you go back to the place they kinda make you feel better, like saying that it's nodules and stuff like that. (Woman, 53, positive, not stopped smoking)

P19: I felt a bit upset [about the test result], yeh. Not dreadfully because the nurse I'd spoken to at the hospital said 'look, it's not cut and dried, you may get this message saying that there's, you know, positive result but don't spare' [despair] type of thing, so I just took it at her word and sorta went along. (Woman, 74, positive, not stopped smoking)

P22: I think I feel worse about being a smoker than I did previously, I've always buried my head in the sand about it ... and it kinda makes it more of a reality and it actually makes you feel worse about smoking. Probably more guilty about it actually. (Woman, 59, positive, not stopped smoking)

Favourable or neutral emotional responses to interpretations of screening results were more often associated with negative results. They included relief, reassurance, and indifference:

P10: Thank goodness ... it was just relief because it [test result] come back clear. (Woman, 54, negative, not stopped smoking)

P4: The fact that I was taking part in a lung cancer study didn't bother me one way or t'other, yeh? I think I probably was quite relieved when I got the results indicating that there was no immediate problem, you know, but it didn't really mean a great deal to me, you know, I didn't get uptight about it or anything. (Man, 58, negative, not stopped smoking)

> P18: It wasnae sort of this great big 'wow'; no I didnae [did not] feel like that, no. I just thought 'oh that's good,' I didnae have lung cancer. (Woman, 58, negative, not stopped smoking)

> P13: I was ninety nine per cent, ninety nine point nine sure that it would be as it turns out on the last scan that I had, which I wasn't surprised because it did show up that there was nodules there. As I says, I didn't get all depressed about it and stuff like that, I just thought 'oops, I need to stop [smoking]'. (Woman, 55, positive, not stopped smoking)

These participants often emphasised the fact that these were not extreme emotional responses and that screening had not had a great emotional impact on them.

Some participants decided to change their smoking behaviour following screening and some wanted to continue smoking. Importantly, there were individual differences in the way in which emotional responses impacted decisions to try to stop smoking, with no clear pattern according to test results or interpretations of their meaning. Some responding emotionally to a positive test result were more motivated to stop smoking and felt they would have continued smoking if the result had been negative. In others the opposite responses were observed – they were motivated to stop smoking by emotional responses to a negative result but would have continued smoking if it had been positive.

5.6.3 Examples of the link between overarching themes and decisions about smoking

Below are three examples that demonstrate the link between participants' interpretations of test results, their emotional responses and their thoughts about smoking. The participant in the first example (below) had a lack of understanding of what her positive test result meant and, with the mention of 'this gene', of the nature of the test she had undergone. She explained how her emotional response to the test result inhibited her ability to understand the risk information provided to her and made her too scared to telephone the study centre to ask questions. She described a vicious circle whereby this emotional response and uncertainty led to her smoke more heavily:

> P12: Have I got it [cancer], or am I going to get it? If I stop smoking will that change, or will I still get it anyway, because of this gene? So there's a lot of questions, you know. And when you go there for that appointment after it all, you cannae [can not] really take it in, you know you're sort of sitting talking and you think 'I must remember that, I must remember that, I must remember that,' … and I did get a letter I couldnae [could not] even tell you where that is.
>
> [...] I'm not quite sure if I'm gonna get cancer or have I got cancer, but I could phone and ask but I'm kind of scared to cause I don't want to know what they're gonna say.
>
> I (interviewer): So has that uncertainty affected your thinking about smoking at all?

P12: Honest to God every time I pick up a cigarette it comes into my mind. It doesn't matter what I'm doing, every cigarette I light I think about it and I think 'I'm gonna stop I'm gonna stop I'm gonna stop' … but I can't and it's like a vicious circle where … because you cannae [can not] stop thinking about it you're smoking more, you know what mean? (Woman, 53, positive, not stopped smoking)

In the second example (below) the participant's understanding of his negative test result is that it means he does not have lung cancer but could still develop the disease in the future. He experienced relief, elation and felt lucky. He said this did not change his thoughts about smoking:

I: Can you remember any time [during the study] where your thoughts or feelings about smoking changed at all?

P9: No, I just knew it wasn't doing me any good, put it that way. It was doing me harm. … But I was relieved to learn that I never had lung cancer but it doesn't mean to say it wouldn't recur [occur in the future].

I: Could you tell me a bit more about the relieved feeling that you had when you found out that your test was negative? Tell me what that was like when you got the result?

P9: Obviously a bit elated, you know, but and lucky. … That's about it.

I: Why did you feel lucky?

P9: Well that it had missed me out. (Man, 67, negative, not stopped smoking)

The third example (below) is from a participant who experienced a 'fright' from a positive test, plus a further fright from a nodule detected on the subsequent CT scan. Her interpretation of her test result (and CT scan findings) and emotional response are both evident here in relation to her decision to try to stop smoking. Having been a smoker for 40 years, her success at stopping has surprised her:

> P1: I never thought I would give it up […] so that's really good.
>
> I: Why did you say you never thought you'd give up?
>
> P1: I don't know I just never thought I would ever stop smoking cos I've tried and tried at different times. It just shows you how a fright like that can really make you stop. And I'm really glad that I went for that [screening]. [...] I'm really glad I done it now. Cos that's what's made me stop smoking. Cos I've got something that's here [in the lung]. I don't even know what it is. The consultant I've seen said I've got something here but it's so many centimetres and they were waiting to see if it grew any more. I had to go back for another CT scan. That's gave me a real fright so that is the reason why I did stop.
>
> [...]
>
> I: When you found out that your screening test result was positive, can you tell me how you felt at that point?
>
> P1: I really got a fright and I didnae [did not] know am I gonna have lung cancer or is it-- you know-- I didnae feel good at all. So I was dying to go back for the CT scan to get that result, to get it all over and done with. So I was quite down at that time you know. Well [research nurse] had said

to me that the blood test was positive, wasn't it? That right? So that even gave me a fright at that. She said it doesn't mean you've got any lung cancer or that, but you're in the positive area ... but no, I got a fright at that time as well.

I: Did you have any thoughts about smoking at that time?

P1: Yeh. That gave me another trigger to stop, you know what I mean? I did want to stop then.

I: So at which point did you kind of make that decision that you were going to try and stop?

P1: Well after I got the result of the CT scan, that was when I decided that I was definitely going to do it. So that was a few weeks after I got the result that I actually stopped, so, I was really really shocked that there was something there. And I've not asked the doctor, I'm going to phone up and ask exactly what this is. I need to phone and ask does he think it is cancer that's there, do you know what I mean? He says it's right here at the front of my lung, but it is only tiny, he said they had to search the scans to actually find it, so it is tiny, six whatever, I don't know if it's centimetres or-- (Woman, 54, positive, stopped smoking)

The passage above shows the participant interpreted her test result reasonably accurately but she sought confirmation from me while stating that she had a positive result. The result gave her a 'fright' and caused her to be 'quite down', which was a 'trigger' to stop smoking and she wanted to stop at that point. She describes her nodule in basic terms: 'I've got something that's here'. The nodule gave her a further fright and she states this clearly as the point she

decided she would definitely attempt to quit. This participant had the longest period between being screened for lung cancer and being interviewed (254 days) so it is notable that even after this length of time she had not established whether or not she had lung cancer and planned to speak to the doctor to find out.

These examples show that individuals' responses were different but that their interpretation of their test result and emotional response were key recurring themes in their decision-making about smoking.

5.6.4 Theme 3: A wake-up call

The third theme 'a wake-up call' describes how screening served as a health scare prompting thoughts about the threat of lung cancer, which were a factor in decisions about smoking. This participant explained the decision-making that he felt this wake-up call necessitated:

> P3: This trial kinda makes-- gives me another wake up call, do you know what I mean? [...] That tells you, look, you've got a choice here. You continue doing what you're doing or you can try and cut down what you're doing or you totally cecease [cease], you know, you've got three choices. (Man, 53, positive, not stopped smoking)

The quote below describes the wake-up call in terms of an objective confirmation of the known risks of smoking:

> P22: Most smokers are very sensible people, you know the risks that you're taking but it's a very concrete thing isn't it when you get a test

> result like that, well it's concrete in some ways, the reality of what you're doing to yourself. (Woman, 59, positive, not stopped smoking)

Another participant expressed surprise that a positive result, interpreted as meaning her life was at risk and that a decision about smoking was needed, had not caused her to decide to stop smoking:

> P2: Even after I found out that I did have a positive result and both lungs have got nodules ... I'm still smoking! I mean I never ever ever thought that I would do that. I thought any time when it comes, I'll have to make a decision and I'll make it and that'll be it, you know, when my life's at risk right away I'll make it and that'll be it and I haven't done that. (Woman, 60, positive, not stopped smoking)

To emphasise the link between the wake-up call and smoking decision-making, the quote below expresses a desire for the receipt of a forceful message from a doctor for an even bigger wake-up call and additional motivation to stop smoking:

> P12: All the doctors need to say is, 'Listen, you. You've came back with a positive result. If you dinnae [do not] stop smoking today, right now, you're gonna die.' (Woman, 53, positive, not stopped smoking)

5.6.5 Theme 4: Now is the time to stop smoking

This theme describes how screening increased the perceived urgency to quit smoking and created a sense that 'now' was the right time to attempt this. This was expressed by one participant as

a warning that she could soon experience adverse health consequences of smoking if she did not stop soon:

> P13: I think probably since I've had the positive its maybe I had a wee jolt more to stop smoking. Probably. Like, I'm not getting away with it much longer. (Woman, 55, positive, not stopped smoking)

The participant below describes a similar feeling of an urgency to stop after learning that his test result was negative:

> P5: You stop now before you make it worse. You're okay at the moment, you're not a hundred per cent but it could be a lot worse. Now's the time to stop. (Man, 62, negative, stopped smoking)

Relating this back to theme 1, the participant above said he did not necessarily trust the test result and attributed this to the possibility of individual error rather than attributes of the test:

> P5: People make mistakes, professionals make mistakes. And they sometimes get too set in their ways and think 'oh this this result says no so it must be no'. It's not always the case. It depends on how you analyse things. Who analysed it, did they screen it properly? (Man, 62, negative, stopped smoking)

Due to these doubts he had sought a second opinion by requesting a chest X-ray through his GP. The chest X-ray was clear and he said that had convinced him that he did not have lung cancer: 'I was determined this time I was going to stop.'

However, the feeling of being given a ‘chance to stop’ was not always acted upon by other participants:

> P20: I says now I've got the chance to stop it but I didnae [did not], know what I mean? (Man, 56, negative, not stopped smoking)

I found again in this theme that participants varied in terms of whether they were (or hypothetically would have been) more motivated to quit by a positive or a negative result:

> I: So as someone who's tried to stop smoking quite a few times and then took part in the lung screening test, what role do you think that, the fact that you were screened for lung cancer, played in your decision to stop and your success in stopping?
>
> P30: Oh quite a big part because if it had come back abnormal, I probably woulda just carried on smoking. I would've because there's no point in stopping smoking cos you've got lung cancer, you know what I mean, cos you're a gonner anyway, I know that. So a big part.
>
> [...] I: So when you found out that it was a negative test result can you remember how you felt then?
>
> P30: That's when I thought I'll try and stop smoking cos I promised my kids and my wife I would give it a crack if it come back that way, I'll give it crack, I'll try and stop smoking. (Man, 51, negative, stopped smoking)

This theme demonstrates how test results led to participants feeling that they should stop smoking ‘now’. This was described in terms of ‘not getting away with it much longer’, stopping now before the consequences get worse and being given a chance to

stop ‘now’. A key feature of this theme was descriptions of this opportunity as time-limited by situating it specifically in the ‘now’.

5.6.6 Theme 5: Family influences

Following screening, family members were influential in guiding individuals’ decisions about smoking. For example one positive test participant, who had been a smoker for forty years, was delighted that her screening experiences, combined with requests to quit from her family, had helped her to quit:

> P1: Well I'm just so happy I've stopped. And I really cannae [can not] believe-- I still cannae believe it, I've actually stopped smoking. My family's all pleased, they're really really happy. They kept saying 'please try', they kept asking me to stop. (Woman, 54, positive, stopped smoking)

This theme interacted with the aforementioned themes, as demonstrated in a longer quote from the participant above (P1) shown in section 5.6.2.

The following quote describes how a screening test result was highlighted by a participant’s family member as an opportunity for a quit attempt:

> P10: I know you really should say well that’s clear, stop smoking and … give yourself a chance for the next one to be clear but … cos that’s what my mother said right away when I told her … she says you’ve been smoking all this time and it’s clear. Don’t smoke but … I just can’t help it.

I: So did you have those thoughts yourself as well?

P10: I didn't really, she said to me but then I thought pffff aye, it was just relief because it come back clear … and I still lit up a cigarette after that. It's just a horrible addiction I just cannae [can not] shake it. I've tried everything. (Woman, 54, negative, not stopped smoking)

The next quote demonstrates how emotional responses of family members to a positive test result were the most important factor in a participant's decision-making. She emphasises that despite this influence, the decision to try to stop smoking was her own:

P27: The reaction of my family [to the screening result], in particular my husband, he was so upset, he was even worse than me to be quite honest with you. He still never turned round and went like that 'well you're gonna have to stop smoking' or anything like that, I done that myself. (Woman, 63, positive, stopped smoking)

Another participant explained how pressure from his wife, combined with the test result, influenced him to try to stop smoking:

P29: She's been on at me for years to stop smoking and I think a combination of her plus the study plus the fact that I was lucky enough that it was clear that I may be chancing my luck if I keep on going. (Man, 70, negative, stopped smoking)

Some participants' partners and other family members had also taken part in the ECLS study but none had been allocated to the screened arm.

In summary, the input of family members in participants' decisions about smoking was commonly cited. This theme indicates that decisions took place in a supportive social context, with family members exerting influence as stakeholders in participants' wellbeing.

5.6.7 Non-screening factors

Screening was not always the overriding factor in decisions about smoking and I found important non-screening factors influencing decisions. These included age and life stage factors, respiratory symptoms, and the financial cost of tobacco use. Example quotes for these themes are presented below:

5.6.7.1 Age and life stage

> P4: As I've got older I suppose there is an effect in the sense that it's all very well saying 'I'll carry on smoking' and then you die, I've been more lately thinking, well yeh but it might be a long painful death. (Man, 58, negative, not stopped smoking)

> P5: My own mortality, reaching sixty two and thinking 'oh you're nearer the end than you are the beginning now, you'd better watch what you're doing,' that sort of thing. I don't want to end up in a home in a wheelchair not being able to walk, things like that. When I go I want to die in my own home, reasonably fit, and I thought if I keep smoking that might not happen. When you start reflecting and you get near the age you were when they [participant's parents] died and you think 'maybe it's time you stopped'. (Man, 62, negative, stopped smoking)

P6: My first grandchild was expected. I just did not want to be a smoking granny. (Woman, 71, positive, stopped smoking)

5.6.7.2 Respiratory symptoms

I: Can you remember what made you decide to try and stop back in January?

P26: Because truthfully it's my health, it's my health. Cos like I don't feel ill, it was more when I lay in my bed at night I could hear myself wheezing and I said 'need to give up these cigarettes I'm gonna end up really ill,' and you know? And I think that was one of the reasons. (Woman, 57, negative, not stopped smoking)

5.6.7.3 Financial cost

P4: My motivation in trying to stop smoking was really financial. It's now something like seven pound fifty a packet, incredible price you know, so that was the real motivator I have to say. (Man, 58, negative, not stopped smoking)

P18: The main reason I would like to stop is the money aspect, cos it is very very expensive and I mean it probably sounds really daft, I mean I should be thinking more about my health but I think more about the money aspect of it because I do enjoy a cigarette. (Woman, 58, negative, not stopped smoking)

5.6.7.4 Pre-screening decisions to stop smoking

P5: And I thought this [ECLS study] is just another way of trying to stop so I'm going to go for it and see what happens. I didn't know what it was all about then, obviously.

I: So you thought it could help you to try and stop smoking?

P5: Yep I needed motivation to stop. And you can do with any motivation you can get. (Man, 62, negative, stopped smoking)

These themes explain how some participants' smoking decision-making was influenced by factors unrelated to their experiences of lung cancer screening.

5.6.8 Coinciding factors

Some individuals said screening had motivated them to try to stop smoking in combination with other coinciding non-screening factors:

> P7: Everything sort of fitted in at the right time for me because ... before I had a wee scare and I kept thinking 'oh I want to stop smoking', different things had happened [family bereavement] and so it all seemed to— (Woman, 53, positive, stopped smoking)

> P6: I felt that the stars were aligned if you like, I had the Champix [medication to treat nicotine addiction], I had [smoking cessation counsellor], I had my granddaughter all as the sort of incentive and I thought I might never be so lucky again as to get that that combination of things all at once. It was a combination of things and I think getting this positive result in a way was sort of marginal, it may have been like a sort of final thing. (Woman, 71, positive, stopped smoking)

Screening for lung cancer was a novel experience that they felt, in combination with other factors, presented an opportunity that might not be available again. Screening was described as having come at the right time, having 'brought it all in' and 'brought it all to a head' in combination with other motivating factors.

5.6.9 Individuals who did not want to stop smoking

Example quotes are shown below describing three themes I extracted from data from participants who did not want to stop smoking:

5.6.9.1 Reassurance from study schedule CT scans

> P14: If they see any changes within the CAT scan it's gonna be caught at an extremely early stage. If there's any changes well, I'll just cross that bridge when I come to it. (Man, 64, positive, not stopped smoking)

5.6.9.2 Too late to stop now

> P14: I think I've had a good life and I've been here long enough and I think now if it was going to be something serious well, what would I get out of it? Another three or four years, you know. I'm not unduly perturbed about it, the prospect. Sad to say. (Man, 64, positive, not stopped smoking)

> P19: I suppose at my age, lack of motive. I mean I've known quite a number of people younger than me have died. I don't expect to live that much longer and I'd rather live it pleasantly. (Woman, 74, positive, not stopped smoking)

The quote above shows how this woman had made a conscious and considered decision to continue smoking. She described how twenty years previously she had stopped smoking and then relapsed because she had found life less enjoyable as an ex-smoker. She acknowledges her resulting trade-off between longevity and quality of life:

P19: Life just didnae [did not] feel normal, you know and I'd come off the pills [medication for depression] and I was coping with everyday problems but I really wasn't enjoying life much. So I thought well maybe they say it [smoking] takes ten years off your life to go. I'd rather have what time I have than longevity and feeling miserable, so I went back onto cigarettes again. And I'm fine.

I: And was life easier after that?

P19: Oh yes. (laughs)

I: So you're happy you made that decision?

P19: Yeh I am, uh huh. I'd rather never have smoked. I'd much rather I didn't but I really don't feel I would be prepared to go through … the torment really. (Woman, 74, positive, not stopped smoking)

This shows how a decision to continue smoking was a continuation of a decision made many years before screening. In this case lung cancer screening experiences had not prompted any thoughts about stopping smoking. However, screening had prompted this individual to begin using filters in roll-up cigarettes.

5.6.9.3 Avoidance of thoughts about smoking

P26: I blank it out my mind, smoking. I blank lung cancer out my mind. (Woman, 57, negative, not stopped smoking)

P22: I think it [smoking] probably is always in my mind but I am a bit of a bury my head in the sand kinda person about it. (Woman, 59, positive, not stopped smoking)

5.6.10 Other observations

Cues to change were experienced at different stages of the screening process and not always immediately following a test result. For example, one participant who stopped smoking was prompted to think about doing so by an ECLS study follow-up questionnaire some time after screening:

> P28: I got that next questionnaire, then I think it started making me think more about the smoking as I was answering each of the questions. Put that in the post and I think it wasnae [was not] long after I posted it I... 'wait a minute, I'll give it a-- let's give it a ... kick here let's get shot of this.' (Man, 55, negative, stopped smoking)

He explained it was the questions measuring emotional responses to screening that were influential, rather than questions about smoking:

> P28: It wasnae [was not] about the smoking habits or anything else it was more about the actual health and reading the questionnaire and then thinking 'now ... had that came back as positive I'd be looking at a totally different set of feelings.' (Man, 55, negative, stopped smoking)

Several participants had decided to try to cut down the number of cigarettes they smoke but had not attempted to stop completely:

> P12: I have cut down drastically but I need to stop completely. What I'm doing now is I'm getting up in the morning and instead of having a whole cigarette I just have half a cigarette and then I keep the other wee half. (Woman, 53, positive, not stopped smoking)

Some people had already decided to try to stop or cut down smoking before screening and their screening experiences either reinforced or did not influence these decisions:

> P4: I had decided to have another serious bash at stopping and it was purely coincidental with the invitation to take part in this study, it wasn't as a result of it or anything. (Man, 58, negative, not stopped smoking)

Interviewees sometimes demonstrated poor understanding of aspects of the study other than the meaning of test results, such as the reason why their friends or family members had been allocated to the control arm and had not been screened like they had:

> P12: That was a wee bit of a downside but then you cannae [can not] do everybody I mean you've not got funding for that. (Woman, 53, positive, not stopped smoking)

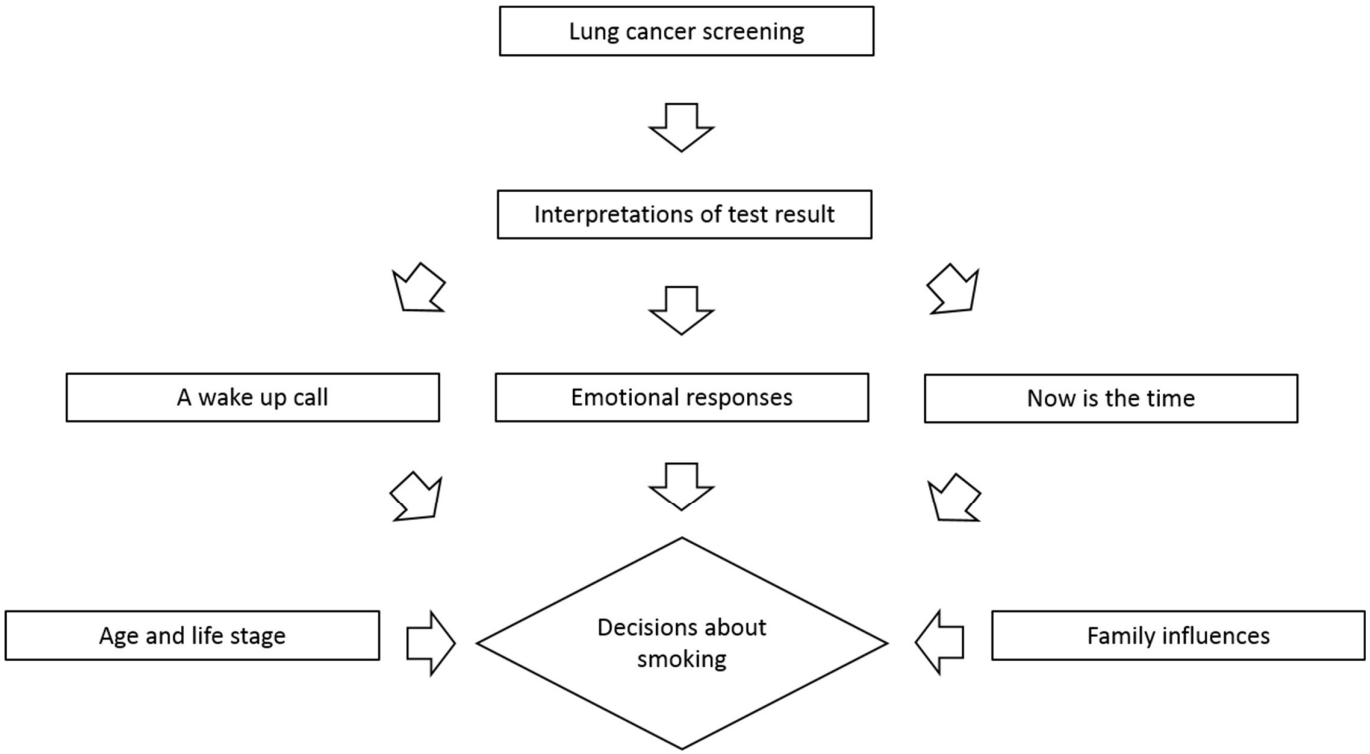
There was evidence that some lung cancer screening participants may have life circumstances that leave them especially vulnerable to adverse emotional responses. For example some of the participants described having caring responsibilities for disabled or chronically ill family members, having a brain injury or having suffered from a mental health disorder. Unrelated to smoking, two participants identified a need for emotional support after test results, for example:

> P6: I think also there has to be something for people like me as well, who get a positive result but haven't yet shown any signs [of lung cancer], I definitely think that. I mean I think personally I've coped with it quite

> well myself but that's not to say there haven't been some dark moments of the soul and I'm not sure-- I don't think it's a role that friends or family could fulfil. You definitely need more expert sort of support. (Woman, 71, positive, stopped smoking)

A diagram of the key themes in decisions about smoking is shown in Figure 5.3. The arrows indicate broad patterns observed in the relationships between the themes and are not intended to be an exhaustive representation of themes that did and did not interact with each other.

Figure 5.3 Key themes in decisions about smoking



5.7 Discussion

5.7.1 Main findings

This is the first in-depth study of how lung cancer screening influences smoking behaviour decisions and the first to purposively recruit and study smokers who report having stopped smoking following lung cancer screening. This allows the impact of lung cancer screening to be explored in detail from the smoker's perspective.

I found that individuals often interpreted their test results inaccurately and responded to this emotionally, influencing decisions about smoking. Differing levels of understanding about what the test result meant, emotional responses to those understandings and pre-existing motivations to change their smoking behaviour, meant individuals differed in terms of their decision-making around smoking and the resulting smoking behaviour was unpredictable. Interpretations of positive and negative results were both described as a reason to stop smoking or a reason to continue smoking. Screening acted as a 'wake-up call' to the health risks of smoking and led to a feeling that 'now' was the time to try to stop smoking. Other influences came from family members, age-related factors and the existence of multiple coinciding non-screening factors. Increased motivation to stop smoking was experienced at different stages of screening and some

people had taken part in screening in order to try to stop smoking. In those who did not want to stop smoking, reassurance from study CT scans, a feeling that it was too late to stop, or avoidance of thinking about stopping, were all observed.

5.7.2 Comparison with quantitative data on smoking in lung cancer screening

The themes I identified can help explain the findings of the ECLS nested questionnaire study and other similar studies[98, 100] in the following ways.

Individuals tended not to make decisions about smoking based on the objective risk implied by their test result. Instead, they interpreted their test result in their own way and responded emotionally to this. Individualistic and unpredictable responses can help to explain why no overall effect of screening on smoking prevalence was observed in the questionnaire study reported in Chapter 4. The study demonstrates that lung cancer screening can increase and decrease perceived risk, sometimes to the extreme, and both can contribute to a so-called teachable moment. It also shows that in lung cancer screening both increases and decreases in perceived risk can have the opposite effect and reduce motivation for smoking cessation.

Misperceptions of the risk of lung cancer associated with the results of lung cancer screening is a novel finding. This sometimes resulted

in distorted perceptions of risk, such as 100% risk of lung cancer, or confusion about risk such as being unsure whether or not one currently has lung cancer. The finding adds complexity to understanding the behavioural impact of lung cancer screening because it challenges the assumption that changes in participants' behaviour are influenced by an adequate understanding of risk information. Lung cancer screening studies have shown that those receiving abnormal test results requiring further investigations are more likely to stop smoking or remain abstinent from smoking.[96, 100, 141, 371, 403, 404] In Chapter 4 I discuss whether between-study variation in the behavioural impact of lung cancer screening can be explained by different proportions of screened behavioural study samples receiving abnormal tests and requiring further imaging investigations (e.g. 55% UKLS,[100] 47% ECLS (Figure 4.1)). This qualitative study shows that changes in smoking behaviour could sometimes have been influenced by a suboptimal understanding of screening information. For example, a participant had stopped smoking under the impression that a positive test result meant lung cancer would definitely develop. This finding indicates the differences observed in smoking behaviour variables between test result groups in Chapter 4 may be the result of more than just an awareness that one has a 'positive' or 'negative' screening test result (and any subsequent investigations for positive test results),

but of more complex psychological processes of cognitive information processing and resulting emotions.

Emotional response was one of two overarching themes in the data, emphasising the heightened importance of emotional response that there may be in the generation of teachable moments in lung cancer screening. This can aid understanding of why the quantitative data show that positive test results promoted quit attempts, smoking cessation and less heavy smoking, meanwhile changes in the negative test result group were generally in the opposite direction. This is because emotional responses reported by positive test participants in the study were more likely to be adverse emotions such as fear, shock and fright. Negative test results led to a more mixed range of responses that were less extreme such as reassurance and 'oh that's good'. Social cognitive models of behaviour that incorporate emotional components tend to prioritise fear responses as an influential factor in behaviour.[405]

There were different distinct dimensions to teachable moments experienced, represented by the themes 'a wake-up call' and 'now is the time to stop smoking'. In those who attempted to stop smoking in the questionnaire study, these themes elucidate the nature of the behaviour change process that occurred. They help explain how lung cancer screening can be a powerful motivator for smoking cessation in long-term smokers, who are well aware of the

health risks and many of whom have 'tried everything' to quit but have struggled to overcome their addiction. Screening can provide an objective and personally relevant reminder ('wake-up call') of the risks of smoking, with serious and potentially imminent consequences, that create a feeling that the time to take action is 'now'.

The qualitative data show that family members were influential in participants' decisions about smoking. An advantage of qualitative research methods is that they are suited to exploring the social context of experiences and I found that close relatives of screening participants played a key role in decisions in conjunction with screening experiences. The influence of family in this population group raises the possibility that the relationship could be bidirectional in that screening could provide additional health benefits by influencing the behaviour of unscreened family members of those screened.

Decisions about smoking were influenced by a number of other factors unrelated to screening. For example, age-related factors were evident and some cited financial reasons rather than health reasons as their main motivator to quit. The nested randomised design of the questionnaire study means that these non-screening factors can be assumed to be balanced between screened and unscreened groups and response rates were high in both arms.

Comparisons between test result groups controlled for confounding variables including age group, smoking history and deprivation. However, is it possible that there was confounding by other non-screening factors associated with lung cancer risk such as respiratory symptoms or family circumstances like being a grandparent. The findings that there were often a number of coinciding factors, that screening sometimes provided only a final tipping point for behaviour change rather than a primary motivator, and that some people decided to attempt to stop smoking before they were screened, all emphasise the importance of controlling for baseline motivations, intentions and risk perceptions in my questionnaire data analyses.

There was some evidence in the qualitative data of measurement effects in the questionnaire study, such as attributing a successful quit attempt to thoughts prompted by a follow-up questionnaire. Conversely, several interviewees commented that they had found the interview beneficial in relation to their motivation to quit, which could have confounded their subsequent questionnaire data.

Lastly, some participants had made small behavioural changes that were not captured by the questionnaires, for instance deciding to start using filters in roll-up cigarettes. Even in those who decide to continue smoking there may be behavioural changes that have not been quantified in studies.

5.7.3 Comparison with other data

It is known that understanding of numerical risk concepts can be low even in well-educated adults[406] but natural frequencies tend to be better understood than percentages.[407] ECLS study participants were presented with natural frequencies in their participant information leaflet and test result letter:

> Eight out of every nine people receiving a positive test result do not have lung cancer.
>
> The test detects 40 of every 100 cases of lung cancer.
>
> Between 98 and 99 out of every 100 people with a negative test do not have lung cancer at the time of the test.

Many (but not all) participants appeared still not to adequately understand what their test results meant in terms of risk. There is a dearth of research on individuals' understanding of the risk associated with positive and negative results from cancer screening tests. A previous qualitative study identified a number of misperceptions about lung cancer screening, including a belief that screening prevents lung cancer.[393] The authors noted that avoidance of a lung cancer diagnosis meant to participants that they were one of the lucky ones who had avoided harm from smoking. Another qualitative study reported that participants who had been screened for lung cancer recalled limited information about the test,[218] with one saying: "I get a letter two, three weeks

later ... with the results. I may not necessarily know what they mean but I figure if [the doctor's] not calling me, then everything's all right." This shows a lack of understanding of lung cancer screening test results combined with an apparent lack of motivation to improve understanding. My finding concurs with this observation, because information about the test was provided to my participants but they were often not well informed about the test.

The finding supports concerns that poorly understood cancer screening test results can be a consequence of dichotomising them into 'positive' and 'negative', with adverse psychological effects on participants.[408] I have not identified any other published data substantiating this argument, so further investigation is needed. Nevertheless, the study extends this argument to show that dichotomised screening test results can be misunderstood even when accompanied by risk information presented as natural frequencies. It also suggests poor understanding can lead to beneficial effects such as smoking cessation, as well as potential adverse effects.

It could be that the information needs of individuals undergoing lung cancer screening are different to when they undergo screening tests with which they may be more familiar, such as breast, cervical or colorectal cancer screening. Perhaps there is too great a

demand placed in expecting participants to read, understand and remember information about a number of different cancer screening tests, each with different attributes. This could be exacerbated by the lack of familiarity with lung cancer screening. For example, even primary care providers have been shown to have deficits in knowledge about lung cancer screening.[75, 409] Alternatively, participants' apparent misinterpretation, such as the use of 'all-clear' to describe negative test results, could reflect a lack of access to screening vocabulary. They may have been aware, for example, that the test is more likely to produce a false negative result than a true positive result but may have reverted to phraseology more commonly used by laypeople such as 'all-clear' for ease of communication during interviews.

The observation that lung cancer screening test results were experienced emotionally, and that this can influence smoking behaviour, has been reported previously. Emotional arousal was one of three key pathways by which lung cancer screening was found to influence motivation around smoking cessation in a qualitative study.[393] However, many of the supporting participant quotes for that finding did not mention any emotions, meaning it could have been an *a priori* hypothesis that influenced the findings during the authors' deductive coding process. The NLST qualitative study reported a lack of emotional impact overall but also stated that half of those who received a positive test result were

'affected'.[392] A different qualitative investigation reported that fear and guilt responses to patient and clinician shared decision-making about lung cancer screening were a barrier to engaging in deliberation about screening.[410] Beyond lung cancer screening, we know that emotion plays a key role in the perception of risk information[313] and that emotional responses can be more influential in decision-making about cancer prevention behaviours than factual knowledge.[411] PMT and EPPM explain how 'fear appeals' can lead to an efficacy appraisal and can result in protective health behaviour or avoidance. The current study shows lung cancer screening can motivate smoking behaviour change through a wider range of positive and negative emotional responses. Abnormal lung screening results have been shown in studies to have a short-term adverse impact on emotional outcomes[64, 148, 153, 154] and to promote smoking cessation.[139] The UKLS demonstrated that short-term emotional distress was associated with positive test results and, in those with a positive test, more strongly associated with being a smoker than an ex-smoker.[148] The current study advances understanding of this link between emotional and smoking outcomes, demonstrating that emotional responses to lung cancer screening results are prevalent and how they can be highly influential in decisions about smoking.

The themes 'wake-up call' and 'now is the time to stop smoking' indicate that lung cancer screening can increase both motivation

and urgency to quit. This supports and develops further the idea that lung cancer screening can provide a teachable moment for smoking behaviour change. Another qualitative study suggested ill health can give smoking cessation a 'now or never' status that allows patients to downplay their responsibility for not having quit before.[412] I found similar evidence that participants saw lung cancer screening as an opportunity to attempt to stop smoking that might not be available to them again. My findings contrast with the NLST study describing individuals' reasons for seeking screening and the effect it had had on their perceived risk, worry and behaviour. That study concluded screening was not a cue to action and high risk perceptions were not related to quitting.[392] This contrast with my findings may be due to my study adopting a more loosely structured approach to data collection, allowing interviews to stray from a semi-structured question schedule and the wider context of smoking decisions to be explored. For example, when lung cancer screening played a role in decisions to attempt to stop smoking in participants, there were often other influential non-screening factors such as thoughts about getting older, respiratory symptoms and money.

Some participants stated they had already decided to try to stop smoking before they had become aware of the ECLS study. This finding conforms to the idea that those who take part in screening are more motivated to stop smoking than those who do not.[380] This

is also consistent with a past finding that motivation to stop smoking was one of three perceived benefits of lung cancer screening in smokers.[413] There was some indication in the current study that reassurance from future scheduled CT scans could reduce motivation to quit, and that some people cut down their smoking or made other beneficial changes, both factors that have been reported in existing studies.[392, 393]

I recruited and interviewed some smokers that reported having not attempted to stop smoking since screening. It was therefore unsurprising that the analysis generated a number of themes explaining decisions to continue smoking. In particular, it was found that some people thought that at their age it was too late to stop smoking. This is consistent with a qualitative study of smokers in Scotland aged over 65 years, in which the majority of participants were aware that smoking had damaged their health but that a barrier to quit attempts was a view that 'the damage was done'.[414] The current study echoes this finding and showed how some smokers who take part in a lung cancer screening trial are not interested in quitting and show avoidance in thinking about quitting. This can be explained in terms of the EPPM, according to which avoidant behaviour is conceptualised as ‘fear control’ and can be the result of greater perceived threat than perceived efficacy.

5.7.4 Implications for research, policy and practice

5.7.4.1 Misinterpretation of test results

The way in which some participants misinterpreted screening test results (e.g. definite future lung cancer/all-clear from lung cancer) was a factor in decisions about smoking. Ethically, it is important that screening uses effective risk communication to enable an accurate understanding of risk in participants. Clinicians are a key influence because they have been shown to anticipate a lack of patient comprehension about lung cancer screening and to provide limited or one-sided information to them as a consequence.[410] In addition, there are implications for the wider organisation of lung cancer screening. The use of the terms 'screen positive' and 'screen negative' could be introduced to prevent interpretation of test results as diagnostic or other misunderstanding of their meaning.[415] Dispensing completely with the use of 'positive' and 'negative' is undesirable because the purpose of screening is to 'sort' the screened population into distinct groups, and it would be difficult to predict and monitor the efficacy and safety of a screening programme in which results are not categorised in this way.[415] The EarlyCDT-Lung test results were communicated to participants as 'positive' or 'negative' along with probabilities using simple frequencies. The finding that there were still significant deficits in understanding highlights a need for further research into understanding of lung cancer screening test results. Specific

questions about communication and understanding of risk to be addressed include:

i) What alternative communication techniques promote better understanding of lung cancer risk in screening participants?
ii) Are there barriers to risk communication specific to lung cancer screening (e.g. greater pre-screening perceived risk due to smoking history, greater anxiety at receipt of test result prohibiting comprehension of information)?
iii) How is understanding of lung cancer risk associated with behaviour change, e.g. smoking cessation?

Some participants' smoking decision-making could have differed if they had more accurately understood their lung cancer risk. Any assessment of the benefits and harms of a lung cancer screening programme should consider how well test results are understood and the resulting emotional and behavioural responses. If changes are made to the way lung cancer risk is communicated, smokers may understand their risk in a different way, respond different emotionally and make different decisions about smoking. Studies of the impact of lung cancer screening on smoking should therefore account for levels of perceived risk so that these relationships can be explored.

5.7.4.2 Individualised behavioural responses

The finding of individualised responses to screening emphasises that caution should be used in associating positive results with increased motivation to quit and negative results with decreased motivation, because increased motivation was evident following positive and negative results, as were decisions to continue smoking. There may be contrasting effects of screening on smoking in different sub-groups that could be explored in future work to identify predictors of these outcomes. There will be a need and obligation to prevent harm if sub-groups are shown to be more likely to continue smoking, smoke more heavily or relapse. A concerning observation from this study was that there were smokers who suffered adverse emotional responses to screening that had been further compounded by subsequent unsuccessful smoking quit attempts. There were also, however, smokers who had reduced the number of cigarettes they smoked since being screened, emphasising the importance of considering the impact of screening in terms of the heaviness of smoking as well as smoking prevalence.

There was a suggestion in the study that the impact of screening could affect quit rates in people other than those screened. When a married individual quits smoking the probability of their spouse quitting greatly increases,[416] an association which could generate further benefits of screening in older adult populations. The impact

of screening on the tobacco use or second hand smoke exposure of unscreened partners or spouses of screened individuals is a potential further outcome which could be relatively easily explored in future behavioural studies. Furthermore, when considering the benefits and harms of screening it should be acknowledged that benefits and harms can interact, for example short-term emotional harms could promote longer term benefits such as smoking cessation.

5.7.4.3 Smoking cessation interventions

The findings suggest that smoking cessation support in lung cancer screening should be tailored to individual interpretations of, and emotional responses to test results. Understanding of test results can be discussed and emotional reactions 'exploited'. Those with a negative test result could be asked to consider 'how would you have felt if it was positive'?

Interventions should be offered after the test result is delivered but there should also be flexibility in the timing of delivery. Screening participants should be able to proactively engage in support when they feel the urgency that 'now' is the time and should not have to wait for an appointment. A participant was prompted to think about their smoking after completing a follow-up questionnaire some time after the test result, leading to a successful cessation attempt. On the other hand, some participants had taken part in screening in

order to try to stop smoking so may have been most motivated to stop before screening. Teachable moments can be an unpredictable opportunity and can be created spontaneously through clinician and patient interaction.[166] Individuals could be asked at the initial screening consultation 'how will you feel if it is positive?'

Involvement of family members in cessation counselling may be beneficial and could facilitate co-ordinated quit attempts. Counselling support should include wider consideration of non-screening as well as screening factors, with an awareness that screening may not be a motivating factor for some to engage in support. It should be responsive to age-related factors, like the possibility that individuals may increasingly be starting to think about the end of their life, and should seek to address the perception that it is too late to stop smoking in older age.

Individuals eligible for lung cancer screening due to their smoking history may be more likely than the general population to have challenging life circumstances or to have experienced mental health problems.[113] Staff delivering smoking cessation support in a lung cancer screening programme should be able to navigate sensitive issues and the potential compounding adverse psychological effect of screening participation.

Screening participants who are not motivated to stop smoking could be difficult to engage in cessation support. Novel cessation

support methods may be required to interest smokers who are not actively seeking an intervention.[147] This might involve a high degree of integration with the screening process, rather than provision by an external party. Ideally it would be delivered by staff with knowledge of the screening programme and of the type of experience that each patient has had.

Smoking cessation support strategies have been piloted in lung cancer screening with varied degrees of individual tailoring. Seven such studies are outlined in Table 5.6.

Table 5.6 Studies of smoking cessation interventions delivered in conjunction with lung cancer screening

Study	Intervention	Tailoring	Outcome
Clark, 2004[417] (SCTS study) RCT n = 171	Intervention = standard written self-help materials Control = standard untailored written list of internet resources for smoking cessation.	None	7-day point prevalence quit rates at 1 year Intervention = 5% Control = 10% (difference not statistically significant)
Ferketich, 2012[389] RCT n = 18	Intervention = tobacco dependence treatment before screening Control = tobacco dependence treatment after screening In both conditions treatment included nurse-delivered weekly telephone counselling and a 12 week programme of nicotine replacement therapy or varenicline	None described	Abstinence rates at 4 months: Intervention = 33% Control = 22% 6 months: Intervention = 22% Control = 11% (no test for difference between groups) Overall = 17%
van der Aalst, 2012[387] (NELSON trial) RCT n = 1284 screened males who had not received a	Intervention = computer-tailored smoking cessation advice sent to the home addresses of those who completed a tailoring questionnaire Control = standard self-help brochure	Advice computer-tailored to responses to questions about smoking history, behaviour and opinions. Not tailored to responses to screening test results.	Point prevalent abstinence rate at 2 years: Intervention = 16% Control = 13% (difference not statistically significant) Overall = 15%

Study	Intervention	Tailoring	Outcome
positive test result			
Fillipo, 2015[418] (Cosmos-II trial, Italy) Retrospective cohort (preliminary report) n = 63	A cognitive-behavioural psychologist follows patients from first lung cancer screening clinical visit and throughout follow-up visits. They evaluate each patient's behavioural changes and decide which pharmacological treatment (nicotine replacement therapy, varenicline, or bupropion) to prescribe	Tailored to 'behavioural changes'	Quit rate at 6 months = 57%
Pozzi, 2015[419] (MILD trial) Retrospective cohort n = 187 persistent smokers despite brief advice during prior MILD visits	Varenicline for 12 weeks plus individual behavioural counselling via 4 telephone calls of at least 10 minutes including advice about how to cope with craving, supporting motivation and self-efficacy	Not tailored to lung cancer screening factors	Point prevalent abstinence: 1 month = 52.4% 3 months = 48.7% 6 months = 33.7% 12 months = 32.6%
Marshall, 2016[388] (Queensland Lung Cancer Screening Study) RCT n = 55	Intervention = motivational interviewing session with audio quit materials, printed quit materials and Quitline contact details Control = printed quit materials and Quitline contact details	Tailored discussion of lung function results and lung cancer risk	Quit rate at 1 year: Intervention = 14% Control = 19% (difference not statistically significant). Overall = 16%

Study	Intervention	Tailoring	Outcome
Taylor, 2017[420] RCT n = 92 registered to undergo lung cancer screening	Intervention = up to 6 brief telephone counselling calls with a trained cessation support counsellor involving motivational interviewing, identifying and coping with smoking triggers, encouragement to consider nicotine replacement therapy and to speak with their doctor about medication Control = usual care	Tailored to test result: aimed to capitalise on the teachable moment of an abnormal result by discussion of result designed to increase risk perceptions, emotional reactions to the result, and challenge one's self-concept as a smoker, and to counteract the potential for reduced motivation to quit after a result showing no nodules or abnormalities by providing education that it was not a permanent 'clean bill of health' and of the health benefits to older adults who stop smoking	7-day point prevalence cessation at 3 months: Intervention = 17% Control = 4% ($p<0.05$)

The most highly tailored intervention, which was personalised to test results to increase risk perceptions and emotional responses, resulted in statistically significantly higher quit rates than usual care.[420] A responsive and multifaceted approach such as this, rather than a simple computer-tailored method, has the flexibility to adapt the advice depending on the attitudes and intentions of the screened smoker, which my study showed can be unpredictable and individualistic. There is the caveat that pilot studies such as these can lack statistical power to detect changes in smoking behaviour as they are usually intended to demonstrate feasibility of interventions. There are also variations between studies in criteria such as the definition of having quit smoking. However, they are examples of increasing efforts to tailor smoking cessation support delivered alongside lung cancer screening. They generally show that greater tailoring is more effective at promoting smoking cessation and abstinence within a lung cancer screening programme. 'Adaptive' interventions that are further tailored to participants' initial response to support could provide greater benefits[421] but this should be informed by an understanding of the barriers and facilitators to abstinence in the context of lung cancer screening. Analysis of a separate subset of the interview data will address this in the future.

Research is needed to explore lung cancer screening participants' attitudes to smoking cessation support, for example whether it

would deter them from attending screening, and what type of support they would find most acceptable and useful.[386] Again, I plan to address these areas with future analyses of other subsets of data from this study. In terms of timing, the evidence in Table 5.6 indicates that support can be more effective when delivered before screening rather than after receipt of the screening test result. Systematic reviews show the most effective cessation strategies generally available are behavioural support and pharmacotherapy (e.g. nicotine replacement therapy or varenicline).[119] Adding nicotine replacement therapy to a counselling program increased the success rate of a program for hospitalised smokers.[422] Smoking cessation support delivered by nurses either in hospitalised patients or in the community can lead to a modest increase in prolonged abstinence.[423] More robust evaluation is required of strategies to deliver support in lung cancer screening, particularly in countries from which there is no evidence available presently. This could be done using RCTs nested within existing screening programmes or those being introduced. It is apparent from the current findings and from the studies in Table 5.6 that interventions should be individually tailored, flexibly timed and should address misperceptions about screening, perceived risk of smoking-related disease and capitalise on the feeling that 'now' is the time to stop.

5.7.5 Reflexivity

The phenomenological approach to qualitative research requires a reflective process. In this section I reflect critically on the interaction between the researcher, the participants and the research itself, and how these shaped the collected data. Key areas to consider are personal and intellectual biases, the effects of personal characteristics and professional status on the data and on the 'distance' between the researcher and participants.[424]

As a doctoral health psychology researcher with relevant theoretical knowledge, I held a prior assumption that ECLS study experiences may have affected participants' thoughts about smoking in some way. This influenced the interview questions, which sought to identify such factors. It may also have influenced the analysis as I could have had an increased awareness of such influences when coding the data. However, I do not feel that such relationships were identified where they did not exist, because there were several participants whose smoking decisions were not influenced by screening and others who said screening was simply a final tipping point on top of other more important factors. The study findings reflect these experiences without making an assumption that everybody's thoughts about smoking were affected by screening.

I held a prior assumption that smoking is undesirable behaviour and that smoking cessation would benefit the participants. I took steps to present the study to participants neutrally in terms of whether smoking was desirable or not and did not reveal this assumption. I stated in the interview pre-amble that I held no strong feelings about smoking and was simply interested in peoples' experiences. It was noticeable that almost all participants asked during the interviews whether I was a smoker and may have adjusted their responses due to 'distance' created when learning I was a non-smoker. However, I was careful to appear neutral on smoking issues. It is still possible that this biased the findings and that an interviewer who was a smoker could have obtained different responses from participants.

In terms of my personal characteristics, participants were aware I was a researcher visiting from the University of Nottingham. They may have read in the information leaflet that the study findings would be used in a PhD thesis, which would have indicated a certain level of experience. There were times when participants asked me medical questions and I explained that I was a behavioural researcher and referred such queries to the local ECLS clinical teams. These characteristics could have reduced bias in the data because as an outside visitor to the study regions I could be distanced from the local clinical study processes and engage simply as an interested outside observer of experiences.

5.7.6 Strengths and limitations

Qualitative methods allowed an in-depth and nuanced exploration that aids understanding of how the participants derived meaning from their experiences and how this meaning influenced their behaviour. There was a good response rate to study invitations, which reduced the possibility of response bias in sampling the interviewees from the existing sample of ECLS questionnaire respondents.

The approach I took to sampling allowed me to gain access to individuals that had had different screening outcomes and had subsequently reported different behavioural outcomes. Purposive sampling approaches can be prone to bias in the judgement of the researcher. Alternative approaches could have been to select individuals from the source population at random, or to focus solely on those reporting a specific behavioural response such as smoking cessation. These strategies could have limited what the data could tell us about smoking decision-making in this context and researcher judgements about sampling were guided by clear criteria (Figure 5.1). With finite resources and limited existing literature on the topic, my strategy probably resulted in findings of more utility and relevance to those who are interested in the behaviour of smokers who are screened for lung cancer.

There are some limitations to the study. Firstly, participants were likely to be more interested in their health and smoking cessation than the wider smoking population because they were effectively taking part in three related studies: the main ECLS study, a nested questionnaire study and a further qualitative study about smoking. Secondly, it could have been an unusual experience for them to have a blood sample taken to be screened for cancer and so the results may be less generalisable to CT lung cancer screening programmes. Related to this point is an observation that some screened participants had family members or friends that also took part in the ECLS study but were allocated to the unscreened arm. In an implemented lung cancer screening programme it is more likely that screened individuals will know somebody else who has been screened, potentially changing the social context of responses to screening that could impact decisions about smoking. Finally, understanding of information such as the meaning of test results could have been inhibited by the demands of information provision during ECLS study recruitment. For example, participants were supplied information about randomisation and allocation to the control group. Pre-trial focus groups indicated this can cause confusion[352] and there was evidence in our data of misunderstanding about the evaluative nature of the screening delivered in the ECLS study, which may not be generalisable to an implemented screening programme.

5.7.7 Conclusion

This study demonstrates individualised and complex motivations about smoking among lung cancer screening participants and the ways in which lung cancer screening can lead to a teachable moment in decisions made about smoking. Emotional and behavioural responses to test results, which were sometimes misinterpreted, varied between individuals. This can help explain why evidence of the impact of lung cancer screening on smoking is mixed. It improves our understanding of screening-related and wider contextual factors that influence decisions about smoking after both a positive and a negative test result. This complements the quantitative evidence base that shows an effect in positive test result groups. Lung cancer screening presents an opportunity to engage high risk smokers in cessation attempts but cessation support may need to be tailored to an individual's emotional response to their understanding of their test result and take account of the range of factors I have identified to be most effective. Further work is needed to improve participant understanding of lung cancer screening test results, explore barriers and facilitators to smoking abstinence after decision-making by screened individuals, and to establish optimum strategies for the provision of integrated cessation support in lung cancer screening.

6 Discussion

6.1 Objectives and summary of findings

Behavioural responses to lung cancer screening are examined in the thesis. Specifically, the aims were to investigate cancer screening uptake and tobacco use behaviours in response to lung cancer screening.

Objectives, findings and conclusions are summarised below.

<u>Objective 1</u>: To systematically search for and synthesise qualitative research evidence that explains cancer screening attendance decisions in the UK (Chapter 3).

A meta-synthesis was conducted using meta-ethnography, enabling a higher level interpretation of existing qualitative studies. Individuals' relationship with the health service was the most important factor explaining cancer screening attendance decisions in the UK. The decision takes place with underlying dynamics of trust, power, control and authority. An important component of this relationship is the information received by the patient and the knowledge and understanding that results. Fear can be an overarching barrier to cancer screening and the relationship with the health service is important in enabling the negotiation of moderate levels of fear to attend screening. Decisions relate closely to perceptions of risk, influenced by beliefs about cancer, current

health and previous experiences of cancer. Attending screening is a strategy to cope with risk but official information about risk can be rejected.

<u>Objective 2</u> To measure and explore tobacco use over a 12-month period in individuals screened for lung cancer (Chapter 4):

A questionnaire study was conducted in a cohort of screened and unscreened participants of the ECLS study, who self-reported smoking behaviour and smoking-related cognitions over a 12 month period. Analyses found there was no effect of allocation to lung cancer screening on smoking point prevalence or on any other tobacco use or related social cognitive variables. Within the screened arm, those who received a positive test result were less likely to smoke heavily, more likely to make quit attempts, more likely to report readiness to quit, more likely to perceive health benefits of quitting but less likely to report self-efficacy to quit at one or more time points than those unscreened. Those who received a negative test result were less likely to attempt to cut down their smoking, less likely to report readiness to quit and less likely to perceive health benefits of quitting at one or more time points than those unscreened. There was no behavioural impact of allocation to lung cancer screening but there were mostly beneficial social cognitive and behavioural effects in the positive test group.

Changes observed in the negative test group were in the opposite direction, suggesting greater likelihood of harmful behaviour in this group. The impact of lung cancer screening on tobacco use may therefore depend heavily on the proportion of positive and negative test results produced by the screening test.

<u>Objective 3</u> To explore in-depth using qualitative methods decisions about smoking in smokers screened for lung cancer (Chapter 5):

Smokers from the ECLS study screened arm took part in semi-structured interviews. Analysis showed they responded to their lung cancer screening test results in unpredictable ways, involving inaccurate perceptions of risk to which they responded emotionally, which impacted decisions about smoking. Themes in the data showed how lung cancer screening can increase both motivation and urgency to quit smoking. Encouragement to quit from family members was influential, as were factors unrelated to screening (e.g. age and life stage, respiratory symptoms, financial cost of cigarettes, pre-screening decisions to try to quit) and sometimes an accumulation of multiple screening and non-screening factors. The findings show how poor understanding of risk information, such as believing that one will definitely get lung cancer or being unsure of whether one currently has a lung cancer diagnosis, can lead to beneficial behavioural effects such as smoking cessation.

They show that factors unrelated to experiences of lung cancer screening and decisions about smoking made prior to receiving the screening invitation are influential in post-screening smoking behaviour change.

6.2 Contribution to knowledge

In order to translate trial results of the effectiveness of lung cancer screening into population benefits, it is critical to understand tobacco use and screening uptake behaviours.[157] The thesis makes contributions to knowledge for the development of effective programmes to detect lung cancer early and to maximising the potential of such programmes to promote smoking abstinence and prevent smoking-related harm.

6.2.1 Lung cancer screening uptake

The contribution to knowledge of lung cancer screening uptake behaviour will first be considered. Chapter 3 reports the first synthesis of qualitative evidence explaining uptake across all types of cancer screening, and the first synthesis of evidence of factors focusing on UK cancer screening uptake.

Previous research has established knowledge of sociodemographic (ethnicity; social deprivation; gender; age), practical (difficulty making an appointment; forgetting to do so; dependency on others to carry out the activities of daily living) and psychological factors

(embarrassment; worry; anxiety; fear; fatalism; self-efficacy; social support; cancer awareness; cancer stigma; dislike of the screening test) that influence uptake of UK cancer screening tests.[194, 197-204] However, there may be factors that influence uptake behaviour that have not been identified by survey research. Qualitative methods are suited to exploring this.

A higher level interpretation of existing evidence is presented in the thesis, achieved by constructing greater meaning from primary qualitative studies through an interpretative process. This allows the substantial volume of qualitative research on the topic to more easily influence policy and practice. This evidence previously existed in a fragmented form, with previous attempts at synthesis only undertaken within specific cancer types and combined with evidence from other countries with important differences in organisation and delivery of screening. There has been no published synthesis of UK studies on the topic, or any published synthesis of evidence across all types of cancer screening.

The findings have usefulness and relevance to population-based lung cancer screening in the UK because most included studies were conducted in the context of NHS national screening programmes. Whilst there may be unique barriers to attending lung cancer screening, these will not be fully understood until the practice becomes more commonplace and more behavioural

evidence about uptake becomes available. An important precursor is, therefore, to advance knowledge of how individuals respond to invitations to other types of cancer screening in the UK.

The knowledge of lung cancer screening uptake behaviour contributed by the thesis is complemented by evidence from elsewhere of factors associated with uptake in lung cancer screening trials and of attitudes and intentions towards lung cancer screening in UK surveys. This is important because the population eligible for lung cancer screening are different to that targeted for other cancer screening programmes. Lung cancer has a strong association with behavioural causes [13] and public health campaigns have ensured awareness of this is high.[106] For this reason, barriers to lung cancer screening may not be the same as those identified across other types of cancer screening. Evidence from research trials suggests lower uptake of lung cancer screening is associated with lower socioeconomic status and being a current smoker,[374, 425, 426] both factors associated with greater risk of the disease.[13, 14] The UKLS analysed free-text responses to a non-participation questionnaire and found that reasons for not taking part in lung cancer screening could be organised into two themes: practical barriers (travel; comorbidities; carer responsibilities; already receiving screening; not being in the area) and emotional barriers (avoidance of lung cancer information; fear).[202] There is evidence that current smokers have different barriers to participating in lung

cancer screening than ex-smokers, such as avoidance, fear, anxiety and being less likely to endorse benefits of screening (e.g. agreeing that screen-detected lung cancer leads to a better chance of survival).[202, 213] Considering UK survey evidence, a study indicated intention to take part in a lung cancer screening programme was high but that it varied depending on whether the hypothetical invitation originated from a GP recommendation (96%) or a national NHS programme (92%).[427] This is consistent with the findings of the thesis in that cancer screening invitations from a known and trusted source are preferred.

In order to develop approaches to maximise uptake of lung cancer screening (and for uptake to be informed) it is important to consider evidence of, firstly, factors associated with uptake of lung cancer screening trials, secondly, hypothetical lung cancer screening invitations and, thirdly, actual real-life cancer screening attendance decisions. The thesis makes an original contribution to knowledge of the third of these elements.

6.2.2 Tobacco use after lung cancer screening

The contribution of the thesis to knowledge of smoking behaviour in response to lung cancer screening will next be considered. Chapter 4 reports what may be one of the most comprehensive studies to date of tobacco use in the lung cancer screening context. It is the first study of behavioural response to biomarker lung

cancer screening and only the second study in the UK across all methods of lung cancer screening. Overall, it is the fourth randomised controlled study on the topic. The three previous RCTs generated inconsistent evidence of effect, suggesting there is either no impact of allocation to lung cancer screening on smoking[96-98] or an impact that promotes smoking cessation.[100]

An implication of the findings of Chapter 4 is that there are now three RCTs indicating no effect of allocation to lung cancer screening on tobacco use and one indicating a beneficial effect. This can increase the confidence in the statement that implementing population-based lung cancer screening will not cause harm via adverse changes in smoking behaviour. However, there is novel evidence in the thesis of adverse responses on social cognitive variables in the negative test group, who in practice represent 90% of those undergoing the biomarker screening test under evaluation in the ECLS study. This group appear to have been more vulnerable to harmful changes in smoking behaviour compared to both the positive test group and unscreened arm. This is a significant contribution to knowledge, highlighting an important area for future research and evaluation. If adverse perceptual and motivational responses were to translate into adverse smoking behaviour change in negative test groups, there could be pivotal implications for the risk-benefit balance and cost-effectiveness of a lung cancer screening programme.[157]

In Chapter 5 a novel in-depth exploration of smoking behaviour after lung cancer screening is reported. The focus of the chapter is decision-making about smoking, aiming to explore screening and non-screening factors that were influential in post-screening smoking behaviour. This is achieved using qualitative methods to study screened smokers from the positive and negative test groups who had reported different behavioural responses to screening: stopping smoking, attempting to stop smoking but not stopping or not attempting to stop smoking. Two previous studies used qualitative methods to study smoking in the lung cancer screening context but they are limited in what they can tell us about how screening may influence smoking behaviour.[392, 393] This is because they did not explore smoking decision-making in depth and individuals who had stopped smoking were unrepresented or underrepresented in their participant samples. If screening promotes smoking cessation and abstinence it is important to explore how and why this might happen by giving a voice to those who have experienced the phenomenon. The thesis makes a contribution to knowledge by undertaking this work for the first time through purposeful in-depth study of individuals who had made decisions about smoking after lung cancer screening.

The findings of Chapter 5 demonstrate how screening participants who smoke interpreted their test result, their emotional responses to this, and how this influenced decisions about smoking. It

highlighted deficits in understanding about lung cancer risk in screening participants and raised questions about how behavioural responses might differ if understanding of risk was improved. Finally, it produced evidence that can be used to develop smoking cessation interventions within a UK lung cancer screening programme. For example, it showed that decisions about smoking were unpredictable, and often involved social contextual influences and a number of non-screening factors. Smokers who decided to attempt to quit varied in terms of when they made these decisions in relation to screening.

This evidence represents a step forward in knowledge because it adds explanatory value to the findings of quantitative studies of tobacco use after lung cancer screening, illuminating the so-called 'teachable moment' and 'false reassurance' often hypothesised to be generated by lung cancer screening.[140, 147] Furthermore, it provides insight into experiences of those who decided to continue smoking.

Integrated lung cancer screening and smoking cessation programmes have been piloted and evaluated for their feasibility.[387-389, 417-420] The findings of the thesis are relevant to lung cancer screening worldwide because the activity is likely to generate common thoughts, experiences and behaviours in groups

with similar lung cancer risk factors between countries, despite the use of different screening strategies and different cultural contexts.

6.3 Strengths and limitations of thesis

In brief, the main strengths of the thesis are that the three individual studies are of high methodological quality, are complementary in nature, and each addresses a timely and important research question with significant implications for public health.

The main limitation of the thesis is that behavioural findings generated from the ECLS study may not be fully generalisable to an implemented population-based lung cancer screening programme.

6.3.1 Generalisability of findings to implemented lung cancer screening

In this section is a consideration of the extent to which the ECLS study differs from likely characteristics of a UK national lung cancer screening programme.

6.3.1.1 Screening method

Based on the available evidence, a national lung cancer screening programme is likely to use the method of chest CT scans for the detection of lung cancer.[44] The ECLS study uses a biomarker blood

test as the primary screening method, followed by chest X-ray and serial CT scans for those who test positive.[95]

There are two reasons why behavioural responses of individuals participating in lung cancer screening might differ depending on the screening method. Firstly, participants' beliefs about the effectiveness of screening might vary across screening methods, which could influence the perceived threat of lung cancer and subsequent behavioural response.[168] Surveys in the USA have found that test accuracy was considered more important in a hypothetical decision to be screened for lung cancer than disease risk, screening cost and screening convenience.[213, 428] The perceived importance of test accuracy was a statistically significant predictor of whether or not individuals would agree hypothetically to undergo CT lung cancer screening.[428] Research shows that the public believe chest CT scans are moderately or highly effective at detecting lung cancer[413, 429, 430] but beliefs about biomarker tests are unknown. Secondly, variations in levels of uptake due to screening method could introduce differences in characteristics of participant groups that might be associated with behaviour. In a Dutch survey 1,111 40-80 year olds indicated whether they would prefer giving a breath sample (45%), a blood sample (31%) or go through a scanner (24%) to be screened for lung cancer.[431] The responses suggest less invasive methods are preferred, meaning uptake of biomarker screening for lung cancer might be higher

than a programme that uses CT as the primary screening method. More invasive screening methods could reach fewer people but they may be more motivated to undertake preventive health behaviour.[432] For these reasons, evidence of the behavioural impact of a screening regime that utilises a blood biomarker test as the screening method may not be fully generalisable to one that uses CT scans.

6.3.1.2 Screening interval

ECLS study screened arm participants underwent a one-off screening test, with further diagnostic scans for those with a positive test result. In the NLST participants underwent three annual screens, and in the UKLS screened arm participants had one CT scan, with further scans at three and/or 12 months depending on the finding of nodules and their categorisation.[433] Existing NHS cancer screening programmes invite those in defined age groups for screening at regular intervals of between two to five years.[186-188] This presents a different experience to undergoing screening in a research trial and it could affect the behavioural response of screening participants. The prospect of future repeat screening could offer greater reassurance to smokers than a one-off screen and could reduce likelihood of quit attempts.[393] Furthermore, lung cancer screening may become a more familiar experience to smokers if a national programme is implemented and the behavioural impact could diminish over time.

6.3.1.3 Participant characteristics

ECLS study participants lived predominantly in areas of increased deprivation in the GGC, Tayside and Lanarkshire regions of Scotland. Greater deprivation is associated with higher smoking prevalence, greater nicotine dependency (30% higher average nicotine intake in the most deprived than least deprived smokers) and consequently, greater risk of lung cancer.[13, 14] The effectiveness of screening at reducing lung cancer mortality may vary at local levels due to regional variations in smoking and screening uptake behaviours and resulting variations in lung cancer risk among those eligible and attending for screening.[434] It is also likely such regional variations may lead to different behavioural responses because greater nicotine dependence is a consistent predictor of unsuccessful quit attempts.[121]

There are different approaches to defining the group who are considered at a level of risk of lung cancer sufficiently high to warrant screening. These include simple eligibility criteria such as age and smoking pack-year history or more complex risk prediction models.[435] The former approach was used in the selection of ECLS study participants, including a requirement to have a ≥20 smoking pack-year history or a family history of lung cancer. This was similar to the criteria used in the Mayo Clinic study, which reported a 2% lung cancer prevalence rate and a further 2% incidence rate over the following five years.[49, 436] In the UKLS the *Liverpool Lung*

Project risk model version 2 was used as an algorithm to select those with a ≥5% five year risk of lung cancer.[56] This model included smoking years but not pack-years. The risk prediction approach used in ECLS may not be the same as that used in a national screening programme, with possible implications for participant characteristics such as smoking history. Risk factors for lung cancer, such as heavier smoking, may be barriers to smoking behaviour change.[105]

Lung cancer screening was a novel opportunity for prospective ECLS study participants meaning that their characteristics and their reasons for participating may be different to an implemented screening programme. There were altruistic reasons reported for taking part in a previous biomarker lung cancer screening feasibility trial,[298] another reason why the ECLS study participant sample may not be representative of participants of a screening programme. In the UKLS those in lower socioeconomic groups were less likely to respond to an initial invitation, an association that was independent of smoking status, and less likely to attend screening if assessed as eligible.[374] In the NLST the background screening-eligible population were older, more likely to be current smokers and more likely to have been diagnosed with comorbidities than trial participants.[437] It is thought that lung cancer screening trial participants are more motivated to adopt cancer prevention behaviours than eligible non-participants.[380, 438] Importantly,

characteristics of the ECLS unscreened arm may be different to those of eligible non-participants in a screening programme because the former are probably more motivated to quit smoking.[380] There may have been progressively greater selection bias in each of the studies: the ECLS study, the questionnaire study reported in Chapter 4 and the qualitative study reported in Chapter 5.

A final consideration is that a proportion of participants in a lung cancer screening programme will receive a lung cancer diagnosis. Lung cancer patients who smoke experience worse treatment outcomes, report worse symptoms, poorer health-related quality of life and in early stage lung cancer continued smoking is associated with an 86% increased risk of recurrence.[439-441] Some in this group will unknowingly be harmed via overdiagnosis, whereas others with lung cancers detected that would have caused harm will be those who benefit most from lung cancer screening. The behavioural impact in the group diagnosed with lung cancer in the ECLS study is unknown but could be beneficial or harmful and could be associated with clinically relevant outcomes.

6.4 Implications for research

Organised lung cancer screening activity continues on a localised basis in the UK in lieu of a decision about whether or not to

recommend a national screening programme.[379] It is important that research into the behavioural impact of lung cancer screening continues alongside such activity.

Further research is needed into behavioural responses to lung cancer screening invitations in the UK. The thesis shows how UK cancer screening uptake is influenced by overarching psychosocial factors but it is unclear to what extent these apply to lung cancer screening and in which groups they are most influential. Those with characteristics associated with greater risk of lung cancer appear less likely to respond to lung cancer screening trial invitations so strategies to address disparities in behavioural response must be developed, informed by appropriate research. Screening targets those with a substantial smoking history, who may experience stigma and perceive blame from others because of the perception of the risk of tobacco-related diseases as self-inflicted.[351, 413] Hence, beliefs about lung cancer screening may be influenced by smoking status. The decision to participate in a lung cancer screening trial involves a combination of factors including acceptability and convenience of screening methods, risk perception, altruism and self-interest.[298] The thesis findings highlight the importance of the relationship with the health service in making attendance decisions. Other research has identified that distrust in the health care system may impact successful implementation of lung cancer screening programmes.[413]

Researchers at Indiana University have developed a conceptual model to guide further study of lung cancer screening participation.[329] However, lung cancer screening in the USA uniquely requires documentation of a shared decision-making process between the individual and the screening provider. NHS cancer screening programmes typically invite participants with mailed letters, which might involve a different decision-making process, to which the conceptual model may not have full relevance. Personalised methods of contact for UK lung cancer screening invitations originating from trusted sources should be piloted and evaluated.[442]

Research should explore individuals' understanding of lung cancer screening test results because the thesis shows this can influence perceptions of risk and behavioural responses such as smoking cessation attempts. There appears to be no published research on this topic.

The thesis findings indicate the ECLS negative test group responded adversely on some perceptual and motivational outcomes but only on one behaviour change outcome at one time point. There is little evidential basis on which to hypothesise that adverse changes in smoking-related cognitive variables increase the likelihood of heavier continued smoking in current smokers. However, such a consequence could have a considerable impact on

the balance of benefits and harms resulting from a lung cancer screening programme.[133, 157] Future studies of the impact of lung cancer screening on tobacco use should evaluate whether negative test groups display harmful changes in behaviour, as the evidence for this is currently uncertain. This may involve measuring multiple dimensions of smoking behaviour, including proximal variables such as perceived risk. Evidence of changes in proximal behavioural variables can help identify appropriate behaviour change methods for use in interventions, so it is important that they are considered in further research. It should measure outcomes over longer follow-ups and in the context of repeat screening to assess the long-term behavioural impact of regular receipt of personal lung cancer risk information.

The research reported in the thesis provides evidence of the impact of undergoing a lung cancer screening test without a routine accompanying offer of smoking cessation support. Pre-trial focus groups suggested that being targeted with encouragement to quit smoking could be a deterrent to participation in the study.[352] It is likely, however, that cessation support will be provided to smokers as part of future lung cancer screening activity. For example, the Lung Check project commences in summer 2018 in the north of England. Researchers plan to provide screening participants with images of their own CT scans showing possible lung and heart damage, along with information about how smoking cessation can

reduce risk of cancer and heart attacks. They will assess whether the provision of this personalised information impacts tobacco use.[443] If integrated lung cancer screening and smoking cessation programmes become the norm, the findings of the thesis will stand as an important example of the impact of lung cancer screening on smoking in the absence of routinely offered cessation support.

There were data collected as part of the studies reported in Chapters 4 and 5, but not included in thesis, that provide scope for making a contribution to answering other important research questions:

- Does lung cancer screening impact perceived risk of smoking-related disease and how is this associated with behavioural change?[140]
- What is the psychological and emotional impact of lung cancer screening?[35]
- What screening-related, sociodemographic or social cognitive factors other than test result are associated with behavioural change in lung cancer screening?[444]
- What is the impact of lung cancer screening on health care use?[34, 36]
- What are the attitudes and preferences of lung cancer screening participants to integrated smoking cessation interventions?[386, 445]

Future research on the behavioural impact of lung cancer screening should seek to examine associations between emotional, social cognitive (including perceptions of risk) and behavioural outcomes, rather than looking at each set of outcomes in isolation. This could help answer questions about, for example, any association and trade-off between emotional harm and behavioural benefits (and vice-versa), or the relationship between test results, perceptions of risk and behavioural outcomes.

6.5 Implications for policy

Cancer screening policy in the UK is co-ordinated at a national level by the UK National Screening Committee. At the time of writing, a decision about whether to recommend a national programme of lung cancer screening in the UK has not been announced. In deciding whether or not to recommend CT lung cancer screening, the Committee will consider all the evidence for benefits and harms that can be expected of such a programme. For relevant high quality evidence they will look to the UKLS, as the only UK RCT of CT lung cancer screening to date, NLST, NELSON and other European randomised CT lung cancer screening trials. Combined evidence from these trials along with modelling studies can help design a screening programme for the UK with the optimum balance of benefits and harms.[158, 446] Smoking outcomes represent one of the key potential benefits or harms in this equation.[157]

The ECLS study is one of the largest studies of lung cancer screening conducted globally. The programme of research reported in the thesis utilised an ECLS participant sample of over 1,000 to make a substantial contribution to the advancement in knowledge of behavioural responses to lung cancer screening. Evidence of smoking outcomes from the study can complement evidence from CT lung cancer screening studies. The findings can increase confidence in the expectation that, firstly, lung cancer screening will not result in harm via adverse smoking behaviour change, and secondly that it is likely to result in benefits via smoking behaviour change for those who receive a positive test result. The UK National Screening Committee can consider this evidence in any future decisions about lung cancer screening policy.

Regardless of whether or not lung cancer screening is implemented in the UK and Europe, biomarker research will continue to advance. CT lung cancer screening will result in harms wherever it is implemented, such as overdiagnosis, unnecessary treatment, false positive test results, adverse emotional response and a costly programme of screening. A biomarker test could be used as a case finding tool to target CT scans, as part of a strategy that may be effective and less harmful at detecting lung cancer early and reducing mortality.[89] The EarlyCDT-Lung test offers a similar specificity to CT lung screening but lower sensitivity, meaning more false negative test results than CT. However, it is quicker and

cheaper to perform. Results of the ECLS study are unknown at the time of writing but the EarlyCDT-Lung test could provide a faster, more acceptable, and cost-effective primary screening method to target subsequent diagnostic imaging. As the first known study of the impact of a biomarker lung cancer screening test on tobacco use outcomes, policymakers seeking to reduce harms by complementing CT screening with an effective biomarker test will place importance on the research reported in the thesis in their assessment of likely benefits and harms of such a screening strategy.

A recommendation to offer lung cancer screening should be accompanied by clear policy on how to invite participants and achieve informed uptake, and how to communicate screening results. It has been suggested that a failure to co-ordinate these aspects of screening is a reason for low uptake thus far in the USA.[379] Unlike other NHS cancer screening programmes, eligibility for lung cancer screening cannot necessarily be assessed using existing primary care records because there may be behavioural eligibility criteria such as smoking history. This might necessitate an eligibility questionnaire or consultation. There will be individuals who seek lung cancer screening but are ineligible and there must be clear policy on how quality is ensured in a screening programme to restrict its usage to those at sufficient risk.[81] Ineligible smokers should be considered for smoking cessation support because they

are likely to be interested in quitting and in receiving help to do so.[381] There should be policy to prevent disparities in uptake between socioeconomic groups in order that lung cancer screening does not reinforce and widen health inequalities.[447]

6.6 Implications for practice

6.6.1 Uptake of lung cancer screening in the UK

The findings of the meta-synthesis reported in Chapter 3 have implications for practice in promoting uptake of lung cancer screening in the UK. Screening invitations should originate from a known trusted source, reliance on written information to communicate screening information should be reduced, and investments should be made in improving the provider-patient relationship to promote a personal connection. This can prevent the rejection of official risk information, particularly in underserved groups such as immigrants. Screening invitation strategies should seek to optimise fear and risk responses within ranges that motivate screening lung cancer screening attendance but do not promote avoidance. The thesis findings suggest that preventing disparities in uptake in some population groups might involve overcoming cancer taboo, stigma, fear and distrust of the health service, along with practical barriers to attendance.

6.6.1.1 Decision aids

To assist with decision-making about lung cancer screening, decision aids can be used.[448] These aim to promote understanding of the risks and benefits of undergoing lung cancer screening. In the USA decision aids have been developed for the patient and provider decision-making process about lung cancer screening participation.[67] However, they have been criticised for unintentionally misrepresenting the findings of the NLST, for example by converting a 20% mortality reduction (247 vs. 309 lung cancer deaths per 100,000 person-years) to a statement that four out of five people who are going to die from lung cancer will still die even if they are screened.[449] They are also accused of failing to present the type of information that is of interest to prospective participants, namely the likelihood of receiving a lung cancer diagnosis if they are screened and the likelihood that the disease can be successfully treated.[449] It is important in UK screening practice that test characteristics and the effectiveness of lung cancer screening are accurately communicated and that individuals receive the information they want and need in order to make an informed decision. This has usually been communicated within NHS screening programmes using information leaflets [31] but the findings of the thesis indicate a need to explore other methods of communication such as videos, web-based tools and mobile phone applications. Due to their interactive nature these

communication methods offer greater opportunity to provide personalised and tailored information and monitor individual fear and risk responses, before screening and throughout the screening pathway.

6.6.2 Uptake of other cancer screening

The findings of the thesis have implications for uptake of other cancer screening programmes in the UK. The results of the meta-synthesis reported in Chapter 3 could lead to the identification of modifiable psychological variables as targets for intervention. NHS screening invitations emphasise the individual's choice in deciding whether or not to take part in screening. To complement this, the perceived control an individual has over other aspects of the process could be enhanced. Rather than screening being experienced as an impersonal call and recall programme, personalised aspects of screening could be emphasised and greater individual control introduced. For example, the taking of samples for biomarker screening could be made available in a number of locations such as health centres, community locations and mobile units. Individuals eligible to be screened could be given greater choice about how, where and when they are screened, who they are seen by and how their test results are communicated. Individuals should have the knowledge to decide what they want to do and they should simultaneously feel the communication is relevant to them. Decision aids could incorporate interactive

methods which address gaps in knowledge and present information tailored to individual levels of fear and perceived risk. The findings could also help in understanding why some sociodemographic groups are less likely to engage with other health processes, as there may be common barriers that are generalisable beyond cancer screening. They could further contribute to understanding of delays in help-seeking when experiencing cancer symptoms.

6.6.3 Understanding of lung cancer screening test results

Evidence reported in the thesis indicates that screened individuals created individual interpretations of risk from a positive or negative test result, sometimes inaccurately, which were influential in decisions about smoking. The thesis showed that lung cancer screening information presented as simple frequencies, the form thought to maximise understanding, resulted in deficits in comprehension. Individuals with a negative test result often interpreted it as a definitive 'all-clear' from lung cancer, although the screening test has 41% sensitivity and therefore does not detect the majority of lung cancers. Implications for lung cancer screening practice may be complex, because screening should seek to ensure participants are fully informed but this could affect the likelihood of decisions to try to stop smoking. It has been suggested that understanding of screening test results might be improved in practice through the use of the terms 'screen-positive' and 'screen-negative' to prevent the interpretation of screening

test results as definitive diagnostic outcomes.[415] There should be greater efforts in practice to provide information about lung cancer screening and the risk implied by test results. This could be assisted at a population-level with better promotion and awareness of the harms of cancer screening using cancer charities and the popular media. This could be improved at an individual level through the use of screening participation decision aids. Attitudes to cancer screening have been found to be overwhelmingly positive and the public are probably relatively unreceptive to information about harms[217] but if individuals participate in screening better informed, they may have a better understanding of the uncertainty surrounding their screening test result. Lung cancer screening programmes should seek to promote informed participation, better understanding of test results and beneficial behaviour change. This requires combining careful communication of the uncertainty involved in test results with the use of strategies to maximise motivation to adopt health protecting behaviours.

Increase in the use of blood tests for cancer might change the way people view and understand risk of cancer in the future. For example, there is the prospect in the UK of a population-based test for genetic mutations that increase the risk of breast and ovarian cancer.[450] Advances in genetics could mean people develop a better understanding of what disease risk means. This could include changes in understanding of overdiagnosis, and deeper

thought about whether new risk information is really wanted by individuals and what, if anything, they are going to do with the information. Changes in understanding of cancer risk and changing attitudes to screening should be considered in practice, along with their potential behavioural effects.[451]

6.6.4 Smoking cessation interventions in lung cancer screening

The MILD trial showed that lung cancer screening participants who have stopped smoking, including recent quitters, benefit from a 39% reduction in overall mortality.[156] In the NLST the greatest mortality reduction (38%) was observed in those screened by CT who were abstinent from smoking for 15 years.[452] In the NLST arm screened by chest X-ray, those who were abstinent from smoking for seven years experienced a lung cancer mortality reduction equivalent to the CT arm.[452] The combination of lung cancer screening and smoking abstinence results in substantially greater prevention of lung cancer death than screening alone, emphasising the importance of the promotion of smoking cessation and abstinence in those who are screened.

Smoking cessation interventions are more cost-effective at reducing mortality than CT lung cancer screening [157] and their integration with screening can improve the cost-effectiveness of screening by 20-45%.[383] There is a consensus that lung cancer screening programmes should include integrated cessation support

for smokers, to utilise this opportunity to improve screening outcomes.[66, 67, 81]

The findings of the thesis support this approach: there was a greater likelihood of quit attempts after a positive test result at three months but smoking prevalence was not significantly lower at any time point, suggesting unsuccessful quit attempts were prevalent in the positive test group. There were few differences between test result groups at the 12-month follow-up, suggesting the behavioural effect of a positive test result might be short-lived. Smoking cessation support can increase the success of quit attempts leading to prolonged abstinence from smoking.[117, 119] Readiness to quit and attempts to cut down were both significantly less likely across all time points and at three months respectively after a negative test result compared to the unscreened arm. Brief smoking cessation advice from a physician and offer of support can increase smoking cessation regardless of initial interest or motivation to quit,[117] emphasising the potential for smoking cessation support to benefit all participants in lung cancer screening. In practice such advice could be delivered by trained cessation support counsellors and adapted to individuals' screening experiences.

Evidence from smoking intervention pilot studies described in Chapter 5 demonstrate that more personalised support appears to

be more effective at promoting cessation in a lung cancer screening context. For example, a particularly effective approach involved motivational interviewing that included discussion of test results that aimed to increase risk perceptions and emotional responses, and education that a negative result is not a certificate of health.[420] The findings of the thesis support this approach, because ECLS study smokers responded in individualistic ways, involving emotional reactions that influenced decisions to attempt to stop smoking or to continue smoking. Smoking cessation support in the lung cancer screening context should take account of emotional responses to test results, should be flexible in the timing of their delivery, involve family members and incorporate consideration of non-screening factors influencing smoking decision-making.

6.7 Concluding remarks

Cancer is a disease responsible for millions of deaths a year and is set to have an increasing impact on health in future decades. Consequently, prevention and early detection of cancer represents one of the most important challenges for behavioural science. Lung cancer is often detected too late to be effectively treated and for that reason has a very low survival rate. Prevention and early detection of lung cancer are priorities for health services. Tackling health inequalities is another key priority in public health, to which

tobacco use is a major contributor and any opportunity to promote smoking cessation should be fully utilised.

Screening for lung cancer is expected to become more commonplace and behavioural responses to the activity must be understood. CT lung cancer screening can reduce all-cause mortality but is known to cause harm through false-positive results, overdiagnosis and overtreatment.[32] It is essential to consider behavioural benefits and harms when designing and evaluating lung cancer screening programmes, to ensure screening does not inadvertently cause more harm than good. Biomarker tests for lung cancer risk have potential to be used in lung cancer screening and until now the behavioural impact of such tests was unknown.

The programme of research reported in the thesis found evidence that there was no 'harmful' behavioural impact of biomarker lung cancer screening. There was evidence that screening had a 'beneficial' behavioural impact in those who received a positive test result. This group are at risk of overdiagnosis or a false positive result and associated short-term psychological harm, so it is important to know that smokers in this group may benefit in terms of a change in a behaviour that is likely to lead to a reduction in risk of smoking-related disease.

The behavioural effect of a combined lung cancer screening and smoking cessation programme will be of greater benefit to participants than screening alone.[156, 157] In practice, lung cancer screening should incorporate smoking cessation support, and the findings of the thesis provide considerations for its provision.

Much work lies ahead in the development and implementation of effective programmes to detect lung cancer early. Understanding screening uptake and smoking behaviour are two critical areas for translating trial results of effective screening tests into population benefits. The work reported in the thesis makes a contribution to maximising the potential of such programmes to promote screening uptake, smoking abstinence and prevent smoking-related harm.

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Appendix A. Study eligibility assessment form

Paper ID:

Title:

Author:

Data extractor:

Date:

Focus of study:

	Assessment (Y/N/U)	**Comments**
Study design		
1. Did the study utilise qualitative methodology?		
Participants		
2. Did the study involve participants in the UK?		
3. Did the study involve adult participants (>=18 yrs)?		
4. Were the participants invited to a screening test for increased risk of cancer?		
5. Were the participants asymptomatic?		
Outcomes		
6. Does the study report reasons for attending or not attending screening?		
<u>Decision</u> INCLUDE (If 'Y' for all 6 questions) EXCLUDE (If 'N' for at least 1 question) UNCLEAR (contact author)	_____ _____ _____	

Appendix B. Invitation letter

Early Cancer Detection Test – Lung Cancer Scotland Study

ECLS Team
Level 3, Residency Block
George Pirie Way, Ninewells Hospital
Dundee, DD1 9SY

Cohort ID:

13/03/2018

Dear ,

Lung Cancer Screening Scotland Study: £5 gift voucher available

When you gave your blood sample the nurse said we might send you some more surveys to fill in. You are one of a small group chosen from the 10,000 people taking part in the ECLS study to do this. Completing the surveys is very important as we need to find out about the full impact of the new screening test.

Please complete the enclosed survey and return it to us in the freepost envelope provided **within the next 7 days**. We will then send you a £5 gift voucher to thank you for your time. There is a list of places where you can spend the voucher on the back of this letter.

We will send you three more surveys over the next year as we would like to see how your thoughts change. A £5 voucher will be available for each survey we send to you. Once we have all the surveys back from you, we will be happy to send you a copy of our findings.

Everything you say in the survey will be kept confidential.

If you have any questions about the survey, or would like some help to fill it in, you can call us on 0115 823 1260. We will be happy to help.

Yours sincerely,

Laura Bedford Ben Young

ECLS Research Team

Appendix C. Reminder letter

Early Cancer Detection Test – Lung Cancer Scotland Study

ECLS Team
Level 3, Residency Block
George Pirie Way, Ninewells Hospital
Dundee, DD1 9SY

Cohort ID: XXXXX

13/03/2018

Dear [patient name here],

Lung Cancer Screening Scotland Study: £5 gift voucher available

This letter is to remind you that we recently sent you a survey to complete as part of the ECLS study. You are one of a small group of people chosen to do this. Completing the survey is very important as we need to find out about the full impact of the new screening test.

As we have not received a reply from you yet, we have enclosed another copy of the survey. Please complete it and return it to us in the freepost envelope provided **within the next 7 days**. When we receive the survey back from you, we will send you a £5 gift voucher as a thank you for your time. If you have already returned your survey, please disregard this letter. Your £5 gift voucher will be on its way to you.

Everything you say in the survey will be kept confidential.

If you have any questions about the survey, or would like some help to fill it in, you can call us on 0115 823 1260. We will be happy to help.

Yours sincerely,

Laura Bedford Ben Young

ECLS Research Team

Appendix D. Follow-up questionnaire cover letter

Early Cancer Detection Test – Lung Cancer Scotland Study

ECLS Team
Level 3, Residency Block
George Pirie Way, Ninewells Hospital
Dundee, DD1 9SY

Cohort ID: «Cohort ID»

13/03/2018

Dear «forename» «surname»,

Lung Cancer Screening Scotland Study: £5 gift voucher available

Thank you for returning the previous ECLS survey. It is now time for the next one to be filled in. Please complete the enclosed survey and return it in the freepost envelope provided **within the next 7 days.** We will then send you another £5 gift voucher to thank you for your time. There is a list of places where you can spend the voucher on the back of this letter.

Everything you say in the survey will be kept confidential.

If you have any questions about the survey, or would like some help to fill it in, you can call us on 0115 823 1260. We will be happy to help.

Thank you for your continued assistance in this important research.

Yours sincerely,

Laura Bedford Ben Young

ECLS Research Team

Appendix E. Baseline questionnaire sociodemographic questions

PART I

Please tell us a little more about yourself. Your answers to these questions will be very helpful to us and will be stored using a unique study code from which you cannot be identified.

1) Date of birth ☐☐ – ☐☐ – ☐☐☐☐

2) Age at which you left full-time education ☐☐

---

3) Marital Status:

Single	☐	Widowed	☐
In a relationship	☐	Separated	☐
Married / in a civil partnership	☐	Divorced	☐

---

4) Which best describes your work situation?

In paid employment	☐
Unable to work due to illness or disability	☐
Unemployed and looking for work	☐
At home and not looking for work	☐
Retired	☐
Other (please describe)	☐ _____

---

5) Do you own or rent your home?

Rented	☐
Owned or mortgaged	☐
Other (Please say what)	☐ _____

6) The total number of people (adults + children) living in my home is:

(Please give a number) _____

7) The total number of rooms (excluding halls, landings, toilets and bathrooms) in my home is

(Please give a number) _____

8) How many cars or vans are available for use by one or more members of your household?

None ☐

One or more ☐

9) Ethnic Origin:

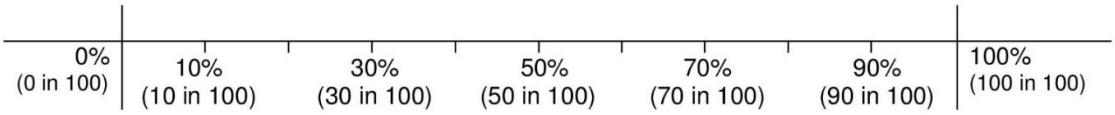
I would describe my ethnic origin as:		
Asian or Asian British	**Mixed**	**Other Ethnic Group**
Bangladeshi ☐	White & Asian ☐	Chinese ☐
Indian ☐	White & Black African ☐	Any other ethnic group (Give details): ☐
Pakistani ☐	White & Black Caribbean ☐	_____
Any other Asian background ☐	Any other mixed background ☐	I do not wish to disclose my ethnic origin ☐
Black or Black British	**White**	
African ☐	Scottish ☐	
Caribbean ☐	Other White British ☐	
Any other Black background ☐	Irish ☐	
	Any other White background ☐	

Thank you for completing this questionnaire.

Appendix F. Piloted risk perception questions

1. What are the chances that the **average person your age and gender** will develop lung cancer over the next five years?

Please place an X on the scale below that indicates chance of developing lung cancer (0% = no chance of developing lung cancer, 100% = will definitely develop lung cancer).

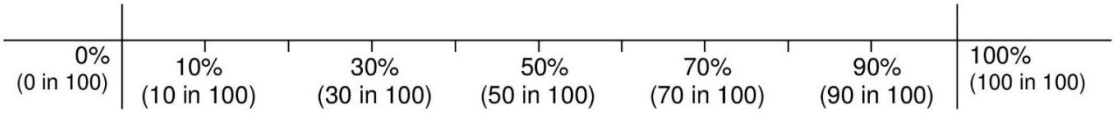


2. **Compared to other people** your age and sex, how likely are **you** to develop lung cancer over the next 5 years? (Please tick one box)

- A lot less likely than other people ☐
- Less likely than other people ☐
- About as likely as other people ☐
- More likely than other people ☐
- Much more likely than other people ☐

3. What are the chances that **you** will develop lung cancer over the next 5 years?

Please place an X on the scale below that indicates your chance of developing lung cancer (0% = no chance of developing lung cancer, 100% = will definitely develop lung cancer).



Appendix G. Final risk perception questions

PART E

1. What are the chances that **you** will develop lung cancer over the next five years? (Please tick one box)

- Approximately 1 in 1000 (0.1%) ☐
- Approximately 1 in 500 (0.2%) ☐
- Approximately 1 in 250 (0.4%) ☐
- Approximately 1 in 100 (1%) ☐
- Approximately 1 in 20 (5%) ☐
- Approximately 1 in 10 (10%), or greater ☐
- Don't know ☐

2. **Compared to other people of** your age and sex, how likely are **you** to develop lung cancer over the next 5 years? (Please tick one box)

- A lot less likely than other people ☐
- Less likely than other people ☐
- About as likely as other people ☐
- More likely than other people ☐
- Much more likely than other people ☐
- Don't know ☐

Appendix H. Baseline questionnaire tobacco use questions

Part H

This study is not about trying to encourage people to stop smoking but we are still interested in your smoking behaviour and your views about smoking.

1) Not counting the last week, have you smoked any cigarettes or tobacco in the last 6 months?

Yes ☐ No ☐

---

2) Have you smoked any cigarettes or tobacco in the last seven days / week?

Yes ☐ No ☐

If YES, please go to **Question 3**
If NO, please go to **PART I**

---

3) How soon after you wake up do you smoke your first cigarette or tobacco? (Tick one box)

After 60 minutes ☐

31 to 60 minutes ☐

6 to 30 minutes ☐

Within 5 minutes ☐

---

4) On average, how many cigarettes do you smoke each day? (Enter a number)

☐

5) Do you have any intention of giving up smoking in the next four weeks? (Tick one box)

Yes, definitely ☐

Yes, probably ☐

Don't know ☐

Probably not ☐

Definitely not ☐

6) How sure or confident are you that if you tried, you could give up smoking for good? (Tick one box)

Very certain ☐

Fairly certain ☐

Don't know ☐

Fairly uncertain ☐

Very uncertain ☐

7) Which one of these statements do you most strongly agree with? (Tick one box)

I would like to keep on smoking ☐

I don't really want to stop smoking ☐

I don't know whether I want to stop smoking or not ☐

I don't really want to carry on smoking ☐

I would like to stop smoking ☐

8) Which one of these statements do you most strongly agree with? (Tick one box)

I never think about stopping smoking ☐

One day I will need to think about stopping smoking ☐

I should stop smoking but I don't think I'm ready ☐

I am starting to think about how I can smoke less ☐

I am trying to stop smoking ☐

---

9) How strongly do you agree or disagree with the statement "My health will improve if I stop smoking." (Tick one box)

Disagree strongly ☐

Disagree ☐

Don't know ☐

Agree ☐

Agree strongly ☐

---

10) How strongly do you agree or disagree with the statement "People who are important to me want me to stop smoking." (Tick one box)

Disagree strongly ☐

Disagree ☐

Don't know ☐

Agree ☐

Agree strongly ☐

---

11) In the LAST 6 MONTHS have you tried to cut down the number of cigarettes you smoke?

Yes ☐ No ☐

---

12) In the LAST 6 MONTHS have you tried to stop smoking?

Yes ☐ No ☐

Please continue to the next page.

Appendix I. Follow-up questionnaire tobacco use question timescale variations

1-month questionnaire

1) Not counting the last week, have you smoked any cigarettes or tobacco in the LAST MONTH?

Yes ☐ No ☐

3-month questionnaire

1) Not counting the last week, have you smoked any cigarettes or tobacco in the LAST 2 MONTHS?

Yes ☐ No ☐

6-month questionnaire

1) Not counting the last week, have you smoked any cigarettes or tobacco in the LAST 3 MONTHS?

Yes ☐ No ☐

Appendix J. Ethics committee approval

EoSRES

NHS SCOTLAND
Research Ethics Service

East of Scotland Research Ethics Service (EoSRES) REC 1
Tayside Medical Sciences Centre (TASC)
Residency Block C, Level 3
Ninewells Hospital & Medical School
George Pirie Way
Dundee DD1 9SY

Professor Frank M Sullivan
NHS Professor of R&D in General Practice
University of Dundee
Division of Population Health Sciences
Mackenzie Building
Kirsty Semple Way
DUNDEE, DD2 4BF

Date: 26 November 2013
Your Ref:
Our Ref: LR/13/ES/0024
Enquiries to: Mrs Lorraine Reilly
Extension: Ninewells extension: 83878
Direct Line: 01382 383878
Email: eosres.tayside@nhs.net

Dear Professor Sullivan

Study title: **Detection in blood of autoantibodies to tumour antigens as a case-finding method in lung cancer using the EarlyCDT-Lung test**
REC reference: **13/ES/0024**
Amendment number: **AM05 (For REC Reference Only)**
Amendment date: **19 November 2013**
IRAS project ID: **111984**

The above amendment was reviewed by the Sub-Committee in correspondence.

Ethical opinion

There were no ethical issues noted.

The members of the Committee taking part in the review gave a favourable ethical opinion of the amendment on the basis described in the notice of amendment form and supporting documentation.

Approved documents

The documents reviewed and approved at the meeting were:

Document	Version	Date
ECLS Invalid Result Letter RB	1	11 September 2013
Questionnaire: ECLS Study - Participant Questionnaire 3S	1.3	06 August 2013
Protocol	2	11 October 2013
Participant Information Sheet: ECLS Sub study 2	1	11 September 2013
Letter of invitation to participant	1	11 September 2013
ECLS Appointment Letter	1.1	11 September 2013
Questionnaire: ECLS Study - Participant Questionnaire 3C	1.3	06 August 2013
ECLS Study CT Scan Nodule Result Letter	1.1	11 September 2013
Letter of invitation to participant	1	11 September 2013
Letter of invitation to participant	1	11 September 2013

Questionnaire: ECLS Study - Participant Questionnaire 1S	1.3	06 August 2013
Questionnaire: ECLS Study - Participant Questionnaire H	1.3	06 August 2013
Letter of invitation to participant	1	11 September 2013
Participant Information Sheet: ECLS Sub study 3	1	11 September 2013
ECLS Reminder Postcard	1	10 October 2013
Questionnaire: ECLS Study - Participant Questionnaire 6S	1.3	06 August 2013
Participant Information Sheet: ECLS Sub study 1	1	11 September 2013
Letter of invitation to participant	1	11 September 2013
Notice of Substantial Amendment (non-CTIMPs)	AM05	19 November 2013
ECLS Invalid Result Letter NO RB	1	11 September 2013
Questionnaire: ECLS Study - Participant Questionnaire 6C	1.3	06 August 2013
Participant Consent Form: ECLS Sub study 1	1	11 September 2013
Participant Consent Form: ECLS Sub study 3	1	11 September 2013
GP/Consultant Information Sheets	1	11 September 2013
Questionnaire: ECLS Study - Participant Questionnaire 1C.	1.3	06 August 2013
Questionnaire: ECLS Study - Participant Questionnaire 12C	1.3	06 August 2013
Participant Consent Form: ECLS Sub study 2	1	11 September 2013
Letter of invitation to participant	1	11 September 2013

Membership of the Committee

The members of the Committee who took part in the review are listed on the attached sheet.

R&D approval

All investigators and research collaborators in the NHS should notify the R&D office for the relevant NHS care organisation of this amendment and check whether it affects R&D approval of the research.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

We are pleased to welcome researchers and R & D staff at our NRES committee members' training days – see details at http://www.hra.nhs.uk/hra-training/

13/ES/0024:	**Please quote this number on all correspondence**

Yours sincerely

pp
Dr Lynda Cochrane
Alternate Vice-chair

Email: eosres.tayside@nhs.net

Enclosures: List of names and professions of members who took part in the review

Copy to: NHS Tayside R&D Office

East of Scotland Research Ethics Service REC 1

Attendance at Sub-Committee of the REC meeting on 26 November 2013

Also in attendance:

Name	Position (or reason for attending)
Mrs Lorraine Reilly	Senior Co-ordinator

Written comments received from:

Name	Position
Dr Lynda Cochrane	Professional Statistician, Alternate Vice-chair
Mrs Shona Carson	Clinical Trials Pharmacist

Appendix K. Participant invitation letter

Early **C**ancer Detection Test – **L**ung Cancer **S**cotland Study

ECLS Team
Level 3, Residency Block
George Pirie Way, Ninewells Hospital
Dundee, DD1 9SY

We want to talk to you about smoking

Dear ,

Thank you for taking part in the **Early Cancer detection test – Lung cancer Scotland (ECLS) Study** and filling in the surveys we have sent you so far.

Since joining the study some people have told us that they have decided to try and give up smoking and others have not. We would like to understand more about how having the lung cancer blood test affects people's decisions about smoking and hope you might be willing to talk to us about this. The aim of this work is not to try to stop you smoking.

We are contacting you because:

- You have agreed to be contacted.
- We have selected you from the people who are filling in the ECLS Study surveys.
- You had the lung cancer blood test.
- Before the test you told us you were a smoker.

If you agree to talk to us:

- We will call you to arrange a face-to-face discussion, lasting between 30 - 60 minutes.
- At the discussion we will ask you questions about smoking and having the lung cancer blood test.
- The things you tell us will be anonymous and will not go on your medical records.
- We will give you a **£5 high street shopping voucher**. See the back of this letter for where the voucher can be spent.

Please read the enclosed Participant Information Leaflet for more details about this research.

To take part please complete the enclosed Contact Form and return in the Freepost envelope **within the next 7 days**. We will then telephone you to arrange a time and place to meet.

If you do not want to take part in this research there is no need to do anything. We may send you one more reminder letter and then we will not ask you again. Please carry on filling in the other surveys we will send you, even if you don't reply to this letter.

If you have any questions about this letter please call Ben Young on **0115 823 1260** or **07477 086476**. We hope you agree to take part in this important research.

Yours sincerely

Ben Young
ECLS Research Team

Professor Frank Sullivan
Chief Investigator, ECLS Study

Appendix L. Participant information leaflet

FINDING OUT MORE ABOUT THIS RESEARCH
Participant Information Leaflet

We invite you to take part in our research

- Before you decide whether to take part, it is important for you to understand why the research is being done and what it will involve.
- Please read this leaflet and think about whether you would like to take part. Talk about it with family and friends if you wish. Ask us if anything is unclear or you would like more information. Our contact details are at the end of this leaflet.

Important things that you need to know

- We want to find out what people think about smoking after a lung cancer blood test.
- If you agree, we will meet you at a time that suits you to talk about this. It will last between 30-60 minutes.
- We will NOT be asking you to stop smoking.
- If you choose not to take part this will not affect the care you receive. You should carry on filling in the surveys we send you.
- You can stop taking part at any time, without giving a reason.
- If you choose to take part you will get a £5 high street shopping voucher.

Contents

1. Why are we doing this research?
2. Why am I being asked to take part?
3. What will I be asked to do if I take part?
4. Possible benefits and disadvantages of taking part.
5. More information about taking part.
6. Contact for further information.
7. What to do next.

How to contact us

If you have any questions about this research, please contact Ben Young, Researcher on Tel: **0115 823 1260**. Or the ECLS study team; Roberta or Stephanie on Tel: 01382 383060.

1 Why are we doing this research?

We want to find out what people think about smoking after having a lung cancer blood test.

We know some people want to stop smoking and others don't want to stop. We know some people find it easier to stop smoking than others. We also know there are lots of reasons people feel that stopping smoking is not right for them.

We will NOT be asking you to stop smoking.

This study is part of the ECLS Study and the results will be used as part of a PhD thesis.

2 Why am I being asked to take part?

We chose you from the people who are filling in the ECLS Study surveys. We chose you because you had the lung cancer blood test and you said before the test that you were a smoker. We are inviting some people who have tried to stop smoking since the test and some people who have not tried to stop.

We want to involve about 30 people in this research.

Do I have to take part?

You do not have to take part. If you do take part we will ask you to sign a consent form. You can stop taking part at any time without giving a reason. This would not affect the standard of health care you receive.

We will ask your permission to use any information already collected (data) which may be used in the study analysis.

3 What will I be asked to do if I take part?

We will call you by telephone to arrange a time for a face-to-face discussion.

Who will meet me?

A member of the ECLS Study research team from the University of Nottingham.

What will happen during the discussion?

You will be asked to talk about:

- Your thoughts and feelings about smoking
- Your thoughts and feelings about the lung cancer blood test
- If you tried to stop smoking, what you found helpful and unhelpful
- If you did not try to stop smoking, what your thoughts and feelings were about this
- Other things like this

Where will it happen?

At a place near to your home, such as a local GP practice or research office, or at your home. We will arrange this when we call you.

Will it cost me anything?

No, we will pay for reasonable travel expenses and the telephone calls.

What will the discussion be like?

The discussion will take between 30-60 minutes. It will be friendly and informal and there will be no right or wrong answers. It will be recorded for research purposes. This is to make

sure we have heard and understood everything you tell us. The recording will be stored anonymously; this means it will not be stored with your name or any other personal information. The things you tell us will not go on your medical records.

We can arrange a taxi or reimburse your travel expenses when you attend the meeting.

4 Possible benefits and disadvantages of taking part

To thank you for your time you will get a £5 voucher to spend in a range of high street stores. You will also be helping us find out what people think about smoking after a lung cancer blood test.

5 More information about taking part

What if I don't want to carry on with the research?

You are free to stop taking part at any time without giving a reason. You may ask us to not use the things you told us within 48 hours of the discussion without giving a reason.

How will we use the results of this research?

This work is part of a postgraduate research degree, called a 'PhD'. The results will be included in a report, called a 'thesis'. The results may also be published in scientific journals and presented at conferences. Your name will not be used when the results are reported.

Who has approved the research?

The research has been approved by East of Scotland Research Ethics Committee 1.

6 Contact for further information

Ben Young, Researcher
Telephone: 0115 823 1260
University of Nottingham, Division of Primary Care, Nottingham NG7 2UH

Professor Frank Sullivan
Telephone: 01382 383060
University of Dundee, Division of Population Health Sciences, Kirsty Semple Way, Dundee DD2 4BF

7 What to do next

If you want to take part

Fill in the enclosed Contact Form and return it to us in the Freepost envelope within 7 days. We will then contact you by telephone to arrange an appointment.

If you don't want to take part

You can just do nothing. If we don't hear back from you we may send you one reminder, then we will not ask you again.

Appendix M. Semi-structured interview question guide

Aim: To identify thoughts, feelings and experiences about being screened for lung cancer

1) How was your experience of taking part in the ECLS study?
2) How did you find out about the study?
3) Were you aware why you had been invited to take part?
4) What were your reasons for wanting to take part?

Aim: To establish smoking history and previous cessation attempts

5) Can you tell me about your smoking history?
    a) When did you start smoking?
    b) Have you ever stopped/tried to stop/cut down smoking?
        i) How did that go?
        ii) How long did you stop smoking for?
        iii) Did you use any particular strategy?
        iv) How easy or difficult did you find it?
        v) How did you feel about that?
        vi) How long ago was that?

Aim: To establish decisions made regarding smoking since finding out about the ECLS study, the success of those decisions and explore reasons for those decisions and perceived barriers and facilitators to cessation.

6) *(for participants who tried to stop smoking since the study)* Can you tell me about your decision to try/stop smoking?
    a) Which method(s) did you use to try to stop smoking?
    b) How easy or difficult was it for you to try to stop smoking?
    c) What do you feel <u>helped</u> you to try to stop smoking? (explore in depth)
    d) Which things did you feel <u>did not help</u> you to try to stop smoking? (explore in depth)
    e) Was there any time during the study that your thoughts or feelings about smoking changed?
        i) When was that?
        ii) How did your thoughts or feelings change?
        iii) Why do you think your thoughts or feelings changed/did not change?

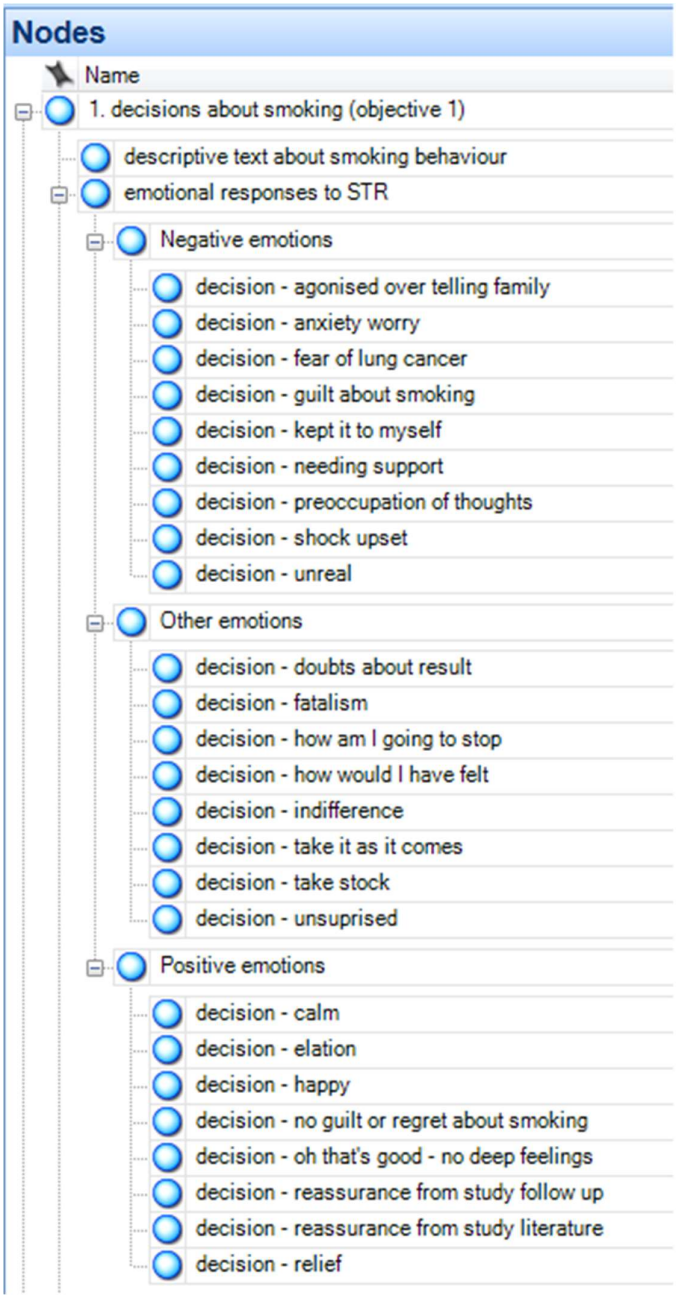
7) *(for participants who did <u>not</u> try to stop smoking)* Did your thoughts and feelings about smoking change at all during your participation in the ECLS study? If so, how?
8) *(for participants who did <u>not</u> try to stop smoking)* We know that some people find that having a lung cancer blood test makes them want to stop smoking but other people find that it doesn't. It is important for us to understand why this is. Based on your experience of having a lung cancer blood test, why do you think this is?
9) If your screening test result had been [positive/negative] (explain briefly what that would mean) would you have felt any differently about smoking?
   a) In what way?

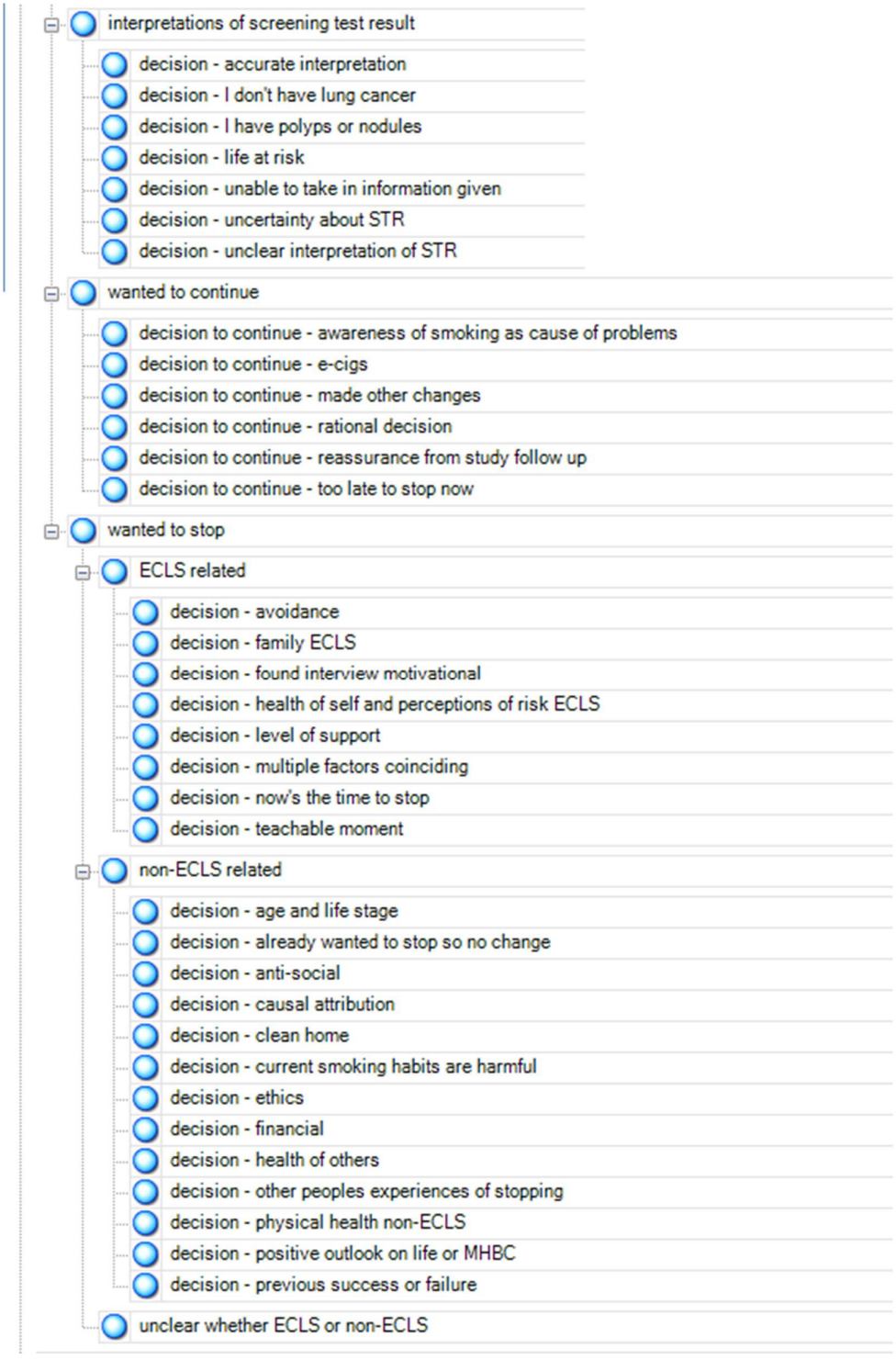
Aim: To explore thoughts and feelings about smoking cessation advice for lung cancer screening patients.

10) Imagine you are having a lung cancer blood test for the first time, but this time everybody who has the test is given special advice and support about stopping smoking. How would this make you feel about smoking?
   a) Would it make you think or feel differently about having the lung cancer blood test if you knew this was going to happen? If so, how?
   b) Would it make you think or feel differently about stopping smoking? If so, how?
   c) Would it change how confident you felt about being able to stop smoking? If so, how?
   d) Would it change your plans to stop or carry on smoking? If so, how?
   e) Would it make you more likely or less likely to have a repeat lung cancer blood test in the future e.g. five years' time? And why?
11) What type of special advice & support would you find most helpful, if it was offered to you during a visit for a lung cancer blood test?
12) Is there anything else you would like to tell me about the things we have talked about?

If participant is not forthcoming with thoughts or feelings about smoking, explore their responses to the study questionnaire smoking items e.g. You said you were fairly uncertain that if you tried, you could give up smoking for good? Why did you select that answer?

Appendix N. Coding structure addressing decisions about smoking




interpretations of screening test result
decision - accurate interpretation
decision - I don't have lung cancer
decision - I have polyps or nodules
decision - life at risk
decision - unable to take in information given
decision - uncertainty about STR
decision - unclear interpretation of STR
wanted to continue
decision to continue - awareness of smoking as cause of problems
decision to continue - e-cigs
decision to continue - made other changes
decision to continue - rational decision
decision to continue - reassurance from study follow up
decision to continue - too late to stop now
wanted to stop
ECLS related
decision - avoidance
decision - family ECLS
decision - found interview motivational
decision - health of self and perceptions of risk ECLS
decision - level of support
decision - multiple factors coinciding
decision - now's the time to stop
decision - teachable moment
non-ECLS related
decision - age and life stage
decision - already wanted to stop so no change
decision - anti-social
decision - causal attribution
decision - clean home
decision - current smoking habits are harmful
decision - ethics
decision - financial
decision - health of others
decision - other peoples experiences of stopping
decision - physical health non-ECLS
decision - positive outlook on life or MHBC
decision - previous success or failure
unclear whether ECLS or non-ECLS

Appendix O. Published papers and conference abstracts

Chapter 3

Young B, Bedford L, Kendrick D, Vedhara K, Robertson J, das Nair R. Factors influencing the decision to attend screening for cancer in the UK: a meta-ethnography of qualitative research. *Journal of Public Health* 2018; 40(2): 315-339.

Chapter 4

Sullivan FM, Farmer E, Mair FS, Treweek S, Kendrick D, Jackson C, Robertson C, Briggs A, McCowan C, Bedford L, Young B, Vedhara K, Gallant S, Littleford R, Robertson J, Sewell H, Dorward A, Sarvesvaran J, Schembri S. Detection in blood of autoantibodies to tumour antigens as a case-finding method in lung cancer using the EarlyCDT®-Lung Test (ECLS): study protocol for a randomized controlled trial. *BMC Cancer* 2017; 17(1): 187.

Young B, Bedford L, Vedhara K, das Nair R, Robertson J, Kendrick D. MA 18.04 Changes in smoking behavior in the Early Cancer Detection Test Lung Cancer Scotland (ECLS) Study. *Journal of Thoracic Oncology 2017;* 12(11): S1878.

Chapter 5

Young B, Vedhara K, Kendrick D, Littleford R., Robertson JFR, Sullivan FM, Schembri S, das Nair R in collaboration with the ECLS study team. Determinants of motivation to quit in smokers screened for the early detection of lung cancer: a qualitative study. *BMC Public Health* 2018; 18(1): 1276.

Young B, Vedhara K, Kendrick D, Robertson J, das Nair R. OP36 Decisions about smoking in patients screened with the EarlyCDT-Lung test for the early detection of lung cancer: A qualitative study. *Journal of Epidemiology and Community Health* 2017; 71(Suppl 1): A19.

Young B, Vedhara K, Kendrick D, Robertson J, das Nair R. P3.06-009 How does screening for the early detection of lung cancer facilitate smoking cessation? A qualitative study of screened smokers. *Journal of Thoracic Oncology* 2017; 12(11): S2297.