Early childhood obesity – exploring the impact of environmental and social factors and parental beliefs of caring for infants with known obesity risk factors.

Deborah Ashton BSc(Hons) BA(Hons) MSc

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Abstract

Background

Macrosomia (birthweight ≥4kg) and rapid weight gain in infancy are both strong independent risk factors for early child overweight. Whilst there are environmental and genetic factors that contribute to an infant's high birthweight, the continued exposure to an obesogenic environment that predisposes macrosomia may also have an effect on early infant growth patterns. Rapid weight gain is potentially modifiable if identified during early life. There is some evidence from randomised controlled trials that interventions delivered in infancy may reduce the risk of early child overweight. However parental beliefs on infant size have identified a preference for bigger babies and as such these beliefs may be barriers to engaging with interventions that could mitigate rapid weight gain.

Aims

1. To determine the prevalence of macrosomia in a representative sample of infants in Nottinghamshire.
2. To explore the relationship between social disadvantage and macrosomia.

3. To determine the prevalence of rapid weight gain in the first year of life.

4. To explore the relationship between social disadvantage and rapid weight gain in the first year of life
5. To explore the interaction between macrosomia and rapid weight gain in socially deprived areas.
6. To investigate whether infants who undergo rapid weight gain in the first year of life in deprived areas remain heavy at year two.
7. To explore the relationship between social disadvantage and rapid weight gain in the first year of life in low birth weight infants.

For infants born big and/or growing rapidly the aim for the qualitative study was: To explore parental beliefs around caring for infants with risk factors for child obesity with a view to informing the development of a targeted behaviour change intervention.

Results

The research cohort contained 8904 term infants, born to mothers registered with a Nottinghamshire General Practitioner. In an area with a high rate of child obesity, the overall prevalence of macrosomia in the 2008 Nottingham birth research cohort was 12.2%, the proportion of rapid weight gain (as an increase of >0.67in weight-for-age z score) infants was 29.7%. Male infants were found to have a 1.9 times increased risk of macrosomia and a 1.4 times increased risk of rapid weight gain compared to females. Asian ethnicity appeared to be protective for both macrosomia (54%) and rapid weight gain (30%) compared to White infants. Black ethnicity

was associated with a three-fold increased risk of being overweight at aged two. There was a 30% increased risk of macrosomia for infants born in the moderately deprived area compared with the most deprived. Infants in the most deprived areas had only 1.2 times increased risk of rapid weight gain compared to the least deprived areas. In a small subsample n=36, infants born macrosomic in the most deprived areas, the risk of rapid weight gain increased more than two-fold compared to infants in the least deprived areas. Being classified as macrosomic at birth increased the infant's chances of being overweight at age two by 3.9 times. Infants who grew rapidly in their first year also had an increased chance of being overweight at aged two by 2.4 times. From this study there appears to be little evidence that deprivation is associated with either macrosomia or rapid infant weight gain. The strongest predictors of child overweight at aged two were being born macrosomic and growing rapidly in the first year.

Twenty four parents of infants who were born big and/or grew rapidly were recruited to the qualitative study. Four key themes emerged from the thematic data analysis. Parents were unconcerned about their child's high weight and justified high weight status with a variety of explanations including familial traits and that weight gain was believed to be positive and indicative of health. Parents' understanding of feeding baby demonstrated a propensity for overfeeding and parents' weaning decisions were heavily influenced

by infant size with parents believing that bigger infants required earlier weaning.

Implications for practice

There is emerging evidence that responsive feeding is effective in reducing early childhood overweight. However rather than targeting responsive feeding interventions in accordance to socioeconomic status for which this research found no justification, focusing on those infants who were born big or growing fast may be more effective. In order to recognise those infants with a growth pattern of concern it is recommended that all infants are weighed at 4 months. This would allow the Health Visiting teams the opportunity to assess early childhood overweight risk based on growth trajectory. The study also identifies that further research is needed to facilitate communication between Health Visitors and parents with regard to preventing rapid infant weight gain and a checklist grounded in the parental beliefs of caring for infants at risk of early childhood overweight needs to be developed.

Conclusions

Macrosomia and rapid weight gain prevalence rates are high in this representative birth cohort. For infants who are born big, and/or grow rapidly their parents report behaviours that will maintain this situation. Whilst responsive feeding interventions have shown promise in mitigating rapid infant growth, there is a need to facilitate communication between Health Visitors and parents on preventing rapid infant weight gain, for these interventions to become effective.

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1 CHAPTER ONE

Early childhood obesity – exploring the impact of environmental and social factors and parental beliefs of caring for infants with known obesity risk factors.

1.1 Introduction

"The prevalence of obesity in infants, children and adolescents is rising around the world and many children who are not yet obese are overweight and on the pathway to obesity" ([1]pg6). Worldwide obesity rates are increasing from less than 1% in 1975 (equivalent to five million girls and six million boys), to nearly 6% in girls (50 million) and nearly 8% in boys (74 million) in 2016. Combined, the number of five to nineteen-year olds classified as obese rose more than tenfold globally, from 11 million in 1975 to 124 million in 2016. In addition, 213 million children and adolescents were overweight in 2016 but fell below the threshold for obesity [2]. Whilst in high-income countries childhood obesity rates appear to be plateauing albeit, at very high rates, they continue to rise rapidly in other countries [3]. For overweight and obese children the associated morbidities are extensive and include hypertension, hyperinsulinaemia, dyslipidaemia, type 2 diabetes, psychosocial problems, and the exacerbation of existing conditions such as asthma [4]. The impact of overweight and obese individuals places a significant burden on NHS resources and is predicted to cost the NHS £9.7 billion per annum by 2050 [5].

It is recognised that there is a public health need to prevent excess weight gain in preschool children as overweight/obese children tend to become overweight/obese adults [6]. There is evidence that factors which increase the risk of child obesity such as rapid weight gain are identifiable in the first year of life [7, 8]. This suggests the potential of early prevention interventions that target rapid weight gain may be effective in reducing the risk of child obesity.

Although genetic factors do contribute to child obesity risk, the tenfold increase in rates of child obesity globally over the past four decades [3] supports the importance of environmental and behavioural factors [9]. For example, a recent systematic review describing the cross-sectional association between adiposity and socioeconomic status found that in over half of the studies conducted over the past fifteen years ($^{10}/_{18}$) incorporating children aged 5-11, that lower social class was associated with higher BMI [10]. This is in contrast to an earlier review which found that lower social class was associated with underweight and not overweight [11]. The association between obesity and socioeconomic deprivation has not been explored in young infants, perhaps in part because of the lack of agreed criteria for measuring and classifying overweight and obesity in infants. There is no evidence that the educational level of a mother at birth is an independent risk factor for child obesity and the evidence for socioeconomic status and later child obesity is mixed [12]. However, Weng *et al* (2013) found that lower household income at birth was associated with higher risk of child obesity in unadjusted analyses but this relationship disappeared once other risk factors such as maternal obesity had been controlled for [13]. There is thorough evidence that obese children living in social deprivation are more likely to remain obese into adulthood compared to more economically advantaged children with obesity [14]. In order to avoid such inequalities, it is important to consider ways of intervening early before patterns of overnutrition and inactivity have been established. There are a number of early markers for obesity risk in childhood such as maternal obesity, paternal obesity, smoking in pregnancy, no breastfeeding, high birthweight, and rapid infant weight gain [13]. Early screening for such risk factors may assist health professionals such as Midwives and Health Visitors to target prevention strategies and help parents to make more informed choices about feeding practices. Weng *et al* (2013) identified early-life risk factors which increased the odds of childhood overweight at age three in developing a risk score algorithm aimed to identify at-risk infants. Rapid weight gain in the first year was the strongest predictor in this study, increasing the risk of overweight more than fourfold [13]. High infant birthweight (≥3.81kg) also increased risk compared to infants in the lowest weight quintile (OR 1.63 (95%CI 1.33-1.95). Repeating the analysis in a more economically advantaged sample (ALSPAC) found that rapid weight gain in the first four months of life and high birthweight were associated with increased risk of overweight at 5 years [15].

Whilst there is compelling evidence that high birthweight and rapid weight gain increase the risk of overweight and obesity in early childhood, few studies have explored the interplay between infant factors such as high birthweight and rapid weight gain and economic deprivation in determining child obesity risk.

This introduction will explore the importance of early obesity prevention and the role of the evidence that lower socioeconomic status is associated with an increased risk of obesity in early childhood. As there is currently a lack of agreed criteria for measuring and classifying overweight and obesity in infants it will also consider the most appropriate measurement and classification of early childhood overweight and obesity.

1.2 Rates of Childhood Overweight/Obesity

Increasing rates of childhood overweight and obesity are a global problem and steadily affecting many low and middle income countries. The worldwide prevalence of childhood overweight and obesity in the under-fives has increased from 4.2% (95% CI: 3.2%, 5.2%) in 1990 to 6.7% (95% CI: 7.3%, 10.9%) in 2010 and this trend is expected to reach 9.1% (95% CI: 7.3%, 10.9%) in 2020 [16]. The World Health Organisation (WHO) report that almost half of all overweight children under five live in Asia and one quarter live in Africa [17]. In developed countries, there has been a rapid increase in childhood overweight/obesity since the 1970's. Whilst the increase over recent years has slowed, the rates remain high. Prevalence of obesity from a state-wide United States study identified that in 2011 12.1% White and 11.5% Black low-income preschool children (birth to four years) were obese. For the United Kingdom, Health Survey 2012-2013 data report overweight (including obesity) rates for children aged 2-15 years as: England 29%; Scotland 29%; Wales 34% and Northern Ireland 25% (age 2-10 years) [18]. The latest National Child Measurement Programme (NCMP) 2014-2015 within England identifies that of children in Reception (age 4-5 years) 9.1% were obese and an additional 12.8% were overweight [19].

1.3 Macrosomia

Macrosomia is a term to describe a high birthweight. The current UK definition of foetal macrosomia is a birthweight of equal to or greater than 4000g, which approximates to the 90th weight centile at 40 weeks gestation [20]. This is consistent with the definition of a "large for gestational age" which is used to describe a foetus growing above the 90th centile [21]. Based on this definition the prevalence of macrosomia in England and Wales is increasing. Data for England and Wales reports that 8.63% of infants weighed ≥4kg at birth in 1983 rising to 9.03% in 1989 [22]. Current data from the Office for National Statistics (ONS) reports 10.7% of live births weighed ≥4kg in 2016 [23].

Numerous studies have sought to establish risk factors for overweight/obesity in preschool children (< 5 years of age) and have found a strong positive association between macrosomia and later overweight status. A prospective nationally representative study conducted England, Scotland, Wales and Northern Ireland (The Millennium Cohort study) found that for every one unit increase in birthweight Z score the odds of being overweight (classified as >90th percentile IOTF cutoff [footnote[1]]) at age three years increased by 1.36 (95% CI 1.30-1.43). Prevalence rates of macrosomia were not reported. The study found some differences by socioeconomic status in adjusted analyses, but after adjusting for individual, family, community and area-level factors only lone parenthood was significant in the final model (OR 1.32, 95% CI 1.15-1.51) [24].

[1] International Obesity Taskforce (IOTF 1999) extrapolates BMI centiles for children with adult overweight and obesity classification cut offs. Child cut off overweight 90-97th percentile. Child cut off obesity > 97th percentile.
Centre for Disease Control (CDC 2000) USA. Child cut off overweight > 85th percentile. Child cut off obesity > 95th percentile.

A further study that presented continuous exposures of birth weight utilised an observational prospective cohort design. Conducted in Mexico the study found that for every 1 unit increase in birth BMI Z score adjusted for gestational age, child sex, maternal factors (BMI, height and age), and family socioeconomic status that the odds of being overweight (classified as ≥95th percentile CDC cut off) between 4 and 6 years of age were 7.62 (95% CI 2.73 – 21.3). Macrosomia prevalence rates were not reported [25].

Several studies have presented their results in terms of birthweight categories. Data from the Quebec Longitudinal Study of Child Development report an overall cohort prevalence of macrosomic infants was reported as 10.7% [26]. Low socioeconomic status classified by household income was an independent risk factor for overweight age 4.5years; OR=2.0 (95% CI 1.1-3.6), adjusting for gestational age and birthweight the risk increases to 2.5 (95% CI 1.3-4.8) [26].

Data collected for the German Kiel Obesity Prevention Study (KOPS) report an overall cohort prevalence obesity rate of 4% classified as a BMI ≥95th percentile aged 4.5 years [27]. From the sample, 15.7% of participants had a birthweight greater than 4kg. Obesity at age 5-7 years stratified by socioeconomic status (SES) category identified that 45.2% of children lived in a low SES household. Multivariate logistic regression analysis identifies for boys a low SES is an independent risk factor for obesity aged 5-7 years (OR=9.3, 95% CI 1.6-51.9) but not high birthweight. For girls, high birthweight is an independent risk factor for obesity (OR=3.2 95% CI 1.3-7.3) and low SES a risk factor for overweight (OR=2.1 95% 1.1-4.2). The level of significance was set at less than 0.05. The study data were a cross-sectional subsample (53%) from the main KOPS study and as such this design could limit the generalisability of the results.

A cross-sectional study conducted in Germany reported an obesity prevalence rate of 4.3% aged 5-7 years classified as a BMI >97th percentile [28]. For the cohort, the prevalence of birthweights greater than 4000g was 9.47%. Compared with the low weight category (<2500g) birthweights greater than 4000g are reported to be an independent risk factor for obesity at age 5-7 years; (OR= 2.93, 95% CI 2.43-3.47). High SES classified by parental education level reduced the risk of obesity at 5-7 years by 40% (OR=0.63 95%CI 0.57-0.69), compared to low SES. Although ethnicity was not assessed in the study, nationality was included as a dichotomous variable, classified as German national or Non-German national. The risk of obesity for a Non-German national child is reported as OR=1.68 (95% CI 1.52-1.84), suggesting different health behaviours between the two classifications of citizen status.

A Swedish population-based, cross-sectional study reports an obesity rate of 3% for children aged 4 years classified by iso-BMI cutoffs; 19.29 (boys) and 19.15 (girls) [29]. Prevalence rates for macrosomia were not reported. The risk of obesity for children with birthweights over 4000g was reported to be OR=1.91 (95%CI 1.43-2.55) adjusted for gender and age. The level of significance was not reported. The prevalence of child obesity at age four was found to be greater in children with either a mother or a father with low educational attainment. For mothers, 19.9% of children were obese compared with 13.2% in the normal weight cohort. For fathers, 22.1% of children were obese compared to 14.3% of the normal weight children. Both results were statistically significant following adjustment for age and gender.

From the reviewed literature the range of macrosomia prevalence was 9.5 to 15.7%. In England and Wales, there were 697,852 live births recorded in 2015 (ONS Births in England and Wales 2015 [23]), of these I estimate that 66,295 to 110,000 infants could be macrosomic with an increased risk of obesity by statutory school age.

The triggers for increased foetal growth are both genetic and environmental. Genetic factors include foetal gender and ethnicity [21]. Foetal genotype has been estimated to account for 20% of human birth weight variations with the male genotype associated with an increased birthweight with males averaging 150-200g more than females at term [30]. Male gender has been associated with an OR=1.6 (95% CI 1.45-1.81) increased risk of macrosomia [31].

There are wide disparities in the prevalence of macrosomia by ethnicity. Data from 350,311 singleton pregnancies collected between 1988 and 1997 in the UK reported a 10.4% (n=36,462) prevalence rate of macrosomic births. White infants had the highest rate of macrosomia at 85.1%, Asian infants represented 4.7% and Black infants 3.9% of the macrosomic infants. [20]. Macrosomia rates by maternal ethnicity for the UK "Born in Bradford" prospective birth cohort study recruited 8,478 mothers carrying a singleton pregnancy during the period March 2007 to December 2010 [32]. The macrosomia rate for the whole cohort was reported at 7.7% (n=655) of which 4.1% of Asian infants were reported to be macrosomic compared to 11.9% of White infants. However, the umbrella term Asian represents a vast and diverse portion of the world's population [33]. Diversity in the Asian population is based on ethnic and cultural subgroups, social and economic condition, degrees of urbanisation and nutritional transitions. One commonality of the Asian population is that in general, the mean or median BMI is lower than that observed for non-Asian populations. BMI for Asian women (excluding Chinese) is lower than that for white women. Evidence from a World Health Organisation (WHO) expert consultation on appropriate BMI for

Asian populations, identifies that on combining all Asian groups for females, BMI is 1.3 kg/m^2 (+/- 0.1) lower [33]. However despite the lower BMI in Asian populations, WHO recommend continuing with the current WHO cut off points for identifying both under and over nutrition [33]. No BMI adjustment for Asian ethnicity has been included in this thesis.

Mean birthweights for Black infants are reported to be lower than White infants [34]. Results from a secondary analysis of NHS data for England and Wales (2005-2006) classified high birthweight as ≥4.5kg reported that only 1.3% of Black African and 0.9% Black Caribbean infants had a high birthweight compared with 2% for White British infants [34].

Environmental risk factors for foetal macrosomia include gestational age and maternal diabetes including both pre-gestational and gestational [21]. Prolonged pregnancies (>41 weeks) are also associated with an increased prevalence of macrosomia (2.5-10% in post-term versus 0.8-1.0% at term) [35].

Maternal diabetes is a major risk factor associated with macrosomic infants as the effect of diabetes on the intrauterine environment directly influences foetal growth. The placental function is a major determinant of foetal growth. In principle, maternal nutrients and other factors including insulin-like growth factors (IGFs) and leptin enter the foetal circulation directly without any interference from the placental tissues. Placental weight tends to be heavier in diabetic mothers. Intrauterine exposure to mild hyperglycaemia is associated with macrosomia. In contrast, foetal exposure to severely hyperglycaemic environments is associated with microsomia [36]. Insulin-like growth factors (IGFs) have been implicated as regulators of foetal growth. In diabetic mothers, foetal growth may be promoted by the diabetes-associated increase in maternal concentrations of IGFs [36]. Maternal and foetal hyperleptinemia is associated with maternal diabetes and leptin levels correlate with adiposity. During pregnancy, maternal leptin concentration rises by 30% and the placenta is the primary foetal leptin source [36]. The hormone leptin is a mediator of long-term regulation of energy and food intake and therefore, high leptin levels should be associated with the prevention of obesity [37]. However, leptin resistance has been suggested as a mechanism in obesity. It is speculated that over-nutrition in pregnancy results in an increase in circulating leptin levels, resulting in a damaging effect on the hypothalamus which results in a lower sensitivity to circulating leptin levels [38]. This leads to a sustained increase in leptin levels [37]. In humans, leptin resistance has been shown to develop because of overeating [39].

The strongest independent risk factor for macrosomia is maternal obesity which is likely to have both a genetic and environmental component and includes both pre-existing and excessive gestational weight gain [21, 40]. Approximately 50% of women of childbearing age (16-44 years) in England are either overweight or obese, and the prevalence of obesity in women of this age group is rising from 12% in 1993 to over 19% in 2013 [41]. Direct comparisons of obese and non-obese mothers and birth outcomes identify a dose-dependent relationship between maternal obesity and foetal macrosomia [42]. Data from two studies published seven years apart report increasing prevalence rates of macrosomia for both obese women (BMI 30kgm^2) at 13.8% (2007) [40] and 15.8% (2014) [43] and morbidly obese women (<40 kgm^2) 14.6% (2014) compared with 8.3% (2007) for normal weight and 9.3% (2014) for underweight/normal weight mothers.

The risk of developing gestational diabetes mellitus (GDM) is positively associated with obesity in pregnancy, with one study reporting the risk of developing GDM in obese women (>30 kgm^2) as OR=2.6 and OR=4.0 for morbidly obese (>40 kgm^2) [44]. The contribution of overweight/obesity and diabetes on macrosomia has been investigated. A North American study collected data between 1997-2001 to determine the relative contribution of obesity and diabetes on the prevalence of macrosomia [31]. Infant macrosomia was defined as a birthweight greater than the 90th percentile for gestational age. The study included complete data for 12,950 deliveries of which 23% of women were classified as obese with a BMI >30 kgm^2. For the obese women, pregestational diabetes rates were reported at 2.4%. The risk of macrosomia in women classified as obese (BMI >30 kgm^2) was reported as OR=1.72 [95% CI 1.57-1.97] compared to normal weight women. For the study population, the risk of a delivering macrosomic infant in pre-pregnancy diabetic women was OR=4.8 [95% CI 3.29-6.86] compared to normal weight women. The study population had an overall macrosomia rate of 11.8%. The population-attributable risks of macrosomia caused by obesity, overweight, and pre-pregnancy diabetes were reported at 1.3%, 0.5%, and 0.4%, respectively. Whilst the population-attributable risks reported are very small the study utilised data collected between 1997 -2001. Since that time maternal obesity rates have risen. The Special Supplemental Nutritional Program for Women, Infants and Children (WIC) a federal assistance programme of health care and nutrition for low income pregnant, breastfeeding women and children under the age of five in North America, reports that obesity levels in women participating in the WIC programme has increased from 19.2% in 1994 to almost 36% in 2014 [45]. Given the trend for maternal obesity is expected to continue to rise, it follows that these population attributable risks will also rise.

Maternal obesity and socioeconomic deprivation are strongly linked, with the risk increasing with greater levels of deprivation [46-48]. A retrospective study of first-trimester obesity classified socioeconomic status by IMD rank (2007). The prevalence of obese women included in the study rose from 7.55% in 1989 to 13.14% in 2007, reflecting the increase reported by the Health Survey for England (2013)[41]. Socioeconomic status was classified by quintiles, with the risk of maternal obesity for the most deprived quintile (Quintile 1) compared to the least deprived quintile (Quintile 5) reported as 0R=2.20 (95% CI 2.13-2.28) [49]. A later UK national cohort study of pregnant women with a BMI ≥35kgm^2, classified deprivation by IMD score, the results from this study identifies that the most deprived quintiles were overrepresented by the obese cohort compared to all maternities in the general population [50].

In summary, it has been shown that rates of macrosomia are rising. This increase may be directly influenced by the rise of maternal obesity rates. The relationship between maternal obesity and deprivation is clear, with the rate of maternal obesity increasing with greater levels of deprivation. Maternal and neonatal obesity might represent a vicious cycle whereby obese mothers have obese infants who in turn give birth to obese generations to come [51]. It is therefore very important to investigate early-life determinants of obesity, in particular, the relationship between macrosomia and social deprivation in order to target interventions that would provide an optimum foetal growth environment and modulate childhood obesity rates.

1.4 Rapid Infant Weight Gain

Rapid infant weight gain (RWG) is a growth pattern of concern that could be used to identify children at increased risk for later obesity. Although there are variations in the classification of infant RWG, the most common and recommended definition of RWG is an increase of >0.67 in gender-specific weight for age z score within a specific time period representing significant weight gain coincident with crossing one major percentile line on a growth chart [52]. There is compelling evidence that rapid infant weight gain is associated with overweight and obesity in childhood [53]. Moreover, rapid infant weight gain has a strong association with overweight over an individual's lifespan [54].

Rapid infant weight gain has been shown to be associated with the risk of being overweight/ obese in adolescence. Results from the SWEDES longitudinal study examined the independent association between weight gain in infancy and early childhood with metabolic syndrome in young adults aged 17. Although the association between RWG and overweight/obesity at age 17 is not reported, RWG was shown to predict adiposity measured by waist circumference (B 0.29 [95%CI 0.09,0.49]) [55].

Further evidence on the association between early RWG and risk of overweight/obesity at adolescence comes from a Greek epidemiological study designed to record the prevalence of overweight/obesity in adolescents. Rapid weight gain was defined as +1 SD weight change between birth and six months of age. From this study, rapid weight gain infants were significantly more likely to be obese adolescents OR= 1.46 (1.10,1.90) [56].

Rapid infant weight gain has been suggested to be a risk factor for adult obesity. Two studies have found an association between RWG in the first six months of life and overweight/obesity in adulthood [8, 57]. Data on a birth cohort of African American children were interrogated to investigate whether RWG between birth and four months was associated with obesity in adulthood (age 20 years). The risk of being obese as an adult in the children that had undergone RWG was reported as OR=4.29 (95% CI 1.32 - 18.3). This study has limitations, the children who participated were born between 1959 and 1966 prior to the substantial rise in obesity rates, and hence the prevalence of overweight/obese at adulthood from this study is 9.3%. Therefore it is difficult to know whether the results would be reproducible with children growing up today.[8].

A retrospective study of Japanese female adults aimed to ascertain whether RWG was associated with indices of obesity in adulthood (age 18-21 years). Infant weight gain was assessed by weight change Z score between birth and three months. The results were presented as correlations between weight change Z score and indices of obesity including BMI and body fat percentage (BFP). The participants current BFP was found to be significantly correlated with weight change between birth and 3 months of age ($r=0.26$, $p=0.034$). This study has a number of limitations. Firstly the sample size is relatively small n=86 and was recruited from a single site, therefore, generalisations to the whole Japanese population should be made with caution. The authors also state that they compared statistically many variables so the significance may be due to type 1 errors [57].

One birth cohort study has tracked the association between early rapid infant weight gain between birth and four months and obesity status at three developmental periods: childhood (age 5); adolescence (age 9-14) and adulthood (age 18-20) [58]. Rapid weight gain was defined as the upper tertile of monthly weight gain (gain of ≥916g or 2lb per month). This study reports the relative risk for obesity at each developmental period adjusted for maternal marital status; health insurance and infant gender. Childhood obesity defined as BMI > 85^{th} percentile was predicted by rapid weight gain (RR=2.2 [95% CI 1.26, 3.73]). At adolescence, the risk of obesity was lower at 1.87 (95% CI 1.24, 2.83) and adulthood 1.71 (95% CI 1.00, 2.92).

Although there is a strong relationship between childhood obesity and low socioeconomic status (SES) [59], there is limited evidence to establish the relationship between socioeconomic status and rapid weight gain in infancy. A United Kingdom study used longitudinal weight data from 2402 families enrolled on the "Gemini" twin cohort study, to examine the socioeconomic status differences in infant weight gain during the first three months of life. Socioeconomic status was indexed by using the National Statistics Socioeconomic Class (NS-SEC) index. The highest household occupation was documented. To confirm the NS-SEC the highest maternal educational qualification was recorded [60]. Infant birth weight and subsequent weight recordings were obtained from the child's personal health record. Infant weight at birth and three months (obtained between 2-4 months) was converted to standard deviation scores. Rapid weight gain was defined as a change in standard deviation scores from birth to three months of >0.67. The results of this study identified that infants from lower socioeconomic status families had a 36% (95% CI 7% - 72%) higher chance of rapid weight gain. However, there were no socioeconomic status differences in birth weight. From the potential explanatory variables, the results show that infants of overweight or obese mothers had a higher birth weight standard deviation score than infants of normal weight mothers. The limitation of this study is the use of the twin birth cohort as the birth weights are lower (mean 2.46kg) than the 1990 singleton reference population (mean 3.5kg) [61]. It is difficult to ascertain whether the growth patterns observed between birth and age 2 – 4 months is due to rapid weight gain or the more favourable outcome – catch up growth [62]. Irrespective of gestational age rapid weight gain has a strong association with later overweight, however as the Z-score scale is linear, accurate calculation of weight for gestation age Z score is required in order to compare rapid weight gain in infants.

Further evidence on the association between SES and increased weight gain in infancy was reported by the Amsterdam Born Children and their Development study team. Following a study that sought to examine the relationship between maternal education as an indicator for socioeconomic status and growth velocity in the first year of life, linear regression analyses showed that children with low educated mothers have increased weight gain in the first year of life (β 0.12; 95% CI 0.08-0.45) compared to children with highly educated mothers [63].

Socioeconomic status (SES) is a composite measure of an individual’s economic and sociological standing [64]. Most individual-level indicators used in health research measure some type of individual resource or asset [65] including income, education, and occupation. For women, education is considered one of the best socioeconomic status indicators because they are socially disadvantaged for income and occupational prestige measures [66].

Dubois *et al* (2006) in a Canadian study examined the early determinants of overweight at 4.5 years utilising a population-based longitudinal study. Monthly weight gain was categorised by quintiles, with quintile 5 representing the highest total weight gain between birth and five months. In unadjusted analyses mothers' educational level did not reach significance, therefore SES was categorised according to total household income at 4.5 years. Adjusting for gestational age, birthweight, maternal smoking, number of overweight/obese parents at age 18 months and household income at 4.5 years, identified that for those children who had the highest weight gain the odds of being overweight at age 4.5 years was 3.9 (95% CI 1.9-7.9). The odds of being overweight at age 4.5 in a low-income household (≤$20,000) were reported as 2.5 (95% CI 1.3-4.8). The outcome measure for "overweight" at age 4.5 years was defined as ≥95th percentile of the CDC growth chart, which is a classification for obese. Therefore the odds ratios calculated for this study are based on an obese classification at age 4.5 years, which may account for the low obesity prevalence rate reported at 8.5% [26].

Whilst the three studies summarised above show a positive association between SES and rapid weight gain, the following studies find little or no effect. Stettler *et al* (2002) through a prospective North American cohort study, sought to determine whether a rapid rate of weight gain in the first few months of life was associated with overweight status at age seven. The unadjusted analysis between rapid rate of weight gain (100g per month between birth and four months) and overweight status at age 7 was 1.29 (95% CI 1.25,1.33). Which means for every 100g increase in weight between birth and four months the risk for overweight status at age seven was increased by 29% (95% CI:23%-33%). However, adjusting for potential confounding variables including maternal education in years completed the odds of being overweight at age 7 increased to 1.38 (95% CI 1.32,1.44). For higher material education the risk of overweight at age 7 was reported at 0.93 (95% CI 0.90, 0.97). Although a major strength of this research is that the weight data were collected prospectively, the sample of children was not fully representative of the entire US population [67].

An observational study conducted in Hong Kong examined growth rate (change in the sex-specific weight for age z score) between 0-3 months and 3-12 months on the risk of elevated BMI at age seven. Accelerated growth was defined as a change greater than 0.67 in weight z score. The whole cohort prevalence of overweight including obesity at age seven was 15.3%. For those infants that grew rapidly in the first three months of life the prevalence of overweight/obesity was 18.7% compared with 11.9% for the infants with the slowest growth. However, highest parental education attainment had no effect on growth rate between birth and three months or three to twelve months and may be reflective of the rapid economic growth experienced in Hong Kong at that time [68].

Project Viva, a prospective cohort study examined the association between weight for length at birth and six months with obesity at age three categorised as a BMI ≥95th percentile. Change in weight for length z scores from birth to six months was categorised into quartiles with quartile 4 representing those infants with the highest change. Multivariate analysis adjusted for birth weight for length z scores and confounding variables including; child's age, gender and ethnicity, maternal age, education, income, parity, plus gestational weight gain, maternal smoking and pre-pregnancy BMI and paternal BMI. The study identified that for each increment in 6-month weight for length z score was associated with higher BMI z scores at aged three years with an increased risk of obesity (OR: 6.84 [95% CI: 3.84– 12.19]). Although a number of factors were included in the analysis, the authors acknowledge that although the study participants had diverse ethnic backgrounds, their educational and income levels were relatively high and therefore, the results may not be generalizable to more socio-economic disadvantaged populations [69].

Other socio-demographic factors including gender and gestation and have been shown to be associated with RWG. Boys have been recognised to gain weight more rapidly than girls [70]. Enrolment data from the NOURISH randomised controlled trial identified gender differences in rapid weight gain defined as an increase in weight for age z-score from birth to the assessment point at 4-7 months, above 0.67 SD. Males were shown to be more likely to undergo rapid weight gain relative to females AOR 1.8 (95% CI 1.10-2.97) [54].

The association between gestation and RWG has been shown to differ according to gestational age category in a prospective birth cohort study [71]. The infants were classified as early preterm <34 weeks; late preterm 34-36 weeks; early term 37-38 weeks and term ≥39 weeks. Rapid infant weight gain was defined as a change in weight gain z-score between 0.67 to 1.28 from birth to four months. For the preterm categories, the percentage of rapid weight infants were high reported as 87.8% early preterm and 67.7% preterm. For the gestational age categories, those infants born preterm (37-38 weeks) were shown to have a higher proportion of RWG in the first four months than those at born at full term 39.9% v 23.8%. Rapid weight gain (weight gain z-score between 0.67 and 1.28) in the first four months of life increases the risk of overweight/obesity at age 2-7 years by about 50% regardless of gestational category.

Low birthweight was defined in 1950 by the World Health Organisation (WHO) as a birth weight less than 2,500g, irrespective of gestation [72]. All low birth weight infants have the potential to undergo catch up growth. Catch up growth may be due to less than favourable intra uterine conditions and may represent a major adaptive mechanism with associated increased risk for independent risk factors including metabolic and cardiovascular disease in adulthood [73-75]. The causal relationship between intrauterine growth retardation and the origins of disease in adulthood is often referred to as the "Barker hypothesis" which states that adverse influences early in development, particularly during intrauterine life, can result in permanent changes in physiological and metabolism which result in an increased disease risk in adulthood [76].

The Dutch famine studies have clearly illustrated the relationship between foetal growth restriction and the risk of obesity later in life [77]. Comparing two periods of severe famine during the Second World War exposes differences in obesity and cardiovascular disease in adulthood. The Dutch Hunger Winter occurred for a relatively short period of time (Winter and Spring 1944) following which normal diet resumed. In contrast, the siege of Leningrad lasted for 2.5 years. In both cases, pregnant women were exposed to severe famine. The Dutch Hunger Winter infants exposed to famine during early gestation experienced elevated rates of obesity, altered lipid profiles, and cardiovascular disease. In contrast, for the Leningrad mothers and infants, food shortage continued and those infants exposed to famine in utero and early infancy did not exhibit higher rates of obesity and cardiovascular disease in adulthood [78]. It is hypothesized that foetal adaptions to undernourishment may become maladaptive resulting in catch up growth only when the affected individuals are later exposed to an obesogenic environment [78, 79]. However, catch up growth may also simply reflect a statistical regression towards the mean [80].

Early life feeding is likely to have consequences for rapid infant weight gain. Infants who are breastfed undergo faster growth in the first month of life, followed by slower growth over the following eighteen months [81]. It is suggested that breastfeeding may protect against rapid infant weight gain due to better appetite control and lower protein intake compared to infants who are artificially fed [82]. The effect on appetite control has mainly been attributed to the composition of breastmilk, particularly the presence of the appetite control hormone leptin [83]. Leptin is considered to be central to appetite regulation and energy balance in infants [84]. Direct comparisons of early infant growth in breast and formula fed infants were examined in an Italian study [85]. Infants born at term (37-42 weeks) with a birthweight greater than 2.5kg were recruited to the study (n=138). Breastfed infants were predominately breastfed for at least four months. The results identify differences in the mean change in weight for age z-scores from birth to twelve months for infants breastfed for 12 months -0.82 (Standard error of mean SEM 0.31); breastfed for 4 months -0.19 (SEM 0.15) and formula-fed 0.37 (SEM 0.13).

The method of feeding may also be a risk factor for rapid weight gain. A study of bottle-feeding and the risk for rapid weight gain in the first year of life, identified that bottle feeding of either artificial milk or expressed breastmilk was found to increase monthly weight gain by 71g (artificial milk $p<0.001$) or 89g (expressed breast milk) per month compared with exclusively breastfed infants [86]. Bovine milk is the basis for most infant formula. However, bovine milk contains higher levels of fat, minerals, and protein compared to human breast milk [87]. A high protein intake is a risk factor for later obesity [88]. In a randomised double-blind study either a lower protein or control formula was introduced to infants of women whose pre-pregnancy weight was categorised as overweight (BMI > $25kgm^2$) on cessation of breastfeeding. The primary study period was between three and six months. The results showed that infants fed the lower protein formula gained less weight (-1.77 g/day $p=0.024$) than the control formula. For infants in the sub-group whose mothers' pre-pregnant weight was categorised as obese (>$30kgm^2$) the weight gain difference between the study and control formulas was -4.21 g/day (p=0.017) [89].

In addition to the composition of infant milk feeds, parental feeding practices have also been shown to be associated with RWG. Feeding styles that encourage rapid sucking and larger frequent feeds have been associated with a higher caloric intake and greater adiposity at age three years [90]. The interim analysis from an ongoing longitudinal study of factors contributing to growth in healthy, term African American infants identified a weak positive linear relationship between infant feeding style at one month and weight gain at four months [91]. From the cohort (n=53), infant feeding intensity was measured by the number of sucks in two minutes (NOS) and maximal sucking pressure (MSP). Infants with a higher NOS at one month, had a higher weight at four months (r=0.36; p=0.022; n=41). Additionally, a higher MSP at one month was positively associated with greater weight gain at four months (r=0.33; p=0.036; n=41). A study on parental control in infant feeding has reported that parental concern that their child was underweight resulted in a "pressured" feeding style that encouraged frequent, larger bottle or breastfeeds (OR= 1.88 95%CI 1.29-2.75) [92]. Infant feeding behaviours, in particular, infant self-regulation of satiety, may be an important predictor of subsequent weight gain. Infants who are artificially fed have an increased risk for overweight/obesity [93, 94]. Evidence from a

North American study examining the independent impact of infant initiated bottle emptying on the infants' risk for excess weight gain in late infancy identified that infants who often emptied their bottles were 69% more likely to gain excess weight by late infancy (OR=1.6; 95% CI 1.09-2.63). It has been suggested that artificially fed infants have an altered satiety response influenced in part by the differences in the protein composition in artificial milk compared with breast milk and a controlling parental feeding style [95]. In infants, a birth cohort study identified that accelerated infant and childhood weight gain is associated with increased energy intake and diminished satiety response at age 5. The increase in energy intake at age 5 was shown to be 3 times in those children who had accelerated weight gain in infancy [96]. In studies of older children, those classified as obese have been found to show less responsiveness to internal satiety signals [97, 98].

The evidence that early weaning i.e. between three and six months of age in high-income countries appears to have an effect on infant growth is mixed. The Millennium Cohort study found that infants introduced to solids before four months of age were 1.2 times (95% CI 1.02-1.23) more likely to be overweight (classified as >90^{th} percentile IOTF cut off) compared to infants introduced to solids after four months [24]. Results from Project Viva a prospective pre-birth cohort study found that formula-fed infants given solids before four months were 6.3 times (95% CI 2.3-16.9) more likely to be overweight (classified as BMI ≥95th percentile) at three years of age compared to infants introduced to solids between four and five months of age. However, this relationship was not significant in breastfed infants [99]. A systematic review of the age of weaning and infant growth found that in high-income countries, weaning between 3 and 6 months appears to have a neutral effect on infant growth [100]. However, age at weaning was inversely associated with BMI at birth (p=0.02) and at three months (p=0.01). To formally test the possibility of reverse causality, rapid weight gain between birth and three months was categorised into < 0.67 SD or ≥ 0.67 SD. Infants exhibiting faster weight gain were weaned earlier than those with slower or average weight gain (P_{trend}= 0.01 adjusted for age, sex birthweight, maternal age, parity and deprivation score). This suggests that parents are using infant size as an indicator to commence weaning

In summary rapid infant weight gain increases the risk of childhood obesity and beyond. UK studies have identified that childhood obesity is disproportionately represented by disadvantaged children [101]. Therefore, the exploration of rapid infant weight gain as a proxy for obesity and the association with low socioeconomic status is essential in order to effectively target innovative obesity prevention strategies.

1.5 High Birthweight and Rapid Infant Weight Gain

Both macrosomia and rapid infant weight gain are positively associated with an increased risk of obesity in childhood [102]. Therefore the continued exposure to an obesogenic environment that predisposes macrosomia may also have an effect on early infant growth patterns. Two large studies that investigated early risk factors for childhood obesity expected that the effect of weight gain and the risk of obesity in childhood may differ by birthweight [67, 103]. In a North American prospective cohort study following stratified analysis for quintiles of birthweight in term infants (37-42 weeks) with quintiles of weight gain during the first four months of life on obesity at age seven no interaction was detected; test for heterogeneity $p=0.5$ [67]. A further retrospective analysis of early life data from Seychelles a country undergoing rapid economic and epidemiological transition, again found no interaction between stratified analysis for the quartiles of birthweight in term infants (37-42 weeks) with quartiles of weight gain in the first year of life on overweight/obesity in schoolchildren; test for homogeneity $p>0.1$ [103]. Each of these studies has limitations. For the US study, the data were collected between 1959 and 1965, a decade before the major rise in childhood obesity. The Seychelles study was conducted on a population experiencing new economic prosperity and as such had no areas of deprivation.

The combined effects of birth weight and rapid weight gain have however been associated with a higher BMI at age 7 [104]. The large prospective Hong Kong 1997 birth cohort study investigated the association between birth weight, infant growth rate, and childhood adiposity. The main outcome measure was BMI Z score at about age 7 with overweight and obesity cutoffs in accordance to the IOTF reference chart. This study identifies that high birth weights in combination with rapid growth in the first three months of life are positively associated with a higher BMI at age 7 with an OR for boys 4.97 [95% CI 3.16-7.83] and for girls 3.32 [95% CI 1.85-5.95] adjusted for gestational age [104]. Socioeconomic status was categorised by years of completed parental education. Following preliminary analysis parental education was not included because it did not change the estimates for the effect of growth (at age 0-3 months or 3-12 months), birthweight, or sex on childhood BMI by more than 5.0%. The study confirms that infant variables rapid weight gain and high birthweight are important markers of child obesity risk, regardless of socioeconomic status. However, the mean birthweight for the heavy at birth group was 3.6kg and only 15% of the sample overall were overweight. The findings may be different for UK samples which have higher birth weights and rates of obesity. One barrier to research in young infants is the lack of a widely accepted criterion for classifying overweight in infants younger than two years. In view of this lack of consensus, the following section will consider the most appropriate measurement and classification of early childhood overweight and obesity.

1.6 Measurement and classification of early childhood overweight and obesity

1.6.1 Body Mass Index (BMI).

The index weight/height^2 was first described by Adolphe Quetelet in the 19th century as an index of weight adjusted for height. In the 1950s, Ancel Keys revisited Quetelet's index and the body mass index emerged [105]. The original adult BMI overweight and obesity classification cutoffs were arbitrary and not based on any outcome measures such as mortality [106]. The common interpretation of BMI is that it represents an index of an individual's fatness. It also is widely used as a risk factor for the development of or the prevalence of several health issues [107]. However, data from a systematic review and meta-analysis of all-cause mortality for overweight and obesity using standard BMI categories identified that relative to normal weight, that obesity (all grades) were associated with significantly higher all-cause mortality. Overweight was associated with significantly lower all-cause mortality [106]. Despite the limitations, BMI retains important practical advantages for obesity research, as height and weight are routinely collected in many areas of medical research. The adoption of this simple numerical index has allowed researchers to directly compare the results of different research [108], therefore BMI remains a widely accepted indicator of adult adiposity. However, the establishment of specific obesity and overweight cut off points for young children has proven to be difficult. Constant changes in body composition during growth mean that the relationship between weight for height and adiposity during childhood is age-dependent and this relationship is further confounded by ethnicity and gender.

There is currently no universally accepted system for the classification of obesity and overweight in young children. Although there is a quantity of BMI classification systems in operation worldwide, these give rise to a number of definitions arising from the diversity in sample size, the nationality of the reference population and the use of differing obesity and overweight cut off points.

Currently, there are 3 main classifications in the literature each based on a specific reference study population: United States of America Centre for Disease Control (CDC 2000), International Obesity Taskforce (IOTF 1999) and United Kingdom (UK 1990) [Figure 1].

Figure 1 - Comparison of cut off classifications of childhood overweight/obese

Reference Chart	Reference age range	Cut off -overweight	Cut off - obesity
CDC 2000	2-19 years	>85th percentile	>95th percentile
IOTF 1999	2-20years	90-97th percentile	>97th percentile
UK 1990	0-23 years	≥85th percentile	≥95th percentile

Examining each of the study reference populations and the contrasting World Health Organisation (2006) growth standards further highlights the lack of consensus in defining overweight and obesity in preschool children.

1.6.2 CDC (2000)

This is based on the United States of America (US) data collected from 5 national surveys conducted during the period 1963-1994. The exclusion criterion for the age cohort under 24 months was a low birth weight (<1.5kg). The sample size and number of observations for the population comprising of the under 2's are equal at 4,697 [109]. Although the growth charts span from birth to 19 years, no weight data were recorded in the surveys for infants under 6 months in the period 1976-1980 (National Health and Nutrition Examination Survey - NHANES II) or for infants under 2 months during the subsequent period 1988-1994 (NHANES III). Similarly, no length was collected in infants under 3 months during the period 1988-1994 (NHANES III) [110]. In order to compensate for the missing data, birth weights were extracted from birth certificates during the period 1968-1980 and 1985-1994 and birth lengths extracted from birth certificates during the period 1985-

1994. However, only two USA states routinely recorded birth lengths [110]. Using a distribution based approach, overweight and obesity was defined as exceeding the 85^{th} and 95^{th} centile for population monitoring and the 85^{th} and 97^{th} centile for clinical measurement [111].

The prevalence of breastfeeding in this study population (n= 4697 <24 months) is estimated to be 50% at birth falling to 33% breastfeeding at 3 months [109]. As there were no exclusion criteria for infants with high birth weights or accelerated growth, the CDC growth reference charts reflect the heavier sample population [109, 110].

The resulting BMI for age centile charts are not designed to fit with adult BMI cut off points.

1.6.3 IOTF (1999)

It is recognised that child growth changes substantially with not only age but also with gender and ethnicity. In recognition of child growth disparity, the objective in the development of the IOTF reference population was to link the adult BMI cut off points with BMI centiles for children in order to provide child cut off points to classify overweight and obesity [112]. The reference data were taken from BMI for children from six nationally representative cross-sectional surveys on growth from Brazil, Great Britain, Hong

Kong, the Netherlands, Singapore, and the United States, during the period 1963 to 1993 [113].

There is a discrepancy in the reported age range of the reference population with the text stating an age range of 6-18 years, whilst the tabled data state an age range of 0-25 years. Age and gender-specific cut off points were extrapolated from the adult BMI cut off points of 25kg/m^2 and 30kg/m^2 for overweight and obesity respectively [113] to provide a comparable cut off points for children. The IOTF (1999) is used to provide international comparisons of the prevalence of overweight and obesity.

1.6.4 UK - 1990

The body mass index curves for the UK were derived from combining data from 11 distinct surveys undertaken in England, Scotland and Wales during the period 1978–1990 [61]. The age range of the White reference population was between 0-23 years.

The distribution-based approach defines overweight and obesity for population monitoring as exceeding the 85th and 95th centiles respectively and the 91st and 98th centiles for clinical measurement.

The data for the UK 1990 BMI classification system is not reported to be nationally representative and includes pre-term infants [61].

1.6.5 WHO Growth Standards (2006)

Conceptually different to the growth reference charts based on a reference study population, the WHO growth reference standard charts are representative of how a child would grow under optimal environmental and health conditions, as opposed to the growth reference charts that describe how certain children grew at a specific place and time [109]. The data for the growth standards are based on the WHO Multicentre Growth Reference Study (MGRS) conducted during 1997-2003 in six sites: Brazil, Ghana, India, Norway, Oman, and California. The exclusion criteria for the under 2 cohort are extensive and include (abridged): pre/post term infants, multiple births, maternal smoking during pregnancy, exclusive breastfeeding for more than 12 months, early/late weaning and weight for length +/- 3 standard deviations for sex from study median.

The primary study hypothesis of the MGRS is that all young children have the potential to grow in the same way, regardless of their ethnic group or place of birth. This hypothesis was confirmed with the children under the age of 2 having virtually identical mean lengths in the 6 study sites [109].

The WHO growth curves for children less than 24 months were based on a longitudinal component of the study. The cohorts of infants (n=882) were measured at set points between birth and 23 months amounting to 18,973 distinct observations of weight and length. The resulting distribution growth standard curves reflect the optimal growth of infants and children [109]. The method of infant feeding is revealed to be paramount in the use of either the growth reference or growth standard charts, as breastfeeding infants tend to gain weight more rapidly in the first three months, whereas, after 3 months, formula-fed infants have a tendency to grow more rapidly than their breastfed peers [109].

For children under five years of age, the classification for overweight is a weight for height greater than 2 standard deviations and for obesity weight for height greater than 3 standard deviations above the WHO child growth standards median. However WHO recommends a cut-off value of +2 SD weight for length and sex z-score which corresponds to the 97.7th percentile to define abnormal growth.

The World Health Organisation recommends adult BMI cut off points 25kg/m^2 and 30kg/m^2 for overweight and obesity commence at the age of 19.

Contrasting the growth reference charts with the growth standards identifies that the growth reference charts are descriptive and pertain to how the children in the reference population did grow. Whereas, the growth standards describe how children should grow [114].

The lack of consensus in both the reference populations and BMI cut off points makes comparisons of BMI in children difficult.

In adults, BMI as weight in kilograms divided by height in meters squared (kg/m^2) is the description of the relationship between weight to height; in effect adjusting the weight for height.

However, as a child's growth pattern changes constantly the adjustment of weight for height becomes problematic requiring data manipulation to produce smooth percentiles. The effect is that the smoothing process generates a BMI z-score. A BMI z-score is representative of a measure of weight adjusted not only for height but also for gender and age.

Also, the cutoff points that define overweight and obesity remain static with age and gender. Therefore, utilising the UK1990 cut off point for obesity as $\geq 95^{th}$ centile implies that only 5% of all 1, 2, 3 etc. year olds are obese. Research studies using the UK1990 definition of obesity have found the prevalence of obesity to be in the range 6.0% (age 24 months) and 5.4%-9.2% (age 3-4 years) [115, 116].

Whilst BMI is extensively used, the wide variety of reference populations and cut off points lead to a tool based on statistical models rather than reflecting the health risk of obesity or the degree of body fatness [114].

1.6.6 Weight

In the first year of life, the Child Growth Foundation (2009) recommends that an infant be weighed naked and the resulting weight be plotted on UK weight charts [117]. The UK weight charts were produced to modify the British 1990 weight reference charts to reflect the growth of long-term breastfed infants [118]. It is well known that infant weight gain differs between breastfed and formula-fed infants. On average in the first 3-4 months, a breastfed infant gains weight relatively quickly but following this period the growth rate decreases until at around 12 months they can be a centile lighter than their infant formula fed peers [118].

Weight is a direct and simple index of body size, easy to measure, cheap and reproducible [119]. In the United Kingdom, paediatric management of obesity considers that weight alone is important until a baby reaches 1 to 2 years to determine the degree of obesity [120].

In a large retrospective Southern German cohort study, whose objective was to assess the best anthropometric predictor from birth to 2 years for later overweight, growth data were collected on 2,435 children. The recordings on height and weight at birth, 6 months, 12 months and 24 months were obtained from the child's handheld record. The sensitivity and specificity of weight, length and BMI gain were determined against the distribution of the respective growth gains for the observational periods: 0-6 months, 6-12 months, 12-24 months, 0-12 months and 1-24 months. The study concludes that within this population weight gain from birth to 24 months was the best overall anthropometric predictor of being overweight at statutory school entry age [121].

The accuracy of height and weight data from children's handheld records (Personal Child Health Record – PCHR) was investigated as part of the wider Avon Longitudinal Study of Parents and Children (ALSPAC). A subsample of the prospective cohort study was selected for an in-depth follow up clinic referred to as Children in Focus (CiF) clinics. The study compared the heights/lengths and weights measured in the CiF clinics and those recorded by health professionals in the PCHR. The CiF clinic measurements were used as the gold standard and the CiF-PCHR measurements were compared to assess the accuracy of the PCHR measurements. The results of the study demonstrated a good accuracy of routine weight and height measurements, particularly from 8 months onwards [122].

1.6.7 Weight for length (height)

Weight for length (height) measurements have become a common method for assessing populations of children especially under the age of five and are used to define both under- and over-nutrition [123]. One of the simplest definitions of weight for height is relative weight. This requires a chart of expected weight for the child's height and sex and the child's weight is expressed as a percentage of expected weight [124]. This method has the advantage that it is cheap, easy to measure and reproducible. However, irrespective of how weight for height is defined it does not measure body fatness [125]. A further criticism of weight for height measurements is the use of reference charts using data for the infancy period originating from a single ethnically homogeneous community where the majority of infants were bottle fed with formula milk [126]. The World Health Organisation introduced in 2006 new child growth standards which are the result of a multinational study investigating the growth patterns of breastfed infants in 7 countries [126]. It is therefore important to note the reference charts used in scientific studies to express the child's relative weight.

1.6.8 Body Circumference

Body circumference including waist and mid-upper arm have both been used to assess body fatness in children [123].

However, the National Institute for Health and Care Excellence (NICE) does not recommend the use of waist circumference measurements in children due to problems with measurement validity and reliability [4].

An evaluation of mid-upper arm circumference as a screening tool for identifying obesity in preschool children, identified that whilst the sensitivity of this measurement was high the specificity was poor. The number of false positives (23.5%) was observed against the obesity definition of weight to height z score of greater than 2 [127].

1.6.9 Skinfold thickness

Skinfold thickness measurements in infants are reported to be measured in order to provide an indication of subcutaneous fat [128]. As a procedure it is relatively non-invasive, requires simple technology, but is subject to measurement and reproducibility error [124, 128]. This is supported by evidence from a much earlier study in which the prediction of total body fat in infants from skinfold measurements was to be validated. The authors discussed the reliability of the measurement of skinfold thickness and concluded that in infants aged between 1-6 months the baby's body movements made accurate measurements difficult to perform [129].

In a prospective case-matched study in which data relating to body composition were recorded from matched cohorts of infants who were either exclusively breastfed (n=46) or artificially fed (n=41) up to 12 months of age [130], the results pertaining to skinfold thickness showed that the measurements of the triceps, flank and quadriceps declined more rapidly in the breastfed cohort. The report discusses that the study has found significant differences in fatness between the two cohorts with the greatest difference being evident between 9 and 15 months (example:12 months sum of all skinfold thicknesses breastfed cohort 46mm, artificially fed cohort 51mm). As a consequence of the differences in body fat identified in this study, the authors suggest that the future development of infant skinfold thickness reference values incorporate the different methods of feeding [130].

Although the WHO does potentially provide a mechanism for assessing extreme high weight in infants (ie weight for height and sex score over 98th centile) it is not typically used by health professionals to judge babies as being obese. There are a number of reasons for this including sensitivities around labelling infants, the risk of alienating parents and the abiding perception that big babies are healthy babies. A focus on two or more neutral infant markers (high birthweight and rapid weight gain) rather than seeking a specific cut-off for concern about weight may be a more acceptable child prevention strategy. Parental feeding practices have been implicated in increasing obesity risk by influencing the early entrainment of appetite control which has been associated with rapid infant weight gain [131]. Consequently, infants with established obesity risk factors such as macrosomia and rapid weight gain may be particularly vulnerable to the obesogenic environment and therefore may be more responsive to early prevention interventions targeting the identification of satiety cues and food responsiveness [132]. If data could highlight beliefs of parents in caring for at-risk infants the results could be used to inform the development of a targeted behaviour change intervention.

2 CHAPTER TWO

Study One – Quantitative - A two-year, prospective birth-cohort study to explore the relationship between macrosomia and social deprivation as measured by index of multiple deprivation (IMD).

2.1 Introduction

Macrosomia refers to a condition whereby infants have an abnormally high birthweight. Definitions of what constitutes a high birth weight vary but birthweights of 4000g and over are generally considered macrosomic [133]. Infant birthweight is a predictor for future body composition [134] and high birthweight is an established independent risk factor for childhood obesity (3 to 6 years) [12]. As discussed in Chapter One, there are a number of factors which could predispose macrosomic infants to future obesity. It is more common in obese mothers and may indicate foetal hyperglycaemia, due to maternal over-nutrition. This can lead to hyperplasia and hypertrophy of the adipose cells resulting in excess fat deposition during the third trimester [135]. In addition, foetal overfeeding, and the associated hormonal disturbances can cause mal-programming of the foetus's body weight regulatory systems which leads to "hungrier" babies with a subsequent increased risk of obesity [136]. Estimates of the prevalence of macrosomia vary between 5 and 20% and rates seem to be rising in many parts of the world [137]. A review of the prevalence of macrosomia in developing countries found rates ranged between 0.5% in India and 14.9% in Algeria [138]. The latest statistics for England and Wales (2015) found that 11.1% of infants weighed 4000g or more at birth [23].

Although genetic factors play a part, the rise in the rates of macrosomia suggests that environmental factors are important. Established risk factors include higher maternal weight, higher gestational weight gain, older maternal age, altered glucose metabolism and higher gestational age of the infant [139]. Interventions that impact on the intrauterine environment such as the treatment and prevention of maternal diabetes and modifications to maternal diet have been shown to reduce the odds of delivering a macrosomic infant [139]. An exercise intervention aimed at reducing pregnancy hypertension significantly reduced the rates of macrosomia by 2.5 times [140].

In order to reduce the risk of child obesity in macrosomic infants, it is important to understand the social context in which it occurs. Rapid weight gain in the first year of life is an independent risk factor for child obesity but it may be that macrosomic infants are also at an increased risk of rapid weight gain because the same obesogenic environment which predisposes macrosomia also increases the risk of rapid weight gain. Rates of maternal obesity are rising, the Health Survey for England data reports a rise from

12% in 1993 to over 19% in 2016 [13]. In the UK, maternal obesity, a strong predictor of macrosomia is substantially more common in disadvantaged social groups with the most deprived quintile having twice the risk of maternal obesity compared to women in the least deprived quintile (OR=2.20) [49]. Rates of maternal obesity are rising, the Health Survey for England data reports a rise from 12% in 1993 to over 19% in 2016 [141]. However, it is unclear whether macrosomia is more common in more disadvantaged populations and whether there is any effect of deprivation on the relationship between macrosomia and rapid weight gain.

The Index of Multiple Deprivation captures social and economic disadvantage from postcode geolocation. There is a strong linear relationship between the index of multiple deprivation (IMD) and obesity prevalence in children, with children in the most deprived areas having twice the risk as those in the least deprived areas [142]. Ethnicity is also linked to an increased risk of obesity due to socioeconomic position [143, 144]. Although it is reported that Asian infants are lighter at birth when compared with White infants [145, 146], births within the “Indian” ethnic group tend to be of a higher socioeconomic position relative to other Asian groups (Bangladeshi and Pakistani). Therefore it is important to recognise that despite pooling ethnic groups individual ethnic classifications may confound the results due to differences in socioeconomic status.

At a population level in England, there are specific timeframes for developmental surveillance of pre-school children, these include the neonatal examination, by the time a child is one and between two and two and half years old. At these time points, all children should have weight and length/height measured and recorded as part of the physical examination [147]. The data from these consultations should be recorded on the NHS SystmOne® Child Health patient record system which is a central NHS database that holds the electronic patient records from child health departments and Health Visiting teams by healthcare professionals. As such these health data provide a resource to track the growth of a cohort of infants from birth to 2-2.5 years.

The present study aims to use data from a complete and representative sample of births in Nottinghamshire to explore the prevalence of infant risk factors for child obesity (high birthweight and rapid weight gain in the first year of life), and the relationship between child risk factors and social risk factors (IMD). A particular question is whether macrosomic children in more deprived areas are more likely to have rapid weight gain than children in less deprived areas.

2.2 Research Aims

1. To determine the prevalence of macrosomia in a representative sample of infants in Nottinghamshire.

2. To explore the relationship between social disadvantage and macrosomia.
3. To determine the prevalence of rapid weight gain in the first year of life.
4. To explore the relationship between social disadvantage and rapid weight gain in the first year of life
5. To explore the interaction between macrosomia and rapid weight gain in socially deprived areas.
6. To investigate whether infants who undergo rapid weight gain in the first year of life in deprived areas remain heavy at year two.
7. To explore the relationship between social disadvantage and rapid weight gain in the first year of life in low birth weight infants.

2.3 Methodology

2.3.1 Study design

A two-year, prospective birth-cohort study

2.3.2 Ethical approval and NHS permissions

Ethical approval for this study was granted by Nottinghamshire Research Ethics Committee 2 (Ref No 11/H0408/7) and NHS

Permissions were received from NHS Nottingham City and NHS Nottinghamshire County PCTs before obtaining the datasets (Appendix 1 + 2).

2.3.3 Participants and Population

The cases in this birth-cohort study are all infants born in 2008 to a mother residing in Nottinghamshire with a NG postcode. Nottinghamshire is situated in the heart of England and covers an area of 2,085 sq km. The two Primary Care Trusts responsible for the commissioning of care for the majority of Nottinghamshire residents were NHS Nottinghamshire County and NHS Nottingham City which when combined have a population of 1,091,483. Males represent 49.5%: females 50.5%. The largest concentration of people is found in the greater Nottingham conurbation. As a county, Nottinghamshire's ethnic diversity reflects total population figures with 86.5% classifying themselves as white (UK 2011 census – white classification category 85.5%) [148].

2.3.4 Classifications of birthweight and weight gain

Birthweight can be classified directly from the measurement of weight with:

Low birthweight – less than 2.5kg irrespective of the period of gestation.

Normal birthweight – between 2.5 and 3.99kg irrespective of the period of gestation.

High birthweight (Macrosomia) – greater than 4kg irrespective of the period of gestation.

Weight percentiles (discussed in detail in Chapter One) are used to classify weight in accordance with gestational age with:

Small for gestational age (SGA) is classified as a newborn with a weight less than the 10^{th} or more than 2SD below the WHO mean for gestational age.

Large for gestational age (LGA) is classified as a newborn with a weight greater than the 97^{th} percentile or more than 2SD above the WHO mean for gestational age [149].

Rapid weight gain (RWG) is defined as a +0.67 change in weight SD score. This 0.67 SD represents the difference between the displayed centile lines on standard infant growth charts (e.g. 2nd, 10th, 25th, 50th, 75th, 90th and 98th centile lines), a gain of ≥0.67 SD may be clinically interpreted as upward centile crossing through at least one of these centile bands [52]. (Centile Charts Appendix 3).

2.3.5 Measure of Relative Deprivation

The English Indices of Multiple Deprivation (IMD) 2010 is a measure based on seven distinct domains of information. Released in March 2011, the IMD 2010 are based on data from 2007-2008 [150]. The domains used in IMD 2010 are income, employment, education, health, crime, access to services and living environment. These domains can be combined, using appropriate weighting to calculate the Index of Multiple Deprivation 2010. This is an overall measure of deprivation and is calculated for every Lower layer Super Output Area (LSOA) used in the census, with each area having a population of approximately 1500. The IMD 2010 can, therefore, be used to rank the 32,482 LSOAs in England. Rank 1 represents the most deprived area and rank 32,482 the least deprived. IMD 2010 is a continuous measure of relative deprivation. There is no definitive point at which an area is considered to be deprived. However, it is usual to define deprived areas as those LSOAs that fall in the lowest 10% of ranks in England (i.e. the bottom centile).

Nottinghamshire (excluding Nottingham City) is comprised of seven local authority districts of which there were 31/493 LSOAs in the 10% most deprived LSOAs in England concentrated in 4 district areas: Mansfield (12 LSOAs); Ashfield (10 LSOAs); Bassetlaw (6 LSOAs) and Newark and Sherwood (3 LSOAs). Nottingham City ranks 17th in deprivation out the 326 districts in England using the average Rank score. For the City, the units for analysis are Super Output Areas (SOA). There are 176 SOAs in the City with the majority having a population in the range of 1,300-1,700. A quarter (n=45) of the City's SOAs are amongst the 10% most deprived in England [151].

2.3.6 Use of IMD in contemporary childhood obesity research

In 2012, the National Obesity Observatory (NOO) reported that child obesity prevalence in the 10% most deprived areas was almost double that in the 10% least deprived (NOO 2012). Three contemporary research studies have been identified that use IMD 2010 to investigate the associations between deprivation and rates of childhood overweight and obesity from the National Child Measurement Programme (NCMP) data [152-154]. However, IMD 2010 has been reported to have limitations. Firstly it is not a direct measure of deprivation and therefore a finer assessment of exposure to deprivation such as household or parental socioeconomic disadvantage may derive larger differences in childhood overweight and obesity prevalence. Another reported limitation is that IMD is biased against rural areas where deprivation is more diversified [152, 155]. As IMD provides an aggregate measure for the whole LSOA population, in rural areas were small pockets of deprivation may be present in large geographical areas deprivation is underestimated [156]. Despite the limitations of IMD 2010 it has been argued that it provides the best available method of comparing area deprivation in England [152].

2.3.7 Data collection

The data were extracted by NHS Data Analysts from the NHS SystmOne® Child Health electronic patient records. Initial data entry to SystmOne is by community health professionals from birth notifications and following development surveillance.

The extracted database contains the anonymised data of all children born to a mother registered to a General Practitioner (GP) in NHS Nottinghamshire County and NHS Nottingham City PCTs. The study database comprises: Date of birth; sex; ethnicity code (2001 census code); truncated postcode (4 digits); birthweight (kg), date of or age at weight measurement 1; weight measurement 1 (kg); date of or age at weight measurement 2 and weight measurement 2 (kg).

For NHS Nottingham City PCT the extraction criteria for age one and age two data were entry closest to 365 days or 912 days representing one and two and a half years respectively. For NHS Nottinghamshire County PCT data were extracted between 180-365 days and over 730 days to minimise missing data. The upper time limit for age two data was set at 1100 days representing three years. These timeframes reflected the then current child health surveillance practice in the respective Primary Care Trust. In children with more than one data entry in the time frame, the most recent entry was extracted.

No maternal data was extracted as in order to link the mother and child records, identifiable maternal information would be required and this was not available.

2.3.8 Eligibility criteria

2.3.9 Inclusion criteria

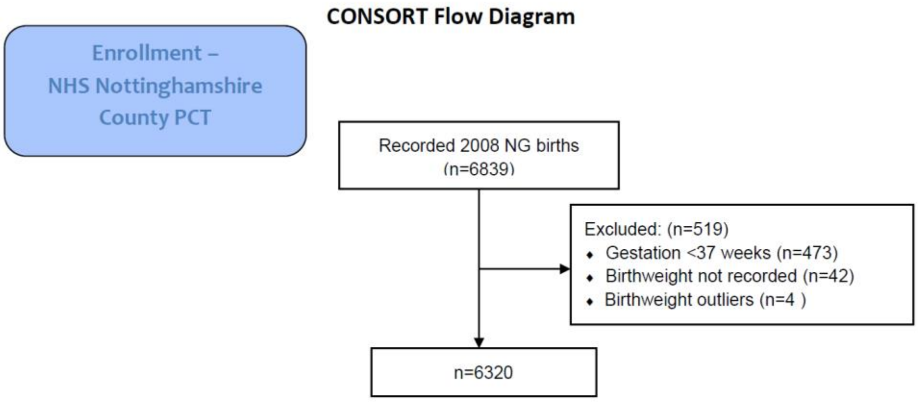
1. Resident in Nottinghamshire and have a recorded NG postcode.
2. Have a recorded birthweight.
3. Full-term infant (Gestation ≥ 37 weeks.

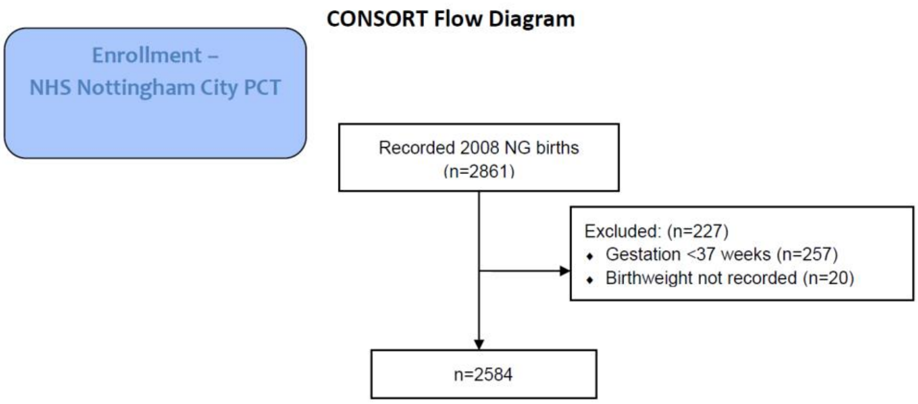
2.3.10 Database Construction

The combined data extracted identified 11,071 births; 7515 NHS Nottinghamshire County PCT and 3556 NHS Nottingham City PCT. Those infants who did not meet the eligibility criteria were excluded. Infants with a non-NG postcode were excluded and represented 676 for NHS Nottinghamshire County PCT and 695 for NHS Nottingham City PCT. Birthweight outliers were identified from the raw data. The minimum birthweight on the 0.4th centile for girls born at 37 weeks is 1.7kg on the UK WHO growth chart 0-4 years [157]. The Nottinghamshire County PCT cohort contained four outliers at 0.299; 0.315; 0.363 and 1.05kg. As these cases are considerably lighter and possibly as a result of original data entry error, these cases were excluded from the dataset. Despite requesting the same data variables from the PCT'-s the resulting raw datasets varied in format, requiring conversion to present uniform variable values. Census ethnicity codes were converted to the appropriate census ethnic group category creating initially 19 ethnicity categories. As some of the categories had small numbers and in order to facilitate univariate and bivariate analysis, these 19 categories were pooled to create 5 ethnicity codes: 1-White; 2-Black; 3-Asian; 4-Mixed and 5-Not known. Infant age at weight measurement 1 and 2 was standardised and reported in days. Ethical approval was granted for the use of 4 digit truncated postcodes. These 4 digits represent the postcode sector and consist of the postcode district, the single space and the first character of the inward code (i.e. NG21 9). Each postcode sector was allocated to the corresponding Lower layer Super Output Areas (LSOA) average Index of Multiple Deprivation (IMD) score and average IMD rank by a Senior Public Health Information Specialist, East Midlands Public Health Observatory. From IMD rank (where 1 is the most deprived) IMD quintiles were calculated to form a separate categorical variable – IMD quintile. From the recorded data, weight for age and gender-specific Z scores were calculated using World Health Organisations Standards which define Z scores as a measure of standard deviations from the median value, adjusted for gender and age [158].

As discussed in Chapter One, the growth trajectories for preterm infants follow a statistically significant different pattern than term infants [159]. Therefore in order to determine the prevalence of infant rapid weight gain and the relationship with social disadvantage all infants with a gestational age of less than 37 weeks were excluded. Finally, the effect of missing data was explored as 3792 year one and 5190 year 2 weight measurements were missing from the County and City cohorts. Therefore, in order to establish whether the missing cases varied significantly from the main research cohort two subset groups (Lost to follow up year one and two) were separated out in order to explore the effect of potential bias on the main research cohort.

Table 1 - Consort diagrams enrolment for NHS Nottingham County and Nottingham City PCTs





2.3.11 Data Analysis

Data were cleaned, variable labels and categorical codes assigned in Microsoft Excel 2010. The analysis was undertaken using IBM SPSS Statistics 23®. Proportions or medians were used to describe the characteristics of the cohorts and study samples. Measures of association between the categorical variables were assessed with χ^2 statistic. An independent *t*-test was used to assess whether means of birthweight, gestation and z score weight change differed between cohorts. Logistic regression models were fitted to explore the relationships outlined in the research aims. Aim 2 - To explore the relationship between social disadvantage and macrosomia (Model 1). The dependent variable used was macrosomia (no macrosomia <4000g =0; macrosomia ≥4000g =1). The explanatory variable was IMD Quintile. Covariates included the categorical variables gender and ethnicity with gestation as a continuous variable. Aim 4 - To explore the relationship between social disadvantage and rapid weight gain in the first year of life (Model 2). The dependent variable used was rapid weight gain (no rapid weight gain <0.67 =0; rapid weight gain ≥0.67 =1). The explanatory variable was IMD Quintile. Covariates included the categorical variables gender and ethnicity with birth weight as a continuous variable. For χ^2 all expected cell frequencies were greater than 5. Statistical significance was set at $p \leq 0.05$.

2.4 RESULTS

2.4.1 Comparison between County and City cohorts

Following construction of the databases, 8904 infants were included in the County and City cohorts. Although the two cohorts are representative of Nottinghamshire they differ in respect of ethnic diversity and social deprivation. Therefore, in order to identify the differences in the two cohorts, direct comparisons of the variables were undertaken as outlined in the data analysis section. Comparisons of the characteristics of the two cohorts are shown in Table 2.

There were no differences between the cohorts in the proportion of males and females. Although the median and range for gestation were equal for both cohorts the differences in the distribution of the frequencies for the variable were sufficient to be statistically significant. An independent samples t-test was conducted to compare gestation (weeks) for NHS Nottingham City PCT and NHS Nottingham County PCT infants. There was a significant difference in NHS Nottingham City PCT ($M=39.61$, $SD=1.177$) and NHS Nottingham County PCT ($M=39.69$, $SD=1.165$), t (8896) -2.873, $p=0.004$. However, the difference of half a day is not clinically significant. Birthweight was significantly higher in County infants ($M=3.43$kg, $SD=0.49$) than the City ($M=3.34$kg, $SD=0.59$), t (8902) -7.771, $p<0.0001$, but again the effect size is small (0.15). When birthweight was reported as three categories representing low <2.5kg; appropriate for age 2.5-3.99kg and high ≥4.0kg, the distribution of the birthweight categories was significant with the County having a greater proportion of high birthweight infants than the City (χ^2 31.384 (df)=2). The distribution of ethnic groups according to pooled ethnic codes was also significantly higher with the City cohort having a greater proportion of Black and Asian infants (χ^2 1265.156 (df=4). There was no difference in the mean weight change Z score. The distribution of IMD quintiles was also significantly different with the City having a greater proportion of infants residing in quintile one (the most deprived) than the County (χ^2 3142.679 df=4).

For all further analysis, the County and City cohorts were combined to obtain a larger (n=8904) and representative sample to address the research aims. The combined research dataset characteristics are summarised in table 2.

Table 2 - NHS Nottinghamshire County; NHS Nottingham City and Combined Research Cohort.

Number of cases		**NHS Nottinghamshire County PCT N=6,320 (%)**	**NHS Nottingham City PCT N=2,584 (%)**	**P value**	**Combined Cohort Total N=8,904 (%)**
Gender	Male Female	3165 (50.1%) 3155 (49.9%)	1271 (49.2%) 1313 (50.8%)	0.445	4436 (49.8%) 4468 (50.2%)
Gestation	Median Range Mean SD	40 weeks 37–43 weeks 39.69 weeks (1.164)	40 weeks 37-43 weeks 39.61 weeks (1.176)	<0.0001	40 weeks 37 -40 weeks 39.67 weeks (1.171)
Birthweight	Median Range Mean SD	3.43kg 1.54-5.46kg 3.44 (0.49)	3.34kg 1.89-5.74kg 3.34 (0.59)	<0.0001	3.4kg 1.54-5.74 kg 3.414kg (0.49)
< 2.5kg 2.5 – 3.99 ≥4.0kg	Low Normal High	148 (2.34%) 5335 (84.4%) 837 (13.2%)	92 (3.6%) 2244 (86.8%) 248 (9.6%)	<0.0001	240 (2.7%) 7579 (85.1%) 1085 (12.2%)
Weight change Z scores	Mean (SD)	1.41 (0.806)	1.46 (0.765)	0.256	1.43 (0.785)
Ethnicity	White	5465 (86.5%)	1545 (59.8%)		7010(78.7%)
	Black	116 (1.8%)	364 (14.1%)		480 (5.4%)
	Pakistani	47 (0.7%)	272 (10.5%)		319 (3.6%)
	Indian	59 (0.9%)	59 (2.3%)		121 (1.3%)
	Asian	28 (0.4%)	47 (1.8%)		75 (0.8%)
	Bangladeshi	19 (0.3%)	9 (0.3%)		28 (0.3%)
	Chinese	20 (0.3%)	16 (0.6%)		36 (0.4%)
	Mixed	147 (2.3%)	175 (6.8%)		322 (3.6%)
	Not recorded	416 (6.6%)	97 (3.8%)		513 (5.8%)
Pooled Ethnic Code	White	5465 (86.5%)	1545 (59.8%)	<0.0001	7010 (78.7%)

	Black	116 (1.8%)	364 (14.1%)		480 (5.4%)
	Asian	176 (2.8%)	403 (15.6%)		579 (6.5%)
	Mixed	147 (2.3%)	175 (6.8%)		322 (3.6%)
	Not Recorded	416 (6.6%)	97 (3.8%)		513 (5.8%)
IMD by Quintile	1**(most deprived)**	270 (4.3%)	1285 (49.7%)	<0.0001	1555 (17.5%)
	2	2086 (33%)	888 (34.4%)		2974 (33.1%
	3	1984 (31.4%)	225 (8.7%)		2209 (24.8%)
	4	1083 (17.1%)	161 (6.2%)		1244 (14.0%)
	5	897 (14.2%)	25 (0.9%)		922 (10.3%)
No weight recorded	Year one	3782 (59.8%)	10 (0.4%)	<0.0001	3792 (42.6%)
No weight recorded	Year two	4071(64.4%)	1119 (43.3%)	<0.0001	5190 (58.3%)

2.4.2 Comparisons between lost to follow up and weight present – YEAR ONE

At year one, there were infants 3792 (42.6%) who had no weight one data recorded on SystmOne. As the research cohort was extracted from the central NHS database it is difficult to ascertain whether the weight measurement at year one was not undertaken or simply not recorded on SystmOne. There was also no indication in the data to identify infants who had moved out of the area. The majority of one year lost to follow up infants reside in NHS Nottinghamshire County (n=3782), only 10 NHS Nottingham City infants had no year 1 weight one data. In order to assess the effect of any potential bias, those infants in NHS Nottinghamshire County (n=3782) with missing data at weight point 1 formed a Year 1 lost to follow up group (LtF1 group) and compared with those infants in NHS Nottinghamshire PCT with year one weight data. With only ten lost to follow up in the City at year one weight point, no comparison was made for this group. The cohort characteristics are summarised in table 3.

There were no differences in sex distribution, gestation or ethnicity between the Year 1 lost to follow up group and the group with recorded weight. Birthweight was significantly higher in the Year 1 recorded weight group (M=3.47kg, SD=0.32) than the LtFU1 (M=3.42kg, SD=0.49), t (6318) 2.72, p=0.006, however, the difference of 50 grams is clinically insignificant. However, in the birthweight categories, there was no difference in the distribution. The distribution of the IMD quintiles was also significantly different with the LtFU1 group having a greater proportion of infants residing in quintiles one and two (most deprived) compared to the infants with a weight recording at year 1 (χ^2 1134.997 df=4).

2.4.3 Comparisons between lost to follow up and weight present – YEAR TWO

At year 2 follow up there were 5190 (58.3%) children who had no weight data recorded on SystmOne. Of these, 1286 (14.4%) children have missing data at both time points. Children with a weight recorded at two-year follow-up were compared with those with no recorded weight at two years (LtFU2). The characteristics are summarised in table 3.

There were no differences between the groups in the proportion of males and females. An independent t-test was conducted to compare gestation in weeks for children with no weight recorded at year 2 with children with a weight recorded at year 2. There was a significant difference in children with no weight recorded (M=39.69, SD= 1.149) and weight recorded (M=39.63, SD= 1.191), t (9600) 2.5, p=0.01. However, the difference of less than half a day is clinically insignificant. For birthweight there was no difference between children with no weight recorded at year 2 (M=3.46, SD=0.44) and children with a weight recorded at year 2 (M=3.45, SD= 0.36) t (9600) 1.2 p=0.2. By birthweight category, the difference in distribution was significant with the LtFU2 group having a greater proportion of high birthweight infants than the weight recorded group (χ^2 6.245 (df=2) p=0.044). The distribution of ethnicity according to pooled ethnic codes was significantly different with the LtFU2 group having a greater proportion of Black, Asian and Mixed ethnic children (χ^2 188.005 df=4). The distribution of IMD quintiles was also significantly different with infants in the weight recorded group having a greater proportion of infants residing in quintile one (most deprived) than the LtFU2 (χ^2 607.174 df=4).

Table 3 - Comparisons between weight present and weight absent cohorts - Year 1 and Year 2

		No weight recorded at 1 year follow up	**Weight recorded at 1 year follow up**	**P value**	**No weight recorded at 2 year follow up County n=4071 City n=1119**	**Weight recorded at 2 year follow up County n=2310 City n=2102**	**P value**
Number of cases		**3782**	**2538**		**5190**	**4412**	
Gender	Male Female	1916 (50.7%) 1866 (49.3%)	1249 (49.2%) 1289 (50.8%)	0.135	2623 (50.5%) 2567 (49.5%)	2153 (48.8%) 2259 (51.2%)	0.089
Gestation	Median Range Mean (SD)	40 weeks 37-43 weeks 39.70 (1.164)	40 weeks 37–43 weeks 39.64 (1.171)	0.1	40 weeks 37-43 weeks 39.69 (1.149)	40 weeks 37-43 weeks 39.63 (1.191)	0.0122
Birthweight	Mean (SD)	3.44kg (0.49)	3.47kg (0.32)	0.006	3.46kg 0.44	3.45kg 0.36	0.2
< 2.5kg 2.5 – 3.99 ≥4.0kg	Low Normal High	99 (2.6%) 3193 (84.2%) 500 (13.2%)	49 (1.9%) 2152 (84.8%) 337 (13.3%)	0.220	135 (2.6%) 4399 (84.7%) 656 (12.6%)	131 (3.0%) 3791 (85.9%) 490 (11.1%)	0.044
Ethnicity	White	3307 (87.4%)	2159 (85%)		4245 (81.8%)	3226 (73.1%)	
	Black	65 (1.7%)	51 (2%)		231 (4.5%)	345 (7.8%)	
	Pakistani	22 (0.6%)	25 (0.9%)		105(2.0%)	239 (5.4%)	
	Indian	30 (0.8%)	29 (1.1%)		54 (1.0%)	78 (1.8%)	
	Asian	16 (0.4%)	15 (0.6%)		29 (0.6%)	55 (1.2%)	
	Bangladeshi	14 (0.4%)	5 (0.2%)		21 (0.4%)	9 (0.2%)	
	Chinese	6 (0.15%)	14 (0.5%)		21 (0.4%)	22 (0.5%)	
	Mixed	81 (2.1%)	65 (2.6%)		153 (2.9%)	227 (5.1%)	
	Not recorded	241 (6.4%)	175 (6.9%)		331 (6.4%)	211 (4.8%)	
Pooled Ethnic Code	White	3307 (87.4%)	2159 (85%)	0.052	4245 (81.8%)	3226 (73.1%)	<0.0001
	Black	65 (1.7%)	51 (2%)		231 (4.5%)	345 (7.8%)	
	Asian	88 (2.3%)	88 (3.5%)		230 (4.4%)	403 (9.1%)	
	Mixed	81 (2.1%)	65 (2.6%)		153 (2.9%)	227 (5.1%)	
	Not Recorded	241 (6.4%)	175 (6.9%)		331 (6.4%)	211 (4.8%)	

		No weight recorded at 1 year follow up	**Weight recorded at 1 year follow up**	**P value**	**No weight recorded at 2 year follow up County n=4071 City n=1119**	**Weight recorded at 2 year follow up County n=2310 City n=2102**	**P value**
IMD by Quintile **(most deprived)**	1	244 (6.5%)	26 (1.0%)	<0.0001	769 (14.8%)	1090(24.7%)	<0.0001
	2	1700 (45%)	386 (15.2%)		2031 (39.1%)	1183 (26.8%)	
	3	1187 (31.3%)	797 (31.4%)		1497 (28.8%)	798 (18.1%)	
	4	402 (10.6%)	681 (26.8%)		624 (12.0%)	669 (15.2%)	
(least deprived)	5	249 (6.6%)	648 (25.5%)		269 (5.2%)	672 (15.2%)	

2.4.4 Macrosomia

The prevalence of macrosomia in the total population of infants born ≥37 weeks was 12.2%. The characteristics of macrosomic infants are shown in table 4.

Table 4 - Characteristics of macrosomic infants in combined NHS Nottingham City PCT and NHS Nottinghamshire PCT cohort

	No Macrosomia N=7819	**%**	**Macrosomia N=1085**	**%**	**P value**
Males	3751	84.6	685	15.4	<0.0001
Females	4068	91	400	9.0	
Gestation 37 weeks	466	98.3	8	1.7	<0.0001
38	1013	96.7	35	3.3	
39	1579	92.7	125	7.3	
40	3232	86.7	496	13.3	
41	1278	79.2	335	20.8	
42	244	74.8	82	25.2	
43	2	40.0	3	60.0	
Not known	5		1		
Pooled Ethnicity 1 White	6104	87.1	906	12.9	<0.0001
2 Black	431	89.8	49	10.2	
3 Asian	548	94.6	31	5.4	
4 Mixed	287	89.1	35	10.9	
5 Not known	449	87.5	64	12.5	
IMD Quintile 1(most deprived)	1414	90.9	141	9.1	<0.0001
2	2603	87.5	371	12.5	
3	1919	86.9	290	13.1	
4	1060	85.2	184	14.8	
5(affluent)	823	89.3	99	10.7	

Comparisons by bivariate analysis revealed that the proportion of males with macrosomia was significantly higher than females (χ^2 87.600 (df=2).

As expected the proportion of macrosomic infants increased with gestational age. A Chi squared for trend test found a strong linear association between macrosomia and gestational age (LLA=322.381 (df=1) p<0.0001). Transforming the gestational age into two categories term (37-40 weeks) and post term (41-43 weeks) a significantly higher proportion of macrosomic infants had been born post term [χ^2 206.425 (df=1) as shown in table 5].

Table 5 - Cross tabulation Macrosomia and gestation

	Birthweight Code n (%)	
	No Macrosomia	Macrosomia
Term infants (37-40 weeks)	6290 (90.5)	664 (9.5)
Post term infants (41-43 weeks)	1524 (78.4)	420 (21.6)

(χ^2 206.425 (df=1) p<0.0001)

By pooled ethnic category, a higher proportion of macrosomic infants were White compared to non-macrosomic infants. Comparing White, Black and Asian pooled ethnic categories indicates that a significantly higher proportion of macrosomic infants were White [χ^2 30.50 (df=2) as shown in Table 6].

Table 6 - Cross tabulation Macrosomia and ethnicity

	No Macrosomia n (%)	Macrosomia n (%)
White	6104 (87.1)	906 (12.9)
Black	431 (89.8)	49 (10.2)
Asian	548 (94.6)	31 (5.4)

(χ^2 30.50 (df=2) p<0.0001)

A further chi square test for association was performed between macrosomia and deprivation. A significantly higher proportion of macrosomic infants reside in quintile 2 [χ^2 26.864 (df=4) as shown in Table 7].

Table 7 - Cross tabulation Macrosomia and deprivation

IMD Quintile	No Macrosomia n (%)	Macrosomia n (%)
1 (Most deprived)	1414 (90.9)	141 (9.1)
2	2603 (87.5)	371 (12.5)
3	1919 (86.9)	290 (13.1)
4	1060 (85.2)	184 (14.8)
5	823 (89.3)	99 (10.7)

(χ^2 25.89 (df=4) p<0.0001)

A binomial logistic regression was performed to ascertain the effects of gender (female=0; male =1), gestation in weeks, pooled ethnic categories (White=1 [reference], Black=2 and Asian=3) and relative deprivation (Q1=1, Q2=2, [medium deprivation Q3=0 reference], Q4=4 and Q5=5) on the likelihood that infants are born macrosomic. Results are displayed in Table 8.

When analysed together, only four were statistically significant: gender, gestation, Asian ethnicity, and level of deprivation. Males had 1.9 times increased odds of being macrosomic than females (95%CI 1.64-2.17). Every additional week of gestational age at birth was associated with a 1.8 increased odds of macrosomia (95% CI 1.66-1.91). Asian infants were 54% less likely to be macrosomic compared to White infants (OR = 0.466 95%CI 0.320-0.679). Infants in the most deprived quintile were 29% less likely to be macrosomic compared to infants in quintile 3 (OR = 0.701 95%CI 1.665-1.910).

Table 8 - Results of binomial regression of risk factors for macrosomia

	B	SE	Wald	Sig	Odds Ratio	95% CI for Odds ratio Lower Upper	
Gender Code	0.636	0.072	78.387	<0.0001	1.889	1.641	2.175
Gestation	0.578	0.035	272.121	<0.0001	1.783	1.665	1.910
White (reference)			16.170	<0.0001			
Black	-0.131	0.161	0.669	0.414	0.877	0.640	1.201
Asian	-0.763	0.192	15.832	<0.0001	0.466	0.320	0.679
Deprived Q1	-0.355	0.119	8.867	0.003	0.701	0.555	0.886
Q2	-0.073	0.091	0.637	0.425	0.930	0.777	1.112
Q3 (reference)			17.39	0.002			
Q4	0.152	0.110	1.915	0.166	1.164	0.939	1.443
Affluent Q5	-0.181	0.132	1.878	0.171	0.835	0.644	1.081

Gender (Female 0/Male 1) Gestation (weeks) Pooled Ethnicity [Categorical White=1 (reference) Black=2 Asian=3] IMD[Categorical Q1=1; Q2=2; Q3=0 (reference) Q4=4; Q5=5] Significance p=0.05

In summary, the risk of macrosomia is increased for males and post-term infants, and decreased if Asian and residing in a deprived area at birth.

2.4.5 Rapid weight gain

The prevalence of rapid weight gain defined as an increase in weight-for-age Z score of ≥0.67 SD [7] between birth and one year in the total population of infants born ≥37 weeks was 29.7%. The characteristics of rapid weight infants are shown in Table 9.

Table 9 - Characteristics of rapid weight gain infants in the combined research cohort

	No RWG N=3595	**%**	**RWG N=1517**	**%**	**P value**
Males	1747	69.5	768	30.5	0.185
Females	1848	71.0	749	29.0	
Gestation 37 weeks	102	37.0	174	63.0	<0.0001
38	366	57.3	272	42.7	
39	638	66.5	322	33.5	
40	1661	75.2	549	24.8	
41	55	25.7	159	74.3	
42	164	80.4	40	19.6	
43	4	100			
Not known	5	83.3	1	16.7	
Pooled Ethnicity 1 White	2642	71.4	1057	28.6	0.009
2 Black	264	64.0	149	36.0	
3 Asian	330	67.5	159	32.5	
4 Mixed	162	67.8	32.2	5.1	
5 Not known	197	72.4	27.6	4.9	
IMD Quintile 1 (most deprived)	891	68.2	415	31.8	0.055
2	873	68.8	396	31.2	
3	733	71.7	289	28.3	
4	618	73.4	224	26.6	
5 (affluent)	480	71.3	193	28.7	

Comparisons by bivariate analysis, χ^2 of rapid weight gain and the variables in the combined research cohort identify no significant difference in the proportion of gender or IMD quintile. Decreasing gestation was associated with rapid weight gain. A Chi squared for trend test found a strong linear association between rapid weight gain and gestational age (LLA 250.765 (df=1) p<0.0001). By ethnicity the highest proportion of rapid weight gain infants are in the Black, Asian and Mixed ethnic categories. Comparing White, Black and Asian pooled ethnic categories indicates that a significantly higher proportion of rapid weight gain infants were Black [χ^2 12.148 (df=2) as shown in Table 10].

Table 10 - Cross tabulation Macrosomia and ethnicity

	No RWG n (%)	RWG n (%)
White	2642 (71.4)	1097 (28.6)
Black	264 (63.9)	149 (36.1)
Asian	330 (67.5)	159 (32.5)

(χ^2 12.148 (df=2) p=0.002)

As over 50% of the rapid weight gain infants reside in the most deprived quintiles (1+2), the IMD quintiles were transformed into two categories most deprived and least deprived (quintiles 3+4+5)(Table 11).

Table 11 - Cross tabulation rapid weight gain and deprivation

	No RWG n (%)	RWG n (%)
Most deprived	1831 (49.1)	811 (53.5)
Least deprived	1764 (50.9)	706 (46.5)

(OR=1.2; 95%CI = 1.06-1.34; p=0.004)

Infants in the two most deprived quintiles had 1.2 increased risk of rapid weight gain compared to infants in the three least deprived quintiles (OR=1.2; 95%CI = 1.06-1.34).

A binomial logistic regression was performed to ascertain the effects of gender, gestation in weeks, birthweight (Kg), pooled ethnic categories (White=1 [reference], Black=2 and Asian=3) and relative deprivation (Q1=1, Q2=2, [medium deprivation Q3=0 reference], Q4=4 and Q5=5) as the independent variables and rapid weight gain (change in weight z-score as the dependent variable. Results are displayed in Table 12.

When analysed together gender, gestation, birthweight, and pooled ethnicity were statistically significant. After controlling for the other predictors IMD quintile does not contribute to the model. Male infants had 1.4 increased odds of rapid weight gain than female infants. Every decreasing week of gestation at birth increases the odds of rapid weight gain by 10% (95% CI 0.843-0.958). Each decreasing kilogram of birthweight increases the odds of rapid weight gain by 88% (95% CI 0.100-0.146). Asian infants were 30% (OR = 0.698, 95% CI 0.556-0.876) less likely to have rapid weight gain compared with White infants.

Table 12 Results of binomial regression of risk factors for rapid weight gain (combined research cohort)

	B	SE	Wald	Sig	Odds Ratio	95% CI Odds Ratio Lower	Upper
Gender	0.309	0.072	18.339	<0.0001	1.362	1.182	1.568
Gestation	-0.107	0.033	10.781	0.001	0.899	0.843	0.958
Birthweight	-2.113	0.097	471.526	<0.0001	0.121	0.100	0.146
White (reference)			13.139	0.001			
Black	0.171	0.123	1.924	0.165	1.187	0.932	1.512
Asian	-0.360	0.116	9.615	0.002	0.698	0.556	0.876
Deprived Q1	0.117	0.108	1.161	0.281	1.124	0.909	1.390
Q2	0.055	00.109	0.256	0.613	1.057	0.853	1.308
Q3 (reference)			1.504	0.826			
Q4	0.052	0.120	0.185	0.667	1.053	0.832	1.333
Affluent Q5	0.117	0.1	0.856	0.355	1.124	0.877	1.442

Gender Female=0; male=1 Gestation (weeks) Birthweight (Kg) Pooled Ethnicity [Categorical White=1 (reference) Black=2 Asian=3] IMD[Categorical Q1=1; Q2=2; Q3=0 (reference) Q4=4; Q5=5]
Significance p=0.05

In summary, the risk of rapid weight gain is increased for males, decreasing gestation, and lower birthweight, and decreased if Asian.

2.4.6 Interaction between Macrosomia and Rapid Weight Gain

Bivariate analysis was performed to examine the relationship between macrosomia and rapid weight gain in the combined research cohort. A significantly higher proportion of age-appropriate birthweight infants had undergone rapid weight gain (χ^2 159.639 (df=1) [Table 13].

Table 13 - Cross tabulation macrosomia and rapid weight gain in the combined research cohort

	No Macrosomia n (%)	Macrosomic n (%)
No RWG	3018 (68.8)	549 (93.8)
RWG	1368 (31.2)	36 (6.2)

(χ^2 159.639 (df=1) p<0.0001)

Of those with 1 year follow-up data, 36 infants (6.2%) had rapid weight gain and macrosomia. (Table 14).

Table 14 - Macrosomia with and without rapid weight gain by IMD Quintile

Deprivation	Macrosomia & RWG n (%)	Macrosomia & NO RWG n (%)
1 + 2 (most deprived)	22 (61.1)	241 (43.9)
3+4+5 (least deprived	14 (38.9)	308 (56.1)

(OR=2.11; 95%CI = 1.05-4.22; p=0.034)

Infants in the two most deprived quintiles had twice the risk of having macrosomia and rapid weight gain compared to infants in the three least deprived quintiles (OR=2.11; 95%CI = 1.05-4.22.

2.4.7 Do infants who undergo rapid weight gain in the first year of life in deprived areas remain heavy at weight point two?

At weight point 2, 2242 (25.2%) children had a weight recorded between 700 – 1100 days on SystmOne. Of these, 519 (23%) children were classified as being "heavy" at weight point two defined as being on or above the 91st centile for gender-specific weight for age. A comparison of children who were heavy and not heavy at weight point two is shown in Table 15. Median birthweight was significantly higher in heavy at weight point two children (3.63kg) than the not heavy (3.38kg $p<0.0001$)).

Table 15 - Comparisons of Children with a birthweight ≥2.5kg at 2 year follow up

	Heavy at weight point 2 N=519 (23)	Not heavy at weight point 2 N=1723 (77)	P value
Gender			
Male Female	271 (52.2) 248 (47.8)	845 (49) 878 (51)	0.169
Birthweight			
Median Range	3.63kg 2.51-5.08kg	3.38kg 2.5-5.33kg	<0.0001
Pooled Ethnicity			
White	461 (88.8)	1496 (86.8)	0.133
Black	8 (1.5)	16 (0.9)	
Asian	16 (3.1)	52 (3)	
Mixed	12 (2.3)	70 (4)	
Not known	22 (4.2)	89 (5.2)	
IMD			
1 (most deprived)	6 (1.15)	24 (1.4)	0.601
2	118 (22.7)	336 (19.5)	
3	129 (24.8)	451 (26.2)	
4	118 (22.7)	411 (24)	
5	144 (27.7)	483 (28)	
Not known	4 (0.77)	18 (1)	

To assess the effect of birthweight on weight at weight point two a chi-square test for association was conducted between birthweight category and heavy at weight point two. Of the 293 macrosomic infants 128 (43.75%) were above the 91st centile weight for age and sex compared to only 391 (20%) of infants in the normal birthweight range [$\chi 2$ 79.907 (df=1) as shown in Table 16].

Table 16 - Cross tabulation Macrosomia and Heavy at weight point two

	Not heavy at weight point 2	Heavy at weight point 2
No Macrosomia (2.5-3.99kg)	1558 (90.4)	391 (75.3)
Macrosomic (≥4kg)	165 (9.6)	128 (24.7)

$\chi 2$ 79.907 (df=1) $p<0.0001$

A binomial logistic regression was performed to ascertain the effects of gender, birthweight (Kg), rapid weight gain (0=No; 1-Yes), pooled ethnic categories (White=1 [reference], Black=2 and Asian=3) and relative deprivation (Q1=1, Q2=2, [medium deprivation Q3=0 reference], Q4=4 and Q5=5) on the likelihood that infants were heavy at weight point two. Results are displayed in Table 17. When analysed together birthweight, rapid weight gain and Black ethnicity were statistically significant. Increasing birthweight had 3.9 times higher odds of being heavy at weight point two (95% CI 2.893-5.345). Infants that had undergone rapid weight gain in their first year had 2.35 times higher odds of being above 91st centile for weight at weight point two (95% CI 1.471-2.497). Black infants were 3.7 times more likely to be heavy at year two compared to White infants (OR = 3.690, (95% CI 1.292-10.542). After controlling for the other predictors IMD quintile does not contribute to the model.

Table 17 - Results of binomial regression of risk factors for heavy at weight point two (weight point two cohort)

	B	SE	Wald	Sig	Odds Ratio	95% CI for Odds ratio Lower	Upper
Gender	-0.134	0.139	0.926	0.336	0.875	0.666	1.149
Birthweight	1.369	0.157	76.501	<0.0001	3.933	2.893	5.345
RWG	0.855	0.140	37.068	<0.0001	2.351	1.471	2.497
White (reference)			5.966	0.051			
Black	1.306	0.536	5.942	0.015	3.690	1.292	10.542
Asian	0.095	0.421	0.051	0.831	1.100	0.482	2.509
Deprived Q1	-0.252	0.947	0.071	0.790	0.777	0.121	4.972
Q2	0.031	0.251	0.015	0.903	1.031	0.631	1.685
Q3 (reference)			1.247	0.870			
Q4	-0.173	0.184	0.889	0.346	0.841	0.587	1.205
Affluent Q5	-0.107	0.176	0.372	0.542	0.898	0.636	1.269

Gender Female=0; male=1 Birthweight (Kg) RWG No=0;Yes=1, Pooled Ethnicity [Categorical White=1 (reference) Black=2 Asian=3], IMD [Categorical Q1=1; Q2=2; Q3=0 (reference) Q4=4; Q5=5] Significance p=0.05

In summary, the risk of being heavy at year two is increased for higher birthweight, rapid weight gain, and pooled Black ethnicity.

2.4.8 To explore the relationship between social disadvantage and rapid weight gain in the first year of life in low birth weight infants (<2.5kg)

By gender, 63.7% of the low birth weight cohort was female. Almost three quarters of the infants were White. Half of the infants reside in relatively deprived households (quintiles 1 +2). For those low birth weight infants with a weight recorded at weight point one, 80.1% underwent rapid weight gain (Table 18).

Table 18 - Characteristics of low birth weight Infants

		Total n=240
		n (%)
Gender	Male Female	87 (36.3) 153 (63.7)
Gestation	Median Range	38 weeks 37-42 weeks
Birthweight	Median Range	2.36kg 1.54 – 2.48kg
Ethnicity	White	172 (71.1)
	Black	15 (6.3)
	Pakistani	13 (5.4)
	Indian	11 (4.6)
	Asian	5 (2.1)
	Bangladeshi	2 (0.8)
	Mixed	12 (5)
	Not Recorded	10 (4.2)
Pooled Ethnic Code	White	172 (71.1)
	Black	15 (6.3)
	Asian	31 (13)
	Mixed	12 (5)
	Not Known	10 (4.2)
IMD by Quintile	1(most deprived)	52 (22)
	2	86 (36)
	3	57 (24)
	4	23 (9.6)
	5	22 (9.2)
Rapid weight gain	YES	113 (80.1)

	NO	28 (19.9)
	Not known	99
Loss to follow up	Year 1	99 (41.3)

For the category pooled ethnic code, the cell counts for no rapid weight gain for Black and Asian infants were small, less than 5, so no further analysis was conducted. Due to the small cell counts for the no rapid weight gain infants in the individual IMD quintiles, the IMD quintiles were converted to two categories; deprived (quintiles 1+2) and not deprived (quintiles 3+4+5) and, a chi-square test for association was performed. No significant result was obtained (χ^2 1.888 (df=1) (Table 19).

Table 19 - Cross tabulation of RWG and relative deprivation in low birthweight infants

	No RWG n (%)	RWG n (%)
Most deprived	7 (13.7)	44 (86.3)
Least deprived	21 (23.3)	69 (76.7)

(χ^2 1.888 (df=1) p=0.169)

In the low birth weight cohort, there are 41.3% missing year one data. By IMD quintile almost half of the missing data is from the deprived quintiles 1 and 2 (n=48 48%). Therefore the missing data may have a significant effect on the results.

2.5 Discussion

The overall aim of the current study was to investigate the effect of social deprivation as measured by the indices of multiple deprivation (IMD) on two major risk factors for child obesity; macrosomia and rapid weight gain. By establishing prevalence rates in a complete and representative sample of births the magnitude of these risk factors could be examined and their effect on future weight status examined over the two-year data collection period. The overall prevalence of macrosomia from this present study was 12.2%, higher than the national rate for England and Wales (2008) at 11% [160]. Comparing the prevalence rate with comparable studies identified in section 1.3 that examined the relationship between macrosomia and risk of childhood overweight/obesity indicates that the prevalence rate of the current study is higher than rates previously reported; Canadian 10.7% [26], German 9.47% [28]. It has been reported that the increasing prevalence of macrosomic births in developing countries is parallel with the rise in diabetes and obesity in women of reproductive age [161]. Maternal obesity rates are rising. A nationally representative study, conducted by Heslehurst *et al* (2010) of maternal obesity in England reports that first trimester maternal obesity rates have significantly increased over time, doubling from 7.6% in 1989 to 15.6% in 2007 [49]. Although BMI has not been historically recorded in Nottingham City or Nottinghamshire County, local authority public health estimates of maternal obesity modelled on Heslehurst *et al* (2010) data suggests that 17.7% of Nottingham City and 16% Nottinghamshire County mothers are obese [162]. Gestational weight gain across all BMI ranges is also associated with macrosomia. Evidence from a systematic review and meta-analysis of more than one million pregnant women that evaluated the association between gestational weight gain and infant outcomes reports that 47% of women gained more than the recommended weight during pregnancy than advocated by the Institute of Medicine (IOM) 2009 guidelines [163]. For these women the odds of delivering a macrosomic infant increased by 1.60 (95% CI 1.46-1.75) compared to those women with the recommended weight gain. A precise estimate of the contribution of maternal obesity to macrosomia has been reported by Gaudet *et al* (2014) [43]. Following a systematic review and meta-analysis, the results provide convincing evidence of the positive relationship between maternal obesity and foetal overgrowth, with a 117% increased odds for delivering a macrosomic infant for obese mothers (BMI $\geq 30kgm^2$). In mothers with excess gestational weight gain with a pre-pregnant BMI classified as overweight the odds are also increased (OR 2.0, 95% CI 1.72, 2.32) and for gestational diabetes (OR 1.6 95% CI 1.26, 2.06) [43].

There was a 30% increased risk of macrosomia for infants born in the moderately deprived quintiles compared with the most deprived.

Griffiths *et al* (2013) in a cross-sectional UK study of the association between area-level deprivation and adiposity in secondary school-aged children found a similar non-linear association reporting mean BMI to peak in the mid-level deprivation areas [164]. The non-linear relationship between macrosomia and deprivation now drives the focus for an explanation for the 30% higher risk of macrosomia in the middle quintiles.

Whilst maternal obesity may be associated with lower socioeconomic status, the distribution of macrosomia prevalence may also be a reflection of other predisposing risk factors for macrosomia. Maternal age has been associated with a higher risk of macrosomia as the metabolic changes that occur with increased maternal age, specifically hormonal and endocrine factors might stimulate higher foetal growth [20]. A Chinese cohort study identified that increasing maternal age (years) was an independent risk factor for macrosomia (OR= 1.09 95%CI 1.03, 1.15) [165]. Whilst a maternal age of 30 years or greater was associated with a 50% increased risk of macrosomia in a Turkish database study [166]. In most developed countries women are delaying childbirth to later in life. Nationally the mean age at first birth has risen from 25.2 years in 1986 to 27.4 years in 2006 [167]. Explanations for the postponement include delayed marriage and partnership formation, participation in higher education and the increasing female contribution to the workforce [168]. Data from the ONS parental characteristics (2014) identifies that households employed in intermediate and routine occupations had a mean age at first birth of less than 30 years, whilst higher managerial, administrative and professional occupations had a mean age over 30 years [169]. Parity, defined as the number of times a woman has given birth to an infant over 24 weeks gestation, and the association with macrosomia has been established for many years. In a study reported by Sack (1969), it was identified that the frequency of multiparity was higher in mothers with macrosomic infants [170]. An Iranian cohort study identified that approximately 81% of macrosomic infants were born to multiparity mothers [171]. Usta *et al* (2017), reported from their cohort study that excluded pregnant women with gestational diabetes, that multiparous women (>1 child) had a 76% increased risk of delivering a macrosomic infant than those mothers delivering their first infant [166]. Data from the Office for National Statistics indicate that the average family size in England and Wales remains consistent at two, and there is no impact of socioeconomic status on family size [172]. Therefore, the possibility of increasing maternal age at first birth in the moderately deprived areas may have affected the prevalence rate of macrosomia by IMD.

The distribution of macrosomia prevalence may also be due to the use of the Indices of Multiple Deprivation (IMD) 2010, as the measure of deprivation. There are limitations to using IMD. Firstly, it is not a direct measure of deprivation; it is used to compare areas. Secondly, as it is an area based measure, which essentially measures concentration, it is as such biased against rural areas where deprivation is more scattered [173]. Rural poverty is an issue in Nottinghamshire with 25% of income deprived households living in rural areas [174]. Alternatives to area deprivation indices are individual assigned markers of socioeconomic position, such as social class. Traditionally, social class has been assigned to the individual who carries the economic responsibility for the household. However, social class classification by either the Registrar General or post 1990 Social class based on occupation excludes "unwaged" persons which could be women raising children.

Spencer *et al* (1999) compared the use of social class and an area based index on the relationship to birthweight in a retrospective cohort study [175]. As only 10% of social class data was available for married and jointly registered births, the results were based on the area based index derived from the total birth population compared with the results from the 10% sample of the selected group from within the same population. By social class the population was divided into the seven groups assigned by the Registrar general whilst the area deprivation index was divided into deciles. The results showed that the area deprivation index demonstrated a stronger association with birth weight than social class. Whilst both individual social class and area deprivation can be seen as "blunt instruments" for measuring the aspects of socioeconomic status that impact on health [176], IMD as a measure of deprivation compares not only areas but also the broader characteristics of where the disadvantaged live rather than simply on the people who live in those areas themselves [177]. Therefore, IMD is a key reporting factor of the National Child Measurement Programme (NCMP) which monitors overweight and obesity prevalence and trends of child weight status at national and local levels. As discussed in section 2.1, there is a strong association between child obesity and deprivation as measured by IMD.

The results from the logistic regression suggest that mothers in moderate deprivation have a 30% increased risk of delivering a macrosomic infant compared to infants in high deprivation areas (Table 12). Studies of individual countries suggest that socioeconomic status (SES) and obesity are positively associated in low-income countries, but negatively associated with high-income countries [178]. Explanations of this reversal in the relationship of SES and obesity may also explain the increased risk of macrosomia in the mid quintiles presented in the current study. Broadly, in poor countries low SES can be categorised by physical demanding employment and a financial insecurity precluding excess food consumption. Conversely, high SES can be categorised by a decrease in physical activity and access to excess food [178]. In high-income countries rising obesity rates in low SES groups can be attributed to the decreased cost and increased availability of calorie dense foods, the obesogenic environment [178]. For high SES groups in high income nations it is suggested that the availability of excess food is countered with health behaviours to prevent excessive weight gain [179]. Therefore, the middle quintiles may fall between these two economic groups, having the economic capacity to consume more calorie dense foods, yet having a sedentary occupation and less income or motivation to participate in health behaviours to combat excess weight gain. The 30% increased risk of delivering a macrosomic infant in the mid quintiles may, therefore, be as a consequence of the distribution of births by IMD quintile. The more deprived quintile may include a higher proportion of younger mothers, mothers with low birthweight infants and mothers who have health behaviours which affect foetal growth such as smoking. Alternatively, the distribution may be an artefact representing the population of Nottinghamshire.

Further results for the risk factors for macrosomia included male gender, gestation and Asian ethnicity. Results from the logistical regression (section 2.4.4) show that males were found to be 1.9 times at greater risk than female infants. This result is equivalent to the study carried out by Ehrenburg *et al* in 2004 [31], who reported a 1.9 times increased risk of macrosomia for male infants. Increasing gestation was associated with a 1.4 greater risk of macrosomia as discussed in section 1.3. A further result indicates that Asian ethnicity may be a protective factor against macrosomia with the risk reduced by 50%. Infants of UK born South Asian origin are known to have lower birthweights than their White British peers and on average are 200-300g lighter at birth [180]. One possible factor for the protective effect of Asian ethnicity on macrosomia may be that large for gestational age (macrosomia) infants are misclassified in minority ethnic groups. The current UK1990 birthweight charts are based on data from White British infants [61]. A UK study that developed specific birthweight charts for the South Asian population in a single NHS trust, also estimated the misclassification of South Asian infants using the current UK1990 birthweight chart [180]. The study reported that using ethnic-specific birthweight charts identified that 6.9% (n=379) of large for gestational age South Asian infants would not have been identified by the UK1990 charts. To assess the impact on South Asian macrosomia classification, a sub-analysis of 150 diabetic mothers was performed. For those infants, the ethnic-specific birthweight charts identified 27 large for gestational infants compared to the 18 identified by the UK1990 chart. Although there is clear evidence that UK-born South Asian infants are lighter at birth by across all gestational ages compared with White British infants, it is currently unclear whether ethnic-specific weight centile charts would be transferable to all populations of South Asians living in the UK. Therefore, no reclassification of macrosomia for the Asian infants included in the present study was undertaken, which may have underestimated the prevalence of macrosomia in Asian infants.

Comparisons of macrosomia prevalence for NHS Nottingham City and NHS Nottinghamshire County emphasises the differences in the two geographical areas. Nottingham City has a much lower macrosomia prevalence rate of 9.6% compared to NHS Nottinghamshire at 13.2%. Ethnic diversity may account for the reduced prevalence rate in Nottingham City, as unlike Nottinghamshire County which has a 86% White population comparable to the total population, Nottingham City is more ethnically diverse. From the study data 60% are recorded as White and 15.6% Asian, consequently the protective effect of Asian ethnicity may have reduced the macrosomia prevalence rate in Nottingham City and/or we may have underestimated the prevalence of macrosomia in Asian infants.

The evidence that early rapid weight gain is a major factor in child obesity is robust [7, 181]. In the present study, the overall prevalence of rapid weight gain (an increase of >0.67 in weight-for-age z score) from birth to weight point one is 29.7%. Infants in Nottingham City were more likely to undergo rapid weight gain compared to those in Nottinghamshire County (31.7% compared with 27.6%). Comparable prevalence rates are elusive. One North American study reported prevalence rates of rapid weight gain between birth and 12 months as 16.7% assessed against the WHO growth standards [182]. However, the apparent high rates of rapid weight gain in the first year are matched with the overweight and obese prevalence rates recorded by the National Child Measurement

Programme (2012/2013), when the children included in the research cohort would have attended Reception class. For Nottingham City, 23% of children aged 4-5 years were overweight or obese compared to 21.3% in Nottinghamshire County [183].

Socioeconomic status has been strongly associated with overweight and obesity in children [10]. The univariate analysis from this study identifies that 53.5% of rapid growth infants reside in quintile 1 and 2, the most deprived areas. However, these infants represent only 16.2% of the children with year one data, as quintile 1 and 2 constitute 51.5% of the loss to follow up year one cohort, which may have underestimated the effect of socioeconomic inequality on rapid infant weight gain.

Demographic risk factors for rapid weight gain were identified as lower birthweight, lower gestational age and pooled Asian ethnicities. Following adjustment for low birthweight, lower birthweight appears to be associated with an 88% increased risk of rapid weight gain. The results from the univariate analysis identified that the proportion of infants born at "term" (37-40 weeks) that underwent rapid weight gain was statistically significantly higher than those born post-term (41-43 weeks). Decreasing gestation also appears to slightly increase the risk of rapid weight gain by 10%. As both decreasing birthweight and gestation increase the risk of rapid infant weight gain, one explanation may be that these infants are using a survival mechanism to "catch up" on growth with an abnormally high velocity until the original or normal growth trajectory is reached [53, 184]. However, Ong *et al* (2000) identified that children who showed catch up growth between birth and two years were heavier, taller and had a greater body fat distribution at five years than other children [74]. This suggests that in affluent societies the biological predisposition to catch up on growth following uterine restraint may result in an acceleration of growth greater than the genetic trajectory. Infants with a birthweight less than 2500 grams birthweight were excluded from the main research cohort but incorporated into a separate low birthweight cohort. Of the 141 infants with data at weight point one 81% had undergone rapid weight gain classified as a change in weight for age z score >0.67.

Rapid weight gain may be associated with feeding style. There is compelling evidence that suggests that parental feeding styles which encourage overfeeding by either pressurising food intake or using food to regulate emotions raise the risk of excess weight gain by undermining the child's ability to self-regulate food intake [92, 185, 186]. Pressurised feeding styles as discussed in section 1.4 have been associated with excessive weight gain in infancy [91, 92]. Using food to regulate a child's emotions particularly in infancy when the child is dependent on others to soothe distress can also be characterised as "feeding to soothe" [187]. Evidence from a North American longitudinal study on parental use of feeding to soothe

(FTS) including the relationship between FTS and weight change between six and eighteen months identified a positive association [187]. The infants of mothers who were observed to use FTS were initially lighter but gained weight more rapidly by eighteen months than those infants whose mothers were not observed to use FTS. The mothers who self-reported to use FTS were found to be breastfeeding longer than mothers who reported little or no use of FTS. There is evidence to suggest that mothers of infants are less experienced at reading infant cues of hunger than mothers of older children and report that infant crying or fussing signals hunger, especially if breastfeeding [188, 189]. The consequences of the use of food to soothe infant distress may lead to a pattern of feeding behaviour in which the child associates food with other states other than hunger. This association may compromise the child's ability to interpret hunger and satiety cues thereby increasing energy intake. Alternatively, an emotional eating style may develop which has been identified as an obesogenic feeding trait (i.e. food to soothe), a poor diet and weight gain [187, 190].

Pooled Asian ethnicity appears to be protective against rapid weight gain with a 30% reduced risk. The influence of race, ethnicity, and culture on infant feeding and attitude to infant size may also influence rapid infant weight gain.

For those children with data at weight point one (approximately 12 months of age), the current study identified that macrosomic infants in quintiles 1 and 2 had twice the risk of having rapid weight gain compared to the macrosomic infants in the less socially deprived areas.

So although there may not be an increased risk of macrosomia in the most deprived areas, if infants are macrosomic they are also more likely to gain weight rapidly. This could be a reflection of the effect of overnutrition in utero which has been recognised to programme permanent changes to infant appetite [191], and differences in parental feeding styles. Breastfeeding is suggested to be protective against rapid weight gain [82], however, the rates of breastfeeding vary with socioeconomic status [192]. Routinely collected data on UK infant feeding at PCT level for 2010-2011 was analysed by Oakley *et al* (2013) to identify the sociodemographic factors associated with variation in area-based breastfeeding rates in England [192]. Whilst the prevalence of breastfeeding initiation in non-London PCTs was reported as 72% this fell to 32% for exclusive breastfeeding at 6-8 weeks. By socioeconomic status (SES) the proportion of mothers breastfeeding decreases as deprivation increases with the odds ratio for the association between SES and initiation of breastfeeding outcome in the most deprived quintile reported as 0.5 (95%CI 0.41-0.61) compared with the least deprived quintile [192]. This suggests that approximately a third of low SES mothers residing in England initiate breastfeeding. Parental pressure to eat has been reported to negatively impact on a child's association with food [193]. Negative associations with food may influence eating behaviour and impact on weight gain[194]. Cardel *et al* (2012) reported that parental feeding practices differ across socioeconomic status (SES), with controlling parental feeding style being more prevalent in lower SES compared to higher SES [194]. Clarifying the contribution of SES to parental feeding styles would be important in informing recommendations and developing interventions to prevent rapid weight gain.

At weight point two (approximately 24 months of age), 23% of children were classified as being heavy, defined as being on or above the 91st centile gender-specific weight for age. For those infants that underwent rapid weight gain in the first year of life, 27.2% were classified as being heavy at weight point two. However, data was only available for 25% of the research cohort.

A major challenge in identifying infants with a high risk for future obesity is the lack of consensus for the classification of obesity in infants under the age of two [195]. Currently, weight-for-length (WFL) is the anthropometric standard for children under the age of two. Unfortunately for the infants included in the current study length measurements are not recorded centrally. Growth in the first two years of life is characterised by a gradual deceleration of both linear growth velocity and rate of weight gain. During this period, infants exhibit the pattern of growth homogenous to their genetic backgrounds [196]. Therefore excessive weight gain, irrespective of length, remains a strong risk factor for later obesity.

For the children with complete data at birth, weight point one and two, both increasing birthweight (kg) and rapid weight gain increased the odds of being heavy at weight point by 3.93 and 2.35 respectively. Pooled Black ethnicity appears to increase the risk of being heavy at 2 years by 3.69. However, evidence from the UK CHASE study identified differences in body size and adiposity in the Black African-Caribbean population. The study found that when compared with White children, Black African-Caribbean's were on average markedly taller and heavier. Mean weight, BMI and weight-for-height indices also tended to be higher. Once height was controlled for there was little difference between the Black and White populations. Therefore by using non-specific ethnic weight-for-age centiles, overweight at age 2 may have been overestimated for the pooled Black category. There was no association with relative deprivation. This suggests that overnutrition of the infant pre and postnatally and a continued exposure to an obesogenic environment continues to have an effect on weight gain irrespective of socioeconomic status.

In summary, the key findings from the current study indicate that the combined research cohort had high prevalence rates of both macrosomia and rapid weight gain. No clear linear relationship was identified between macrosomia and deprivation and infants in the most deprived quintile have low rates of macrosomia. However, infants in quintiles one and two have higher rates of rapid weight gain (OR=1.2: 95% CI 1.06-1.35). Although infants with macrosomia have lower rates of rapid weight gain, the current study identified that macrosomic infants in quintiles one and two had twice the risk of having rapid weight gain compared to macrosomic infants in the less socially deprived areas.

Rapid infant weight gain was used as a proxy for overweight and obesity at weight point one. Data from the 2012/2013 National Child Measurement Programme for Nottinghamshire which temporally represents the age of which the research cohort would be attending reception class at age 4-5 years the prevalence of overweight/obesity is reported to be over a fifth. This indicates that overweight identified in infancy is reflected in the early childhood overweight/obesity rates. Therefore, the area of interest is why infants in the research cohort have a high rate of rapid weight gain?

As infants are wholly dependent on caregivers to meet their nutritional needs the behaviours of the individual caregivers require further investigation to explore the beliefs and attitudes of feeding infants at risk of early childhood overweight or obesity. This would lead to an understanding of how to introduce healthy behaviours and mitigate unhealthy beliefs. Capturing data which explores the experiences of caregivers with infants at risk of overweight or obesity would be able to inform the development of early interventions to reduce the risk of overweight and obesity and understand the environmental factors which may contribute to that risk.

2.6 Strengths and Limitations of the research

The strength of this research is that by establishing prevalence rates in a complete and representative sample of births the magnitude of these risk factors and their effect on future weight status could be examined over the two-year data collection period.

The routine data collected presented several limitations. Firstly length was not routinely collected and therefore the calculation of rapid weight gain was based on gender-specific weight for age measurements rather than BMI for age/gender. However, we used the international standards developed by the WHO to calculate the Z scores and to identify rapid weight gain and overweight/obesity at weight point two, thereby enabling more meaningful comparisons across the cohort. The high levels of missing data at weight point one and two were reported as per the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [197] (Appendix 4). However, as we were unable to predict the growth trajectory of the infants with missing data a degree of caution is required when interpreting the prevalence estimates. The lack of maternal measurements in particular pre-pregnancy BMI meant that we were unable to analyse maternal overweight or obesity as a potential risk factor.

3 CHAPTER THREE

Study Two – Qualitative – Parents' beliefs about feeding infants and caring for infants with risk factors for child obesity.

3.1 Introduction

Both macrosomia and rapid infant weight gain are positively associated with an increased risk of obesity in childhood [102]. Evidence from study one identified that in an area with a high rate of child obesity there were substantial rates of rapid weight gain and macrosomia. The prevalence of rapid weight gain in this study was nearly 30%, whilst macrosomia was found to be 12%. Overall 38% of the sample had rapid weight gain or macrosomia. Infants with macrosomia in quintiles 1 and 2 were more likely to also have rapid weight gain than infants in the less deprived quintiles.

Parental feeding practices have been implicated in increasing obesity risk by influencing the early entrainment of appetite control [131]. In addition, for macrosomic infants' over nutrition in utero has been recognised to programme permanent changes to appetite/satiety and energy regulation [191]. Rapid growth in the first months of life is associated with an increased obesity risk across the whole life course [198]. Genomewide association studies (GWASs) have discovered genetic variants that predispose children to a higher body mass index [132]. The UK Gemini population twin cohort study examined the associations between infant satiety and food responsiveness with weight gain in a sample of 288 same-sex non-identical (dizygotic) appetite-discordant twin pairs [199]. Using the co-twin design prohibited confounding by any factors that influenced both appetite and weight gain such as the constitution of breast milk, the feeding environment and maternal biases in reporting on appetite. The study identified that the twin with the greater appetite, lower satiety responsiveness (SR) and higher food responsiveness (FR), gained weight more rapidly. From birth the differences emerged quickly and at three months, the twin with the higher appetite was already heavier than their sibling with the lower appetite, (mean = 0.392kg [95% CI 0.243 – 0.541 kg]) for SR and (mean = 0.370kg [95%CI 0.169 – 0571kg]) for FR. Appetite was not related to weight at birth.

Consequently, infants with established obesity risk factors such as macrosomia and rapid weight gain may be particularly vulnerable to the obesogenic environment and therefore may be more responsive to early prevention interventions targeting the identification of satiety cues and food responsiveness [132].

3.2 Responsiveness to hunger cues

Interventions designed to help parents understand responsiveness to infant cues may be effective in reducing the rate of weight gain in the first two years [200]. Published in 2008, Kavanagh *et al* conducted a double blind, randomised educational intervention in order to assess the effect on infant formula intake and weight gain. Recruiting only formula fed infants the intervention consisted of a single 45-60 minute class run at a Women, Infant and Children (WIC) clinic in California, North America. The intervention consisted of three key messages 1) awareness and responsiveness to infant satiety cues; 2) reduction of feed volumes and 3) via handout and audio visual presentation techniques for calming a fussy baby. The target sample size was 125 per group n=250, calculated to allow detection of a difference in formula intake between the two groups of 110 ml, allowing for up to 25% attrition. However, despite 214 caregivers meeting eligibility, only 61 were randomised and in the intervention group only 18 completed the study. Only infants with complete data were included in the final analysis. The results identified that the infants in the intervention group had a greater final weight than the control group, mean unadjusted weight 7262g (intervention) compared to 6715g (control) despite similar daily formula feed intake 1119 mls/24 hrs (intervention) compared to 1115 mls/24 hrs (control). The authors' of this study report that the greater weight gain in the infants within the intervention group was contrary to the hypothesis and may reflect a random error. However, there was a large reported increase in formula intake from 800 mls to over 1100 mls, which is reported to be greater than the daily amount observed with breastfeeding infants during the same age interval and suggests that both the intervention and control groups were being overfed by the end of the study [201].

The North American SLIMTIME pilot study enrolled only mothers who intended to exclusively breastfeed and incorporated two interventions: i) reducing feeding to soothe practices ("soothe to sleep") and ii) education on hunger and satiety cues ("introduction of solids") delivered by nurses at two home visits [202]. Recruitment included 160 mothers and singleton infants with a minimum gestation age of 34 weeks from a single maternity unit. The primary outcome for the study was weight-for-length percentile at one year. The participants were randomised into one of four groups: no intervention, "soothe to sleep", "introduction of solids" or both interventions. Randomisation was stratified by maternal pre pregnancy BMI of either below 25 kgm^2 or above 25 kgm^2. Although the rationale is not stated in the research article, it is surmised that the sample is stratified because the intervention may be more effective where mothers have a BMI of over 25 kgm^2. However, no sub group results were presented. The generalised results identified that those infants in the "soothe to sleep" intervention group gained weight more slowly than the nil intervention group, whilst the results for the "introduction of solids" or a combination of both interventions were insignificant. Comparisons of the frequency of feeds, both the total number of daily feeds and number of nocturnal feeds for those infants exclusively breast fed receiving the "soothe to sleep" intervention were significantly lower than the infants who were mix or formula fed. Using the data from the 110 infants who completed the study, those who had received both interventions had a lower mean weight-for-length (33^{rd} percentile) than those receiving either the "soothe to sleep" (50^{th} percentile) or "introduction to solids" (56^{th} percentile) only. The control group mean weight-for-length was reported at the 50^{th} percentile. However, attrition from this study was quite high, with only 69% of the mother-infant dyads completing the study. As a consequence of the attrition, in addition to the analysis of the complete data, the weight for length percentile data for those attrition infants who had growth data from the second home visit occurring between four and six months were estimated for 1 year, resulting in a complete data set. Those infants with only weight data from the first home visit occurring between two and three weeks were not included in this analysis. A comparison between the demographic and anthropometric characteristics of the two groups was stated to have been undertaken. Although the characteristics of both groups are not published, the authors report that the mothers of the attrition group were significantly younger and less educated at baseline. The mothers were also more likely to be single, non-White and in receipt of a means tested health and medical service programme (Medicaid) compared to the mothers who participated through to the one-year study visit.

An Australian cluster randomised trial assessed the effect of a parent focused intervention on infant obesity risk behaviour and BMI [203]. Recruiting first time parents from parent support groups, n=542 parents and their infants were randomised to either an intervention group of six two-hourly dietitian delivered sessions over 15 months or the control group in which parents received six newsletters on non-obesity themes. The primary outcome was child diet (three 24 hour recall diaries) which identified a reduction in sweet snack consumption in the intervention group. BMI z scores were recorded as secondary outcomes. The results identified no impact on growth at 20 months. Unlike the SLIMTIME pilot study, the reported lost to follow up rates were low with 10% (n=27) in the control group and 8% (n=21) in the intervention group. The sample size was calculated with an assumption of 80% power and type 1 error of 5% (2 tailed), each arm requiring 160 participants. As data were not available to inform estimates of cluster or individual attrition, the study purposefully over recruited to each arm with 542 children randomised. However, missing data in the form of the diet recall diaries (primary outcome measure) were reported as n=50 (10%) mid-intervention and n=83 (17%) post-intervention.

A further Australian randomised controlled trial, the NOURISH study, evaluated the outcomes of a universal intervention to promote protective feeding practice commencing in infancy to prevent childhood obesity [204]. First time mothers and their infants allocated to the intervention group attended two modules comprising of six interactive group sessions that provided anticipatory guidance on early feeding practices. The control group continued to access normal care. The outcome at two years identified a lower mean weight (kg) and BMI z scores for the intervention group, but this difference failed to reach significance (p=0.10). However, non-responsive feeding practices were found to be reduced in the intervention group. The NOURISH study addressed attrition and anticipated a 35% attrition rate which was incorporated into the sample size calculation. At follow up, the total final attrition rate was 22% (n=157). An intention to treat approach analysis was used as far as the missing data permitted and no imputations were made. Withdrawal was reported to be higher among younger and less educated mothers (number not stated). Whilst there was an attempt to ascertain the reasons for withdrawal, only 40 (25%) responses from mothers are included in the report.

It would appear that the two trials focusing on infant feeding practices including feeding to soothe in infancy, SLIMTIME and NOURISH showed promise on parental behaviour and rate of infant weight gain. Both of these trials incorporated guidance on responsive feeding in the intervention group. However, for the SLIMTIME trial the first intervention visit occurred between 2 and 3 weeks after birth, whilst the NOURISH trial commenced between 4 and 7 months. Evidence from the Feeding Infants and Toddlers Study (FITS) emphasises that breastfeeding plays a significant role in the development of a child's response to internal hunger and satiety cues and may foster the development of a self-regulatory ability during feeding [205]. Therefore, the early intervention evaluated in the SLIMTIME study may have promoted the self-regulatory ability of the infants in the "soothe to sleep" intervention arm by educating parents shortly after birth. However, both the NOURISH and SLIMTIME studies were both universal interventions offered to all parents irrespective of maternal obesity status or child obesity risk. It may be that infants with established obesity risk factors may be particularly vulnerable to the obesogenic environment and therefore these infants may be more responsive to early prevention interventions.

The ProAsk feasibility study was designed to identify infants at risk of overweight and provide the parents of infants' with the greatest risk strategies to prevent overweight [206]. The Proactive Assessment of Obesity Risk during Infancy (ProAsk) is a novel interactive digital technology intervention designed to equip Health Visitors (HVs) with an individual infant's risk of future overweight and to support discussions with parents. This study identified significant problems with recruitment and protocol adherence. The ProAsk study screened for eligibility 324 infants of which 66 (20%) parent-infant dyads consented to participate [206]. These figures are comparable with the NOURISH trial in which 3334 eligible participants met the inclusion criteria, but only 698 (21%) of the parent-infant dyads consented to participate [204]. In total the ProAsk study retained 51% (n=34) of the participants for the duration of the study. As identified in all the intervention studies discussed earlier, the ProAsk study recruited more than expected numbers of mothers with degree-level education [202-204, 206].

The ProAsk study identified a number of barriers to recruitment and protocol adherence and these pertained to both individuals and the health care professional teams. At an individual level, 88 participants declined to take part in the study; the main reason cited was a "lack of interest" in the intervention. Qualitative data analysis of the interviews conducted with members of the health care professionals identified concerns with assessing and communicating overweight risk to parents of infants.

Successful recruitment and retention are critical for evaluating intervention effectiveness in clinical trials that address childhood obesity. However, the recruitment and retention of participants is challenging in interventional studies [207] as demonstrated in the reviewed research. The community based interventional studies all sought to modify parental behaviours on an aspect of infant feeding. The behaviours identified were without exception identified as potential modifiable factors in the prevention of early overweight/ obesity from previous research studies. With the exception of Redsell *et al* (2017)[206] who used behavioural strategies identified in a systematic review to develop the therapeutic wheel, no theoretical underpinnings of behaviour change theory were incorporated in the remaining research designs

3.3 Health behaviours

The study of behaviours that influence health and the factors determining which individuals will and will not perform such behaviours is a key area of research within health psychology [208]. The justification for the study of health behaviours is based on two assumptions:

1. In industrial countries the major causes of death are due to a particular behaviour
2. These behavioural patterns are modifiable (Conner and Norman 2005[208]).

Whilst health behaviours have been defined as "any activity undertaken by a person believing him/herself to be healthy for the purpose of preventing disease or detecting it at an asymptomatic stage" [209]. Conner and Norman (2005) argue that this definition neglects those lay or self-defined health behaviours and excludes activities carried out by an individual with a recognised illness that are directed at self-management [208]. As such, Conner and Norman (2005 page 2) suggest that a broad definition of health behaviours should include any activity undertaken for the prevention of disease, detecting disease or for improving health and well-being [208].

A variety of factors account for the individual differences in the propensity to undertake health behaviours and these include:

1. Demographic factors
2. Social factors
3. Emotional factors
4. Perceived symptoms
5. Access to medical care
6. Personality factors
7. Cognitive factors [210, 211]

Demographic factors such as age, gender, socioeconomic and ethnic status show reliable associations with health behaviours. Evidence from Study One indicates that male infants (63%) of White ethnicity (83%) residing in the most deprived quintiles (47%) had the greatest prevalence of macrosomia. Whilst Asian infants had a 50% reduced risk. Over half (53%) of the rapid weight gain infants included in Study One combined research cohort resided in the most deprived quintiles. Social factors such as parental influences are important in instilling health behaviours in early life [208]. Additionally cultural factors in particular ethnicity which is used to categorise individuals, families and social groups on the basis of shared characteristics such as language, ancestry, religious traditions, dietary preferences, and history, also influence health behaviours [143]. Data from the National Child Measurement Programme, England (2012-2013) identified that compared to White children at reception class age (8.6%) a greater prevalence of obesity was found in Mixed (9.7%), Asian (10.3%) and Black (15.5%) ethnic groups [183]. Perceived symptoms will control health behaviours, however, as discussed later in this chapter, heavy or "bonny" babies are viewed as being normal and healthier than leaner infants [212, 213]. Accessibility to health services for preschool children in England is addressed as part of the Department of Health, Healthy Child Programme, "Pregnancy and the first five years" Core Universal Programme [214], yet both the ProAsk (n=3) and NOURISH studies (n=146) had parents who cited lack of access to health services as a reason for not enrolling or continuing with study participation. Personality factors have either been positively (i.e. optimism) or negatively associated with health behaviours and there is considerable evidence to link personality with behaviour [215]. Early child personality traits have been identified as a possible longitudinal predictors of obesity [216]. Anzman and Birch (2009) demonstrated that low inhibitory control in a cohort of 197 Caucasian girls was associated with a higher weight gain and BMI at aged seven compared to children with a high inhibitory control [217]. Finally, cognitive factors also determine whether or not an individual undertakes health behaviours. Social cognition factors, incorporating beliefs, attitudes and knowledge are enduring characteristics of the individual which shape behaviour and are acquired through the socialisation process [208].

3.4 Social cognition models

Social cognition models describing key cognition variables and their inter-relationships in the adjustment of behaviour have been developed and extensively applied to the understanding of health behaviours [208].

There are five major social cognition models that show a number of similarities and differences (Figure 2).

Figure 2 - Social Cognition Models

1. The Health Belief Model (HBM)
2. Protection Motivation Theory (PMT)
3. Self-efficacy Theory (SET)
4. The Theory of Reasoned Action (TRA)
5. The Theory of Planned Behaviour (TPB)

The HBM (Becker 1974), is based on four core constructs (discussed in detail later in the chapter), two referring to a particular disease, whilst the other two refer to a possible course of action to reduce the risk of that disease [218]. PMT (Rogers 1983), was developed to explain how people respond to a fear-arousing health communication and is regarded as an adaption of the HBM. The protection motivation refers to the individual's motivation to protect themselves against a health threat (intention to adopt the recommended action). There are four main determinants of intention specified by PMT; vulnerability and severity, response efficacy and perceived self-efficacy [219]. Self-efficacy theory is a subset of Bandura's (1986) social cognitive theory which incorporates two key determinants of behaviour perceived self-efficacy (confidence) and outcome expectancies. Outcome expectations refer to both the perceived positive and negative consequences of undertaking the behaviour [220]. The TRA assumes that most behaviours of social relevance are under volitional control and that an individual's intention to perform the behaviour is both the immediate determinant and the single best predictor of that behaviour [221]. The intention is held to be a function of two basic determinants: the individual's attitude towards the behaviour and the perceived expectations of the individual's significant others should the individual undertake the behaviour. The TPB, is an extension of the TBA to include behaviours that are not entirely under volitional control and as such the variable "perceived behavioural control" was added. This additional variable refers to the perceived ease or difficulty of performing the behaviour and is assumed to reflect on past experiences and the individual's perception of anticipated obstacles [222]. As infants are wholly dependent on their primary caregivers for all their needs, the social cognition model of choice requires the flexibility to incorporate the health behaviours of an individual i.e. a mother and the impact of those health behaviours on another individual i.e. an infant.

The Health Belief Model was originally developed as a systematic model to explain and predict preventative health behaviours. Originally the focus was on the relationship of health behaviours, practices, and utilisation of health services. The model is influenced by the theories of Kurt Lewin who states that it is the world of the perceiver that determines what an individual will and will not do [223]. The original Health Belief Model introduced by Rosenstock (1966) was based on four constructs of core beliefs on which individuals based their perceptions:

1. Perceived susceptibility (an individual's assessment of their risk of getting the condition).
2. Perceived severity (an individual's assessment of the seriousness of the condition and its potential consequences).
3. Perceived barriers (an individual's assessment of the influences that facilitate or discourage adoption of the promoted behaviour).
4. Perceived benefits (an individual's assessment of the positive consequences of adopting the behaviour) [224]. (Adapted from Tuzova 2009 page 1).

The model attempts to predict the likelihood of an individual's concern to adopt a recommended health action. The Health Belief Model highlights only individual cognitions and not the social content of these cognitions [224]. The Health Belief Model's effectiveness in predicting and explaining behaviour has been well documented in one critical review and two meta analyses over the last three decades: Janz and Becker (1984); Harrison, Mullen and Green (1992) and Carpenter (2010) [225-227].

Published in 1984, the Janz and Becker review was not a meta-analysis in the traditional sense because it counted statistically significant relationships rather than estimating mean effect sizes, therefore the article has been categorised as a critical review [225]. Janz and Becker present a critical review of twenty nine Health Belief Model related investigations published during the period 1974-1984 [225]. The review criteria included:

1. Only Health Belief Model-related investigations published during the period 1974-1984.
2. The studies needed to include at least one behavioural outcome measure.
3. Only findings concerning the relationship of the four fundamental health belief dimensions to behaviours were reported.
4. Limited to medical conditions only.

As the current study aims to identify possible modifiable parental health behaviours to reduce the prevalence of early childhood obesity, the following discussion of Janz and Becker's (1984) review focuses on the preventive health behaviour, particularly risk-factor behaviours. Within the results for the preventive health behaviours, the authors report that three of the four constructs of core beliefs were consistently associated with positive outcomes and include "susceptibility", "benefits", and "barriers". However, "severity" was shown only to be significant in approximately one third of the studies reviewed. It is speculated by the authors that for perceived severity the study respondents may have difficulties in conceptualising this dimension. The reasons suggested are that the study respondents are asymptomatic, view the health condition as long standing and is a medical condition for which the respondents have no or very little personal experience.

For the current study, as discussed in section 3.4 the results from Janz and Becker (1984) identify that in order for a health behavioural intervention to be effective, parents of at risk infants will need to recognise that it has been clearly identified that overweight/obesity in infancy tracks into early childhood [26, 68, 69]. Parental perception of the perceived severity of early childhood obesity may be related to the difficulties conceptualizing this dimension as discussed by Janz and Becker (1984) [225]. Therefore the "bonny baby" in infancy is not perceived as a potential health risk by a parent that has the potential to track into all life stages.

Harrison *et al* (1992) conducted a meta-analysis of the relationships between the four Health Belief Model dimensions, susceptibility, severity, benefits and costs and health behaviours in sixteen studies that measured all four of the dimensions [226]. The inclusion criteria also required a measured behavioural dependent variable, a measurement of reliability and criteria for establishing validity of the dimensions. The Cronbach alpha values are reported as a range for the four dimensions and suggest $\alpha=0.47$ (poor) to $\alpha=0.91$ (excellent) measures of reliability for the included studies survey tools. Using effect sizes, the meta-analysis identified significant positive relationships between the Health Belief Model dimensions and health behaviours. However, it is reported that although Health Belief Model dimensions labels were used in the sixteen incorporated studies, it is possible that they measured different constructs. In this meta-analysis the dimension "barriers" as used in the Janz and Becker (1984) article, has been replaced with "cost" reflecting the revision of the Health Belief Model by Becker and Maiman in 1975 [228].

Published in 2010, Carpenter's article evaluates the accuracy of the direct effects of the Health Belief Model, by undertaking a meta-analysis of longitudinal studies [227]. The Health Belief Model construct is specified as "if individuals perceive a negative health outcome to be severe, perceive themselves to be susceptible to it, perceive the benefits to behaviours that reduce the likelihood of that outcome to be high and perceive the barriers to adopting those behaviours to be low then the behaviour is likely for those individuals (Carpenter 2010 pg 661). Eighteen studies were included to determine whether measures of these beliefs could longitudinally predict behaviour. Benefits and barriers emerged as the strongest predictors of behaviours. Severity was a weak predictor and as discussed previously with the Janz and Becker (1984) paper may reflect difficulties in the study participants conceptualizing the dimension. Susceptibility was found to be almost always unrelated to behaviour and Carpenter (2010) suggests that one possible explanation is that study participants who already have a disease do not vary their perception of susceptibility. The commonality between the critical review and the meta-analyses is that the benefits to and barriers against adopting a behavioural change are strong predictors. The effects of susceptibility and severity may be moderated by each other, as an individual's perceived susceptibility to an illness or disease will be less strongly associated with an disease or illness if the perceived severity of that disease or illness is assessed as being low [227].

In early childhood obesity, the associated possible modifiable risk factors relate to parental behaviours. Therefore the individual focus of the Health Belief Model may not be transferable to the wider focus of parenting and child health. As such Roden (2004) reconceptualised the Health Belief Model for the use with young families [229]. The premise was that as the Health Belief Model has been successfully implemented with programmes targeting individuals, that following modification the model could be utilised for families [229]. The author suggests that in order to improve family decision making and provide clarity to the existing dimensions of the Health Belief Model, aspects of Ajzen's (1985) Theory of Planned Behaviour should be incorporated into the Health Belief Model. Widely used in health promotion studies including nutrition interventions Sweitzer *et al* (2011) [preschool children] and McConnon *et al* (2012) [weight regain] [230, 231], the Theory of Planned Behaviour (TPB) predicts deliberate behaviour change and is guided by three considerations:

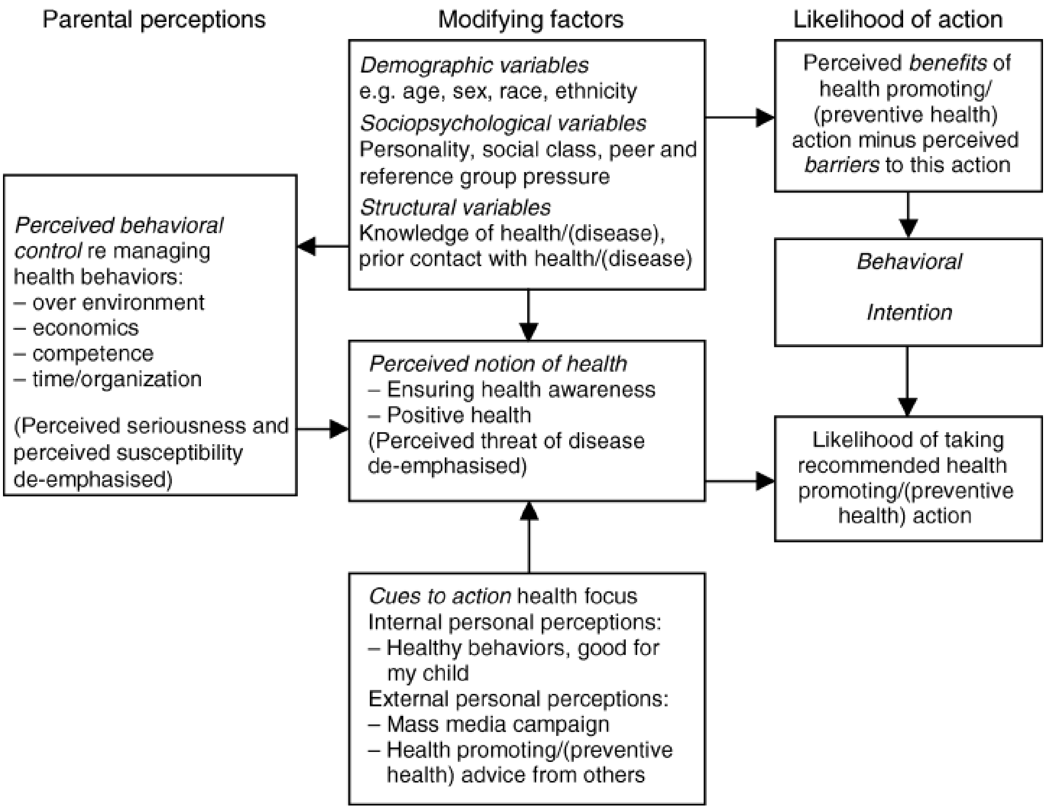
1. Behavioural beliefs – (beliefs about the likely consequence of the behaviour).
2. Normative beliefs – (beliefs about the normative expectations of others).
3. Control beliefs – (beliefs about the presence of factors that may facilitate or impede performance of the behaviour) [232].

Roden (2004) argues that in order to develop the Health Belief Model for use with young families, the construct of behavioural control is considered important for families who are trying to develop healthy behaviours for their young children. Therefore, the addition of the two TPB constructs “perceived behavioural control” and “behavioural intention” reflect the three TPB considerations of individual belief and attitude to adopting behaviour and the perceived social pressures that would facilitate or impede the adoption of the behaviour. It was anticipated that the addition of these two constructs would improve the decision-making ability of the Health Belief Model when economic and environmental barriers prevent the family from undertaking health behaviours. Additionally it was predicted that these additions would provide clarity and accuracy of the Health Belief Model to improve the prediction of health promoting behaviours.

Utilising a mixed method approach, 75 mothers were recruited from day care and preschools from a suburb in New South Wales Australia, to investigate the intention of families to undertake health behaviours for their preschool children and to validate the modified Health Belief Model (Figure 2). The results identified that socioeconomic background was an important determining factor for intentions to undertake health promotion activities such as dental and health checks, smoking cessation, and reducing sedentary lifestyles   It was identified that the higher socioeconomic group parents believed that they had more control over child health matters as well as the perception that they were more able to initiate child health promoting activities [229].

The review of the Health Belief Model has identified that it is important that interventions that aim to reduce rapid weight gain in infancy by changing maternal health behaviours need to take into account maternal beliefs around infant care and feeding. As infants in socially deprived areas are at a higher risk of child obesity, it is especially important to understand the beliefs of this group of parents in order, but also the influences which drive these beliefs in order to inform the development of future interventions.

Figure 3 - Revised Health Belief Model for young families Roden 2004[229]



Infant size, in particular bigger, chubbier babies tend to be viewed as "normal", and healthier than leaner infants [212, 213]. Growth is viewed as a measure of health with perceived insufficient growth being a source of concern for many mothers [233, 234]. Heinig *et al* (2006), identified that higher infant weight gain is believed to be a sign of health and reassurance that infants are well nourished [234]. Baughcum *et al* (1998) identified a major theme to be a "bigger baby is a better baby" and that the mothers participating in the focus group interviews believed that a heavy infant was a healthy infant and was the result of successful feeding and parenting. No mother indicated that an infant could be too heavy and no mother identified any particular age at which an infant or toddler might be considered overweight. Parents participating in this study also believed that the faster and bigger their child grew, the better the food intake must be and therefore, the better their health must be. Whilst it has been identified that parents associate food with infant growth, food is also used to influence infant behaviour [235].

Redsell *et al* (2010) explored the parental beliefs of appropriate infant size, growth and feeding behaviour. The results identified that a major parental belief was that the main cause of infant distress was hunger which drove inappropriate feeding [213]. Russell *et al* (2016) reports that mothers perceived that using milk to settle an infant is an "effective settling technique", and the mothers who participated in the interviews disclosed that they would do "whatever works" to settle their infant and this often involved offering food [236]. Happiness and contentment have been identified by parents as measures of infant health [237, 238]. Using a grounded theory method, Waller *et al* (2015) explored maternal perceptions of mother-infant communication in a cohort of low income first time mothers. The participating mothers expressed the desire for infant happiness and this desire led to the early introduction of solids, despite acknowledged discouragement from health care professionals. Infant behavioural cues such as taking an interest in food and posturing towards food were also reported by mothers to signal readiness for the introduction of food. The perceived infant desire reinforced early weaning practice irrespective of the child's age, developmental readiness or contradictory recommendations from health care professionals [238].

Harrison *et al* (2015) conducted a qualitative systematic review of maternal infant feeding practices in transitioning from milk feeds to family foods. Incorporating a search strategy from four major journal citation databases, the timeframe 2000 to 2014 was purposively selected in order to capture the current social context around infant feeding. In total, twenty three papers met the inclusion criteria and were included in the review [226]. Three major themes were identified:

1. Infant driven transitional feeding practices,
2. Mother driven transitional feeding practices,
3. Community driven transitional feeding practices.

As discussed earlier in this chapter, Harrison *et al* (2015) reiterates that many mothers use food to influence infant growth, contentment and sleep and choose ease of feeding over infant feeding recommendations. Both maternal identity and parenting success are associated with infant feeding practices and that obesity and long term health rarely influences infant feeding decisions. The authors conclude that the rationale for transitional feeding practices are underreported in the literature and requires further research to identify the best avenues for supporting healthy infant feeding practice [239]. However to date no study has explored parental beliefs around caring for infants with known risk factors for child obesity. As human behaviour plays a central role in the maintenance of health and the prevention of disease, collecting data on parental behaviours in caring for infants would allow for a crucial insight into their beliefs and attitudes. As previously discussed interventions that have sought to modify parental feeding behaviours have targeted those behaviours postulated to be both modifiable and associated with early overweight/obesity. Whilst the results are promising, the disengagement reported as a "lack of interest" may reflect the individual's perceived susceptibility of their infant to later overweight/obesity. If data could highlight beliefs and the drivers of those beliefs of parents of at risk infants, specifically targeted interventions could be developed that recognised the perceived barriers and benefits, which may encourage participation and increase the impact of the intervention. As such the remaining chapter outlines the design and implementation of a study that captured the parental beliefs and understanding of caring for at risk infants.

3.5 Research aim

To explore parental beliefs around caring for infants with risk factors for child obesity with a view to informing the development of a targeted behaviour change intervention.

3.6 Methodology and methods

3.6.1 Introduction

In this section the methodology and methods used in this study are discussed. This begins in section 3.6.2 with the rationale of choosing qualitative methodology instead of quantitative methodology for this study. This is followed by a discussion on qualitative methodology and the use of the qualitative interviews. This leads to a discussion on qualitative data analysis principles, in particular thematic analysis as a tool to analyse the qualitative data in this study. This is followed by a discussion on the use of semi-structured interview as the qualitative interview research method.

Section 3.7 focuses on the concerns regarding quality in qualitative research including patient and public involvement and a discussion on reflexivity.

In section 3.8 the research design of the study are discussed in detail. Starting with the participant recruitment ethical approval, screening and consent of the participants are explored.

3.6.2 Choice of research methodology

Research into health seeks to improve health, the impact of healthcare activity on an individual (health outcomes) and improve health services [240]. The two major research paradigms are quantitative (positivistic) and qualitative (naturalistic) [241]. Quantitative health research often employs experimental designs usually to test hypotheses, such as randomised controlled trials. Viewed from a broader perspective quantitative research can be defined as a type of empirical research into a social phenomenon or human problem, testing a theory consisting of variables which are measured with numbers and analysed with statistics in order to determine if the theory explains or predicts phenomena of interest [242]. Qualitative research is an umbrella term covering a range of interpretative techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency of naturally occurring phenomena [243]. Whilst quantitative research methods describe and measure the level of occurrences on the basis of numbers and calculations, qualitative research aims to develop concepts that can help us understand social phenomena in natural settings giving emphasis to the meanings, experiences and views of the participants [244]. It could therefore be upheld that the differences in qualitative and quantitative research methods imply that qualitative methods are inductive in nature contrasting with quantitative methods which are deductive. Glaser and Strauss (1967) argue that qualitative research can be undertaken in a deductive way where prior assumptions are tested on new cases [245]. However, Miles and Huberman state that no study conforms to a standard methodology and that the researcher shapes the methodology to the peculiarities of the study [246].

Qualitative methodology does not simplify the views of the participant in order to measure and count the occurrences of an issue or events; however it takes on a more holistic perspective which preserves the complexities of human behaviour [247]. It emphasises the meanings, experiences, and views of people and it is particularly suited to the exploration of parents' beliefs about feeding and caring for infants with risk factors for child obesity [244]. It helps us to understand the nature, strengths, and interactions of variables. This approach is particularly useful in complex situations such as patients' health behaviours or where the relevant variables associated with an outcome are not apparent [247]. As a result qualitative research is notably a useful tool for policy makers and healthcare professionals because it allows a clear understanding of descriptive information and the context in which policies are implemented [248].

3.6.3 Qualitative research limitations

Qualitative research cannot infer causality. Sampling methods and small sample sizes mean that findings cannot be generalised to other populations. The time investment for participants can be significant and it may mean that participants with stronger views are more likely to express more extreme views. Qualitative research can generate hypotheses and can illuminate meaning. However, there is no way of verifying participant accounts, for example their accounts of information they have been given by health professionals [249]. There has been increasing interest in how to enhance rigor of qualitative research with the development of a number of quality checklists. One example is the consolidated criteria for reporting qualitative checklist (COREQ) [250]. The COREQ checklist was developed to promote explicit and comprehensive reporting of interview and focus groups (qualitative studies). Presented as a 32-item checklist COREQ (Appendix 5) incorporates three domains:

Domain 1 – Research teams and reflexivity

Domain 2 – Study design

Domain 3 – Analysis and findings.

The COREQ checklist was utilised to report on the parents' beliefs about feeding infants and caring for infants with known risk factors for child obesity – qualitative study.

3.6.4 Qualitative research methods

As established in section 3.6.2 qualitative research is used to develop concepts that help us understand a social phenomenon in a natural setting. In this study the beliefs of parents feeding and caring for infants with risk factors for childhood obesity is an area that has not previously been researched. During the design of this study different research strategies within qualitative methodology were carefully considered. The choice of research strategy is influenced by factors such as the researcher's preferred ontological and epistemological positioning, their preferred research methods and research strategies and also pragmatic factors such as time and funding [251]. Ontology is the starting point of all research, it is about what we may know, and epistemology is one of the core branches of philosophy and is about how we come to know what we know [252]. Epistemology focuses on the knowledge gathering process and is concerned with developing new theories and models that improve competing theories and models [252]. For this study, focusing on the lived experiences of parents with infants at risk of early childhood obesity, a focus on models of health behaviour was considered the most appropriate approach. As discussed further in section 3.4 the Health Belief Model is one of the most widely applied theories of health related actions [253]. It postulates that a person's behaviour in relation to their health is related to their perceptions of the severity of illness and their susceptibility to it and the benefits and costs incurred in following a particular health promoting action [240]. The modified model also embraces that socio-demographic, social and psychological factors such as perceived behavioural control, are likely to modify health beliefs [229]. Whilst it has been identified that there is a strong association between macrosomia and/or rapid weight gain and child overweight or obesity, there are also complex and confounding risk factors for child obesity. Therefore, a qualitative approach underpinned by the Health Belief Model, was chosen on the basis that it suited an exploration of the views, perceptions and experiences of parents rather than taking a quantitative approach which would only effectively quantify predetermined outcome measures.

The most ubiquitous aspect of social science research is its reliance on talking to people about their experiences, attitudes, opinions, complaints, feelings, emotions and beliefs [254]. As such, the usefulness of interviews in social science research has long been recognised, as qualitative researchers tend to provide detailed descriptions of individuals and events in their natural setting [255]. More specifically as interviews are interactive, interviewers can pursue clearer answers and probe into any emerging topics. Schostak (2006:54) identifies an interview as an extended conversation between partners with the aim of obtaining "in-depth information" about a certain topic or subject through which a phenomenon can be interpreted in terms of the meanings interviewees bring to it [256].

There are three types of one-on-one research interview: structured, semi-structured and unstructured. Structured interviews are in essence verbally administered questionnaires. Although they are relatively quick to conduct and can be useful for the clarification of certain questions, they only allow for limited responses from the participants [257]. In contrast, unstructured interviews provide participants with considerable control over the interview process, but often involve lengthy time periods [258]. Semi-structured interviews consist of several key open-ended questions that define the areas to be explored, but also allows flexibility for the interviewer or interviewee to pursue a response in more detail [259]. This type of interview is most frequently used in social science [257] and was utilised for the current study.

3.6.5 The role of the researcher in qualitative research

For one-on-one interviews it is essential that the interviewer rapidly develops a positive relationship with the interviewee for the duration of the in-depth interview [260]. The process of establishing rapport is described by Douglas (1985) and essentially involves trust and respect for the interviewee and the information that they share [261]. It is also the means by which a safe and comfortable environment is established in which the experiences and attitudes of the interviewee can be shared. Stages of rapport between the interviewer and interviewee have been described by Spradley (1979)[262] and are summarised in Figure 4.

Figure 4 -Stages of Rapport

Apprehension phase – characterised by uncertainty stemming from the strangeness of the context in which the interviewee and interviewer are new

Exploration phase – is characterised when the interviewee becomes engaged in in-depth descriptions

Co-operative phase – is characterised by a comfort level in which the participants are not afraid of offending each other and both find satisfaction in the interview process.

Participation phase – may occur at any time during the interview and reflects the greatest degree of rapport in which the interviewee guides and teaches the interviewer.

Patton (2002 pg513) states that the "human element in qualitative research is both its strength and weakness" [263]. Whilst considered a strength because it allows human insight and experience to develop new understandings of a phenomenon, the weakness refers to the researcher skills [264]. A major skill for the qualitative researcher is the ability to create an interaction that goes beyond a conversational exchange to a point as discussed above where the interviewee feels safe enough to talk openly about their experiences. To an extent, the researcher is exercising power to generate an atmosphere conducive to a successful interview. However, the researcher is also aware of the ethical issues of emotions and power. These two sides of research interviews have been termed "conquest or communion" with researchers exercising power through the adoption of questioning techniques such as probing in order to generate data from interviewees, but also experiencing an emotional interdependency with the interviewees [265]. From a psychosocial perspective in particular power and emotions come together in both conscious and unconscious ways in a research interview [266].

In studies were the interviewer is also a health professional it could be argued that potential power issues between the interviewer and interviewee could arise. It is suggested that there is an inevitable power imbalance in the research relationship and that when the researcher is also a health professional that the power imbalance is exaggerated in two ways [267]. Firstly, the participant may feel pressurised to participate in research because of a sense of duty and secondly there is an assumption that allowing a participant to speak in their own words can be therapeutic. However, for the present study none of the research team were in clinical practice, therefore minimising the “sense of duty” for potential participants. Whilst the data collected were pertinent and specific to the participant the research protocol, local ethical review, participant information and consent process aimed to reduce the risk of harm and are discussed in more detail in section 3.7.

3.6.6 Purposive Sampling and Sample Size

Sampling strategies are determined by the purpose of the research study. In quantitative research probability sampling is often used to seek statistical representativeness but is not appropriate for qualitative research [268, 269]. Quantitative research uses probability sampling to choose participants from a population randomly to represent in the sample their true proportions. Qualitative research on the contrary uses non-probability sampling to select participants. Participants are deliberately selected to reflect particular features of the sampled population. It is not intended to be statistically representative and participants are selected in accordance with pre-determined criteria for the purpose of the study objectives, hence purposive sampling [268]. Participants are chosen with two 'purposes' in mind: firstly they are likely to generate useful research data and secondly to ensure that the sample is credible.

Sample sizes for qualitative studies are generally much smaller than those used in qualitative studies [270] and often reflect the research with phenomenology research often having as few as six participants in contrast to ethnographies or grounded theory studies where between 30-50 interviews/observations are recommended [271]. The concept of saturation, meaning when the acquisition of new data does not shed any further light on the topic under investigation is often cited in published studies [270]. There are various forms of saturation with the original being theoretical saturation associated with a grounded theory approach [272]. Other forms include; data saturation, thematic saturation and simply saturation [273]. Guest *et al* (2006) suggests that there is a general vagueness surrounding these terms, but O'Reilly and Parker (2012) state that they do have distinct meanings and are applied to all qualitative methods [272, 273]. Generally, data and thematic saturation are taken to mean that data should be collected until nothing new is generated [274].

Mason (2010) conducted a content analysis of qualitative methodological PhD theses via a Universities of Great Britain and Ireland index to theses deposited in one calendar month [270]. From the 2533 theses identified, 560 were included and the sample size and methodology extracted. The overall range for the number of participants ranged from 95 to 1, with a median of 28 and a mean of 31. The most common sample sizes were 20 and 30. From Mason's analysis 80% of the studies investigated adhered to Bertaux's (1981 cited by Mason 2010) guideline of 15 being the smallest number of participants for a qualitative study.

Although the guidance on sample size appears to be fluid, purposeful sampling of participants that meet the study's inclusion criteria should produce quality data with maximum variation within the topic of interest.

3.6.7 Interview Topic Guide

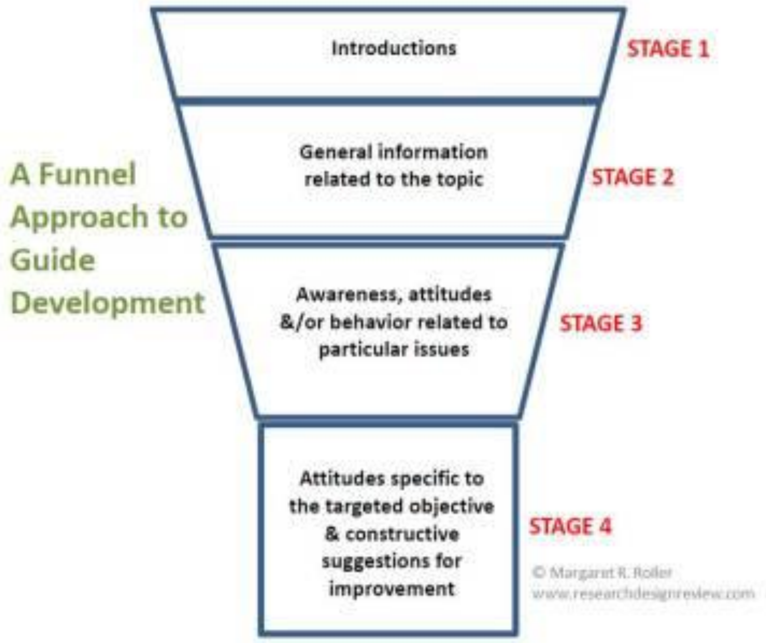
In preparation for the interviews an interview topic guide was developed (Appendix 6). The purpose of the topic guide is to enable the researcher to efficiently incorporate all the issues that are important to achieving the research objectives. Polit and Hungler

(1999) suggest that the topic guide should consist of an outline of categories that are relevant to the research on which the interview questions are ultimately based [275]. As previously discussed rapport and trust are essential in research interviews and therefore the sequencing of interview questions must take account of the developing relationship between the interviewer and interviewee. Roller (2015) suggests a four stage funnel approach when developing an interview topic guide [276] (Figure 5).

Figure 5 - Roller (2015) Funnel Approach to interview guide development

Roller, M.R. Qualitative Research Design www.researchdesignreview.com page 18

Utilising the Roller (2015) approach an interview topic guide was developed as described below:



Stage One – Introduction to the study and verification of consent.

Stage Two – General information – reiteration of the research aims and objectives. Collection of demographic data (family structure, employment, highest educational level obtained).

Stage Three –Awareness/Attitudes/Behaviours – pregnancy, related pregnancy health beliefs, foetal growth, intended mode of infant feeding.

Stage Four – Specific Attitudes/ Influences – early weeks feeding, infant temperament, parental influence, external influence, infant feeding cues, weaning and child growth.

Turner (2010) suggests that it is important to pilot the interview topic guide in order to refine unclear or inappropriate questions [277]. For the current study the interview topic guide was piloted with the lay PPI volunteer, no revision was undertaken. The pilot interview was not included in the final data set.

3.6.8 Data Analysis

Miles and Huberman (1994) identify three major activities involved in qualitative data analysis [246]:

- Data Reduction
- Data Display
- Verification.

The important first step in qualitative data analysis is to read the data for an overall understanding of the content [278]. Once the data has been reviewed, coding provides a formal system to organise the data, uncovering and documenting additional links within and between experiences and concepts described in the data [278]. Thematic coding as a process for encoding data was initially developed by Strauss (1978) and expanded further by Boyatzis (1998) who describes thematic coding as a multistep procedure that can be performed inductively or deductively[279]. Codes are essentially tags or labels which are assigned to whole documents or segments of documents to catalogue key concepts while preserving the context in which the concepts occur [246]. Boyatzis (1998) suggests that a good code should have five elements [279] (Figure 6).

Figure 6 - Boyatzis (1998) Five elements for a good code

1. A label
2. A definition of what the theme concerns
3. A description of how to know when the theme occurs
4. A description of any qualifications or exclusions to the identification of the theme
5. Examples of both positive and negative to eliminate possible confusion when looking for the theme

(Boyatzis 1998 ppx-xi)

Thematic analysis is a widely used qualitative analysis process, the purpose of which is to identify patterns of meaning across a data set that provides an answer to the research question being asked. The patterns are identified through a rigorous process of data familiarisation, data coding and theme development and revision

[280]. Braun and Clarke (2006) developed a six-phase process of thematic analysis [280], summarised in Figure 7.

Boyatzis (1998) describes thematic analysis as a process used widely in qualitative research rather than a separate method such as grounded theory or ethnography [279] One of the major advantages of thematic analysis is that it is theoretically flexible and can be used within different research frameworks including inductive, deductive, semantic, essentialist, constructionist and latent approaches. Additionally, thematic analysis has been used in qualitative studies exploring both parents' beliefs about appropriate infant size (Redsell *et al* 2010) and parents and grandparents perceptions of pre-schoolers' body weight (Eli *et al* 2014)[213, 281]. The widely accepted use of thematic analysis within qualitative research and the flexible approach to analysis were the two main factors for using this data analysis process in the current research study.

Figure 7 - Summary of the six phases of thematic analysis

Source: (Braun & Clarke, 2006:35)

3.7 Quality in Qualitative Research

3.7.1 Patient and Public Involvement

Patient and public involvement (PPI) in research is strongly advocated to improve the way research is prioritised, commissioned, undertaken, communicated and used [282]. A systematic review of the impact of PPI involvement in health and social care research reported that there is clear evidence that PPI can have a positive impact on research by enhancing the quality of research and ensuring its appropriateness and relevance [283]. As the current research focused on the parents' perceptions of feeding infants with risk factors for child obesity, the research team needed to ascertain how parents would respond to being approached by the researchers and whether they would feel judged in terms of their parenting by having a "heavy" infant. For the purpose of this study a mother of a macrosomic infant and a Health Visitor Team Leader were recruited as PPI volunteers. The research topic was well received by them and they subsequently contributed to the development of the research protocol, interview topic guide, participant information sheet, consent forms and promotional materials, providing valuable insights and plain English summaries which contributed to high engagement with parents approached as potential research recruits. The mother of the macrosomic infant consented to be interviewed to pilot the interview topic guide, following the interview the topic guide was amended, this interview was not used in the final analysis.

3.7.2 The Research Team

Three researchers conducted the research interviews for the current study, the post graduate researcher and two BMedSci students (third year medical students). This gave the post graduate researcher an opportunity to supervise the work of undergraduate students. The research gave the undergraduate students valuable experience. At their stage of training they had experience of interviewing patients, including history taking and had completed a communication skills portfolio incorporating a reflexive piece. The undergraduate students had also attended a qualitative research course with hands-on experience of interviewing and of thematic qualitative analysis. Having three researchers conducting the interviews and analysing data broadened the perspective of the work and allowed multiple viewpoints. One of the students was from a South Asian background. In contrast to the post graduate researcher they were both outsiders [284], in that they were not mothers, but they were female and interested in a career in paediatrics. Having additional researchers allowed more flexibility with recruitment.

As multiple interviewers are common features of multisite qualitative studies utilising a developed protocol and standardised interview topic guide [285, 286], the two BMedSci students were enlisted over two consecutive years to assist with recruitment and data collection. For the current study both students were recruited from the same University home base. The students were encouraged to role play interviews with their peers and both students undertook a number of pilot interviews with family members who had children of the appropriate age.

At the time the first BMedSci student was recruited, nine interviews had been conducted and no revisions made to the topic guide. For both students, a non-substantial amendment was granted from University of Nottingham Medical School Ethics Committee (Appendix 8). Both students were introduced and orientated to the Childrens Centres by the post graduate researcher for two sessions. The students initially shadowed and then under direct supervision promoted the research study and obtained declarations of interest from the participants. The students followed up the potential recruits and arranged the face to face interviews. All the student interviews were conducted either in the Childrens Centre or by telephone. Following each first interview a supervision meeting was held to discuss the interview, encourage reflection and explore recruitment problems. Further supervision meetings were held regularly through the active data collection period. Both students transcribed the audio recordings and these were all checked for accuracy by the post graduate researcher. An additional member of the research team reviewed 25% of the transcripts and compared them directly to the audio recordings.

Each researcher completed a research diary reflecting on the research process and individual interviews. Regular research meetings were held to discuss the research experience. Overarching the entire research process were the PhD supervision meetings in which each stage of the research process was subject to interrogation and the feedback received assisted in the reflection on, and the development and refinement of the research.

3.7.3 Reflexivity

Reflexivity in simple terms can be described as an awareness of the researcher's role in the practice of research and the way this influences the object of the research enabling the researcher to acknowledge the way in which they affect both the research process and outcomes [287]. It is often described as a process by which research turns back upon and takes account of itself [288, 289]. Reflexivity is often confused with reflection and as such Finlay (2002) suggests that the concepts reflexivity and reflection are best viewed as a continuum where both ends are acknowledged to be important throughout the research process [290]. At one end of the scale, reflection can be understood to be distanced; taking place after the event. Whilst at the other end of the scale, reflexivity connects into a more immediate, dynamic continuing and subjective self-awareness. Hertz (1997) elucidates that to be reflexive is "to have an ongoing conversation about the experience whilst simultaneously living in the moment" ([291]page viii).

It has been argued that reflexivity in its many forms is the defining feature of qualitative research [292]. As such qualitative researchers will be aware of their role in the construction of knowledge. Cunliffe (2003:pg985) states that researchers "need to go further than questioning the truth claims of others and to question how we as researchers also make truth claims and construct meanings" [293]. Therefore the process of reflexivity throughout the research process requires careful consideration. Haynes (2012) proposes that researchers should be aware of how our ontological, social and political positioning affects the choices made on research topics, questions, approaches and analysis [294]. Haynes (2010:pg78) further suggests that researchers might ask of themselves and their research the following questions:

- *What is the motivation for undertaking this research?*
- *What underlying assumptions am I bringing to it?*
- *How am I connected to the research theoretically, experientially, emotionally? And what effect will this have on my approach?*

3.7.4 Reflexive Statement

The motivation for the current research has its origins in my clinical practice. When I was practising as a Health Visitor in 2003, I began to observe infants who were growing fast, often crossing several centile lines on their weight for age charts. At this time the increase in childhood obesity was being noticed and recognised a public health priority, but only for school aged children. Yet as a Health Visitor monitoring these rapidly growing infants I was concerned about the future health of these children and wanted to understand whether there was any cause for the weight gain. Although I left Health Visiting in 2008 to resume my research career, the desire to investigate early causes of childhood obesity prevailed.

The communities in which I practised gave extensive support to mothers via the extended family but also via the lifelong friendships of the extended family. Any introduction of a health concern by a Health Visitor needed to be handled sensitively to avoid not only alienating the family but also the community. I deliberately designed a research study that would not label a mother or her infant as "fat", nor did I want Health Visitors to gate keep and nominate heavy infants on their caseload. As Childrens Centres provide universal services for children under five these were selected as recruitment sites. It was anticipated that parents of heavy infants would be able to approach the research team freely and be able to "self-nominate" themselves as potential recruits based on simple inclusion criteria. Although parents did self-nominate and consented to interview, my apprehension in referring to a child as being born big or growing fast remained. However any apprehension I might have brought was overcome by using the same terms to represent baby being heavy as the parent such as "big baby" / "heavy baby" / "long baby" irrespective of the child's actual weight. Parents were genuinely open about their infant being heavy and spoke with pride about continued growth and reaching important milestones such as sleeping through the night or showing an interest in food.

During my clinical time I had observed what I perceived to be overfeeding of infants either by widening the bottle teat hole to encourage bottle emptying or by adding cereal to milk feeds to "fill up" a baby. I anticipated that I would find evidence of these behaviours alongside other bottle feeding behaviours that would encourage a full night sleep.

I informed all parents interviewed that I was a registered Health Visitor. From my clinical and personal experience, parent's perceptions of Health Visitors and their role in promoting family health seems to be based on their pervious encounters or of the experiences of those close to them. Positive experiences tended to be associated with a motivational approach to child health and parenting. Whilst prior negative experience of either the parent or a close acquaintance tended to be associated with suspicion, indifference and even distain. Therefore, the interview responses were likely to be influenced by the parent's perceptions of Health Visitors. Parents who had a positive perception of Health Visitors may have given their responses freely. For those who had a negative perception of Health Visitors my concern was that they would either withhold information or alter their responses in line with their current understanding of feeding guidance.

From both a professional and parental viewpoint I believe that infant nutrition is the basis for child health and the decision making on feeding a child commences antenatally. However, the infant feeding milestones are not fixed and parents feeding decisions are based on a multitude influences including their infant, spouse, family, NHS and commercial literature, employment and media viewpoints. As a NHS health professional, infant feeding guidelines provided the basis for all infant feeding advice, including breast is best and delay weaning until six months. My child health surveillance training stressed the importance of a child putting on weight, with the focus of intervention on infants who were losing weight and the anxiety of "non-organic failure to thrive". There was no training or guidance provided for babies who grow rapidly.

Following the literature review, I did have extensive knowledge of the risk factors for early childhood obesity, but the interventions to mitigate those risks showed poor results. I did not believe that parents of infant's with risk factors for early childhood obesity were aware of the risk. Therefore, the knowledge of infancy risk factors were reflected in the research protocol and interview topic guide, with the study seeking to identify all beliefs and the drivers of those beliefs in influencing parents care of their infant from conception to up to one year.

I acknowledge that my personal attachment to the research topic and the preconceptions that I had, present both as strengths and weaknesses for the research undertaken. I recognise this as bias that has the potential to limit the effectiveness of my research. To minimise the effects of my beliefs and bias, the data was collected and analysed by three researchers, with my PhD supervisors providing a further level of quality assessment. All of my interviews were conducted in the participant's home. Immediately following each interview, I recorded my feelings towards the interview, which formed the basis for my reflective diary. Prior to immersing myself in the data for analysis, I listened to the audio recordings reviewing my interview technique, mindful of bias or prior assumption's made in the questions, prompts or clarification points.

3.7.5 Validity and reliability

In contrast to quantitative studies where statistical methods are deployed to establish validity and reliability of the research findings, qualitative research incorporates methodological strategies to ensure rigour [249]. The debate as to whether the terms validity and reliability are appropriate for qualitative research is ongoing [295, 296]. Sandleowski (1993) argues that a major threat to qualitative research is the notion that validity rests on reliability, insinuating that researchers claim that their findings are valid when research participants respond consistently over time and with each other concerning an experience or that a panel of experts other than the investigator coded information the same way [295]. The suggestion is that what is embedded in this notion of validity is that reality is multiple and constructed rather that singular and palpable. The narratives of research participants can change over time and for each participant their story will differ from another. Therefore, the idea that empirically validating the information in one participant's story against the information in another's for consistency is seen as alien to the concept of narrative truth according to Sandelowski (1993) [295]. Unlike Sandelowski (1993), Long and Johnson (2000) separate the terms reliability and validity and cite Hammersley's (1992 p 69) definition of qualitative validity as being "an account that is valid or true if it represents accurately those features of the phenomenon that it is intended to describe, explain or theorise"[296]. Long and Johnson (2000) suggest that the assessment and assurance of validity can be undertaken in qualitative studies by utilising the existing terms and concepts and reason that the need is not for novel terms or new criteria but for a different means of addressing the existing criteria [296]. Therefore, in the broadest context these terms are transferable from quantitative research with validity referring to the integrity and application of the methods deployed and the precision in which the findings accurately reflect the data, whilst reliability describes the consistency of the employed analytical procedures [296].

An assessment of the quality of qualitative research should take account of theory in the design of the research, analysis and interpretation of the data [297]. As such there are tools developed specifically to assess and appraise qualitative health studies. For the purpose of the current study the Critical Appraisal Skills Programme (CASP) qualitative research appraisal tool (1998) was utilised to perform quality assessment at all stages of the research process (Appendix 9).

3.8 Study Design

A qualitative study was conducted using one to one interviews either in person or by telephone (n=1). These were conducted using a semi-structured interview guide as discussed in Section 3.6.7, and included in the appendices (Appendix 6).

3.8.1 Recruitment of participants

Both purposive and snowball sampling techniques (as discussed in section 3.6.6) were employed to select parents of young children at risk of overweight/ obesity. The research received no formal funding, so no costs were available for translators therefore all participants were required to conduct the interview in English. The inclusion criteria were:

1. Primary caregivers of an infant aged 12 months or under who weighed 8lb 8oz (3.85kg) or above at birth, or had crossed one or more weight centile on gender specific weight charts.
2. Aged 18 or over.
3. They had commenced the weaning process.
4. Able to conduct the interview in English.

Surestart Childrens Centres were established to provide a wide range of universal support services for children and their families and were selected as recruitment sites for the current study as they provided access to families of young children. All of the Childrens Centres were located in areas of deprivation. Via the promotional material parents self-identified either that they had an infant who was big at birth or was growing rapidly. Six study sites were selected to increase the maximum variation of the recruited sample. The target sample size for the current study was ≥20 participants. In addition to recruitment posters displayed in the Childrens Centres the researchers also visited sessions held at the Childrens Centres and directly approached all the primary caregivers attending the sessions, giving them details about the study (Appendix 10. Approaching all parents attending the Childrens Centre activities with a child less than one year of age was necessary to reduce the potential of parental anxiety or distress by targeting only parents who appeared to have "heavier" infants. Participants meeting the inclusion criteria who either gave their contact details on a study postcard (Appendix 11) at the Childrens Centre or responded to the recruitment posters were subsequently emailed the Participant Information Sheet (PIS) (Appendix 12) and consent form (Appendix 13), primary caregivers who didn't meet these criteria were thanked for their interest and no further contact made. To increase variation within the sample participants recruited from the Childrens Centre were provided with additional interest postcards and requested to pass on details of study to any friends who might meet the eligibility criteria. All participants at the end of the interview were offered a £10 gift voucher as an inconvenience allowance.

3.8.2 Data Collection Methods

Following informed written consent each parent partook in one to one interviews either in person or by telephone (n=1). Participants were offered a choice of venue where the interview could take place either the Childrens Centre or their own home. As discussed in section 3.6.5, a successful qualitative interview requires a comfortable environment. Therefore by allowing the participants the choice of interview venue it was anticipated that the participants would feel more comfortable and in control of their surroundings reducing the invasive nature of the research interview. The choice of interview venues also incorporated the safety and comfort of the researcher. The university "lone worker" policy was implemented and a "buddy system" of a nominated colleague to whom the researcher checked in and out of each interview and was available for contact during the time spent working off site, was in operation for all twenty six interviews whether they occurred in the participant's home or chosen Childrens Centre venue (Appendix 14).

At the start of each interview, the aim and purpose of the research was outlined and with the participant's written consent the interview was audio-recorded using a digital voice recorder.

3.8.3 Ethical Approval

The study was conducted in accordance with the ethical principles originating from the Declaration of Helsinki, (World Medical Association, 2008); principles of Good Clinical Practice (ICH GCP), and the Research Governance Framework for Health and Social care (Department of Health, 2005). This study was subject to review by University of Nottingham; Faculty of Medicine, Health Sciences Research Ethics Committee (REC) with full approval received (ref: E15082013 SoM Psychiat) (Appendix 7). Permissions to display recruitment materials and attend Sure Start Childrens Centres was obtained from the District Childrens Centre Co-ordinators.

3.8.4 Consent

In line with the Research Governance Framework for Health and Social Care (Department of Health, 2005), written informed consent was obtained from all study participants. The researcher explained the details of the study and provided a Participant Information Sheet, ensuring that the participant had sufficient time to consider participating or not. Informed consent was collected from each participant before they underwent the interview. One copy of which was kept by the participant and one by the researcher and stored in the study site file.

3.8.5 Confidentiality

All audio recordings were transcribed by the researcher verbatim. All identifying remarks were removed and the participant identified only by study number. For reliability of transcription, an additional member of the research team reviewed 25% of the transcripts and compared them directly to the recordings. The transcripts were assessed as being accurate representations of the audio recordings. Following the reliability procedure all digital recordings of the interviews were deleted. (Example of an anonymised interview transcript appendix 16)

3.8.6 Qualitative Data Analysis

Transcripts from interviews are the raw data which are descriptive record of the research, but they cannot provide explanations without analysing the data [298]. The researcher has to make sense of the data by closely examining and interpreting them. The process for data analysis used a thematic analysis approach, following the steps identified in Figure 6.

The steps involved for data analyses are described in stages. Step one was *familiarisation with the data which* involved transcription of the interviews and immersion in the data. Step two was *generation of initial codes* and step three was *searching for themes,* which involved grouping all codes into potential themes. Step four was *reviewing themes*. Step five was *defining and naming themes* and for each theme a clear definition was created. Finally step six was *producing the report*, which provided an opportunity for further analysis and final review of the themes [280]. However, in practice these steps are not independent processes but cyclic in nature. It is important to execute the principle of constant comparison in this study. Therefore, both data collection and analysis processes were cyclic in nature, an iterative and not a linear process [246]. The data analysis is however discussed as a linear step for the purpose of this thesis.

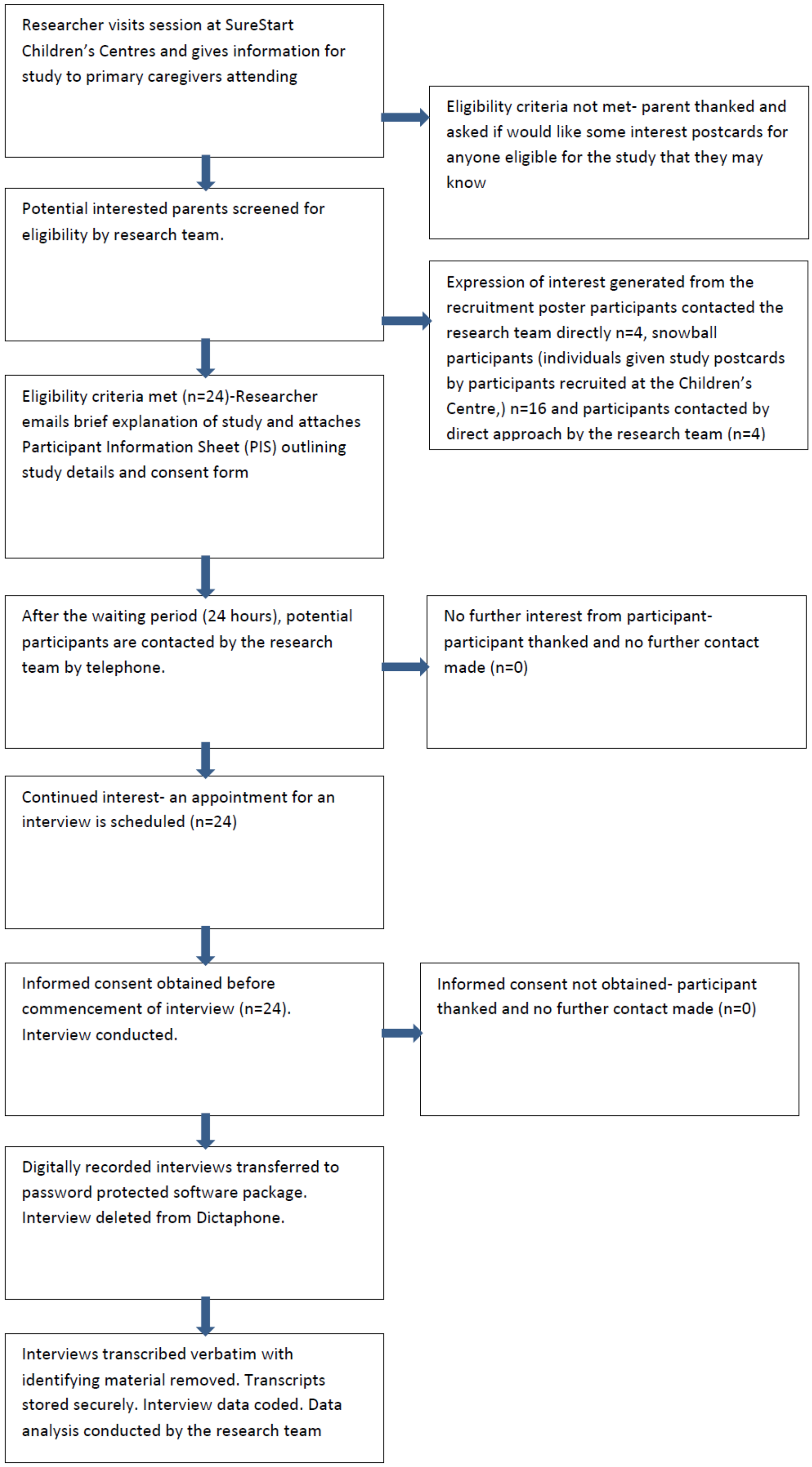
Once identified, the codes were organised into a coding book (Appendix 15). The coding book was structured on Boyatzis' '5 elements of a thematic code' with each theme possessing a meaningful label, definition, inclusion criteria, exclusion criteria and examples of positive and negative occurrence [279]. The coding book was reviewed by a second researcher to establish consistency in themes [279]. Quotations from each theme were randomly selected and given to the second researcher to code according to the coding book. The second researcher was able to correctly match every quote to a theme, thus the themes were deemed to be consistent in line with recommended standards [279]. The coding book was reviewed and final themes and sub-themes were agreed upon, after which the transcripts were reviewed to ensure they still matched with the revised codes. The coding frame was then analysed further to look for links between codes and explanatory themes. The final themes chosen included both deductive and inductive themes.

Deductive codes are based on previous knowledge, and the research allows testing of a theory or hypothesis. Alternatively, inductive analysis is used when existing knowledge of the subject is lacking or fragmented [299]. Deductive analysis is often described as moving from the general to the more specific, whilst inductive analysis can be thought of as moving from the specific to the more general [299]. Quotations were used to support the themes; the beliefs and experiences of the parents, in their own words, provided the themes with credibility and face validity and an analysis trial that the data interpretation links back to the words of the parents [263].

3.8.7 The Coding Process

During the data analysis process, the Boyatzis (1998) five elements of a good code (Figure 5) were used to produce the code book (Appendix 15). The coding process can be done manually which involve the use of coloured pens or highlighters, scissors and glue to literally cut and paste sections of text onto cards or piece of poster that could later be examined together in a bigger picture [300]. In this study, a manual cut and paste technique, as well as an electronic database of codes and data abstracts were compiled using Microsoft Word© and these were revised during the iterative process.. A flow diagram of the recruitment process is detailed in Table 20.

Table 20 - Flow diagram of the recruitment process



3.9 RESULTS

3.9.1 Participant demographics

Twenty six parents (n=1 father) were recruited to the study. All recruited parents completed the face to face interview. However, data on rapid weight gain and the effect on weight-for-age centile crossing for two infants that had a "normal" birth weight were not collected; therefore they were assumed not to have met the inclusion criteria and were subsequently excluded. Fourteen interviews took place at a Childrens Centre, nine interviews took place in the participants' homes and one by telephone. A wide variation in maternal education from High School to a Postgraduate qualification was recorded. Infant milk feeding was recorded as of the time of the interview with eighteen mothers exclusively breastfeeding, five mixed feeding (breast milk and formula feeds) and three formula feeding. Age at which weaning commenced ranged from 9 weeks to 26 weeks (Table 21).

Table 21 - Participant demographics

Participant Number	Birthweight	Birthweight centile	Centile Crossing	Maternal education level	Household	Parity	Feeding method	Age of weaning
01	2.64kg (5lb 13oz)	2^{nd}	2^{nd} to 50^{th}	College	2 parent	1^{st} child	Breast	22 weeks
02	4.08kg (9lb)	50^{th}	macrosomic[2]	Graduate	2 parent	2^{nd} child	Breast	22 weeks
03	3.94kg (8lb 11oz)	91^{st}	macrosomic	Graduate	2 parent	1^{st} child	Breast	26 weeks
04	4.45kg (9lb 13oz)	$\uparrow 98^{th}$	macrosomic	Graduate	2 parent	1^{st} child	Mixed	20 weeks
05	3.83kg (8lb 7oz)	$\uparrow 50^{th}$	75^{th} to 95^{th}	College	2 parent	2^{nd} child	Mixed	9 weeks
06	3.09kg (6lb13oz)	$\uparrow 9^{th}$	25^{th} to 91^{st}	College	2 parent	1^{st} child	Breast	16 weeks
07	3.99kg (8lbs 13oz)	$\uparrow 75^{th}$	macrosomic	Graduate	2 parent	2^{nd} child	Breast	22 weeks
08	3.32kg (7lb 5oz)	$\uparrow 25^{th}$	75^{th} to 91^{st}	Graduate	2 parent	2^{nd} child	Formula	24 weeks
09	3.77kg (8lb 5oz)	$\uparrow 50^{th}$	50^{th} to above 99^{th}	Graduate	2 parent	1^{st} child	Breast	20 weeks
10	3.99kg (8lb 13oz)	91^{st}	macrosomic	High school	1 parent	1^{st} child	Breast	16 weeks
11	2.80kg (6lb 3oz)	$\uparrow 9^{th}$	9^{th} to 50^{th}	Post graduate	2 parent	1^{st} child	Breast	20 weeks
12	3.57kg (7lb 14oz)	$\uparrow 50^{th}$	25^{th} to 91^{st}	Post graduate	2 parent	1^{st} child	Breast	20 weeks
13	3.43kg (7lb 9oz)	$\uparrow 25^{th}$	9^{th} to 91^{st}	High school	2 parent	2^{nd} child	Breast	23 weeks
14	4.31kg (9lb 8oz)	98^{th}	macrosomic	High school	2 parent	2^{nd} child	Mixed	22 weeks

[2] Centile crossing not recorded for macrosomic infants

15	3.32kg (7lb 5oz)	↑25^{th}	25^{th} to 99.8^{th}	College	2 parent	2^{nd} child	Breast	24 weeks
16	3.51kg (7lb 12oz)	50^{th}	50^{th} to 91^{st}	Graduate	2 parent	2^{nd} child	Formula	24 weeks
17	3.20kg (7lb 1oz)	↑25^{th}	25^{th} to 91^{st}	Graduate	2 parent	2^{nd} child	Mixed	23 weeks
18	4.17kg (9lb 3oz)	↑75^{th}	macrosomic	Graduate	2 parent	2^{nd} child	Mixed	26 weeks
19	4.40kg (9lb 11oz)	↑91^{th}	macrosomic	Graduate	2 parent	1^{st} child	Formula	24 weeks
20	3.97kg (8lb 12oz)	↑75^{th}	macrosomic	Graduate	2 parent	1^{st} child	Breast	26 weeks
21	4.20kg (9lb 4oz)	91^{st}	macrosomic	Post graduate	2 parent	2^{nd} child	Breast	26 weeks
22	4.14kg (9lb 2oz)	91^{st}	macrosomic	Graduate	2 parent	2^{nd} child	Breast	24 weeks
23	3.88kg (8lb 9oz)	75^{th}	macrosomic	Graduate	2 parent	1^{st} child	Breast	24 weeks
24	3.91kg (8lb 10oz)	↑75^{th}	macrosomic	Graduate	2 parent	1^{st} child	Breast	26 weeks

Table 22 - Themes and sub themes

Theme One **Positive connotation associated with high weight**	Theme Two **Weight gain is perceived as positive and an indication of successful feeding**	Theme Three **Parents understanding of feeding baby**	Theme Four **Parents weaning decisions**
1. Parents justifying baby's higher birthweight.		1. The need to feed on demand.	1. Parents manipulation of weaning guidance
2. A bigger child is more desirable.		2. Parents beliefs that you cannot over feed a breast fed baby.	2. Weaning in response to infant cues.
		3. Feeding to soothe.	3. Bigger babies require modified weaning.
			4. Parents seeking information

Four major themes emerged from the data:

1. Positive connotation associated with high weight

2. Weight gain is perceived as positive and an indication of successful feeding

3. Parents understanding of feeding baby

4. Parents weaning decisions

3.10 Theme One –Positive connotation associated with high weight

Poor recognition of child overweight status has been widely reported [301-303]. However, a strong theme emerged from the current study that parents with infants at risk for early childhood obesity were not concerned about infant size viewing weight gain as proof of successful parenting and as previously reported by Harrison *et al* (2017 pg 9) the parents interviewed focused on the "here and now", rather than their child's long term health [239].

3.10.1 Subtheme - Parents justifying baby's higher birthweight

At the beginning of the interview, participants were asked about their pregnancy experience. From the discussion with mothers it became evident that they associated the size of their pregnancy bump with the anticipated birthweight of their infant, often remarking that because they had a small or "neat" bump" they expected a small or "neat" infant.

P04 (line 83 + 79) - "*Oh no. I did know like 'cause erm my bump was quite neat the whole time, so it literally was mostly baby . . . 'Cause sometimes like the bump's big because of the fluid, but it was mostly baby, So I was quite surprised at how like substantial she was*"(Baby was born 9lb 13).

One mother whilst expressing surprise at the birth weight of her infant also demonstrated positive feelings about her daughter's high birthweight.

P10 (line 68) – "*Erm I was impressed when she was in my belly I didn't look so big (laughter) she's erm I was very impressed that she was so big*" (Baby was born 8lb 13).

Whilst pregnancy bump was believed to be an indicator of new-born birthweight, another reason stated for high birthweight was gestational length over the estimated due date (EDD). As discussed in Chapter Two, increasing gestational age is associated with macrosomia, however as demonstrated in the following quote the expectation that overdue infants will have a higher birthweight appears to be widely believed by pregnant mothers.

P03 (line 98) – "*possibly the fact that she was 9 days over, giving her that extra bit of cooking time". (*Baby was born 8lb 11*)*

A variety of different explanations were used to justify a higher than average birthweight. A genetic predisposition for higher weight was often attributed, whereby participants declared that there are other babies in the family or that certain members of the family are taller or larger than average.

P23 (line 117) – *"I don't know you see what an average…an average size is, I suppose. So I suppose to me, because I was quite big when I was born and my sister was big, he didn't sound that big at 8lbs 9ozs . . . So I mean I don't know whether that that has any relevance but I was 10 lbs 10 when I was born."*

As well as familial associations parents also discussed other reasons for their child's high birth weight and these included increased length.

P08 (line 206) - *"So in herself, she looked quite petite, but for a girl I remember thinking she's got really long legs."*

Parents reported comparing their infants with other babies born at a higher birthweight, which led them to believe that their own infant's birthweight was not high.

P22 (line 183) – "*I mean they didn't reach the 10 pound mark like some do or like…A friend of mine had a 13 pound baby*".

3.10.2 Subtheme - A bigger child is more desirable

One theme recurrent in the majority of the interviews was the perception that a bigger infant was more desirable. When one mother compared a family member's child to her son, **P07 (line 184)** – "*Uh no, my sister, uh she had a baby after [him]. About a month [he] is older than her, but she looks like very fat, and has got very a, she is very beautiful, I say why is [he] not looks like that . . . And I say maybe he is very skinny and the doctor they said no he is very good health". (*Baby was born 8lb 13*)*.
Examination of affectionate nicknames descriptive of size showed that parents were not ashamed of their child's weight, and seem pleased that their child was big i.e. **P09 (line 149)** – "*chunky monk*". (Baby was born 8lb 5), **P05 (line 30)** – *"you're a fatty bum, aren't ya"* (Baby was born 8lb 7), **P22 (line 226)** – "*Momma's little chunk*" (Baby was born 9lb 2).
Used to describe an older person, these terms would be considered derogatory, yet in these interviews they were used freely, positively and indicative of pride. An experiment that tested the effect of baby schema (a set of infant physical features that includes chubby cheeks, a plump body shape, large head, large eyes and small nose and mouth) on the caretaking motivation in adults was conducted by Glocker *et al*

al (2009) [304]. Their results identified that high baby schema characteristics represented by original and manipulated images, not only evoked a high cuteness rating but also a high motivation for caretaking compared to the infant images that had been manipulated to produce low baby schema characteristics. These findings indicate that the baby schema response is a fundamental function of human social cognition that forms the basis of adult-infant caregiving.

Parents were happier and more willing to describe their sons as being bigger than average weight. In male babies, gender was often identified as a factor influencing baby's weight, and in fact gender alone was considered sufficient explanation for higher than average weight. **P16 (line311)** - *"They call him a little piggy. . .everybody sort of refers to him as a big boy, a chunky boy, a bonny boy".*

Alternatively, girls were thought of as smaller and more petite. Parents were generally more reluctant to admit that their daughter weighed more than average.

P08 (line 535) - *"When she was on the 75th I was like 'Oh god, that seems really small' and they were like 'no, no, no, she's a, she's a girl' so you know that's what girls do."*

It has been argued that parents of boys associated lower risk with their child's overweight, [305] which may explain why they were more willing to comment on their child's increased weight.

Parents who recognised their infants as bigger did not show awareness or concern about the potential long term impact of overweight in infancy on health.

P14 (line 222) – *"I don't think it's much wrong with it (baby being bigger). You know obviously she's bigger than an average…average you know baby and stuff, but no it doesn't concern me".*

Parents struggled to conceptualise their babies as being overweight for their age and described their baby's size as matching the size or growth of older babies, suggesting their baby was slightly more "advanced" in their size for their age.

P20 (line 537) – *"I've got some friends that have babies a couple of months older than him and he's the same size. So he's certainly a good size, so I'd say in terms of how they've tracked and how they've grown, they've done exactly the same as him".*

Despite acknowledgment of their baby being bigger, parents mentioned there is natural variation in size.

P09 (line 216) – *"the ten/eleven babies that my ten friends are all different every single one of them is small big whatever you know hes the biggest of cause out of all of them."*

Parents recounted other babies in the community that they were happy to identify as "fat".

P21 (line 1266) – *"I saw a baby today and he had like…I thought my baby's thighs were quite fat but actually this child was unbelievable. And I was like ye, my baby is not actually that fat. He's quite… He is quite... Again he is quite slender like his brother".*

This study demonstrates the shifted views of parents of "normal" weight underpins them feeling detached from issues of overweight in infancy. Jones *et al* (2011, p5) reported that parents define childhood overweight as "when a child's weight exceeded an acceptable level or clinical parameter" however, they showed poor understanding in what an "acceptable level" was [306]. Thus parents used alternative objective measures such as visual assessments and comparisons with other children; often the children used as a reference point were extreme and exceptional cases on the overweight side of the spectrum [306]. One mother interviewed who was referred to see the doctor regarding her child's weight didn't see anything "wrong" with her son, highlighting that concern had not been previously raised at child health appointments and therefore she had no "medical definition" that her son's growth was abnormal.

P09 (line 228) – "*I'm not turning up I'm not coming I don't want to talk to her about his weight and it got me upset I was thinking yeah he is so much bigger than all my other friend kids does she think that there is something wrong with him that she's not told me so he had to go for his injections done his last set of injections so I thought hang on a second so I took him to the Health Visitor and she said no there is nothing wrong with him he is following his centile he's just a big boy there is no worries he's healthy he's making the milestones so in the same sense my friends who've got small babies*."

Only one of the infants was flagged by a healthcare professional for rapid weight gain; the reluctance for healthcare professionals to discuss weight may stem from the current lack of a definitive classification of overweight/obese in infancy and weight being a sensitive issue. Health Visitors are often reluctant to identify obesity during infancy and would reportedly delegate crucial decisions about infants who rapidly gain weight to general practitioners/paediatricians [307], but as the previous quote shows this may send mixed messages to the parent. Consistent with previous qualitative studies, parents did not see weight as an issue until there was a detrimental impediment on the child's physical fitness or mobility [235, 306]. This lack of concern may be due to the long time lag between overweight during infancy and the potential negative consequences incurred later in life [308].

Furthermore, parents held the belief that excess weight in infancy could be lost after the infant becomes more active or their growth would eventually slow down without any intervention.

P03 (line 544) – "*But generally all of my mums' siblings, the babies start out very chubby and then as soon as they move, they lose it".*

Mothers felt that babies starting to be more active acted as a justification to increase the quantity feed.

P24 (line 408) – "*So [baby] not… not been chubby at all um I think, ye I'd go for more [food] but it's kind of he's a bit of an active… active one*".

3.11 Theme Two – Weight gain is perceived as positive and an indication of successful feeding.

Weight gain is perceived as encouraging to parents for healthy development and growth, with parents holding the belief that this idea is positively reinforced by HCPs. Baughcum *et al*. (1998), reported low-income mothers recounting that faster weight gain was a result of successful feeding and parenting and was associated with better health [235].

P03 (line 235) - *"Her size certainly enabled me to continue breast-feeding with confidence… Gave me a lot of confidence that yes, I was producing milk, it was of decent quality to nourish her."*

Bigger babies are seen as attractive, and less fragile, reassuring parents that their feeding routine was sufficient to support baby's development. Weight gain provided tangible evidence of successful feeding and parenting. Losing weight, in contrast has negative connotations; parents with babies who lost weight have felt the weight loss was a consequence of their shortcomings and felt guilty.

P12 (line 114) – "*only me that could have responded it felt that it was just me responsible for her putting weight on and she wasn't putting weight on so it just felt really like (mimes deflated) what can I do no matter how much I seemed feeding her and how much we were trying and she seemed to I remember once I though oh you know she's had loads this weekend we've really as soon as she'd cries she was on the boob feed her you know I didn't wait and think oh it was only 10 minutes ago she can't be hungry again we just put her on all the time and Monday morning came we weighed her and she'd still* *lost weight and I just thought on my god so yeah it was just very stressful and sort of and demoralising in terms of you know what it felt like for as err as a Mum looking after her".*

Importance is placed on infants tracking on their centile by parents and that their continued weight gain should be maintained.

P09 (line 209) – "*I feel fine because he's gone up [on chart] and he's stayed there".*

Redsell *et al*. (2010, 2013), found that parents voiced a sense of fulfilment when their infants gained large amounts of weight according to the centile charts [213, 307].

One parent was dubious about regular weight checks to maintain infant weight along the centile line as she was aware an infant's weight often fluctuates. She commented that individuals raise concerns about infant weight if their position on the chart drops.

P02 (line 171) - "*I think the weight can vary at this stage so much because of illnesses and stuff that if you start weighing too much you can end up with a chart that comes up and down you get people saying oh they've lost a bit of weight".*

Parents are wary that the charts are used by healthcare professionals to monitor infant progress and an infant dropping centiles is interpreted to represent poor parenting. Jones *et al*. (2011), reported conflicting information given to parents about appropriate weight gain in infancy and childhood; during infancy weight gain is promoted with emphasis put on following the centile line, whereas in childhood being "big" was discouraged. These mixed messages confuse parents and make them doubt the source of information for healthcare professionals [306].

Change in weight during infancy is used as an indicator to monitor how well feeding is progressing by parents and healthcare professionals. An increase in the infant's weight motivated parents that feeding was going successfully and encouraged them to continue with their feeding practices. Some parents were reassured by weight gain when they had personal doubts that the baby wasn't feeding enough.

P21 (line 851) - *"He was tracking on his line like nicely so he was eating a good amount."*

In situations where babies lost weight parents felt that their current feeding method was unsuccessful. Some parents felt the need to increase the quantity and/or frequency of feeding or supplement with formula or solids to encourage weight gain when the infant's change in weight didn't meet their expectations. The perceived stigma around weight loss partially may be influenced by infants losing more than 10% of their initial birth weight being flagged up to healthcare professionals for observation.

P19 (line 93) - *"I attempted to breastfeed; he lost quite a bit of weight. So he lost 10% after birth, and I think breastfeeding probably wasn't going as well as it should have, because he took a while to get back to his birthweight really…I did supplement from quite early on because my Health Visitor really wanted him to put on weight. Um, so she said to help you and to help him put on weight it would be a good idea to supplement with formula."(Baby born 9lb 11oz)*

3.12 Theme Three - Parents understanding of feeding baby.

Within this overarching theme all of the sub - themes identified a propensity for overfeeding with a desire for weight gain as opposed to feeding in response to the infant's hunger and satiety cues.

3.12.1 Subtheme - The need to feed on demand.

Unanimous across all eighteen breastfeeding parents was the notion that babies were fed on demand.

P12 (line 118) - *"As soon as she'd cry she was on the boob feed her you know, I didn't wait and think oh it was only 10 minutes ago she can't be hungry again, we just put her on all the time."*

Mothers who formula fed their babies were able to establish a regular routine in both the quantity and times at which they fed their baby. This belief was held by parents who were both breast feeding and bottle feeding.

P16 (line 163) – *"I got him into quite a good routine um, he was feeding roughly every 3-4 hours, um, yeah I managed to get him in a really good routine and yeah there's not really much, it sort of went smoothly really, there wasn't any problems at all"*

Due to the nature of formula feeding being measured out, parents who formula fed tended to adhere to a routine of feeding a set volume at a particular interval and were able to quantify this amount.

P18 (line 185) - *"Ye. Now he'll have… he'll have seven ounces, um, every four hours in the daytime"*.

Some parents of formula fed babies restricted how much milk their infant consumed within the established routine and were more wary of how much their baby was drinking. Redsell *et al* (2010), reported parents of formula fed infants felt satisfied about being able to quantify and time feeds, as well as making them feel less anxious about unexplained crying [213]. Some parents of breastfed babies mentioned formula fed babies may sleep better through the night.

P04 (line 112) - *"I kind of wanted to breastfeed her exclusively, but I was just like...it (formula milk) might help her to sleep better."*

Encouraging an infant to sleep through the night also identified the practice of night feeding, where an infant is woken to feed with the expectation that they will sleep for longer as explained by this mother:

P16 (line 187) – "*Um at night it was, um, he was exactly the same as he is now, he would go to bed at 6 oclock I would feed him, then would feed him again around 10 oclock and then he would wake up around 3 oclock in the morning and we would feed him, he wouldn't wake up crying, but we could just hear him babbling so we would just feed him and then, or I would have an alarm set to get up and feed him and then again at 6 in the morning*".

3.12.2 Subtheme – Parents beliefs that you cannot over feed a breastfed baby.

Mothers who breastfed did not think there would be any negative consequences from overfeeding with breast milk. Mothers reported breastfeeding "on tap", despite self-identifying their baby as not hungry and knowingly fed for other reasons such as comfort.

P17 (line 103) – *"I don't believe you can over breast feed a child anyway erm it's something that came up in our breast feeding training was you know if baby's full then they'll stop feeding you can't overfeed them and similarly I don't think that using a breast to comfort a child is wrong erm daughter was I did the same with daughter."*

Some mothers offered babies' breast milk at the suggested intervals without consideration whether the infant needed feeding. One mother used the recommended intervals to work out a minimum number of feeds in the day and after speaking to the Health Visitor regarding concerns about underfeeding solids realised she was overfeeding on breastmilk.

P22 (545) – *"With [baby] on one trip to the Health Visitor, I said he doesn't seem to be eating as much as my friends' children and she said, well how much did he eat and I explained. She was like, "you are giving him too much breastmilk. You need to cut down on your feeds and then he will take more solids."*

3.12.3 Subtheme – Feeding to soothe

Only one parent suggested that she thought her baby would only eat to satisfy hunger, commenting, "*I think he won't eat if he's not hungry*." **(P02 line 241).**

The other parents recognised that they used feeding to soothe, acknowledging that their babies might be eating when they were not hungry.

P03 (line 285) - "*Especially if breast can't fix it… If the problem isn't solved by a breast, then I'm not sure what is. She's stopped doing the sort of new-born feeding cues, so it's generally offer breast, just in case she happens to be hungry or needing a bit of comfort, as it tends to work ideally for both*."

Similarly, parents acknowledge that feeding is also used to help infants sleep.

P01 (line 151) - "*I feed him sleep at night and then if we're at home he kind of needs me to have a nap because he won't take a dummy*"

3.13 Theme Four - Parents weaning decisions.

Alongside physical development, bigger infant size was the major influence not only to determine when to start weaning but also reflected in portion sizes.

3.13.1 Subtheme – Parents manipulation of weaning guidance

Although WHO guidelines recommend exclusive breastfeeding until 6 months [309], 19 of the 24 parents who participated in this study chose to wean their infants earlier, from 9 to 24 weeks. Previous guidelines advised weaning from 4 months.

Awareness of the correct guidelines varied between parents, and those who were aware of the guidelines did not necessarily follow them.

This parent is seemingly unaware of the new guidelines.

P05 (line 366) - *"I mean, he's getting on for 4 months now, so it's around the time that I can do it anyway."*

Conversely, this mother is certainly conscious of the 6 month guideline, yet chooses not to follow it.

P06 (line 327) - *"We go to quite a lot of baby groups and all the other mums were waiting 'til 6 months and at first I didn't tell them that we'd started weaning him at 4 months, 'cause I just felt a bit awful really."*

Finally, this parent purports to follow the guidelines, but is actually interpreting them to suit her own agenda.

P01 (line 158) - *"I know that they recommend to wait until 6 months but it was only a couple of weeks before."*

If parents are contravening guidelines, it may be that they don't fully appreciate the importance of doing so. Additionally, labelling inconsistencies in supermarkets may add to parental confusion, as suggested by a study which found that parents believed that food labelled 'from 4 months' would not legally be allowed to be sold if it was harmful to the infant [139].

3.13.2 Subtheme –Weaning in response to infant cues

A small number of parents justified their decision to wean prematurely with infant cues taken from sections of the recommended guidelines, including demonstration of hand-eye coordination and head control.

P01 (line 155) - "*I waited for the signs that his head control was really good so he wasn't bobbing umm he could sit up... well not on his own but if you place him in a certain position he doesn't fall... his hand to mouth co-ordination*."

However, the majority supported their early weaning decisions with infant cues falsely suggesting early readiness. Babies who watched parents eat or expressed an interest in food were interpreted to be ready to eat, and this was confirmed when babies ate food when it was offered to them – the ability to eat was understood as verification that they should be eating.

P16 (line 246) - "*I knew that he was getting more interested in food, and looking at us while we was eating, he was grabbing at things, and putting them in his mouth, so I just thought you know, I'd try him on it*."

Contradicting this is the knowledge that stereoscopic vision in infants begins to develop between 4-6 months, characterised by development of depth perception and 3-dimensional vision

[310]. An infant will therefore be following movement of many things, not specifically food.

P02 (line 80) – *"He was interested in what we were doing. We got a high-chair, and sat him at the table with us, and at the point when he was paying attention and watching us eat [so] I gave him his own spoon, and when he started putting it to his mouth I gave him food." (Weaning age=22 weeks).*

This accentuates the need to expose false ideas about infant cues suggesting an early readiness for weaning. Reinforcement for this theme comes from Walsh *et al*. (2015), who found that infant cues were the primary motivators driving parental decisions to wean [139]. Therefore, better education for parents as to why their infant is not ready for complementary food, such as the risks of choking, underdeveloped stomachs and the threat of obesity might convince them against weaning prematurely.

Infant size was another factor which influenced the decision to commence a few weeks earlier. One mother introduced complementary foods at 9 weeks because she felt that was unable to "fill" her baby on a milk based diet.

P05 (line 472) - *He's having baby porridge, 'cause obviously he's a big baby and 'cause he was just constantly wanting to* *feed on to me, and I was just sat there for 3 hours at night feeding him. (Weaning age=9 weeks).*

Mothers who started weaning at or approaching to six months commented that their babies enjoyed eating a variety and were not "fussy". Parents observed their infant's response to complementary foods after commencing weaning, with two mothers reverting back to exclusive milk feeds after a poor response to early weaning, such as sickness and diarrhoea. Whereas Baughcum *et al*. (1998) described low-income mothers as unwilling to return to a previous stage, even if suggested by a healthcare professional [235]. Mothers are trying to be receptive to the infant's nutritional needs and adapting their feeding style to what they deem most appropriate.

Teething was interpreted by some parents as indicating that the baby was ready for weaning. Furthermore, some parents associated teeth with suitability for finger foods.

P10 (line 108) – *"I could see she was teething so I thinking that she's getting ready to feed" (weaning age=16 weeks).*

Although parents perceive teething as associated with being ready for solid foods, most infants are sufficiently skilled at 6 months to consume finger foods [311]. WHO (2012) mentions that at 6 months, infants can eat pureed, mashed or semi-solid foods, with the food consistency and variety increasing as the infant grows older [312]. Baby led weaning encourages carers to introduce finger foods first as infants are not developmentally ready to use a spoon themselves at six months [311]. With spoon-feeding the opportunity for the infant to exercise autonomy over the quantity consumed and pace of feeding is significantly reduced [311].

3.13.3 Subtheme – Bigger babies need modified weaning.

Parents suggested that their infant's size altered the weaning process. They expressed the opinion that earlier weaning was required because of their infant's bigger size.

When asked why the mother had introduced solids earlier than recommended, this mother stated "*Um I suppose because she was a big baby*" **P22 (line 462)**.

As well as the view that bigger infants required weaning earlier, some parents also felt that their "bigger" child needed more food once the weaning process was established.

P20 (line 263) – "*I don't recall ever being told sort of… even sort of suggestions of portions sizes for babies, of any sized babies let alone one who might want a little bit more. I was never told because he is a little bit bigger he may want to feed more*".

Although weaning had been established this mother continued to give large quantities of high calorific milk.

P18 (line 143) - *"but milk is still his main source of food if you like. I'd say he has half a litre of milk throughout the day. So ye, a good bottle in the morning, about 8 ounces in the morning and then 2 smaller bottles mid-morning and afternoon and then a big one in the evening."*

3.13.4 Subtheme - Parents seeking information

Parents referred to non-official sources of information including recipe books, web forums, and internet searches or from peers to guide their infant feeding decisions. Commercially pureed baby products also particularly appealed to parents.

P23 (line 146) – *"I think there's an Ella's Kitchen book and read through that advice um and all of those were some of to try vegetables first as their first foods and before fruit so they don't get too used to sweet things." (First child).*

Parents did not refer to using online material published by official sources (such as the NHS or DoH). Sources of written information provided reassurance and support to mothers, especially first-time mothers, as mothers with other children also had previous experience to guide them. If a problem was encountered, parents would resort to these sources of information for guidance, with one first-time mother saying this resourcefulness hid her lack of confidence in making decisions.

Nevertheless, parents were aware that not all websites and informational available was reliable.

P19 (line 164) – *"The internet is obviously has been very useful, but I tend to be a bit careful with things like that because I'm not sure if every forum is monitored". (First Child).*

Research was often used to justify not following advice from other individuals. Whilst there was some influence from older generations in feeding decisions, parents considered the advice they received and compared it against the guidelines and information from other resources. In multiple cases parents felt the advice from older generations was out-dated and preferred to base their decisions on research.

P03 (line 247) - *"In terms of weaning it certainly meant even from people like my mother-in-law, who are otherwise quite supportive, you have to kind of fend of the ' ohh she's a big girl and she's getting hungry, she must be ready for solids!' Actually, have you seen the inside of her stomach recently? Can you tell me that it's ready? No? Stick with the scientific evidence then that says it's probably not!" (First Child).*

Previous studies have suggested more of an influence of grandparents, particularly maternal grandmothers on influencing feeding decisions [213, 235]. Amongst the plethora of information parents receive from their own research and advice, it is easy for parents to feel overwhelmed when making feeding decisions [139].

3.14 Discussion

The results from the qualitative study have provided a valuable insight into the health beliefs and behaviours of parents with infants at risk for later obesity.

The study found that there was a positive connotation with high infant weight. The mothers interviewed talked openly about their pregnancy and the estimation of infant size from their pregnancy bump and referred to eating for two or binging on high calorific foods without any expressed concern for weight gain either for themselves or their baby. Evidence from a qualitative study exploring pregnant women's weight related attitudes and beliefs in the UK, (The Bloom Study) 2015, identified that women perceived their bodies as fragmented into "my pregnancy" (the bump) and "me" (rest of my body") [313]. Whilst women enrolled in the Bloom study were unsure of the effect of their dietary or activity behaviours on their infant "my pregnancy" most believed that their behaviours definitely affected their own weight gain "me". Maternal gestational weight gain across all BMI ranges is associated with macrosomia [40]. Macrosomia as a result of over-nutrition in utero has also been recognised to programme permanent changes to appetite with a tendency towards hyperphagia (excessive hunger) and alter satiety cues [191, 314]. Pregnancy, with multiple opportunities for regular contact with healthcare professionals is an opportune time to assist women with healthful behaviour change as they may be motivated to change for the benefit of their offspring [315]. However, studies suggest that obstetric clinicians do not routinely counsel pregnant women on weight, nutrition or physical activity, whilst the majority of women do not recall being counselled about weight during pregnancy [313, 316, 317]. Data from the current study contained no evidence of antenatal counselling on weight gain in pregnancy.

Parents also believed that familial or genetic predisposition was responsible for their heavy or rapidly growing infants, speaking with pride that their infant was continuing a familial trait. The high heritability of body weight is well established, with a systematic review reporting heritability estimates from twin studies of between 47 to 90% [318, 319]. Llewellyn and Wardle (2010) hypothesised that satiety and satiation could also be inherited [318]. Using data from the Gemini Study, a population based sample of twins born in England and Wales during 2007, the research investigated the heritability of four appetite traits in infants aged three months. The results identified that whilst heritability was moderate for food responsiveness and enjoyment of food, both slowness in eating

(84% [95% CI 83%, 86%]) and satiety responsiveness (72% [95% CI 69%, 80%]) had high heritability, suggesting that genes are playing an important role in appetite regulation from the earliest period of feeding. Parental expectation that a larger infant is inevitable because of family history can be seen as a potential barrier to adopting feeding behaviours that would help mitigate rapid weight gain, especially for those children whose parents are overweight.

There was a strong belief that a bigger child is more desirable, less fragile and healthy. The findings reinforced the idea of parents equating weight gain to health and parental concern about possible child underweight, an idea heightened in mothers who were overweight [320]. Redsell *et al.* (2010), observed parents being biased towards larger babies only amongst parents classified as overweight or obese, however this study found this belief common across accounts regardless of weight classification [213]. Fildes *et al* (2015) identified that mothers who were concerned about infant underweight were more likely to adopt pressurised feeding behaviours [92]. However the current study also identified that healthcare professionals encouraged overfeeding in response to anxieties of an infant being underweight. The role of healthcare professionals is crucial in raising awareness of the health threats of child overweight especially with infants at an increased risk, as the motivation to reduce obesity will diminish if parents continue to underestimate their infant's weight. Jeffery *et al* (2005) reported that overweight is largely unrecognised with parents being poor at identifying overweight in themselves and their children and less likely to identify overweight in sons [321]. Macrosomia prevalence rates are rising as discussed in Section1.3 and Lucas *et al* (2007 pg 127) proposes that given the value placed by parents on being like everyone else, that if "trends in infant size continue towards greater fatness, "being normal" will include infants who are fatter than those in the past [322]. This could result in parents overfeeding infants to promote weight gain until their weight reaches the 'normal' range. If so, this perceived behavioural control may be more prevalent in overweight mothers who already demonstrate increased concerns of infant underweight [320]. For those parents whose infant had lost weight there was a profound feeling of failure and an urgency to assist their infant to regain not only their weight but also their centile line on their weight chart. Weight loss in the first few days of life is a well-known clinical entity, the median and 95^{th} percentile of acceptable weight loss from the baseline (birthweight) has been defined as 6.6 and 11.8% respectively [323]. For macrosomic infants a weight loss at the 95^{th} centile can be seen as alarming.

However, the parental belief and as evidenced in the interview data the healthcare professionals belief that infants should continue to gain weight and at least remain on their birth weight centile predisposes the discontinuation of breastfeeding. Kools *et al* (2006) in a prospective cohort study evaluated the material motivational determinants to continue breastfeeding until three months [324]. Of the 220 mothers who initiated breasting 24% introduced formula feeding because of “doubts about infant growth” before three months. Given that breastfeeding may protect against rapid weight gain due to better appetite control and lower protein intake [325] the possible risk of weight loss may be a perceived barrier to continuing breastfeeding and increase overfeeding behaviours to encourage weight gain and centile trajectory preservation in breastfed infants.

The feeding beliefs of the parents interviewed in the current study demonstrated a propensity for overfeeding. A common belief is that infants need to be fed on demand and this was communicated by all of the eighteen breastfeeding mothers. Parents of formula fed infants were more reliant on times and volumes of milk than infant cues for hunger and satiety. In a recent study, Shloim *et al* (2017), video recorded mothers either breastfeeding or formula feeding their infants (n=27) and feeding cues were identified using a validated list of communication cues [326]. Breastfed infants exhibited higher levels of both engagement and disengagement cues and at a greater frequency than formula fed infants. Consequently the irregular temporal nature of feeding in breastfed babies is due to an infant-led feeding approach in which the caregiver has a higher awareness of infant hunger and satiety cues. However, the parents of infants who were formula fed reported that they fed set volumes at set times and often fed their baby a volume greater than that recommended by the infant formula manufacture. A pressured feeding style that encourages an infant to empty a bottle has been shown to increase the risk of excess weight gain by late infancy [92].

Interwoven with the belief that infants need to be fed on demand irrespective of feeding type is the belief that breastfed infants cannot be overfed. Mothers are aware that their babies are breastfeeding frequently, but are able to reassure themselves with the misconception that overfeeding was impossible, and believe that their bigger than average infant will require more milk. It is unsurprising that mothers believe that they cannot overfeed a breastfed infant as this is the mantra that Health Visitors and Midwifes have to promote. The current advice on the NHS website states, “don’t worry about feeding your baby whenever either of you wants. You can't overfeed a breastfed baby, and your baby won't become spoilt or demanding if you feed them whenever they're hungry or need comfort." [327]. However although breasting feeding is a protective factor, in countries with high levels of breastfeeding (i.e. without the social bias) overweight breastfed infants are as likely to become overweight children as overweight bottle fed infants, (OR=4.102; 95%CI 2.912,5.778) [328]. Rapid weight gain is an independent risk factor for childhood overweight [12]. As these ideas were prevalent in many of the interviews, it is clear that there are a number of misconceptions resulting in inappropriate feeding behaviours. In order to effect a social change in infant feeding a concerted inclusive message to parents via health, community groups and the media is required to assist in combatting childhood obesity.

Parents acknowledged that they used food in response to infant cues other than hunger. Feeding to soothe was also recognised as a feeding behaviour by Redsell *et al* (2010) who found that parents over-attribute infant distress as hunger. Although breastfed infants are able to self-regulate and provide cues for hunger, appetite and satiation, where mothers are not receptive of these cues either during a feed or when adding extra feeds, unresponsive feeding or feeding to soothe may result in overfeeding the infant [326]. Shloim *et al*. (2017) noted lower sensitivity to infant's feeding cues at 6 months was positively associated with a higher weight gain at 12 months and 2 years. Missing satiation cues or responding to difficult temperament and/ or feeding to soothe are all potential pathways whereby breastfed infants can be potentially overfed [187, 326]. As discussed previously, infancy is a vital time for developing the capacity to regulate hunger. Mismatched feeding cues, such as feeding when the infant is not hungry, can interfere with this and impede proper development of responses to hunger and satiety, which is theorised to be linked to the development of obesity [131].

Early weaning was reported as a direct result of an infant's physical development and the reasons stated included posturing towards food, head control, and teething and the parents' believe that this advancement in their baby's development is a cue to introduce solid foods. However, early weaning has been linked to rapid weight gain [329], a known risk factor for obesity, which amplifies the risk for these bigger babies who are already at an increased risk. Findings from the qualitative study by Walsh *et al* (2015), found that mothers felt that they were depriving their babies by withholding food until the recommended time of 6 months [139], so it is possible that this feeling is heightened in mothers of bigger infants who they already perceive to be hungrier. Vail *et al* (2015) identified that age of weaning was inversely associated with infant size suggesting that parents are using infant size as an indicator to commence weaning. Infant size and the belief that parents were unable to maintain their child's appetite on milk alone was frequently cited by parents as the reason for early weaning in the current study further supporting the notion that bigger infants require modified weaning.

All of the participants in the current study reported interactions with either Midwives or Health Visitors and reported that they had sought advice and information on caring for their infant. From the research sample only one mother had a direct communication from a Practice Nurse with regard to her infant's weight status which she dismissed as she believed that the practitioner with the most knowledge on infant growth was her Health Visitor who had expressed no concerns with her child's growth. None of the parents interviewed identified concerns with regard to their infant's weight. A systematic review of lay beliefs about infant size and growth identified that notions of healthy size and growth were dominated by the concept of normality. Lay participants created "norms" by assessing and comparing size and growth against several reference points including: medical definitions, comparisons with other children, use of clothing sizes, inherited differences, and quality of care. All of which were referred to throughout the interviews. However, when size or growth differed from these norms, explanations were sought that could account for this difference. Only when no plausible explanation could be found did growth or size become a worry for parents [322]. Walker *et al* (2007) found that community staff, including General Practitioners and Practice Nurses were reluctant to speak to mothers with regard to infant overweight reporting concerns about the sensitive nature of the subject and the negative effect that bringing attention to a child's weight might have on their relationship with the family unit [330]. Redsell *et al* (2017; 2011) also encountered similar responses from Health Visitors, General Practitioners and Practice Nurses [206, 331]. However, despite a greater knowledge of the health risks associated with obesity, General Practitioners and Practice Nurses reported a low level of concern about infants who may be at risk of developing childhood obesity [331]. Whilst community staff with regular contact with infants may be concerned with preserving a positive relationship with a family unit the failure to acknowledge infants at risk of early childhood overweight/obesity could be viewed by parents as affirmation of successful parenting and a positive indicator of infant's health.

3.15 Conclusion

The promotion of healthy feeding is recognised as being an important obesity prevention strategy. But parental efforts to achieve healthy infant feeding are strongly influenced by individual, cultural and societal beliefs [205]. This study has shown how the parental beliefs of caring for at risk infants might influence feeding behaviour.

The study found that parents are unconcerned about infant size and that there is actually an expectation that an infant will be big and this expectation starts in pregnancy. There were no anxieties expressed by any parent in regard to their infant's size and equally there were no concerns on the impact of further health. Weight gain is believed to be healthy and a positive indicator of successful feeding. Mothers although they recognise that they feed to soothe or to manipulate an infant's behaviour (i.e. sleep), they fail to recognise these behaviours as overfeeding. There was evidence of mismatched feeding cues with the belief that breastfed infants cannot be overfed. Infant size was taken as an indicator to commence weaning with parents believing that a bigger infant required more food, which in infants with a genetic predisposition to obesity can only increase the risk of later overweight/obesity.

All of the parents reported regular contact with healthcare professions for growth and development reviews. Yet only one mother received advice on overfeeding. Whilst parents reported that healthcare professionals had concerns with regard to weight loss and encouraged feeding practices to compensate for that weight loss, the ambiguity surrounding rapid weight gain from healthcare professionals was understood by parents to be an acknowledgement of healthy infant growth. Whilst Redsell *et al* (2017) reported that Health Visitors had anxieties about raising the topic of weight with parents, healthcare professionals need to recognise the impact of rapid weight gain on future obesity risk and that parental feeding beliefs may be modifiable [206]. The parental beliefs identified are all underpinned by the propensity for overfeeding with a desire for weight gain rather than feeding in response to their infant's hunger and satiety cues. The findings from the current study identify two main areas for investigation. Firstly healthcare professions working with preschool children are aware that the prevention of child overweight should begin early and focus on the parents as the primary agents of change. However, it has been identified that healthcare professionals have anxieties with regard to labelling a child and alienating the family unit. The second is that parents appear to be unconcerned about their child's weight and the associated impact on lifelong health. Therefore, the focus of the thesis now seeks to discuss the implications of the results and the potential impact on clinical practice.

3.16 Strengths and limitations

The aim of this study was to explore parental beliefs around caring for infants with risk factors for child obesity with a view to informing the development of a targeted behaviour change intervention. A key strength of this study is the recruitment of parents of an infant with a major risk factor for early childhood obesity; either macrosomia and/or rapid weight gain. Recruiting participants via Sure Start Childrens Centres in socially deprived areas was also a strength of the study. However, the participants who volunteered were more socially advantaged educationally. Breastfeeding mothers and two-parent families were also overrepresented. As we did not record the participant's postcode we were unable to show the proportion of socio-economically deprived participants. It may have strengthened the diversity of the recruits if following NHS ethical approval, we had recruited from NHS clinical lists. However, as Redsell *et al* (2017) cautions this could potentially reduce parental engagement [206].

One of the researchers, who undertook the field work for the study, is a qualified Health Visitor the other two are medical students not yet in clinical practice. The 'health-care professional-as-researcher' is uniquely placed as they are already immersed in the field and have important insights into patient issues [332]. However, they can add a significant power imbalance and raise difficulties for participants in how free they feel to be open and/or critical [333]. At the time of the study the researcher was not practising and this information was shared with the participants. This research was undertaken in areas where the researcher had never practised and, therefore, could not have had a professional relationship with the parents.

4 CHAPTER FOUR

4.1 Summary of key findings

In an area with a high rate of child obesity, the overall prevalence of macrosomia in the 2008 Nottingham birth research cohort was 12.2%, higher than the 2008 national rate of England and Wales which has been reported as 11% [160]. Temporal trends of average birth weights are increasing with birthweight distribution of live single births shifting towards heavier births [334]. Male infants were found to have a 1.9 increased risk of macrosomia and a 1.4 increased risk of rapid weight gain compared to females. Asian ethnicity appeared to be protective for both macrosomia (54%) and rapid weight gain (30%) compared to White infants. Black ethnicity was associated with over a three-fold increased risk of being overweight at aged two.

The relationship between the independent risk factors for childhood obesity and deprivation was not straightforward. Infants in the most deprived area had a lower rate of macrosomia compared to the moderately deprived area (quintile 3), whilst infants in the most deprived areas (quintile 1 and 2) had a 1.2 increased risk of rapid weight gain compared to the least deprived areas (quintile 3, 4 and 5). For those infants born macrosomic in the most deprived areas, the risk of rapid weight gain increased more than two-fold compared to infants in the least deprived areas. Being classified as macrosomic at birth increased the infant's chances of being overweight at age two by 3.9. For those infants who grew rapidly in their first year, they had an 2.4 increased chance of being overweight at aged two.

For infants who were born big and/or grew rapidly, analysis of the interview data revealed a number of parental beliefs that were likely to maintain this situation. Parents were unconcerned about their child's high weight and justified high weight status with a variety of explanations including familial traits: "*He's (father) very tall and fairly broad he's 6 2 I think and yeah fairly sturdily built (laughter) so yeah she was always going to be she was never going to be a petite dainty little thing I don't think*".

Weight gain was believed to be positive and indicative of health and parents also held the belief that maintaining or crossing centile lines was a reflection of a successful feeding regime as revealed in the following example: *"He was tracking on his line like nicely so he was eating a good amount."* The belief that weight gain is an indicator of health can also be attributed to Health Visitors too. Parents reported being encouraged to add top up feeds by Health Visitors to encourage weight gain, and in the case of one mother the lack of concern demonstrated by the Health Visitor for her rapidly growing child was evidence of approval and as such she refused to see her General Practitioner when invited to discuss her son's weight.

Parents' understanding of feeding baby demonstrated a propensity for overfeeding. Many of the parents held the belief that their infant should be fed on demand, equating a crying child with a hungry child as expressed by this mother *"As soon as she'd cry she was on the boob feed her you know, I didn't wait and think oh it was only 10 minutes ago she can't be hungry again, we just put her on all the time."* For those mothers who breastfed there was a strongly held belief that you cannot overfeed a breastfed infant and therefore both hunger and satiety cues could be overlooked as succinctly put: *"Boob solves everything, nothing else will".*

Parents' weaning decisions were heavily influence by infant size with parents believing that bigger infants required earlier weaning and more food was related to their size and not their age as stated by this mother: *"He's having baby porridge, 'cause obviously he's a big baby and 'cause he was just constantly wanting to feed on to me… Only a little bit, just 'cause he needed something else." "He wouldn't have been able to cope until he's 6 months! He'd be wasting away!"* Parents discussed feeling overwhelmed by the plethora of feeding advice available in the actual and online communities and this led to overfeeding practices with parents reporting that they were guided by their infant with respect to food quantities.

4.1.1 Limitations with infant weight data.

As discussed earlier in the thesis a limitation of the quantitative research was the large quantity of missing data. The majority of one year lost to follow up infants resided in NHS Nottinghamshire County (n=3782). During the early stages of analysis the data was interrogated to identify whether the missing data was unique to one particular Nottinghamshire Primary Care Trust (PCT), as in 2008 Nottinghamshire was comprised of six individual Primary Care Trusts. There appeared to be a uniform distribution of missing data across those six PCTs. The interrogation then focused on child growth surveillance to identify differences in practice between Nottinghamshire County PCTs and Nottingham as a single PCT. Utilising a clinical network facilitated by a Health Visitor Team Leader recruited as a patient and public involvement (PPI) volunteer, we were able to ascertain that there were in fact differences in child growth surveillance between Nottingham PCT and the Nottinghamshire County PCTs. The two main differences were the introduction of "self-weigh" clinics, in which parents could weigh their infant and self-record the infant weight in their Personal Child Health Record (PCHR), which bypassed uploading to SystmOne. General Practitioner practices had also adopted growth measuring as part of the child vaccination schedule. Currently, the NHS has no integrated personal care record system. General Practitioners as independent practitioners are able to utilise an electronic patient record system that meets their needs, however, not all patient record software can feed into and update the central NHS database, SystmOne.

4.1.2 Association between obesity and deprivation in young infants.

The association between socioeconomic status and risk factors for early child overweight has previously produced conflicting evidence. Analysis of the Quebec Longitudinal Study of Child Development (QLSCD) data collected from a prospective cohort of children born in 1998 used two measures of socioeconomic status, maternal education and house income at birth [26]. In this cohort (n=2,103) 10.7% were born macrosomic, however there was no statistical association between macrosomia and either maternal education or household income at birth. Rapid weight gain was not measured in this study. In adjusted analysis, low income at birth (<$20,000) was associated with a 2.2 increased risk of overweight at age 4.5 years compared with high household income at birth (≥$60,000). There was no association with maternal educational level.

The results from the UK Millennium Cohort Study, a prospective nationally representative study of children born between 2000 and 2002, utilised three measures of socioeconomic status, maternal education, maternal employment and annual household income [24]. Although this study found some evidence of a socioeconomic gradient in childhood overweight at age 3 (at p=0.1 level) in unadjusted analysis. Once the model was adjusted for individual, family, community and area-level factors, only lone parenthood status was significant in the final model. Following a systematic review and meta-analyses of risk factors for childhood overweight identifiable in early infancy, no association was found between socioeconomic status at birth measured by maternal education and the risk of overweight in childhood [13].

One of the aims of this thesis was to establish an association between obesity and socioeconomic deprivation in young infants. However, this relationship was not straightforward. In the deprived area there was a lower rate of macrosomia compared with the moderately deprived area. An explanation for this non-linear relationship may be that the most deprived quintile includes a higher proportion of younger mothers, mothers with low birthweight infants, and mothers who have lifestyle behaviours which affect foetal growth such as smoking. Maternal smoking during pregnancy is associated with foetal growth retardation, an increased risk of pre-term delivery, and low birthweight [335]. Adult smoking prevalence is highly associated with socioeconomic status. In 2007, the Health Survey for England reported that there was a 2.5-fold difference in female smoking prevalence for those living in the poorest households in England compared to those in the most affluent (HSE 2007 32% v 13%) [336]. Although maternal smoking in pregnancy can result in foetal growth restriction, studies have also found that infants exposed to smoking in utero exhibit rapid postnatal weight gain [337, 338]. However, maternal smoking in pregnancy may itself be a proxy marker for socioeconomic circumstances and might be confounded by other lifestyle factors, such as poor diet [12, 339]. The subsequent rapid infant weight gain resulting from these maternal lifestyle factors is a well-established risk factor for later child overweight. At age 5, there is a strong positive relationship between deprivation and obesity prevalence. The results from the National Child Measurement Programme, England (2012-2013), identified that obesity prevalence among Reception children attending schools in the least deprived decile was 6.4% compared to 12.1% among those attending schools in the most deprived decile [183].

For the Nottinghamshire 2008 birth cohort, the non-linear association between macrosomia and deprivation may have been influenced by maternal lifestyle behaviours. At birth these infants exhibit rapid growth, suggesting that these infants are using a survival mechanism to "catch up" on growth with an abnormally high velocity until the original or normal growth trajectory is reached [53, 184]. Although there was a 1.2 increased risk of rapid weight gain for infants born in the most deprived areas compared with least deprived, the large proportion of missing data at year one, especially from those infants in the more deprived areas is likely to have underestimated rapid weight gain rates.

A systematic review of prospective observational studies, Weng *et al* (2013) identified strong evidence that high birthweight, early rapid weight gain, maternal pre-pregnancy overweight, and maternal smoking in pregnancy increased the likelihood of childhood overweight [13]. From this systematic review, most of the identified risk factors are static (non-modifiable) [13], however, early rapid weight gain may be dynamic (modifiable) if healthcare practitioners recognise this infant growth pattern of concern.

4.1.3 Identifying an infant's weight trajectory

Studies have repeatedly shown a robust association between rapid infant weight gain and subsequent childhood obesity as an outcome measure [340]. The World Health Organisation (WHO) advocates the use of the weight for age Z-score classification as an outcome measure in children, as it expresses the anthropometric value as the number of standard deviations (SD) below or above the reference value.

For population-based use interpreting the results in terms of Z-scores has several advantages:

1. Z-scores have the same statistical relation to the distribution of the reference (around the mean at all ages) which makes results comparable across ages, groups, and indicators.

2. Z-scores can also be sex independent so permitting the evaluation of children's group status by combining age and gender groups.

3. The characteristics of Z-scores allow further calculation of summary statistics to classify a population's growth status [341].

However, calculating a Z-score requires an accurate measurement of both weight and age and clinicians may be hesitant to calculate the score, although online Z-score weight for age calculators are available such as http://www.who.int/childgrowth/standards/weight_for_age/en/.

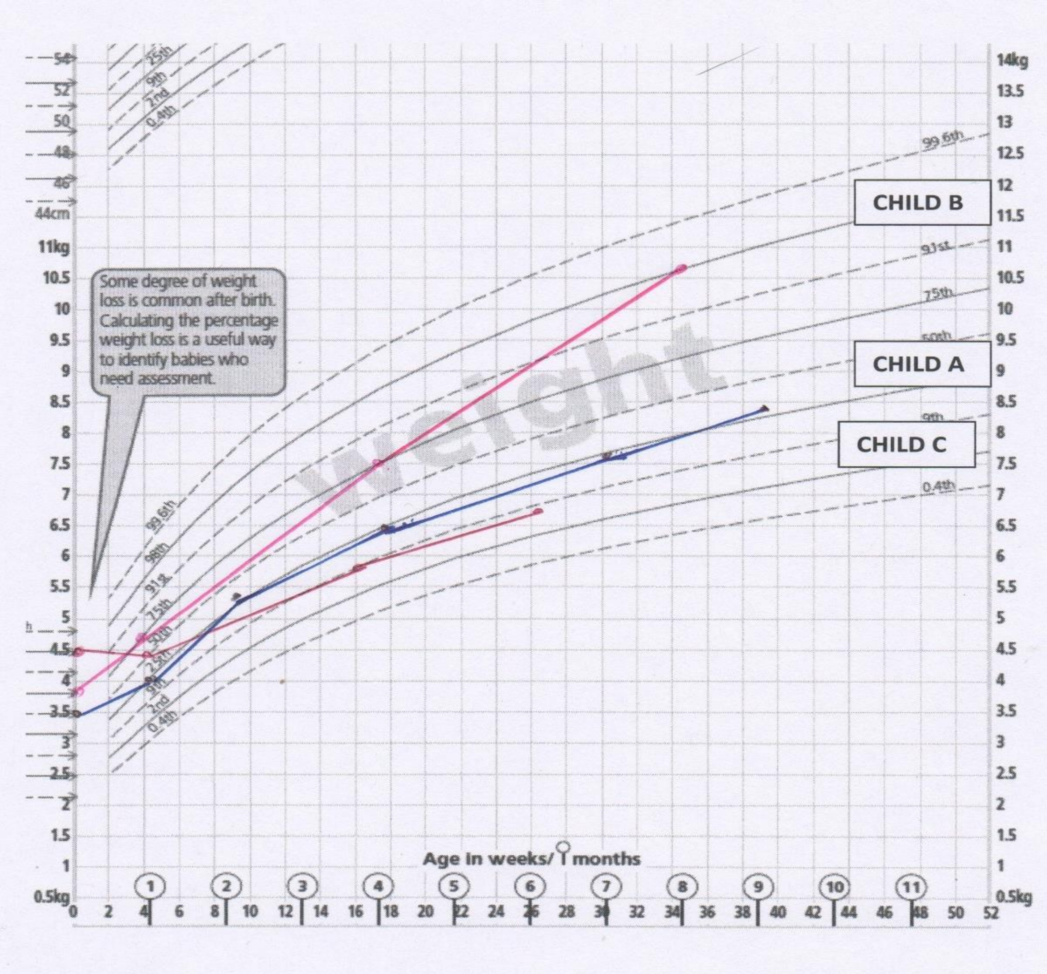
Clinically an increase of 0.67 SD represents an upward crossing of one centile band when plotted on a gender-specific weight-for-age centile chart, representing rapid weight gain [342].

Within the NHS Healthy Child programme [147] between birth and a child's first birthday there are a minimum of three universal contacts with community health teams, including Midwives, Health Visitors, and General Practitioners during which an infant weight should be measured and monitored.

4.1.4 Interpreting growth trajectories in clinical practice

The weight of an infant plotted over a period of time is expected to track fairly close to the weight for age Z-score, represented by a centile band on the gender-specific weight for age centile chart. This is classified as normal growth (Table 23 CHILD A). As discussed previously (section 2.3.4) with rapid weight gain, weight plotted on a gender-specific weight for age centile chart will display a weight gain trajectory that upwardly crosses one or more centile bands (Table 23 CHILD B). Conversely, an infant with a high birth weight or following rapid weight gain may experience a period of slow growth which realigns an infant's body weight to their genetically determined trajectory, catch down growth (Table 23 CHILD C).

Table 23 - Normal, rapid and catch down growth examples.



It has been suggested that following the escape from the strong maternal influence on intrauterine growth, large for gestational (LGA) infants return to their genetically-determined growth trajectory [343]. In 1980, Davies *et al* reported a rapid downwards shift in length in the first three months of life in LGA infants as well as slower than average weight gain in the first six months [343]. Taal *et al* (2013) further confirmed catch down growth in LGA infants in both length and weight occurs in the main in the first six months of life [344]. In addition, Chiavaroli (2015) reported that LGA infants display slower length and weight velocity, so by the age of six months LGA infants are anthropometrically similar to infants born appropriate for gestational age [345]. From Study Two there are reported examples of Health Visitors encouraging overfeeding of macrosomic infants in order that they maintain weight gain, represented by tracking their centile band. Yet these infants may have been demonstrating catch down growth. As catch down growth affects both length and weight, the trajectory of both weight and length will both appear to level off.

There is a strong emotive response from mothers whose infants appear to be either losing weight or gaining weight slowly which are reported in Study Two. Therefore it is imperative to clinically recognise and report to parents the signs that an infant is feeding well (Figure 8).

Figure 8 - Clinical Signs that indicate an infant is feeding well

- He/she has a healthy layer of body fat
- He/she is outgrowing their clothes
- He/she displays hunger
- He/she appears satisfied by the amount that he/she is willing to drink
- He/she is energetic and active
- He/she is generally content between feeds (except when bored or tired)
- He/she sleeps well
- He/she has 5 or more wet nappies in a 24 hour period
- He/she has regular bowel motions.

Bennett, R. 2016 Catch down growth
www.babycareadvice.com/article/detail/Catch-down_growth *[346]*

All catch down infants will require careful monitoring until the genetically appropriate growth trajectory is achieved. The empirical evidence reviewed in this chapter suggests that this is within the first six months of life.

However, rapid weight remains a strong independent risk factor for early childhood obesity. The results from Study One found that rapid weight gain was associated with a 2.4 increased risk of being above the 91^{st} centile for weight at age two. Additionally, although the sample size was small (n=36), infants in the two most deprived quintiles with macrosomia had twice the risk of having rapid weight gain compared to macrosomic infants in the three least deprived quintiles. Therefore for some LGA infants, the same obesogenic environment which predisposes macrosomia may also increase the risk of rapid weight gain.

4.1.5 Implications for practice

Health Visitors need to be aware that catch down growth is a compensatory growth pattern that realigns the infant's growth pattern to their genetically determined trajectory. By advocating overfeeding in order to achieve concordance with weight for age growth reference curves, they are inadvertently altering the hunger and satiety cues.

Community healthcare providers including Health Visitors, General Practitioners, and Practice Nurses must better understand patterns of healthy growth and those of concern and communicate these effectively to parents and carers of infants.

There is strong evidence that early rapid weight gain increases the likelihood of childhood obesity [12]. Yet in Study One over 40% of infants had no weight recorded on SystmOne at one year. In order to identify rapid weight gain, the infant's weight needs to be known. Therefore, the introduction of a Health Visitor universal child growth review between the existing birth and one year contacts would provide an opportunity to identify and monitor growth patterns of concern. As discussed in section 2.5, rapid weight gain has been associated with early life feeding. The data from Study Two identified that parents' understanding of feeding, demonstrated a propensity for overfeeding, and parents' weaning decisions were heavily influenced by infant size. For infants weaned early, the higher dietary intake at four months has been associated with greater gains in weight between birth and ages 1, 2, and 3 years [347]. Therefore, if a universal child growth review was initiated at four months and a rapid weight gain indicator introduced on SystmOne, nationally, healthcare professionals would be able to readily identify infants who may benefit from early intervention to reduce the risk of early childhood obesity.

4.1.6 Early interventions for preventing childhood overweight

Parental practices for infant feeding may have a direct impact on the quality and quantity of food intake, rapid infant weight gain and the development of obesity in later life [348]. Infants self-regulate their energy intake from birth with feeding initiated in response to hunger and concluded in response to satiation signals [349]. Infants, in particular, are dependent on parents and caregivers for feeding, and ultimately an infant's ability to self-regulate is influenced by parental or caregivers decisions about how and when to feed a child [349]. The use of food as a strategy to soothe infants is also associated with poor sleep habits and may also be a contributing factor in weight gain [350].

A systematic review of randomised controlled trials of interventions that aim to reduce the risk either directly or indirectly, of overweight in infancy and early childhood identified 27 unique trials [351]. The interventions identified were designed to reduce the risk of overweight and obesity from birth to seven years of age and included those that commenced antenatally and/or during the first two years of life. The review found that interventions that aim to improve diet and parental responsiveness to infant cues improved feeding practice and had some impact on child weight. A further systematic review that included both complete and incomplete interventions occurring in the first 1,000 days (from conception through to 24 months) included the prevention of childhood overweight/obesity as an outcome between 6 months to 18 years [352]. This review found only a small number of effective early life interventions for childhood obesity with only two of the published interventions meeting all criteria for high quality study design, the NOURISH trial [204] and the German Infant Nutritional Intervention study which studied the long-term effect of hydrolyzed protein infant formula on growth [353].

It would appear that interventions that target parental feeding behaviours that influence hunger and satiety cues and soothe to sleep techniques may contribute in the reduction of rapid infant weight gain. In Chapter Three (section 3.2) the WIC (Kavanagh 2008); SLIMTIME (Paul 2011) and NOURISH (Daniels 2013) randomised controlled trials were reviewed [201, 204, 354]. Additionally, published in 2016, the INSIGHT parenting intervention had a central hypothesis that responsive feeding will promote self-regulation and shared parent-child responsibility for feeding reducing the risk of overeating and overweight [355]. Developed from the SLIMTIME pilot [354], the study design was a two-arm randomised controlled trial recruiting all English speaking mothers over the age of 20, with a singleton full-term infant. In this study, nurses delivered interventions in both study arms during four home visits in the first year, followed by annual follow up visits at a clinical research facility at ages 1, 2 and 3 years.

The intervention arm comprised of obesity prevention messages delivered at each home visit that included infant feeding, sleep hygiene, active social play, emotion regulation, and growth record education. The control group received developmentally appropriate home safety messages. Although the priori outcome measure for the study was BMI Z-score at 3 years, in the interim published paper the main outcome measures were conditional weight gain from birth to 28 weeks and overweight status at age 1. In addition, the randomisation scheme stratified on both birthweight for gestational age ($<50^{th}$ or $\geq 50^{th}$ percentile) and intended feeding mode (breastfeeding or formula feeding). Conditional weight gain (CWG) was calculated as reported by Griffiths *et al* (2009) [356] as the standardised residuals from the linear regression of the 28-week weight z-score on birthweight z-score, with age and sex entered as covariates. The conditional weight gain z-score has a mean of 0 and a standard deviation of 1 and is normally distributed. A positive value indicates a faster, and a negative value a slower rate of weight gain compared with the population mean weight gain.

The study cohort comprised of 279 mother-infant dyads and attrition at 28 and 52 weeks was reported at 3.6% and 10% respectively. All missing data were imputed. The results show that at 6 months the mean CWG was negative for the intervention arm (mean -0.18; 95% CI -0.36 to 0), whilst the CWG for the control arm was positive (mean 0.18; 95% CI 0.02 to 0.34). At age 1 there were 5.5% (n=7) infants classified as overweight (weight for length ≥ 95th centile) compared to 12.7% (n=16) in the control group. The effect of the responsive parenting intervention on CWG from birth to 28 weeks did not vary by feeding mode and the results for birthweight stratification were not reported. The results for the priori outcome measure, BMI z-score at 3 years were published in 2018 [357]. It was reported that the interventional group had a lower mean CWG BMI z-score at -0.13 than the control group 0.15. The absolute z-score difference for the two groups was less than the pre-specified clinical definition of rapid weight gain (0.67 SD), at 0.28 SD.

The INSIGHT trial did not explicitly focus on nutrition, feeding, and obesity in discussion with parents, opting to use a "stealth" approach to preventing childhood obesity [355]. Stealth does not imply deception or manipulation in this context but the process of motivating a behavioural change. Robinson (2010) suggests that behavioural change depends on two types of motivation [358]. One is motivation to adopt behaviour and achieve a particular outcome – outcome motivation. The other is motivation to participate in the intervention itself – process motivation. Medical and public health interventions tend to focus on outcome motivation by focusing on the risks posed by obesity and other chronic health states. As motivating forces such as fun, choice, social interaction, sense of accomplishment and peer approval/disapproval are the factors that are more likely to predict whether an individual will participate in the process of behavioural change. Robinson (2010) suggests that it is the process that is important and therefore, interventions can be successful if designed to focus on intrinsically motivating characteristics of behavioural change without appearing to be directly related to obesity, a "stealth intervention". In the INSIGHT trial the mothers were invited to participate in a research study the purpose of which was "to see if nurse visits to your home during your baby's infancy can improve your ability to either respond to your child's cues related to feeding and fussiness or improve your ability to provide a safe environment for your child and prevent injuries" ([355]page e3).

The results showed a significant difference in weight gain in the first six months between the intervention and control arms. However, by log-transforming highly skewed data to less skewed, the analysis has effectively flattened the growth trajectory from birth to six months. It is difficult to assess the differences in weight gain between the two arms or to determine whether a specific interventional message, i.e. delay weaning, had an effect. As the study was powered to detect a 0.67 difference in BMI z score at 3 years, to provide consistency the results at six months could have been presented to detect a 0.67 difference in weight for age z score at 28 weeks. At 1 year although overweight status is reported as a classification of weight for length ≥ 95^{th} centile, for the UK-1990 classification this represents obesity. Given the small number of obese one-year-olds in the intervention arm, it is difficult to ascertain whether these infants remained big or had undergone a period of rapid weight gain. The study reports that the mothers were recruited from a single hospital and as a group were well educated, therefore the results cannot be generalised to other populations.

For the universal early interventions for preventing childhood obesity that showed promise on parental behaviour and rate of infant weight gain, the inclusion criteria included all first-time singleton infants born at term. Although the SLIMTIME pilot study stratified randomisation by pre-pregnancy BMI to either below $25Kgm^2$ or above $25Kgm^2$, this stratification was dropped in the INSIGHT randomised control trial. The modest results reported in these studies may be improved if the interventions were targeted towards infants at greater risk of early childhood overweight.

The results from Study One indicated in unadjusted analyses that infants born in the more deprived areas (quintiles 1+2) had a 1.2 times increased risk of rapid weight gain compared to the least deprived areas (quintiles 3, 4 +5), However, after controlling for the other predictors, there was no association between IMD quintile and rapid weight gain. Weng *et al* (2013) systematic review and meta-analyses, also found no association between socioeconomic status at birth and the risk of overweight in childhood [13]. Therefore, responsive parenting educational interventions for the primary prevention of obesity may be more effective if the interventions were targeted towards infants with rapid weight gain rather than socioeconomic status.

4.1.7 Targeted early interventions for preventing childhood overweight

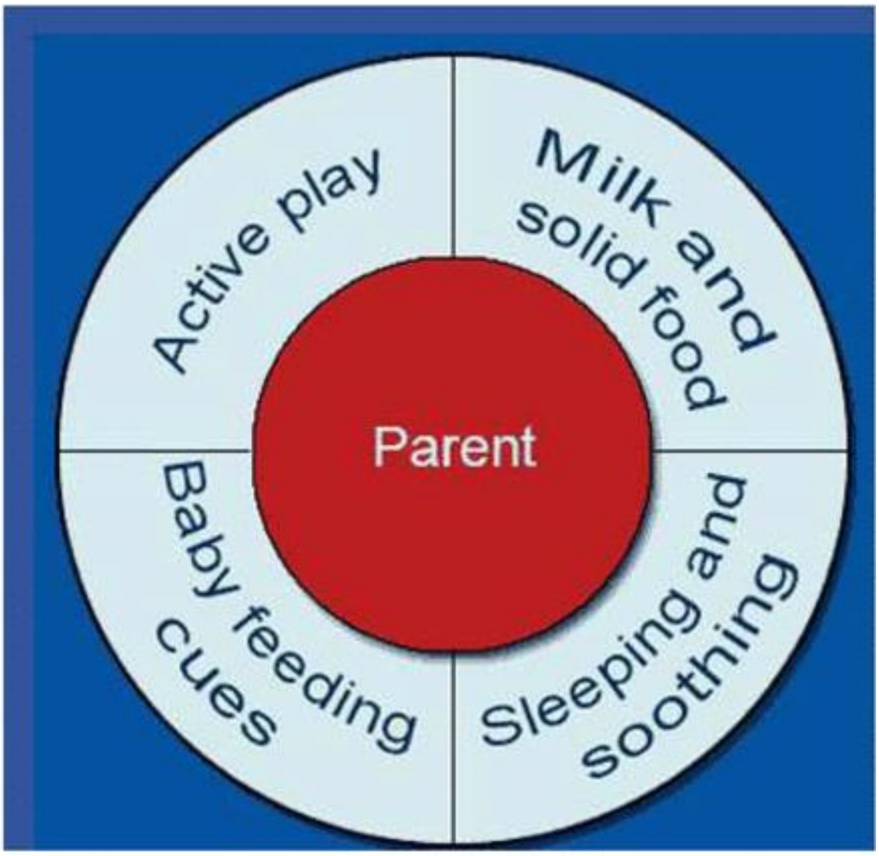
Weng *et al* (2013) utilised the UK Millennium Cohort Study data with the aim of developing and validating a risk score algorithm for childhood overweight based on a prediction model in infancy [13]. The strongest factors predicting overweight at age three were found to be; female gender, rapid weight gain in the first year of life, high maternal pre-pregnancy BMI, high paternal BMI and never breastfed. Socioeconomic status did not improve the prediction. Following categorisation of the risk factors, an integer score was assigned and the Infant Risk of Overweight checklist (IROC) was developed that predicts the risk score of a child being overweight at age three (Figure 9). The IROC checklist was validated using the data obtained from the Avon Longitudinal Study of Parents and Children (ALSPAC) children-in-focus prospective birth cohort that followed up children and their families until five years of age [15]. The results confirmed that the IROC algorithm is a valid measure of risk predicting overweight in childhood up to the age of five.

Figure 9 - Risk Scoring algorithm for overweight risk in children derived from Weng *et al* (2013) using factors that can be identified in the first year of life [12, 13, 15]

Risk Factors	Categories	Score
Gender	Male	0
	Female	2
Infant birth weight (kg)	<2.93	0
	2.93- <3.24	1
	3.24-<3.49	3
	3.49-<3.81	5
	≥3.81	7
Infant weight gain	≤0.67 SD	0
	>0.67 SD	19
Maternal BMI (kg/m^2)	<18.5	0
	18.5- <25	8
	25- <30	12
	≥30	15
Paternal BMI (kg/m^2)	<18.5	0
	18.5- <25	1
	25- <30	6
	≥30	9
Mum smoked in pregnancy	No	0
	Yes	4
Ever breast fed	Yes	0
	No	3
Total Risk Score	--	0-59
Risk Score Categories	Very Low Risk	0-15 (4.1% to 11.1%)
	Low Risk	16-19 (11.8% to 14.2%)
	Medium Risk	20-24 (15.1% to 19.1%)
	High Risk	25-37 (20.2% to 37.2%)
	Very High Risk	38-59 (38.9% to 73.8%)

To assess the feasibility and acceptability of using digital technology incorporating the IROC checklist for the proactive assessment of obesity during infancy (ProAsk), a multicentre, pre- and post-intervention feasibility study with process evaluation was conducted [206]. The ProAsk intervention comprised of two stages. Firstly, the IROC assessment of infant risk status, resulting in either a (population risk) "your baby’s risk of being above a healthy weight is the same as other babies" or an (above population risk) "your baby’s risk of being above a healthy weight is more than other babies" outcome score. Following the assessment, Health Visitors offered parents who received the above population risk score an opportunity to explore the therapeutic wheel [206](Figure 10).

Figure 10 - Therapeutic wheel showing the options to support a healthy weight.



Redsell *et al* 2017

The therapeutic wheel is an interactive graphic promoting evidence-based behavioural change strategies in four domains: active play; milk and solid foods; sleep and soothing and infant feeding cues. It was designed to prompt Health Visitors to use a motivational interview approach to build parental self-efficiency for agreed behavioural goals, which were supported by leaflets left with the parent as a cue to action for behavioural change.

Motivational interviewing (MI) can be defined as a directive, client-centred counselling style for eliciting behaviour change by helping clients to explore and resolve uncertainty [359].

Compared with nondirective counselling, it is more focused and goal-directed [360]. In a critical review, MI has been found to be effective in the promotion of change with a wide range of health behaviours [361]. The principles of MI are succinctly illustrated by the acronym RULE as shown in Figure 11 [359].

Figure 11 - Principles of MI illustrated by the acronym RULE

R: Resist the righting reflex.

U: Understand and explore the patient's own motivations.

L: Listen with empathy.

E: Empower the patient, encourage hope and optimism.

Rollnick; Miller and Butler 2008 Chapter 1 pg 7

In adults a North American study, project CHAT, examined the use of motivational interviewing on weight loss at 3 months post intervention [362]. Adult patients with a BMI ≥25 attending for primary care non-acute visits were recruited to attend an encounter with a physician one week later. The mean length of the MI was reported at 3.3 minutes. Quality of the MI was evaluated using three assessment tools. Firstly, the Motivational Interview Treatment Integrity scale (MITI) stated as a reliable and valid assessment of motivational interview technique. In addition an assessment of the global rating of "empathy" and motivational interview "spirit" which included three components: evocation (eliciting patients own reason for change), collaboration (acting as partners) and autonomy (conveying that change only come from patients).

For patients whose physician had a high global motivation interview “spirit” score (ie collaborated with the patient) the estimated weight loss at three months was 1.6kg (95% CI -2.9,-0.3) compared to those whose physician had a low global motivation interview “spirit” score gaining an estimated 0.2kg (95%CI -.02,0.6). In this study, 426 (92%) of recruited patients completed the three-month follow-up. The correlation between baseline and three-month weight was estimated at 0.98 indicating that for this study regression to the mean did not occur. This study convincingly supports motivational interviews for weight management in adults were even a three minute MI-based intervention can promote weight loss. As maternal obesity is the strongest independent risk factor for macrosomia [21, 40], interventions that use motivational interviews to prevent excessive gestational weight gain in overweight/obese pregnant women may improve the outcomes for both mother and child.

A Swedish pilot study evaluated the effect of a behavioural intervention for pregnant women with a BMI ≥30kgm^2 on gestational weight gain and postpartum weight retention [363].

The published study reports the results of the first 50 women recruited to the intervention and the matched controls. Both the intervention and control group received standard antenatal care comprising of approximately 9 midwifery visits throughout the pregnancy. All the Midwives engaged with intervention were trained in motivational interviewing. The intervention group also received two extra 30 minute appointments early in pregnancy and an additional 5 minutes per routine visit dedicated to lifestyle coaching. All the women in the intervention group were offered individualised dietary advice, a prescription for physical activity, walking equipment, access to food discussion groups and information on community health centres. The highest uptake rate for the optional services was for pedometers with 50% of the intervention group using the device. Weight was recorded at each antenatal visit for both groups.

The results identified that the mean total weight gain for the intervention group was 8.6 kg compared with 12.5kg for the control group. For postpartum weight retention, the intervention group had a mean BMI of 33 kgm^2 (enrolment BMI mean=33.1 kgm^2) whilst the control group had an increased mean postpartum BMI at 33.3 kgm^2 (enrolment BMI mean=32.6 kgm^2). Although it is not possible to determine which parts of the intervention were the most effective. The findings suggest that for obese pregnant women adhering to and completing a short-term antenatal healthcare intervention can limit both gestational and postpartum weight gain.

Although stated in the NHS (England) National Health Visiting Service specification 2014/15 [364] that motivational interviewing is a remit of the Health Visiting service, most Health Visitors in the ProAsk study showed parents all the preventative information available on the therapeutic wheel rather than guiding them towards their own goals for behaviour change, suggesting that that Health Visitors found this approach challenging in a subject area that they found uncomfortable [206].

Macrosomia and rapid weight gain are well established independent risk factors of early childhood obesity [102] and rapid weight gain is potentially modifiable if identified during early life [206]. Presently, the Health Visiting teams have the skills to promote evidence-based behaviour change strategies through motivational interviews, delivered using the ProAsk therapeutic wheel interventions. Yet despite identifying these at-risk infants, there is a gap between identification and the delivery of the intervention in clinical practice. Whilst the IROC algorithm can identify infants at risk of early childhood obesity, there appears to be a requirement to also identify parental behaviours that contribute to rapid infant weight gain an independent risk factor for early childhood obesity.

4.2 Future Research Directions

The results from Study Two identified that parents of infants at risk for early childhood obesity were unconcerned about their child's weight and identified no future health risks. The risk factors for childhood obesity are well established and the need for early interventions to prevent childhood obesity widely published. However, communicating with families about obesity has been recognised to be difficult and stressful. Redsell *et al* (2013) investigated the beliefs and current practices of UK Health Visitors and other nurses within their team in relation to identifying and intervening with infants at risk of developing obesity [307]. Thirty nurse members of Health Visiting teams were recruited and participated in a semi-structured telephone interview. The results identified that whilst the Health Visitors and their associated nursing team had a poor understanding of non-modifiable risk factors such as macrosomia and the contribution to early childhood obesity, they also believed that parental preference for a bigger infant made it difficult for them to approach families about inappropriate rapid growth. The lack of knowledge and reluctance to identify young children as being at risk for early childhood obesity by Health Visitors has been reported as a concern. Data from a qualitative study exploring the obesity-related knowledge of UK primary care healthcare professionals and the current practice of General Practitioners (GP) and Practice Nurses in identifying infants at risk of developing childhood obesity clearly identified that GPs and nurses had a low level of concern for infants at risk of developing obesity, but also believed that infant feeding advice was the Health Visitor's area of expertise [331]. As with Health Visitors, GPs also reported adopting a cautious approach to the subject of child obesity and as such this approach has been implicated in constraining their attempts to identify infant obesity and/or improve parental feeding practices during routine consultations [331]. Redsell *et al* (2013) conclude that there is a need to develop tools and training to help healthcare professionals identify infants at risk of developing obesity and to develop strategies to manage that risk without creating a sense of blame [307].

It is clear that further research is needed to improve the communication of overweight/obesity risk during infancy but also to explore strategies to support parents of the infants identified as being at risk. For older children, the Child Feeding Questionnaire (CFQ) was designed to assess universally, parents' perceptions and concerns regarding child obesity and child feeding attitudes and practices [365]. Primarily the CFQ was designed for use in the research setting with parents of children aged 18 months to 8 years. However, as rapid weight gain the in first year of life is an independent risk factor for future early childhood obesity [12, 102] and potentially modifiable it is important that overweight/obesity risk is communicated prior to 18 months. Within Section 4.1.5, a recommendation that all infants are weighed at 4 months has been made. This would allow the Health Visiting teams the opportunity to assess the overweight/obesity risk based on the growth trajectory. Therefore, a tool is required that would facilitate the communication of overweight/obesity risk during infancy that is acceptable for the Health Visiting teams and supports the parents in a manner that is neither judgmental nor stigmatising.

Data from Study Two and the Harrison *et al* (2017) qualitative systematic review [239] have identified a wide variety of salient beliefs and practices in feeding infants in the first year of life. These findings could be used to develop checklists for healthcare professionals to enhance communication about the prevention of rapid infant weight gain.

Whilst these data provide a picture of current parental practices, they do not explore the complexity of the psychological, social or cultural factors that influence these feeding behaviours. Therefore, future research should be underpinned by a theory of change. In Study two, the Health Belief Model was used to identify parental beliefs and the drivers of those beliefs in caring for infants at risk of early childhood obesity. In the development of a tool that would improve obesity communication between parents and healthcare professionals, the Theory of Planned Behaviour may be better suited as a theoretical underpinning to understand specific action-orientated behaviours such as infant feeding [222]. As a summary of social-cognitive models is given in Chapter 3, section 3.4, the following discussion focuses on the potential of the Theory of Planned Behavior (TPB) as a theoretical basis in further research into identifying further salient beliefs of parents caring for infants at risk for early childhood obesity. TPB proposes that an individual's intention to perform a behaviour is the most important determinant of their action. Underlying TPB are the antecedents of attitude, subjective norms, corresponding salient beliefs which reflect both an individual's intention and subsequent behaviour [222]. The TPB has been widely used to predict breastfeeding intention [366, 367]. In these studies, TPB was used to elicit factors influencing breastfeeding initiation and duration, including attitudes to breastfeeding and bottle feeding, subjective norms and normative beliefs and perceived control and control beliefs [368]. TPB has also been used to identify the determinants of parents' intention to introduce complementary feeding at six months [139]. Conducted in Australia, Walsh *et al* utilised both individual interviews and focus groups to identify factors influencing first-time mothers' decision making in preparation for and intention to commence complementary feeding. A purposive, convenience sample of 21 first time mothers self-selected to participate. There was no sampling stratification. Data were analysed thematically within the theoretical constructs: behaviour beliefs, normative beliefs and perceived control beliefs. As found in Study Two, Walsh *et al* (2015)[139] also identified that concerns about infant weight were a major influence in commencing complementary feeding before six months. Infant hunger cues and/or perceived readiness for solids were also frequently cited as a reason to introduce early complementary feeding. In addition, peer-to peer-influences was identified as having a strong authority over behavioral intention and subsequent action. The mothers in the Walsh *et al* (2015) study also identified that knowledge changed over time and sought advice from family and friends who had young children and therefore had recently been through the decision making process on when to start weaning [139]. Although some of the mothers valued the advice given by healthcare professionals, the authors refer to a UK (2010) study which reported inconsistent advice regarding complementary feeding timeframes from healthcare professionals [369]. Whilst this qualitative study was conducted in a single Australian region and therefore, the findings may not be generalisable, the authors state that theoretical generalisation is possible.

To date, using data from Study Two and from the Harrison *et al* (2017) [239] qualitative systematic review, parental salient beliefs on feeding infants in the first year of life have been extracted (Table 24).

Table 24 - Parental salient beliefs on feeding infants in the first year of life

1. It is good that my baby is heavier than average because he is a boy	Primary research
2. My baby needs to stay at the top of the chart for weight because they were born large	Primary research
3. My baby's weight is a good guide to when I should start to introduce solid foods	Primary research
4. I am not worried that my baby is bigger than average	Primary research
5. My baby is growing fast but will slow down later	Primary research
6. Feeding is always the best way to soothe my baby id he/she cries	Primary research Redsell *et al* 2010 [370] Hodges *et al* 2008 [188] Anderson *et al* 2001 [233]
7. My baby needs to stay at the top of the chart for weight	Primary research
8. My Health Visitor wants my baby to stay at the top of the chart for weight	Primary research
9. My baby needs to eat more because he/she was born heavy	Primary research Heinig *et al* 2006 [234] Anderson *et al* 2001 [233]
10. Feeding my baby more in the day helps him/her to sleep at night	Primary research
11. I find making feeding decisions for my baby stressful	Primary research Heinig *et al* 2006 [234] Anderson *et al* 2001 [233]
12. I am pleased that baby is putting on weight fast	Primary research
13. My baby's weight is a good guide that he/she is feeding well	Primary research
14. My baby needs to be at the top of his./her weight chart	Primary research
15. My health visitor wants my baby to eat more	Primary research Redsell *et al* 2010 [370] Arden 2010 [369]
16. Feeding my baby solids at night helps him/her sleep at night	Primary research

	Redsell *et al* 2010 [370] Heinig *et al* 2006 [234] Anderson *et al* 2001 [233] Horodynski *et al* 2007 [371]
17. My baby is happy when he/she feeds	Afflerback 2013 [372]
18. My baby needs more than milk because he/she is growing quickly	Primary research Arden 2010 [369]
19. Seeing my baby growing quickly makes me happy	Harrison *et al* 2017 [239]
20. My family helped me decide when to start weaning	Primary research Heinig *et al* 2006 [234] Horodynski *et al* 2007 [371]
21. My baby needs to be at the top of his./her weight chart	Primary research
22. Seeing my baby growing quickly makes me happy	Harrison *et al* 2017 [239]

In order to expand and strengthen the current extracted parental beliefs in caring for infants in the first year of life, further exploration is required. The recommendations for future research studies that have emerged from this research thesis would include the following.

To enhance and give a broad perspective of parental beliefs in caring for infants at risk of early childhood overweight further interviews with a diverse sample of parents is essential.

Redsell *et al* (2011) identified a lack of knowledge and a reluctance to identify young children as being at risk for early childhood obesity by Health Visitors [331], the knowledge, beliefs, and attitudes of Health Visitors to caring for these at-risk infants requires exploration. Health Visitors have been identified as being pivotal in delivering interventions that have the potential to modify rapid weight gain. Therefore their input to inform, direct and develop a theory-based instrument to measure factors influencing parents in caring for infants at risk of early childhood obesity, is essential.

4.3 Conclusion

From this thesis and the incorporated research studies it has been identified that in an area with high rates of child obesity, there were substantial rates of both macrosomia and rapid weight gain. However, it was also identified that there was no weight data at one year of age for over 40% of the cohort recorded on SystmOne. A recommendation that has emerged from this thesis is that all infants are weighed at four months in order that their weight trajectory can be monitored. There is a need for child growth trajectories to be better understood by Health Visitors in order to recognise normal growth patterns and those of concern and for these patterns to be communicated effectively to the infant's families.

The qualitative study data identified a propensity for overfeeding, with the maintenance of high weight or rapid weight gain being attributed to successful parenting. There is emerging evidence that responsive feeding is effective in reducing childhood overweight [131]. However rather than targeting responsive feeding interventions in accordance to socioeconomic status for which the research conducted in this thesis found no justification, focusing on those infants who were born big or growing fast may be more effective. To identify infants at risk of early childhood obesity, Weng *et al* [13] have developed and validated the IROC algorithm to predict the risk score of a child being overweight at age five. Yet in clinical practice, Health Visitors have reported difficulties in discussing the IROC result with parents fearing alienating families. In order to facilitate communication between Health Visitors and parents with regard to preventing rapid infant weight gain, a checklist grounded in the parental beliefs of caring for infants at risk of early childhood overweight needs to be developed. Further research is required to incorporate a diverse sample of parents to widen the experiences, beliefs, and practices. Health Visitors have been identified as being pivotal in identifying infants at risk for childhood overweight, and also in the delivery of responsive feeding intervention. Therefore their input to inform, direct and develop a theory based checklist to facilitate communication with parents with regard to preventing rapid infant weight gain, is essential.

5 References

1. World Health Organisation, *Report of the Commission on Ending Childhood Obesity. Implementation plan: executive summary.* . 2017, (WHO/NMH/PND/ECHO/17.1). Geneva.

2. World Health Organisation. *Tenfold increase in childhood and adolescent obesity in four decades: new study by Imperial College London and WHO*. 2018; Available from: http://www.who.int/news-room/headlines/11-10-2017-tenfold-increase-in-childhood-and-adolescent-obesity-in-four-decades-new-study-by-imperial-college-london-and-who.
3. Abarca-Gómez, L., et al., *Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults.* The Lancet. **2017**.
4. National Institute for Health and Clinical Excellence, *Obesity: guidance on the prevention, identification, assessment and management of overweight and obesity in adults and children*, National Institute for Health and Clinical Excellence, Editor. 2006.
5. Department of Health, *Healthy Lives, Healthy People: A call to action on obesity in England*. 2011.
6. Gardner, D.S.L., et al. (2009) *Contribution of early weight gain to childhood overweight and metabolic health: A Longitudinal Study (Early Bird 36)*. Pediatrics **123**, e67-e73.
7. Ong, K.K. and R.J.F. Loos, *Rapid infancy weight gain and subsequent obesity: Systematic reviews and hopefully suggestions.* Acta Paediatrica, 2006. **95**: p. 904-908.
8. Stettler, N., et al., *Rapid weight gain during infancy and obesity in young adulthood in a cohort of African Americans.* American Journal of Clinical Nutrition, 2003. **77**: p. 1374-1378.
9. Bouchard, C., *Childhood obesity: are genetic differences involved?* Am J Clin Nutr, 2009. **89**(5): p. 1494S-1501S.
10. Shrewsbury, V. and J. Wardle, *Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005.* Obesity (Silver Spring), 2008. **16**.
11. Sobal, J. and A. Stunkard, *Socioeconomic status and obesity: a review of the literature.* Psychol Bull, 1989. **105**(2): p. 260 - 275.
12. Weng, S.F., et al., *Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy.* Archives of Disease in Childhood, 2012. **97**(12): p. 1019-1026.
13. Weng, S.F., et al., *Estimating Overweight Risk in Childhood From Predictors During Infancy.* Pediatrics, 2013. **132**(2): p. e414-e421.
14. Power, C. and C. Moynihan, *Social class and changes in weight-for-height between childhood and early adulthood.* International Journal of Obesity, 1988. **12**(5): p. 445-453.
15. Redsell, S.A., et al., *Validation, Optimal Threshold Determination, and Clinical Utility of the Infant Risk of Overweight Checklist for Early Prevention of Child Overweight.* Childhood Obesity, 2016. **12**(3): p. 202-209.
16. de Onis, M., M. Blossner, and E. Borghi, *Global prevalence and trends of overweight and obesity among preschool children.* Am J Clin Nutr, 2010. **92**(5): p. 1257 - 1264.
17. WHO, *World Health Organisation: Commission on Ending Childhood Obesity*. 2016.
18. Health & Social Care Information Centre, *Health Survey for England 2014:Health, social care and lifestyles*. 2015.
19. Health and Social Care Information Centre, *National Child Measurement Programme: England, 2014/15 school year*. 2015.
20. Jolly, M.C., et al., *Risk factors for macrosomia and its clinical consequences: a study of 350,311 pregnancies.* European Journal of Obstetrics and Gynecology and Reproductive Biology, 2003. **111**(1): p. 9-14.
21. Wallace, S. and A. McEwan, *Fetal macrosomia.* Obstetrics, Gynaecology and Reproductive Medicine, 2007. **17**(2): p. 58-61.

22. Power, C., *National trends in birth weight: implications for future adult disease.* BMJ, 1994. **308**(6939): p. 1270-1271.
23. ONS, *Births in England and Wales: 2015 Live births, stillbirths, and the intensity of childbearing measured by the total fertility rate*. 2016.
24. Hawkins, C., T.J. C, and C. Law, *An ecological systems approach to examining risk factors for early childhood overweight: findings from the UK Millenium Cohort Study.* Journal of Epidemiology & Community Health, 2009. **63**.
25. Jones-Smith, J.C., L.C.H. Fernald, and L.M. Neufeld, *Birth Size and Accelerated Growth during Infancy Are Associated with Increased Odds of Childhood Overweight in Mexican Children.* Journal of the American Dietetic Association, 2007. **107**(12): p. 2061-2069.
26. Dubois, L. and M. Girard, *Early determinants of overweight at 4.5 years in a population-based longitudinal study.* Int J Obes, 2006. **30**(4): p. 610-617.
27. Danielzik, S., et al., *Parental overweight, socioeconomic status and high birth weight are the major determinants of overweight and obesity in 5-7[thinsp]y-old children: baseline data of the Kiel Obesity Prevention Study (KOPS).* Int J Obes Relat Metab Disord, 2004. **28**(11): p. 1494-1502.
28. Apfelbacher, C.J., et al., *Predictors of overweight and obesity in five to seven-year-old children in Germany: Results from cross-sectional studies.* BMC Public Health, 2008. **8**(1): p. 171.
29. Mangrio, E., M. Lindström, and M. Rosvall, *Early life factors and being overweight at 4 years of age among children in Malmö, Sweden.* BMC Public Health, 2010. **10**(1): p. 764.
30. Lamming, G.E., ed. *Marshall's Physiology of Reproduction: Volume 3 Pregnancy and Lactation*. 4th Edition ed. 2013, Springer Science & Business Media.
31. Ehrenberg, H.M., B.M. Mercer, and P.M. Catalano, *The influence of obesity and diabetes on the prevalence of macrosomia.* Am J Obstet Gynecol, 2004. **191**(3): p. 964-8.
32. Bryant, M., et al., *A comparison of South Asian specific and established BMI thresholds for determining obesity prevalence in pregnancy and predicting pregnancy complications: Findings from the Born in Bradford cohort.* International journal of obesity (2005), 2014. **38**(3): p. 444-450.
33. WHO, E.C., *Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies.* Lancet (London, England), 2004. **363**(9403): p. 157.
34. Datta-Nemdharry, P., N. Dattani, and A.J. Macfarlane, *Birth outcomes for African and Caribbean babies in England and Wales: retrospective analysis of routinely collected data.* BMJ Open, 2012. **2**(3).
35. SPELLACY, W.N., et al., *Macrosomia-Maternal Characteristics and Infant Complications.* Obstetrics & Gynecology, 1985. **66**(2): p. 158-161.
36. Vambergue, A. and I. Fajardy, *Consequences of gestational and pregestational diabetes on placental function and birth weight.* World Journal of Diabetes, 2011. **2**(11): p. 196-203.
37. Klok, M.D., S. Jakobsdottir, and M.L. Drent, *The role of leptin and ghrelin in the regulation of food intake and body weight in humans: a review.* Obes Rev, 2007. **8**(1): p. 21-34.
38. Tzanetakou, I.P., D.P. Mikhailidis, and D.N. Perrea, *Nutrition during pregnancy and the effect of carbohydrates on the offspring's metabolic profile: in search of the "Perfect Maternal Diet".* The open cardiovascular medicine journal, 2011. **5**: p. 103.
39. Kolaczynski, J.W., et al., *Response of leptin to short-term and prolonged overfeeding in humans.* J Clin Endocrinol Metab, 1996. **81**(11): p. 4162-5.
40. Leddy, M.A., M.L. Power, and J. Schulkin, *The Impact of Maternal Obesity on Maternal and Fetal Health.* Reviews in Obstetrics and Gynecology, 2008. **1**(4): p. 170-178.
41. Health and Social Care Information Centre, *Health survey for England: 2013*, N. Statistics, Editor. 2014.
42. Dinatale, A., et al., *Obesity and fetal-maternal outcomes.* Journal of Prenatal Medicine, 2010. **4**(1): p. 5-8.

43. Gaudet, L., et al., *Maternal Obesity and Occurrence of Fetal Macrosomia: A Systematic Review and Meta-Analysis.* BioMed Research International, 2014. **2014**: p. 640291.
44. Ovesen, P., S. Rasmussen, and U. Kesmodel, *Effect of prepregnancy maternal overweight and obesity on pregnancy outcome.* Obstet Gynecol, 2011. **118**(2 Pt 1): p. 305-12.
45. Edmunds, L.S., et al., *Association of prenatal participation in a public health nutrition program with healthy infant weight gain.* American Journal of Public Health, 2014. **104**(S1): p. S35-S42.
46. Heslehurst, N., et al., *Trends in maternal obesity incidence rates, demographic predictors, and health inequalities in 36[thinsp]821 women over a 15-year period.* BJOG: Int J Obstet Gynaecol, 2007. **114**: p. 187-194.
47. Gaillard, R., et al., *Risk factors and outcomes of maternal obesity and excessive weight gain during pregnancy.* Obesity, 2013. **21**(5): p. 1046-55.
48. Ng, M., et al., *Global, regional and national prevalence of overweight and obesity in children and adults 1980-2013: A systematic analysis.* Lancet (London, England), 2014. **384**(9945): p. 766-781.
49. Heslehurst, N., et al., *A nationally representative study of maternal obesity in England, UK: trends in incidence and demographic inequalities in 619[thinsp]323 births, 1989-2007.* Int J Obes, 2010. **34**(3): p. 420-428.
50. Modder, J., *MANAGEMENT OF WOMEN WITH OBESITY IN PREGNANCY* C.R.J. GUIDELINE, Editor. 2010.
51. Dabelea, D. and T. Crume, *Maternal Environment and the Transgenerational Cycle of Obesity and Diabetes.* Diabetes, 2011. **60**(7): p. 1849-1855.
52. Ong, K. and R. Loos, *Rapid infancy weight gain and subsequent obesity: systematic reviews and hopeful suggestions.* Acta Paediatr, 2006. **95**(8): p. 904 - 908.
53. Young, B.E., S.L. Johnson, and N.F. Krebs, *Biological Determinants Linking Infant Weight Gain and Child Obesity: Current Knowledge and Future Directions.* Advances in Nutrition: An International Review Journal, 2012. **3**(5): p. 675-686.
54. Mihrshahi, S., et al., *Determinants of rapid weight gain during infancy: baseline results from the NOURISH randomised controlled trial.* BMC Pediatrics, 2011. **11**(1): p. 99.
55. Ekelund, U., et al., *Upward weight percentile crossing in infancy and early childhood independently predicts fat mass in young adults: the Stockholm Weight Development Study (SWEDES).* Am J Clin Nutr, 2006. **83**.
56. Birbilis, M., et al., *Obesity in adolescence is associated with perinatal risk factors, parental BMI and sociodemographic characteristics.* Eur J Clin Nutr, 2013. **67**(1): p. 115-121.
57. Oyama, M., T. Saito, and K. Nakamura, *Rapid weight gain in early infancy is associated with adult body fat percentage in young women.* Environmental Health and Preventive Medicine, 2010. **15**(6): p. 381-385.
58. Rooney, B., M. Mathiason, and C. Schauberger, *Predictors of Obesity in Childhood, Adolescence, and Adulthood in a Birth Cohort.* Maternal and Child Health Journal, 2011. **15**(8): p. 1166-1175.
59. National Obesity Observatory, *Child Obesity and Socioeconomic Status*. 2010, Public Health.
60. Wijlaars, L.P.M.M., et al., *Socioeconomic status and weight gain in early infancy.* Int J Obes, 2011. **35**(7): p. 963-970.
61. Cole, T., J. Freeman, and M. Preece, *Body Mass Index reference curves for the UK, 1990.* Archives of Disease in Childhood, 1995. **73**: p. 25-29.
62. Yeung, M.Y., *Postnatal growth, neurodevelopment and altered adiposity after preterm birth—from a clinical nutrition perspective.* Acta Pædiatrica, 2006. **95**(8): p. 909-917.
63. Van Den Berg, G., et al., *Low maternal education is associated with increased growth velocity in the first year of life and in early childhood: the ABCD study.* European Journal of Pediatrics, 2013. **172**(11): p. 1451-1457.

64. Miner, L., et al., *Practical predictive analytics and decisioning systems for medicine: Informatics accuracy and cost-effectiveness for healthcare administration and delivery including medical research*. 2014: Academic Press.
65. Galobardes, B., J. Lynch, and G.D. Smith, *Measuring socioeconomic position in health research.* British medical bulletin, 2007. **81**(1): p. 21.
66. Liberatos, P., B. Link, and J. Kelsey, *The measurement of social class in epidemiology.* Epidemiol Rev, 1988. **10**: p. 87 - 121.
67. Stettler, N., et al., *Infant weight gain and childhood overweight status in a multicenter, cohort study.* Pediatrics, 2002. **109**(2): p. 194-9.
68. Hui, L.L., et al., *Birth weight, infant growth, and childhood body mass index: Hong kong's children of 1997 birth cohort.* Archives of Pediatrics & Adolescent Medicine, 2008. **162**(3): p. 212-218.
69. Taveras, E., et al., *Weight status in the first 6 months of life and obesity at 3 years of age.* Pediatrics, 2009. **123**(4): p. 1177 - 1183.
70. Tate, A.R., C. Dezateux, and T.J. Cole, *Is infant growth changing?* Int J Obes, 0000. **30**(7): p. 1094-1096.
71. Wang, G., et al., *Weight Gain in Infancy and Overweight or Obesity in Childhood across the Gestational Spectrum: a Prospective Birth Cohort Study.* Scientific Reports, 2016. **6**: p. 29867.
72. World Health Organisation, *EXPERT GROUP ON PREMATURITY* W.T.S.n. 27, Editor. 1950.
73. Jimenez-Chillaron, J.C. and M.-E. Patti, *To catch up or not to catch up: is this the question? Lessons from animal models.* Current Opinion in Endocrinology, Diabetes and Obesity, 2007. **14**(1): p. 23-29.
74. Ong, K.K.L., et al., *Association between postnatal catch-up growth and obesity in childhood: prospective cohort study.* BMJ, 2000. **320**(7240): p. 967-971.
75. Barker, D., et al., *Growth in utero, blood pressure in childhood and adult life, and mortality from cardiovascular disease.* BMJ, 1989. **298**(6673): p. 564-567.
76. de Boo, H.A. and J.E. Harding, *The developmental origins of adult disease (Barker) hypothesis.* Aust N Z J Obstet Gynaecol, 2006. **46**(1): p. 4-14.
77. Roseboom, T., S. de Rooij, and R. Painter, *The Dutch famine and its long-term consequences for adult health.* Early Human Development, 2006. **82**(8): p. 485-491.
78. Schulz, L.C., *The Dutch Hunger Winter and the developmental origins of health and disease.* Proceedings of the National Academy of Sciences, 2010. **107**(39): p. 16757-16758.
79. Desai, M., et al., *Programmed obesity in intrauterine growth-restricted newborns: modulation by newborn nutrition.* Am J Physiol Regul Integr Comp Physiol, 2005. **288**(1): p. 5.
80. Fabricius-Bjerre, S., et al., *Impact of Birth Weight and Early Infant Weight Gain on Insulin Resistance and Associated Cardiovascular Risk Factors in Adolescence.* PLoS One, 2011. **6**(6): p. e20595.
81. Oyama, M., et al., *Unhealthy maternal lifestyle leads to rapid infant weight gain: prevention of future chronic diseases.* Tohoku J Exp Med, 2009. **217**(1): p. 67-72.
82. Koletzko, B., *Long-term consequences of early feeding on later obesity risk.* Nestle Nutr Workshop Ser Pediatr Program, 2006. **58**: p. 1-18.
83. Cannon, A.M., et al., *The Effects of Leptin on Breastfeeding Behaviour.* Int J Environ Res Public Health, 2015. **12**(10): p. 12340-55.
84. Palou, A. and C. Picó, *Leptin intake during lactation prevents obesity and affects food intake and food preferences in later life.* Appetite, 2009. **52**(1): p. 249-252.
85. Agostoni, C., et al., *Growth patterns of breast fed and formula fed infants in the first 12 months of life: an Italian study.* Archives of Disease in Childhood, 1999. **81**(5): p. 395-399.
86. Li, R., et al., *Risk of bottle-feeding for rapid weight gain during the first year of life.* Arch Pediatr Adolesc Med, 2012. **166**(5): p. 431-6.
87. Martin, C., P.-R. Ling, and G. Blackburn, *Review of Infant Feeding: Key Features of Breast Milk and Infant Formula.* Nutrients, 2016. **8**(5): p. 279.

88. Günther, A.L., et al., *Early protein intake and later obesity risk: which protein sources at which time points throughout infancy and childhood are important for body mass index and body fat percentage at 7 y of age?* The American Journal of Clinical Nutrition, 2007. **86**(6): p. 1765-1772.
89. Inostroza, J., et al., *Low-Protein Formula Slows Weight Gain in Infants of Overweight Mothers.* Journal of Pediatric Gastroenterology and Nutrition, 2014. **59**(1): p. 70-77.
90. Agras, W.S., et al., *Does a vigorous feeding style influence early development of adiposity?* The Journal of Pediatrics, 1987. **110**(5): p. 799-804.
91. Roy, S.M., et al., *Infant Sucking Intensity, Weight Gain, and Adiposity in the First Four Months of Life*, in *Pediatric Endocrinology I (posters)*. 2016, Endocrine Society. p. FRI-019-FRI-019.
92. Fildes, A., et al., *Parental control over feeding in infancy. Influence of infant weight, appetite and feeding method().* Appetite, 2015. **91**: p. 101-106.
93. Butte, N.F., et al., *Infant Feeding Mode Affects Early Growth and Body Composition.* Pediatrics, 2000. **106**(6): p. 1355-1366.
94. Li, R., S.B. Fein, and L.M. Grummer-Strawn, *Association of Breastfeeding Intensity and Bottle-Emptying Behaviors at Early Infancy With Infants' Risk for Excess Weight at Late Infancy.* Pediatrics, 2008. **122**(Supplement 2): p. S77-S84.
95. Buvinger, E., et al., *Observed infant food cue responsivity: Associations with maternal report of infant eating behavior, breastfeeding, and infant weight gain.* Appetite, 2017. **112**: p. 219-226.
96. van Deutekom, A.W., et al., *The association of birth weight and postnatal growth with energy intake and eating behavior at 5 years of age – a birth cohort study.* International Journal of Behavioral Nutrition and Physical Activity, 2016. **13**(1): p. 15.
97. Fisher, J.O., et al., *Heritability of Hyperphagic Eating Behavior and Appetite-Related Hormones among Hispanic Children.* Obesity, 2007. **15**(6): p. 1484-1495.
98. Moens, E. and C. Braet, *Predictors of disinhibited eating in children with and without overweight.* Behaviour Research and Therapy, 2007. **45**(6): p. 1357-1368.
99. Huh, S.Y., et al., *Timing of Solid Food Introduction and Risk of Obesity in Preschool-Aged Children.* Pediatrics, 2011. **127**(3): p. e544-e551.
100. Vail, B., et al., *Age at Weaning and Infant Growth: Primary Analysis and Systematic Review.* J Pediatr, 2015. **167**(2): p. 317-24.
101. Goisis, A., A. Sacker, and Y. Kelly, *Why are poorer children at higher risk of obesity and overweight? A UK cohort study.* European Journal of Public Health, 2016. **26**(1): p. 7-13.
102. Baird, J., et al. (2005) *Being big or growing fast: systematic review of size and growth in infancy and later obesity* BMJ **331**, e1-e6 DOI: 10.1136/bmj.38586.411273.EO.
103. Stettler, N., et al., *Prevalence and risk factors for overweight and obesity in children from Seychelles, a country in rapid transition: the importance of early growth.* International Journal of Obesity, 2002. **26**(2): p. 214.
104. Hui, L.L., C.M. Schooling, and S.S.L. Leung (2008) *Birth Weight, Infant Growth and Childhood Body Mass Index*. Archives of Pediatrics and Adolescent Medicine **162**, 212-218.
105. Müller, M.J., et al., *Beyond BMI: conceptual issues related to overweight and obese patients.* Obesity Facts, 2016. **9**(3): p. 193-205.
106. Flegal, K.M., et al., *Association of all-cause mortality with overweight and obesity using standard body mass index categories: A systematic review and meta-analysis.* JAMA, 2013. **309**(1): p. 71-82.
107. Nuttall, F.Q., *Body Mass Index: Obesity, BMI, and Health A Critical Review.* Nutrition Today, 2015. **50**(3): p. 117-128.
108. Isabel, F., *Defining an epidemic: the body mass index in British and US obesity research 1960–2000.* Sociology of Health & Illness, 2014. **36**(3): p. 338-353.

109. Grummer-Strawn, L.M., C. Reinold, and N.F. Krebs (2010) *Use of World Health Organisation and CDC Growth Charts for Children aged 0-59 months in the United States*. Morbidity and Mortality Weekly Report **September 10**, 1-15.
110. de Onis, M., et al., *Comparison of the WHO Child Growth Standards and the CDC 2000 Growth Charts.* The Journal of Nutrition, 2007. **137**(1): p. 144-148.
111. Kuczmarski, R.J., C.L. Ogden, and S.S. Guo, *CDC Growth Charts for the United States: Methods and development*, N.C.f.H. Statistics, Editor. 2000, Vital Health Stat.
112. Cole, T., et al., *Establishing a standard definition for child overweight and obesity worldwide: international survey.* BMJ, 2000. **320**: p. 1240.
113. Cole, T.J., et al., *Establishing a standard definition for child overweight and obesity worldwide: international survey.* British Medical Journal, 2000. **320**: p. 1240.
114. Flegal, K.M. and C.L. Ogden, *Childhood Obesity: Are We All Speaking the Same Language?* Advances in Nutrition: An International Review Journal, 2011. **2**(2): p. 159S-166S.
115. Reilly, J.J., A.R. Dorosty, and P.M. Emmett, *Prevalence of overweight and obesity in British children: cohort study.* British Medical Journal, 1999. **319**(7216): p. 1039.
116. Bundred, P., D. Kitchiner, and I. Buchan, *Prevalence of overweight and obese children between 1989 and 1998: population based series of cross sectional studies.* British Medical Journal, 2001. **322**: p. 1-4.
117. Child Growth Foundation (2009) *Growth Assessment Recommendations*.
118. Cole, T.J., A.A. Paul, and R.G. Whitehead, *Weight reference charts for British long-term breastfed infants.* Acta Paediatrica, 2002. **91**: p. 1296-1300.
119. Power, C., J.K. Lake, and T.J. Cole, *Measurement and long-term health risks of child and adolescent fatness.* International Journal of Obesity and Related Metabolic Disorders, 1997. **21**(7): p. 507-526.
120. Whitlock, E.P., et al., *Screening and Interventions for Childhood Overweight: A Summary of Evidence for the US Preventive Services Task Force.* Pediatrics, 2005. **116**(1): p. e125-144.
121. Cross Government Obesity Unit Department of Health and Department of Children Schools and Families, *Healthy Weight, Healthy Lives: a Cross Government Strategy for England*. 2008, www.dh.gov.uk/publications. p. 1-60.
122. Howe, L.D., K. Tilling, and D.A. Lawlor, *Accuracy of height and weight data from child health records.* Arch Dis Child, 2009. **94**: p. 950-954.
123. Lobstein, T., L. Baur, and R. Uauy, *Obesity in children and young people: a crisis in public health.* Obesity reviews, 2004. **5**(Suppl. 1): p. 4-85.
124. Power, C., J.K. Lake, and T.J. Cole, *Measurement and long-term health risks of child and adolescent fatness.* International Journal of Obesity, 1997. **21**: p. 507-526.
125. Roche, A.F., et al., *Grading body fatness from limited anthropometric data.* The American Journal of Clinical Nutrition, 1981. **34**(12): p. 2831-2838.
126. WHO Working Group on the Growth Reference Protocol and the WHO Task Force on Methods for Natural Regulation of Fertility, *Growth patterns of breastfed infants in seven countries.* Acta Paediatrica, 2000. **89**: p. 215-22.
127. de Almeida, C.A.N., et al., *Assessment of mid-upper arm circumference as a method for obesity screening in preschool children.* Jornal de Pediatria, 2003. **79**(5): p. 6.
128. Paul, I.M., et al., *Opportunities for the Primary Prevention of Obesity during Infancy.* Advances in Pediatrics, 2009. **56**(1): p. 107-133.
129. Ciampa, P.J., et al., *Interventions Aimed at Decreasing Obesity in Children Younger Than 2 Years: A Systematic Review.* Arch Pediatr Adolesc Med, 2010. **164**(12): p. 1098-1104.
130. Dewey, K.G., et al., *Breast-fed infants are leaner than formula-fed infants at 1 y of age: the DARLING study.* American Journal of Clinical Nutrition, 1993. **57**: p. 140-145.
131. DiSantis, K.I., et al., *The role of responsive feeding in overweight during infancy and toddlerhood: a systematic review.* International Journal of Obesity, 2011. **35**(4): p. 480-492.

132. Belsky, D.W., *Appetite for prevention: Genetics and developmental epidemiology join forces in obesity research.* JAMA Pediatrics, 2014. **168**(4): p. 309-311.
133. Mohammadbeigi, A., et al., *Fetal Macrosomia: Risk Factors, Maternal, and Perinatal Outcome.* Annals of Medical and Health Sciences Research, 2013. **3**(4): p. 546-550.
134. Sacco, M.R., et al., *Birth weight, rapid weight gain in infancy and markers of overweight and obesity in childhood.* Eur J Clin Nutr, 2013. **67**(11): p. 1147-1153.
135. Yu, Z.B., et al., *Birth weight and subsequent risk of obesity: a systematic review and meta-analysis.* Obesity Reviews, 2011. **12**(7): p. 525-542.
136. Schellong, K., et al., *Birth Weight and Long-Term Overweight Risk: Systematic Review and a Meta-Analysis Including 643,902 Persons from 66 Studies and 26 Countries Globally.* Plus One, e47776, 2012. **7**(10).
137. Henriksen, T., *The macrosomic fetus: a challenge in current obstetrics.* Acta Obstetricia et Gynecologica Scandinavica, 2008. **87**(2): p. 134-145.
138. Koyanagi, A., et al., *Macrosomia in 23 developing countries: an analysis of a multicountry, facility-based, cross-sectional survey.* The Lancet, 2013. **381**(9865): p. 476-483.
139. Walsh, A., L. Kearney, and N. Dennis, *Factors influencing first-time mothers' introduction of complementary foods: a qualitative exploration.* Bmc Public Health, 2015. **15**: p. 939-939.
140. Barakat, R., et al., *Exercise during pregnancy protects against hypertension and macrosomia: randomized clinical trial.* American Journal of Obstetrics & Gynecology, 2015. **214**(5): p. 649.e1-649.e8.
141. GovUK, *Health Survey for England 2015*, N. Digital, Editor. 2016.
142. National Obesity Observatory, *NOO data factsheet: Adult Obesity and Socioeconomic Status*, NOO, Editor. 2012.
143. Caprio, S., et al., *Influence of Race, Ethnicity, and Culture on Childhood Obesity: Implications for Prevention and Treatment: A consensus statement of Shaping America's Health and the Obesity Society.* Diabetes Care, 2008. **31**(11): p. 2211-2221.
144. Gray, R., et al., *Towards an understanding of variations in infant mortality rates between different ethnic groups in England and Wales*. 2009, Oxford: National Perinatal Epidemiology Unit.
145. Kelly, T., et al., *Global burden of obesity in 2005 and projections to 2030.* Int J Obes, 2008. **32**(9): p. 1431 - 1437.
146. Kelly, Y., et al., *Why does birthweight vary among ethnic groups in the UK? Findings from the Millennium Cohort Study.* Journal of Public Health, 2009. **31**(1): p. 131-137.
147. Shribman, S. and K. Billingham, *Healthy Child Programme – Pregnancy and the first five years* s.a.f. Department for children, Editor. 2009: London.
148. Office for National Statistics. *National Census 2011*. 2011 [cited 2012 3/3/2012]; Available from: https://www.ons.gov.uk/census/2011census.
149. WHO, *WHO Child Growth Standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development*. 2006, Geneva: World Health Organisation.
150. Conrad, D. and S. Capewell, *Associations between deprivation and rates of childhood overweight and obesity in England, 2007–2010: an ecological study.* BMJ Open, 2012. **2**(2).
151. The Policy and Research Team Development Department Nottingham City Council. *The Indices of Deprivation, 2010, Compendium of results for Nottingham City*

2011 [cited 2013 3/3/2013]; Available from: www.nottinghaminsight.org.uk/d/63285.
152. Conrad, D. and S. Capewell, *Associations between deprivation and rates of childhood overweight and obesity in England, 2007 -2010: an ecological study.* BMJ Open, 2012. **2:e000463**.
153. Ells, L.J., et al., *Prevalence of severe childhood obesity in England: 2006–2013.* Archives of Disease in Childhood, 2015.

154. White, J., D. Rehkopf, and L.H. Mortensen, *Trends in Socioeconomic Inequalities in Body Mass Index, Underweight and Obesity among English Children, 2007–2008 to 2011–2012.* PLoS One, 2016. **11**(1): p. e0147614.
155. Anderson, S.E. and R.C. Whitaker, *Prevalence of obesity among US preschool children in different racial and ethnic groups.* Archives of Pediatrics & Adolescent Medicine, 2009. **163**(4): p. 344-8.
156. Fecht, D., et al., *Inequalities in rural communities: adapting national deprivation indices for rural settings.* Journal of Public Health, 2017: p. 1-7.
157. Royal College of Paediatrics and Child Health. 2009 1st June 2012]; Available from: http://www.rcpch.ac.uk/child-health/research-projects/uk-who-growth-charts/uk-who-growth-chart-resources-0-4-years/uk-who-0.
158. WHO, M., Growth, Reference, Study, Group, *WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development.* 2006.
159. Saigal, S., et al., *Growth Trajectories of Extremely Low Birth Weight Infants From Birth to Young Adulthood: A Longitudinal, Population-Based Study.* Pediatr Res, 2006. **60**(6): p. 751-758.
160. ONS, *Live births, stillbirths and infant deaths: babies born in 2008 in England and Wales,* . 2011
161. Koyanagi, A., et al., *Macrosomia in 23 developing countries: an analysis of a multicountry, facility-based, cross-sectional survey.* Lancet, 2013. **381**(9865): p. 476-83.
162. Obesity Integrated Commissioning Group, *Nottinghamshire JSNA: Excess weight young people, children and adults*, N. Insight, Editor. 2016.
163. Goldstein, R.F., et al., *Association of gestational weight gain with maternal and infant outcomes: A systematic review and meta-analysis.* JAMA, 2017. **317**(21): p. 2207-2225.
164. Griffiths, C., et al., *Area-level deprivation and adiposity in children: is the relationship linear[quest].* Int J Obes, 2013. **37**(4): p. 486-492.
165. Li, Y., et al., *Weight Gain in Pregnancy, Maternal Age and Gestational Age in Relation to Fetal Macrosomia.* Clinical Nutrition Research, 2015. **4**(2): p. 104-109.
166. Usta, A., et al., *Frequency of fetal macrosomia and the associated risk factors in pregnancies without gestational diabetes mellitus.* The Pan African Medical Journal, 2017. **26**: p. 62.
167. Office of National Statistics, *Families and households in the UK: 2016*, ONS, Editor. 2016.
168. Bhrolcháin, M.N. and É. Beaujouan, *Fertility postponement is largely due to rising educational enrolment.* Population Studies, 2012. **66**(3): p. 311-327.
169. ONS, *Office for National Statistics: Birth characteristics in England and Wales, 2014*. 2015.
170. Sack, R.A., *The large infant.* American Journal of Obstetrics & Gynecology, 1969. **104**(2): p. 195-204.
171. Najafian, M. and M. Cheraghi, *Occurrence of fetal macrosomia rate and its maternal and neonatal complications: a 5-year cohort study.* ISRN obstetrics and gynecology, 2012. **2012**.
172. Whiting, S., *Socio-demographic comparison between those UK families with up to two children and those with three or more.* Population Matters, 2011.
173. OCSI (2011) *Why the Indices of Deprivation are still important in the open data era*.
174. Nottinghamshire Child Poverty Reference Group, *Nottinghamshire Child Poverty Needs Assessment*, N.C. Council, Editor. 2011.
175. Spencer, N., et al., *Socioeconomic status and birth weight: comparison of an area-based measure with the Registrar General's social class.* Journal of Epidemiology & Community Health, 1999. **53**(8): p. 495-498.
176. Pattenden, S., H. Dolk, and M. Vrijheid, *Inequalities in low birth weight: parental social class, area deprivation, and" lone mother" status.* Journal of Epidemiology & Community Health, 1999. **53**(6): p. 355-358.

177. Smith, G.D., et al., *Individual social class, area-based deprivation, cardiovascular disease risk factors, and mortality: the Renfrew and Paisley Study.* Journal of Epidemiology & Community Health, 1998. **52**(6): p. 399-405.
178. Pampel, F.C., J.T. Denney, and P.M. Krueger, *Obesity, SES, and economic development: A test of the reversal hypothesis.* Social Science & Medicine, 2012. **74**(7): p. 1073-1081.
179. Philipson, T.J. and R.A. Posner, *Is the Obesity Epidemic a Public Health Problem? A Review of Zoltan J. Acs and Alan Lyles's <i>Obesity, Business and Public Policy</i>.* Journal of Economic Literature, 2008. **46**(4): p. 974-82.
180. Seaton, S.E., et al., *Birthweight centile charts for South Asian infants born in the UK.* Neonatology, 2011. **100**(4): p. 398-403.
181. Taveras, E.M., et al., *Crossing Growth Percentiles in Infancy and Risk of Obesity in Childhood.* Archives of Pediatrics & Adolescent Medicine, 2011. **165**(11): p. 993-998.
182. Eckhardt, C.L., et al., *The prevalence of rapid weight gain in infancy differs by the growth reference and age interval used for evaluation.* Annals of Human Biology, 2016. **43**(1): p. 85-90.
183. Health and Social Care Information Centre, *National Child Measurement Programme: England, 2012/13 school year*. 2013.
184. Prader, A., *Catch-up growth.* Postgrad Med J, 1978. **1**: p. 133-46.
185. Johnson, S.L. and L.L. Birch, *Parents' and childrens' adiposity and eating style.* Paediatrics, v. 94, p. 653-661, 1994(5).
186. Birch, L. and J. Fisher, *Development of eating behaviors among children and adolescents.* Pediatrics, 1998. **101**(3 II SUPPL): p. 539 - 549.
187. Stifter, C.A. and K.J. Moding, *Understanding and Measuring Parent Use of Food to Soothe Infant and Toddler Distress: A Longitudinal Study from 6 to 18 months of age.* Appetite, 2015. **95**: p. 188-196.
188. Hodges, E.A., et al., *Maternal decisions about the initiation and termination of infant feeding.* Appetite, 2008. **50**(2): p. 333-339.
189. Hodges, E.A., et al., *Development of the Responsiveness to Child Feeding Cues Scale.* Appetite, 2013. **65**: p. 210-219.
190. Braden, A., et al., *Associations between child emotional eating and general parenting style, feeding practices, and parent psychopathology.* Appetite, 2014. **80**: p. 35-40.
191. Carolan-Olah, M., M. Duarte-Gardea, and J. Lechuga, *A critical review: early life nutrition and prenatal programming for adult disease.* Journal of Clinical Nursing, 2015. **24**(23-24): p. 3716-3729.
192. Oakley, L.L., et al., *Factors associated with breastfeeding in England: an analysis by primary care trust.* BMJ Open, 2013. **3**(6).
193. Department of Health, *High Quality Care For All: NHS Next Stage Review final report. (Darzi)*. 2008, London: The Stationery Office.
194. Cardel, M., et al., *Parental feeding practices and socioeconomic status are associated with child adiposity in a multi-ethnic sample of children.* Appetite, 2012. **58**(1): p. 347-53.
195. Roy, S.M., et al., *Infant BMI or Weight-for-Length and Obesity Risk in Early Childhood.* Pediatrics, 2016. **137**(5).
196. Rogol, A.D., P.A. Clark, and J.N. Roemmich, *Growth and pubertal development in children and adolescents: effects of diet and physical activity.* The American Journal of Clinical Nutrition, 2000. **72**(2): p. 521s-528s.
197. Benchimol, E.I., et al., *The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement.* PLOS Medicine, 2015. **12**(10): p. e1001885.
198. Dietz , W.H., *Overweight in Childhood and Adolescence.* New England Journal of Medicine, 2004. **350**(9): p. 855-857.
199. van Jaarsveld, C.M., et al., *Appetite and growth: A longitudinal sibling analysis.* JAMA Pediatrics, 2014. **168**(4): p. 345-350.

200. Redsell, S.A., et al., *Systematic review of randomised controlled trials of interventions that aim to reduce the risk, either directly or indirectly, of overweight and obesity in infancy and early childhood.* Maternal & Child Nutrition, 2016. **12**(1): p. 24-38.
201. Kavanagh, K.F., et al., *Educational Intervention to Modify Bottle-feeding Behaviors among Formula-feeding Mothers in the WIC Program: Impact on Infant Formula Intake and Weight Gain.* Journal of Nutrition Education and Behavior, 2008. **40**(4): p. 244-250.
202. Paul, I.M., et al., *Preventing Obesity during Infancy: A Pilot Study.* Obesity (Silver Spring, Md.), 2011. **19**(2): p. 353-361.
203. Campbell, K.J., et al., *A parent-focused intervention to reduce infant obesity risk behaviors: a randomized trial.* Pediatrics, 2013. **131**(4): p. 652-60.
204. Daniels, L.A., et al., *Outcomes of an early feeding practices intervention to prevent childhood obesity.* Pediatrics, 2013. **132**(1): p. e109-e118.
205. Birch, L., J. Savage, and A. Ventura, *Influences on the development of children's eating behaviours: From infancy to adolescence*. 2007: Can J Diet Pract Res, v. 68, s.1-s.56.
206. Redsell, S.A., et al., *Digital technology to facilitate Proactive Assessment of Obesity Risk during Infancy (ProAsk): a feasibility study.* BMJ Open, 2017. **7**(9).
207. Cui, Z., et al., *Recruitment and retention in obesity prevention and treatment trials targeting minority or low-income children: a review of the clinical trials registration database.* Trials, 2015. **16**: p. 564.
208. Conner M and Norman P, *Predicting Health Behaviour: A Social Cognition Approach 2nd Edition*. 2005: Open University Press.
209. Kasl, S.V. and S. Cobb, *Health behavior, illness behavior, and sick role behavior. I. Health and illness behavior.* Arch Environ Health, 1966. **12**(2): p. 246-66.
210. Adler, N. and K. Matthews, *Health psychology: why do some people get sick and some stay well?* Annu Rev Psychol, 1994. **45**: p. 229-59.
211. Baum. A and D.M. Posluszny, *HEALTH PSYCHOLOGY: Mapping Biobehavioral Contributions to Health and Illness.* Annual Review of Psychology, 1999. **50**(1): p. 137-163.
212. Higgins, B., *Puerto Rican Cultural Beliefs: Influence on Infant Feeding Practices in Western New York.* Journal of Transcultural Nursing, 2000. **11**(1): p. 19-30.
213. Redsell, S., et al., *Parents' beliefs about appropriate infant size, growth and feeding behaviour: implications for the prevention of childhood obesity.* BMC Public Health, 2010. **10**(1): p. 711.
214. Department for Children Schools and Families, *Healthy Child Programme - Pregnancy and the first five years of life*. 2009, Department of Health.
215. Furnham, A. and P. Heaven, *Personality and social behaviour*. Personality and social behaviour. 1999, London, England: Arnold. xiii, 336-xiii, 336.
216. Vos, M.B. and J. Welsh, *Childhood obesity: update on predisposing factors and prevention strategies.* Curr Gastroenterol Rep, 2010. **12**(4): p. 280-7.
217. Anzman, S.L. and L.L. Birch, *Low inhibitory control and restrictive feeding practices predict weight outcomes.* J Pediatr, 2009. **155**(5): p. 651-6.
218. Becker, M.H., *The Health Belief Model and Sick Role Behavior.* Health Education Monographs, 1974. **2**(4): p. 409-419.
219. Maddux, J.E. and R.W. Rogers, *Protection motivation and self-efficacy: A revised theory of fear appeals and attitude change.* Journal of Experimental Social Psychology, 1983. **19**(5): p. 469-479.
220. Sutton, S., *Health Behavior: Psychosocial Theories. University of Cambridge UK*. 2002.
221. Ajzen, I. and M. Fishbein, *Understanding attitudes and predicting social behaviour.* 1980.
222. Ajzen, I., *The theory of planned behaviour.* Organ. Behav. Hum. Decis. Process., 1991. **50**.
223. Hochbaum, G., I. Rosenstock, and S. Kegels, *Health belief model.* United States Public Health Service, 1952.
224. Tuzova, M., *Health belief Model: losing a battle against obesity*. 2009.

225. Janz, N.K. and M.H. Becker, *The Health Belief Model: a decade later.* Health Educ Q, 1984. **11**(1): p. 1-47.
226. Harrison, J.A., P.D. Mullen, and L.W. Green, *A meta-analysis of studies of the Health Belief Model with adults.* Health Education Research, 1992. **7**(1): p. 107-116.
227. Carpenter, C.J., *A meta-analysis of the effectiveness of health belief model variables in predicting behavior.* Health Commun, 2010. **25**(8): p. 661-9.
228. Becker, M.H. and L.A. Maiman, *Sociobehavioral determinants of compliance with health and medical care recommendations.* Med Care, 1975. **13**(1): p. 10-24.
229. Roden, J., *Validating the revised Health Belief Model for young families: Implications for nurses' health promotion practice.* Nursing & Health Sciences, 2004. **6**(4): p. 247-259.
230. McConnon, A., et al., *Application of the Theory of Planned Behaviour to weight control in an overweight cohort. Results from a pan-European dietary intervention trial (DiOGenes).* Appetite, 2012. **58**(1): p. 313-8.
231. Sweitzer, S.J., et al., *Psychosocial outcomes of Lunch is in the Bag, a parent program for packing healthful lunches for preschool children.* J Nutr Educ Behav, 2011. **43**(6): p. 536-42.
232. Ajzen, I., *Perceived Behavioral Control, Self-Efficacy, Locus of Control, and the Theory of Planned Behavior1.* Journal of Applied Social Psychology, 2002. **32**(4): p. 665-683.
233. Anderson, A.S., et al., *Rattling the plate--reasons and rationales for early weaning.* Health Educ Res, 2001. **16**(4): p. 471-9.
234. Heinig, M.J., et al., *Barriers to Compliance With Infant-Feeding Recommendations Among Low-income Women.* Journal of Human Lactation, 2006. **22**(1): p. 27-38.
235. Baughcum, A.E., et al., *Maternal Feeding Practices and Childhood Obesity: A Focus Group Study of Low-Income Mothers.* Arch Pediatr Adolesc Med, 1998. **152**(10): p. 1010-1014.
236. Russell, C.G., et al., *A qualitative study of the infant feeding beliefs and behaviours of mothers with low educational attainment.* BMC Pediatrics, 2016. **16**(1): p. 69.
237. Brophy, S., et al., *Risk factors for childhood obesity at age 5: analysis of the millennium cohort study.* BMC Public Health, 2009. **9**.
238. Waller, J., et al., *Using grounded theory methodology to conceptualize the mother–infant communication dynamic: Potential application to compliance with infant feeding recommendations.* Maternal & Child Nutrition, 2015. **11**(4): p. 749-760.
239. Harrison, M., W. Brodribb, and J. Hepworth, *A qualitative systematic review of maternal infant feeding practices in transitioning from milk feeds to family foods.* Maternal & Child Nutrition, 2017. **13**(2): p. e12360-n/a.
240. Bowling, A., *Research methods in health. Maidenhead*. 2002, Open University Press.
241. Howlett, B., *Healthcare Research Methods.* 2013.
242. Creswell, J.W., *Research design: Qualitative, quantitative, and mixed methods approaches*. 2013: Sage publications.
243. Van Maanen, M., *Researching lived experience.* Human Science for an Action Sensitive Pedagogy. London, 1990.
244. Mays, N. and C. Pope, *Rigour and qualitative research.* BMJ: British Medical Journal, 1995. **311**(6997): p. 109.
245. Glaser, B. and A. Strauss, *Discovering grounded theory.* Chicago, IL, 1967.
246. Miles, M.B. and A.M. Huberman, *Qualitative data analysis: An expanded sourcebook*. 1994: sage.
247. Black, N., *Why we need qualitative research.* Journal of Epidemiology and Community Health, 1994. **48**(5): p. 425-426.
248. Murphy, E., et al., *Qualitative research methods in health technology assessment: a review of the literature.* Health Technol Assess, 1998. **2**(16): p. 1-274.
249. Noble, H. and J. Smith, *Issues of validity and reliability in qualitative research.* Evidence Based Nursing, 2015.

250. Tong, A., P. Sainsbury, and J. Craig, *Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups.* International journal for quality in health care, 2007. **19**(6): p. 349-357.
251. Blaikie, N., *Designing social research*. 2009: Polity.
252. Grix, J., *Introducing Students to the Generic Terminology of Social Research.* Politics, 2002. **22**(3): p. 175-186.
253. Jones, C.L., et al., *The Health Belief Model as an Explanatory Framework in Communication Research: Exploring Parallel, Serial, and Moderated Mediation.* Health communication, 2015. **30**(6): p. 566-576.
254. Briggs, C.L., *Interviewing, Power/Knowledge, and Social Inequality. Teoksessa: Gubrium, J., & Holstein, J.(eds.) Handbook of Interview Research. Context & Method*. 2002, Sage, Thousand Oaks.
255. Weiss, R.S., *Learning from strangers*. 1994, New York: The Free Press.
256. Schostak, J., *The interview in the project context.* Interviewing and representation in qualitative research, 2006: p. 9-25.
257. Gill, P., et al., *Methods of data collection in qualitative research: interviews and focus groups.* Bdj, 2008. **204**: p. 291.
258. Corbin, J. and J.M. Morse, *The unstructured interactive interview: Issues of reciprocity and risks when dealing with sensitive topics.* Qualitative Inquiry, 2003. **9**(3): p. 335-354.
259. Britten, N., *Qualitative Interviews*, in *Qualitative research in health care*, C. Pope and N. Mays, Editors. 1998, BMJ Publishing Group.
260. DiCicco-Bloom, B. and B.F. Crabtree, *The qualitative research interview.* Medical education, 2006. **40**(4): p. 314-321.
261. Douglas, J.D., *Creative interviewing*. Vol. 29. 1985: Sage Publications, Inc.
262. Spradley, J., *The ethnographic interview.* New York (ua), 1979.
263. Patton, M., *Qualitative research and evaluation methods*. 2002: Thousand Oaks, CA: Sage Publications.
264. Al-Busaidi, Z.Q., *Qualitative research and its uses in health care.* Sultan Qaboos University Medical Journal, 2008. **8**(1): p. 11.
265. Ezzy, D., *Qualitative interviewing as an embodied emotional performance.* Qualitative Inquiry, 2010. **16**(3): p. 163-170.
266. Edwards, R. and J. Holland, *What is qualitative interviewing?* 2013: A&C Black.
267. Hammersley, M., *Social research: philosophy, politics and practice*. 1993: Sage.
268. Ritchie, J., et al., *Qualitative research practice: A guide for social science students and researchers: Sage*. 2013.
269. Britten, N., *Qualitative research: qualitative interviews in medical research.* BMJ, 1995. **311**(6999): p. 251-253.
270. Mason, M., *Sample Size and Saturation in PhD Studies Using Qualitative Interviews*. 2010. Vol. 11. 2010.
271. Morse, J.M., *Designing funded qualitative research*, in *Handbook of qualitative research*, N.K.L. Denzin, Y.S.,, Editor. 1994, Thousand Oaks, CA: Sage.
272. Guest, G., A. Bunce, and L. Johnson, *How Many Interviews Are Enough?:An Experiment with Data Saturation and Variability.* Field Methods, 2006. **18**(1): p. 59-82.
273. O'reilly, M. and N. Parker, *'Unsatisfactory Saturation': a critical exploration of the notion of saturated sample sizes in qualitative research.* Qualitative research, 2013. **13**(2): p. 190-197.
274. Green, J. and N. Thorogood, *In-depth interviews.* Qualitative methods for health research, 2004. **2**: p. 93-122.
275. Polit, D.H. and P. Hungler, *Nursing research. Principals and methods. Sixth edition.* . 1999: Lippincott Williams & Wilkins, Philadelphia, USA.
276. Roller, M.R., *Research Design Review*, in *Qualitative Research Design*, M.R. Roller, Editor. 2015.

277. Turner III, D.W., *Qualitative interview design: A practical guide for novice investigators.* The qualitative report, 2010. **15**(3): p. 754.
278. Bradley, E.H., L.A. Curry, and K.J. Devers, *Qualitative Data Analysis for Health Services Research: Developing Taxonomy, Themes, and Theory.* Health Services Research, 2007. **42**(4): p. 1758-1772.
279. Boyatzis, R., *Transforming qualitative information: Thematic analysis and code development* 1998: Thousand Oaks, CA: Sage Publications.
280. Braun, V. and V. Clarke, *Using thematic analysis in psychology.* Qualitative Research in Psychology, 2006. **3**(2): p. 77-101.
281. Eli, K., et al., *"A little on the heavy side": a qualitative analysis of parents' and grandparents' perceptions of preschoolers' body weights.* BMJ Open, 2014. **4**(12).
282. Faulkner, A., *A story of colliding worlds: A report to INVOLVE*. 2004.
283. Brett, J., et al., *Mapping the impact of patient and public involvement on health and social care research: a systematic review.* Health Expect, 2014. **17**(5): p. 637-50.
284. Braun, V. and V. Clarke, *Successful qualitative research: A practical guide for beginners*. 2013: sage.
285. Boutain, D. and J. Hitti, *Orienting multiple interviewers: the use of an interview orientation and the standardized interview.* Qual Health Res, 2006. **16**.
286. Kaae, S., et al., *Experiences from a pilot study on how to conduct a qualitative multi-country research project regarding use of antibiotics in Southeast Europe.* Journal of Pharmaceutical Policy and Practice, 2016. **9**(1): p. 20.
287. Symon, G. and C. Cassell, *Qualitative organizational research: core methods and current challenges*. 2012: Sage.
288. Weick, K.E., *Essai: real-time reflexivity: prods to reflection.* Organization Studies, 2002. **23**(6): p. 893-898.
289. Alvesson, M., C. Hardy, and B. Harley, *Reflecting on reflexivity: Reflexive textual practices in organization and management theory.* Journal of management studies, 2008. **45**(3): p. 480-501.
290. Finlay, L., *Negotiating the swamp: the opportunity and challenge of reflexivity in research practice.* Qualitative research, 2002. **2**(2): p. 209-230.
291. Hertz, R., *Reflexivity and voice*. 1997, Thousand Oaks, CA: Sage.
292. Banister, P., *Qualitative methods in psychology: A research guide*. 2011: McGraw-Hill Education (UK).
293. Cunliffe, A.L., *Reflexive inquiry in organizational research: Questions and possibilities.* Human Relations, 2003. **56**(8): p. 983-1003.
294. Haynes, K., *Reflexivity in qualitative research.* Qualitative organizational research: Core methods and current challenges, 2012: p. 72-89.
295. Sandelowski, M., *Rigor or rigor mortis: the problem of rigor in qualitative research revisited.* ANS Adv Nurs Sci, 1993. **16**(2): p. 1-8.
296. Long, T. and M. Johnson, *Rigour, reliability and validity in qualitative research.* Clinical Effectiveness in Nursing, 2000. **4**(1): p. 30-37.
297. Noyes, J. and J. Popay, *Directly observed therapy and tuberculosis: how can a systematic review of qualitative research contribute to improving services? A qualitative meta-synthesis.* J Adv Nurs, 2007. **57**(3): p. 227-43.
298. Pope, C., S. Ziebland, and N. Mays, *Qualitative research in health care: analysing qualitative data.* BMJ: British Medical Journal, 2000. **320**(7227): p. 114.
299. Elo, S. and H. Kyngaes, *The qualitative content analysis process.* Journal of Advanced Nursing, v. 62, p. 107-115, 2008.
300. Ziebland, S. and A. McPherson, *Making sense of qualitative data analysis: an introduction with illustrations from DIPEx (personal experiences of health and illness).* Medical education, 2006. **40**(5): p. 405-414.

301. Suzanne Goodell, L., et al., *Parental perceptions of overweight during early childhood.* Qualitative Health Research, 2008. **18**(11): p. 1548-1555.
302. Baughcum, A.E., et al., *Maternal perceptions of overweight preschool children.* Pediatrics, 2000. **106**(6): p. 1380-1386.
303. Doolen, J., P.T. Alpert, and S.K. Miller, *Parental disconnect between perceived and actual weight status of children: a metasynthesis of the current research.* Journal of the American Association of Nurse Practitioners, 2009. **21**(3): p. 160-166.
304. Glocker, M.L., et al., *Baby Schema in Infant Faces Induces Cuteness Perception and Motivation for Caretaking in Adults.* Ethology, 2009. **115**(3): p. 257-263.
305. Latzer, Y. and D. Stein, *A review of the psychological and familial perspectives of childhood obesity.* Journal of eating disorders, 2013. **1**: p. 7-7.
306. Jones, A.R., et al., *Parental perceptions of weight status in children: the Gateshead Millennium Study.* International Journal of Obesity, 2011. **35**(7): p. 953-962.
307. Redsell, S.A., et al., *UK health visitors' role in identifying and intervening with infants at risk of developing obesity.* Maternal and Child Nutrition, 2013. **9**(3): p. 396-408.
308. McCormick, D., P., et al., *Infant obesity: Are we ready to make this diagnosis?* The Journal of Pediatrics, 2010. **157**: p. 15-19.
309. World Health Organization and UNICEF, *Global strategy for infant and young child feeding*. 2003: World Health Organization.
310. Reim, M., C. Teping, and J. Silny, *The development of stereoscopic vision in 1st months of life.* Journal Francais D Ophtalmologie, 1989. **12**(10): p. 623-627.
311. Rapley, G., *Baby-led weaning: transitioning to solid foods at the baby's own pace.* Community Pract, 2011. **84**.
312. World Health Organisation, *Infant and young child feeding. Model chapter for textbooks for medical students and allied health professionals*. 2012, Geneva: World Health Organisation.
313. Padmanabhan, U., C.D. Summerbell, and N. Heslehurst, *A qualitative study exploring pregnant women's weight-related attitudes and beliefs in UK: the BLOOM study.* BMC Pregnancy and Childbirth, 2015. **15**(1): p. 99.
314. Frias, A.E. and K.L. Grove, *Obesity: a transgenerational problem linked to nutrition during pregnancy.* Semin Reprod Med, 2012. **30**(6): p. 472-8.
315. Jackson, R.A., et al., *Improving diet and exercise in pregnancy with Video Doctor counseling: A randomized trial.* Patient Education and Counseling, 2011. **83**(2): p. 203-209.
316. McDonald, S.D., et al., *Despite 2009 guidelines, few women report being counseled correctly about weight gain during pregnancy.* American Journal of Obstetrics and Gynecology, 2011. **205**(4): p. 333.e1-333.e6.
317. Stotland, N.E., et al., *Preventing excessive weight gain in pregnancy: how do prenatal care providers approach counseling?* Journal of Women's Health, 2010. **19**(4): p. 807-814.
318. Llewellyn, C.H., et al., *Nature and nurture in infant appetite: analysis of the Gemini twin birth cohort.* The American Journal of Clinical Nutrition, 2010. **91**(5): p. 1172-1179.
319. Elks, C.E., et al., *Variability in the heritability of body mass index: a systematic review and meta-regression.* Frontiers in endocrinology, 2012. **3**.
320. Baughcum, A.E., et al., *Maternal feeding practices and childhood obesity - A focus group study of low-income mothers.* Archives of Pediatrics & Adolescent Medicine, 1998. **152**(10): p. 1010-1014.
321. Jeffery, A.N., et al., *Parents' awareness of overweight in themselves and their children: cross sectional study within a cohort (EarlyBird 21).* BMJ, 2005. **330**(7481): p. 23-4.
322. Lucas, P., et al., *A systematic review of lay views about infant size and growth.* Archives of Disease in Childhood, 2007. **92**(2): p. 120-127.
323. Macdonald, P.D., et al., *Neonatal weight loss in breast and formula fed infants.* Arch Dis Child Fetal Neonatal Ed, 2003. **88**(6): p. F472-6.

324. Kools, E.J., C. Thijs, and H.d. Vries, *The behavioral determinants of breast-feeding in The Netherlands: predictors for the initiation of breast-feeding.* Health education & behavior, 2005. **32**(6): p. 809-824.
325. Koletzko, B., et al., *Infant feeding and later obesity risk.* Adv Exp Med Biol, 2009. **646**: p. 15 - 29.
326. Shloim, N., et al., *Looking for cues – infant communication of hunger and satiation during milk feeding.* Appetite, 2017. **108**(Supplement C): p. 74-82.
327. NHS Choices. *https://www.nhs.uk/conditions/pregnancy-and-baby/your-breastfeeding-questions/*. 2017 [cited 2018 30/9/2018]; Available from: https://www.nhs.uk/conditions/pregnancy-and-baby/your-breastfeeding-questions/.
328. Van der Willik, E.M., et al., *Exclusively breastfed overweight infants are at the same risk of childhood overweight as formula fed overweight infants.* Archives of Disease in Childhood, 2015: p. archdischild-2015-308386.
329. Sloan, S., et al., *Early weaning is related to weight and rate of weight gain in infancy.* Child Care Health and Development, 2008. **34**(1): p. 59-64.
330. Walker, O., et al., *A qualitative study of primary care clinicians' views of treating childhood obesity.* BMC Family Practice, 2007. **8**.
331. Redsell, S.A., et al., *Preventing childhood obesity during infancy in UK primary care: a mixed-methods study of HCPs' knowledge, beliefs and practice.* BMC Family Practice, 2011. **12**(1): p. 54.
332. Gibbs, L., et al., *What have sampling and data collection got to do with good qualitative research?* Aust N Z J Public Health, 2007. **31**(6): p. 540-4.
333. Draper, A. and J.A. Swift, *Qualitative research in nutrition and dietetics: data collection issues.* Journal of Human Nutrition and Dietetics, 2011. **24**(1): p. 3-12.
334. Ghosh, R.E., et al., *Birth weight trends in England and Wales (1986–2012): babies are getting heavier.* Archives of Disease in Childhood - Fetal and Neonatal Edition, 2017.
335. Andres, R.L. and M.-C. Day. *Perinatal complications associated with maternal tobacco use*. in *Seminars in Neonatology*. 2000: Elsevier.
336. Craig, R. and N. Shelton, *Health Survey for England 2007 Volume 1: Healthy lifestyles: knowledge, attitudes and behaviour.* Leeds: The NHS Information Centre for health and social care, 2008.
337. Karaolis-Danckert, N., et al., *How pre-and postnatal risk factors modify the effect of rapid weight gain in infancy and early childhood on subsequent fat mass development: results from the Multicenter Allergy Study 90–.* The American Journal of Clinical Nutrition, 2008. **87**(5): p. 1356-1364.
338. Jacobson, J.L., S.W. Jacobson, and R.J. Sokol, *Effects of prenatal exposure to alcohol, smoking, and illicit drugs on postpartum somatic growth.* Alcoholism: Clinical and Experimental Research, 1994. **18**(2): p. 317-323.
339. Massion, S., et al., *Exploring the impact of early life factors on inequalities in risk of overweight in UK children: findings from the UK Millennium Cohort Study.* Archives of Disease in Childhood, 2016: p. archdischild-2015-309465.
340. Gungor, D.E., et al., *Risky vs Rapid Growth in Infancy: Refining Pediatric Screening for Childhood Overweight.* Arch Pediatr Adolesc Med, 2010. **164**(12): p. 1091-1097.
341. De Onis, M., M. Blossner, and W.H. Organization, *WHO global database on child growth and malnutrition*. 1997, Geneva: World Health Organization.
342. Ong, K.K., *Size at birth, postnatal growth and risk of obesity.* Horm Res Paediatr, 2006. **65**.
343. Davies, D., *Size at birth and growth in the first year of life of babies who are overweight and underweight at birth.* Proceedings of the Nutrition Society, 1980. **39**(1): p. 25-33.
344. Taal, H.R., et al., *Small and large size for gestational age at birth, infant growth, and childhood overweight.* Obesity, 2013. **21**(6): p. 1261-8.

345. Chiavaroli, V., et al., *LGA infants display early catch down growth in length and weight without epigenetic changes.* International Journal of Pediatric Endocrinology, 2015. **2015**(Suppl 1): p. P106.
346. Bennett, R. *Catch-down growth*. 2016 1/6/2018]; Available from: https://www.babycareadvice.com/article/detail/Catch-down_growth.
347. Ong, K.K., et al., *Dietary energy intake at the age of 4 months predicts postnatal weight gain and childhood body mass index.* Pediatrics, 2006. **117**(3): p. e503-e508.
348. Haire-Joshu, D. and R. Tabak, *Preventing Obesity Across Generations: Evidence for Early Life Intervention.* Annual Review of Public Health, 2016. **37**: p. 253-271.
349. Birch, L. and A. Ventura, *Preventing childhood obesity: what works?* Int J Obes (Lond), 2009. **33**(Suppl 1): p. S74 - 81.
350. Committee on Evaluating Progress of Obesity Prevention Effort Food and Nutrition Board; Institute of Medicine, *Evaluating Obesity Prevention Efforts: A Plan for Measuring Progress.*, S.L. Green LW, Breiner H,, Editor. 2013, National Academies Press US.
351. Redsell, S.A., Edmonds, B., Swift, J. A., Siriwardena, A. N., Weng, S., Nathan, D. and Glazebrook, C., *Systematic review of randomised controlled trials of interventions that aim to reduce the risk, either directly or indirectly, of overweight and obesity in infancy and early childhood*. 2015: Maternal and Child Nutrition, v. 12(1), p. 24-38.
352. Blake-Lamb, T.L., et al., *Interventions for childhood obesity in the first 1,000 days a systematic review.* American Journal of Preventive Medicine, 2016. **50**(6): p. 780-789.
353. Rzehak, P., et al., *Short-and long-term effects of feeding hydrolyzed protein infant formulas on growth at< or= 6 y of age: results from the German Infant Nutritional Intervention Study.* The American Journal of Clinical Nutrition, 2009. **89**(6): p. 1846-1856.
354. Paul, I., et al., *Preventing obesity during infancy: a pilot study.* Obesity (Silver Spring), 2011. **19**.
355. Savage, J.S., et al., *Effect of the INSIGHT responsive parenting intervention on rapid infant weight gain and overweight status at age 1 year: a randomized clinical trial.* JAMA Pediatrics, 2016. **170**(8): p. 742-749.
356. Griffiths, L.J., et al., *Effects of infant feeding practice on weight gain from birth to 3 years.* Arch Dis Child, 2009. **94**(8): p. 577-82.
357. Paul, I.M., et al., *Effect of a responsive parenting educational intervention on childhood weight outcomes at 3 years of age: The insight randomized clinical trial.* JAMA, 2018. **320**(5): p. 461-468.
358. Robinson, T.N., *Stealth interventions for obesity prevention and control: motivating behavior change*, in *Obesity Prevention*. 2010, Elsevier. p. 319-327.
359. Rollnick, S., et al., *Motivational interviewing in health care: helping patients change behavior*. 2008, Taylor & Francis.
360. Cavill, N., H. M., and A. T., *Brief interventions for weight management*, N.O. Observatory, Editor. 2011: Oxford.
361. Martins, R.K. and D.W. McNeil, *Review of motivational interviewing in promoting health behaviors.* Clinical Psychology Review, 2009. **29**(4): p. 283-293.
362. Pollak, K.I., et al., *Physician communication techniques and weight loss in adults: Project CHAT.* American Journal of Preventive Medicine, 2010. **39**(4): p. 321-328.
363. Haby, K., et al., *Mighty Mums – An antenatal health care intervention can reduce gestational weight gain in women with obesity.* Midwifery, 2015. **31**(7): p. 685-692.
364. NHS England, *NHS England. National Health Visiting Service Specification 2014/15*. 2014.
365. Birch, L.L., et al., *Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness.* Appetite, 2001. **36**(3): p. 201-210.
366. Duckett, L., et al., *A Theory of Planned Behavior-Based Structural Model for Breast-Feeding.* Nursing Research, 1998. **47**(6): p. 325-336.

367. Dodgson, J.E., et al., *Theory of planned behavior-based models for breastfeeding duration among Hong Kong mothers.* Nursing Research, 2003. **52**(3): p. 148-158.
368. Lewallen, L.P., *A review of instruments used to predict early breastfeeding attrition.* The Journal of perinatal education, 2006. **15**(1): p. 26.
369. Arden, M., *Conflicting influences on UK mothers' decisions to introduce solid foods to their infants.* Matern. Child Nutr., 2010. **6**.
370. Redsell, S.A., et al., *Parents' beliefs about appropriate infant size, growth and feeding behaviour: implications for the prevention of childhood obesity.* BMC Public Health, 2010. **10**.
371. Horodynski, M., et al., *Low-income mothers' decisions regarding when and why to introduce solid foods to their infants: influencing factors.* J Community Health Nurs, 2007. **24**.
372. Afflerback, S., et al., *Infant-feeding consumerism in the age of intensive mothering and risk society.* Journal of Consumer Culture, 2013. **13**(3): p. 387-405.

6 Appendices

Appendix 1

National Research Ethics Service

Nottingham Research Ethics Committee 2
The Old Chapel
Royal Standard Place
Nottingham
NG1 6FS

Telephone: 0115 8839436
Facsimile: 0115 8839294

24 January 2011

Professor C Glazebrook
Professor of Health Psychology
University of Nottingham
Division of Health Psychology
School of Community Health Sciences
Queens Medical Centre Nottingham
NG7 2UH

Dear Professor Glazebrook

Study title:	**Risk Factors for childhood obesity: the impact of environmental and social factors on rapid weight gain in preschool children.**
REC reference:	**11/H0408/7**
Protocol number:	**11006**

The Proportionate Review Sub-committee of the Nottingham Research Ethics Committee 2 Research Ethics Committee reviewed the above application on 24 January 2011.

Ethical opinion

The committee noted that 3 digits of the postcode are being used, however they felt that the use of 4 digits could give a narrower field. The committee would be happy for the use of 4 digits however they are not making it a condition of approval.

On behalf of the Committee, the sub-committee gave a favourable ethical opinion of the above research on the basis described in the application form, protocol and supporting documentation, subject to the conditions specified below.

Ethical review of research sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Conditions of the favourable opinion

The favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission or approval must be obtained from each host organisation prior to the start of the study at the site concerned.

For NHS research sites only, management permission for research ("R&D approval") should be obtained from the relevant care organisation(s) in accordance with NHS research *governance arrangements. Guidance on applying for NHS permission for research is available in the Integrated Research Application System or at http://www.rdforum.nhs.uk.*

Where the only involvement of the NHS organisation is as a Participant Identification Centre (PIC), management permission for research is not required but the R&D office should be notified of the study and agree to the organisation's involvement. Guidance on procedures for PICs is available in IRAS. Further advice should be sought from the R&D office where necessary.

Sponsors are not required to notify the Committee of approvals from host organisations.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Approved documents

The documents reviewed and approved were:

Document	*Version*	*Date*
Protocol	Final 1.0	09 January 2011
Investigator CV	Christine Glazebrook	15 January 2011
Investigator CV	Deborah Boyle	14 January 2011
Evidence of insurance or indemnity		22 July 2010
Referees or other scientific critique report	Evaulation projects peer review form - PJ Standen	22 December 2010
Referees or other scientific critique report	R7D Projects peer review form - Dr Sarah Rodgers	21 December 2010
Covering Letter		18 January 2011
Letter from Sponsor		14 January 2011
REC application	65922/17988 4/1/28	13 January 2011

Membership of the Proportionate Review Sub-Committee

The members of the Sub-Committee who took part in the review are listed on the attached sheet.

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees (July 2001) and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Now that you have completed the application process please visit the National Research Ethics Service website > After Review

You are invited to give your view of the service that you have received from the National

Research Ethics Service and the application procedure. If you wish to make your views known please use the feedback form available on the website.

The attached document "After ethical review – guidance for researchers" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Progress and safety reports
- Notifying the end of the study

The NRES website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

We would also like to inform you that we consult regularly with stakeholders to improve our service. If you would like to join our Reference Group please email referencegroup@nres.npsa.nhs.uk.

11/H0408/7	Please quote this number on all correspondence

With the Committee's best wishes for the success of this project

Yours sincerely

pp

Dr Martin Hewitt
Chair

Email: trish.wheat@nottspct.nhs.uk

Enclosures:	List of names and professions of members who took part in the review
	"After ethical review – guidance for researchers"
Copy to:	Mr Paul Cartledge, NUH

Appendix 2

NHS
Nottinghamshire County

Nottinghamshire County Teaching PCT
Research and Evaluation
Birch House
Ransom Wood Business Park
Southwell Road West
Rainworth
Nottinghamshire
NG21 0HJ

Tel: 01623 673338
Fax: 01623 673340
www.rdnottspct.nhs.uk

Date: 28th March 2011

Professor Cris Glazebrook
Professor of Health Psychology
University of Nottingham
Division of Health Psychology
School of Community Health Sciences
Queens Medical centre
Nottingham
NG7 2UH

Dear Professor Glazebrook

Ethics Reference Number: 11/H0408/7
Project Title: Risk Factors for childhood obesity: the impact of environmental and social factors on rapid weight gain in pre-school children.

Thank you for submitting the above project to the NHS Nottinghamshire County Research and Evaluation Department. The project has now been given Organisational Approval by:

Dr Chris Packham, R & D Lead, on behalf of NHS Nottingham City
Dr Amanda Sullivan, R & D Lead, on behalf of NHS Nottinghamshire County

Although Organisational approval has been given for this study it does not guarantee that independent contractors such as GPs, dentists, optometrists and community pharmacists will be able to take part in your study.

Appendix 2

NHS
Nottinghamshire County

The *Research Governance Framework for Health & Social Care* sets out the responsibilities of all those involved in research in order to enhance the ethical and scientific quality of health research and to safeguard patients and the public. The lead investigator and all involved in the research have a responsibility to comply with Research Governance.

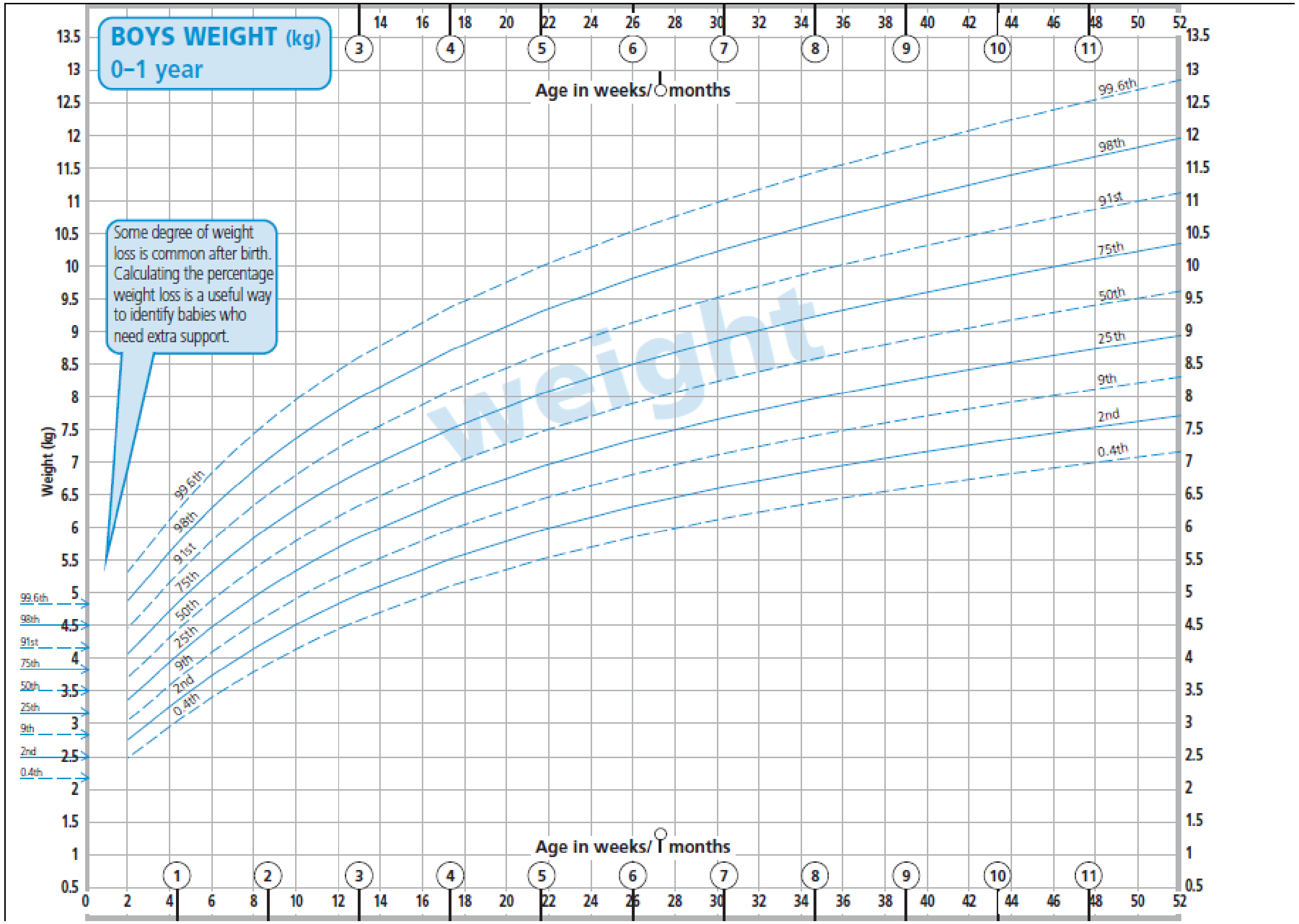
Full details can be found in the RGF document available at www.dh.gov.uk or via the Research and Evaluation Department.

Yours sincerely,

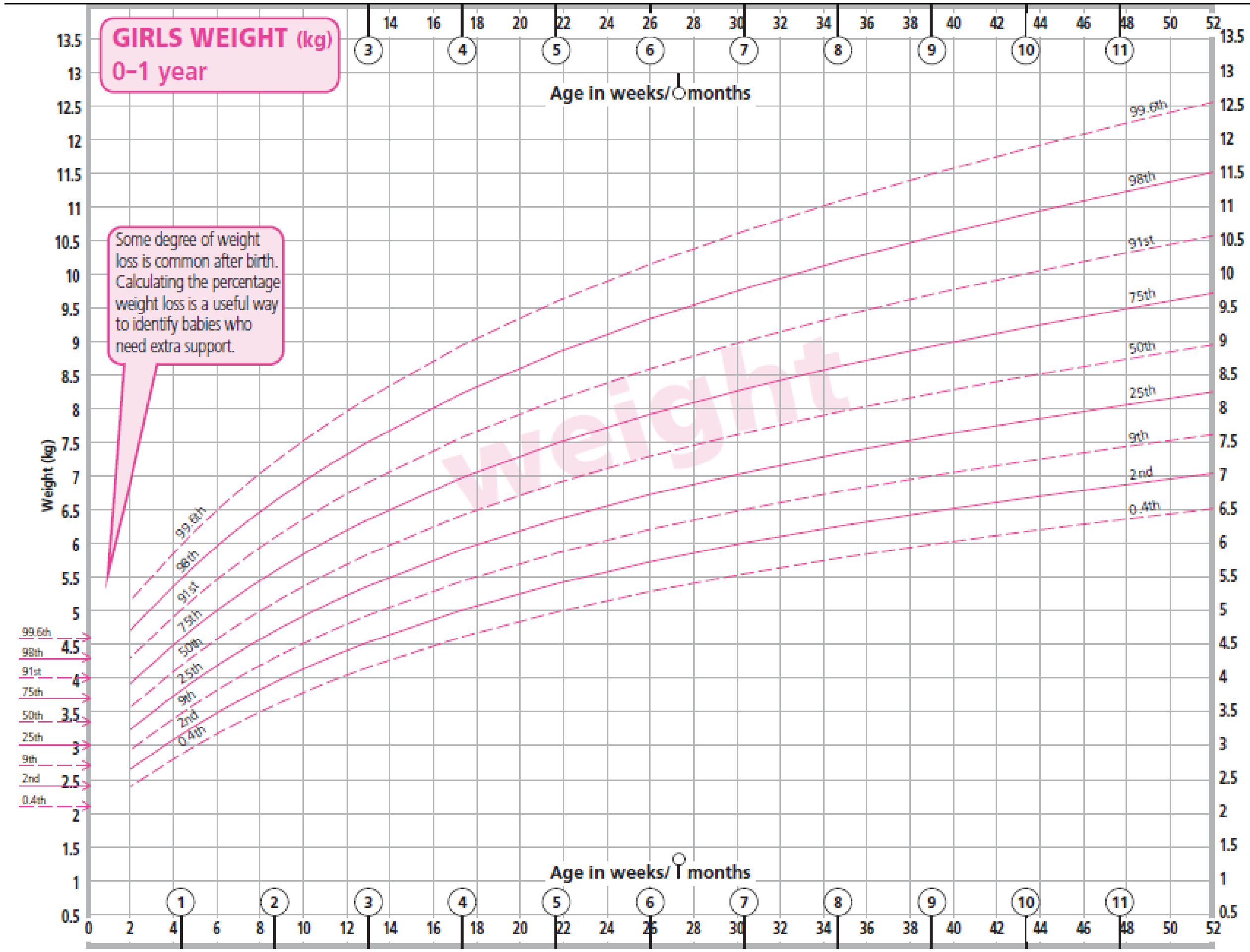
R Illingworth.

Rachel Illingworth
Head of Research and Evaluation

Copy to
R&D leads: Dr Chris Packham, Dr Amanda Sullivan
Ethics: Nottingham Research Ethics Committee 2
Student: Debbie Boyle



BOYS WEIGHT (kg)
0–1 year
Some degree of weight loss is common after birth. Calculating the percentage weight loss is a useful way to identify babies who need extra support.
Age in weeks/months
Weight (kg)
weight
99.6th
98th
91st
75th
50th
25th
9th
2nd
0.4th


GIRLS WEIGHT (kg)
0–1 year
Some degree of weight loss is common after birth. Calculating the percentage weight loss is a useful way to identify babies who need extra support.
Age in weeks/months
Weight (kg)
weight
99.6th
98th
91st
75th
50th
25th
9th
2nd
0.4th

Appendix 4

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

Item

No Recommendation

(*a*) Indicate the study's design with **Title and abstract** 1 a commonly used term in the title or the abstract
(*b*) Provide in the abstract an informative and balanced summary of what was done
and what was found

Introduction

Background/rationale 2 Explain the scientific background and rationale for the investigation being reported
Objectives 3 State specific objectives, including any prespecified hypotheses

Methods

Study design 4 Present key elements of study design early in the paper
Setting 5 Describe the setting, locations, and relevant dates, including periods of recruitment,
exposure, follow-up, and data collection
(*a*) Give the eligibility criteria, and the sources and methods of selection of
participants. Describe methods of follow-up
Participants 6
(*b*) For matched studies, give matching criteria and number of exposed and
unexposed
Variables 7 Clearly define all outcomes, exposures, predictors, potential confounders, and effect
modifiers. Give diagnostic criteria, if applicable
Data sources/
measurement
8* For each variable of interest, give sources of data and details of methods of
assessment (measurement). Describe comparability of assessment methods if there is
more than one group
Bias 9 Describe any efforts to address potential sources of bias
Study size 10 Explain how the study size was arrived at
Quantitative variables 11 Explain how quantitative variables were handled in the analyses. If applicable,
describe which groupings were chosen and why
(*a*) Describe all statistical methods, including those used to control for confounding
(*b*) Describe any methods used to examine subgroups and interactions
(*c*) Explain how missing data were addressed
(*d*) If applicable, explain how loss to follow-up was addressed
Statistical methods 12
(*e*) Describe any sensitivity analyses

Results

(a) Report numbers of individuals at each stage of study—eg numbers potentially
eligible, examined for eligibility, confirmed eligible, included in the study,
completing follow-up, and analysed
(b) Give reasons for non-participation at each stage
Participants 13*
(c) Consider use of a flow diagram
(a) Give characteristics of study participants (eg demographic, clinical, social) and
information on exposures and potential confounders
(b) Indicate number of participants with missing data for each variable of interest
Descriptive data 14*
(c) Summarise follow-up time (eg, average and total amount)
Outcome data 15* Report numbers of outcome events or summary measures over time
(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and
their precision (eg, 95% confidence interval). Make clear which confounders were
adjusted for and why they were included
(*b*) Report category boundaries when continuous variables were categorized
Main results 16
(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a

meaningful time period
Other analyses 17 Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion
Key results 18 Summarise key results with reference to study objectives

Limitations 19 Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation 20 Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability 21 Discuss the generalisability (external validity) of the study results
Other information
Funding 22 Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based
*Give information separately for exposed and unexposed groups.
Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and
published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely
available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at
http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	
Occupation	3	What was their occupation at the time of the study?	
Gender	4	Was the researcher male or female?	
Experience and training	5	What experience or training did the researcher have?	
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	
Sample size	12	How many participants were in the study?	
Non-participation	13	How many people refused to participate or dropped out? Reasons?	
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	
Repeat interviews	18	Were repeat inter views carried out? If yes, how many?	
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	
Field notes	20	Were field notes made during and/or after the inter view or focus group?	
Duration	21	What was the duration of the inter views or focus group?	
Data saturation	22	Was data saturation discussed?	
Transcripts returned	23	Were transcripts returned to participants for comment and/or	

Topic	Item No.	Guide Questions/Description	Reported on Page No.
		correction?	
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	
Description of the coding tree	25	Did authors provide a description of the coding tree?	
Derivation of themes	26	Were themes identified in advance or derived from the data?	
Software	27	What software, if applicable, was used to manage the data?	
Participant checking	28	Did participants provide feedback on the findings?	
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	
Data and findings consistent	30	Was there consistency between the data presented and the findings?	
Clarity of major themes	31	Were major themes clearly presented in the findings?	
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Appendix 6

Interview Schedule – Qualitative Study – Research part 2-Version 2

Parents' experiences of caring for babies who have experienced rapid weight gain: a qualitative study.

1. **Introduction**

- **Personal introduction**
    - **PhD researcher and nature of the research**

- **Recap purpose of the study**

- **If it's ok with you I will turn the recorder on now and everything we talk about from now on will be recorded.**

Start recording

2. **Demographic information**

- **Would you mind if I asked you some questions about yourself first?**

  Is X your first baby? Ages of other children.
  Who else lives in the family home with you.
  Are you working outside the home at the moment?
  What job do you do / did you do?
  What about educational qualifications?

Now I would like to ask you some questions about the your pregnancy and birth.

What sort of pregnancy did you have with X?

Appendix 6

Prompt if not covered -How did X's size and growth affect your pregnancy?

Was X born at around the time he/she was expected (prompt weeks gestation)

What sort of delivery did you have?

Prompt type of delivery

Prompt feelings about delivery

How did X's size affect his/her birth?

How did you feel about X's birthweight when she/he was born?

What sort of things might have affected his/her birthweight?

Prompt family history

How were things after the birth?

How were you feeding X? If bottle fed prompt type of formula

What influenced your decision to bottle/ breast feed?

Prompt advice from family members, health professionals, web etc

Prompt if not covered Did X's size have any impact on your decisions about feeding in the first few weeks.

If breast fed are you still breast feeding? When did you stop? Why did you stop?

How did you/ do you find breast feeding?

If bottle feeding how did find bottle feeding? Is X still having a bottle? When did he/she stop? Why did you stop?

How did you find caring for X in the early months?

Prompt what sort of baby?

Prompt about sleep / feeding routines (if not covered)

Prompt about soothing baby?

Can we talk about weaning X on to other foods

What sort of foods did you introduce first?

What influenced your decisions about early foods?

Prompt advice from family/ health professionals

Prompt infant size

So now that X is Y months old what sort of foods does he/ she like to eat?

Prompt tell me about a typical day

What sort of appetite? Probe factors influencing appetite

How do you know when X is hungry?

Prompt if not covered How does his/ her appetite compare with other babies his/her age?

How do you feel about the way that X is growing?

Prompt concerns

Prompt how does his/her growth compare to other infants?

Are there any other feeding experiences you wish to share?

Thank you for sharing your experiences.

Stop recording.

Appendix 7

Direct line/e-mail
+44 (0) 115 8231063
Louise.Sabir@nottingham.ac.uk

The University of Nottingham
Faculty of Medicine and Health Sciences

Medical School Research Ethics Committee
Division of Therapeutics & Molecular Medicine
D Floor, South Block
Queen's Medical Centre
Nottingham
NG7 2UH

Tel: +44 (0) 115 8231063
Fax: +44 (0) 115 8231059

16th August 2013

Deborah Boyle
PhD Student
c/o Professor Cris Glazebrook
Head of Division of Psychiatry
Room B12, B Floor Institute of Mental Health
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB

Dear Deborah

Ethics Reference No: E15082013 SoM Psychiat **– please always quote.**
Study Title: Parent's experiences of caring from babies born at above average weight: a qualitative study.
Academic Supervisors in Charge: Professor Cris Glazebrook, Head of Psychiatry, Institute of Mental Health, Professor Penny Standen, Division of Rehabilitation and Ageing, School of Medicine
Student Investigator: Deborah Boyle, PhD Student, Division of Psychiatry, School of Medicine.
Duration of Study: 12mths **No of Subjects:** 20

Thank you for your recent application which was considered by the Committee at its meeting on 15th August 2013 and the following documents were received:

Parents' experiences of caring for babies born at above average weight: a qualitative study.

1. UoN FMHS Research Ethics Application form dated 8/5/2013.
2. Study Proposal, Final version 1.0, 26th May 2013.
3. Participant Information Sheet Final version 1.0, 26th May 2013.
4. Interview schedule, version 1.0, 26 May 2013
5. Consent form, Final Version 1.0: date 26 May 2013
6. Recruitment Poster version 1.0: 26 May 2013

These have been reviewed and are satisfactory and the study is approved.

Approval is given on the understanding that the Conditions of Approval set out below are followed.

1. Please can you submit a letter/e-mail of permission from the managers of the Nottingham Local Authority Sure Start Children's Centre when available for our files.

2. You must follow the protocol agreed and inform the Committee of any changes using a notification of amendment form (please request).

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3. This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.

4. An End of Project Progress Report is completed and returned when the study has finished. Please request a form.

Yours sincerely

Dr Clodagh Dugdale
Chair, Nottingham University Medical School Research Ethics Committee

Appendix 8

The University of Nottingham

Faculty of Medicine and Health Sciences

Research Ethics Committee
School of Medicine Education Centr
B Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham
NG7 2UH

Direct line/e-mail
+44 (0) 115 8232561
Louise.Sabir@nottingham.ac.uk

10th October 2014

Deborah Boyle
PhD Student
c/o Professor Cris Glazebrook
Head of Division of Psychiatry
Room B12, B Floor Institute of Mental Health
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB

Dear Deborah

Ethics Reference No: E15082013 SoM Psychiat **– please always quote.**
Study Title: Parent's experiences of caring from babies born at above average weight: a qualitative study.
Academic Supervisors in Charge: Professor Cris Glazebrook, Head of Psychiatry, Institute of Mental Health, Professor Penny Standen, Division of Rehabilitation and Ageing, School of Medicine
Student Investigator: Deborah Boyle, PhD Student, Division of Psychiatry, School of Medicine.
Duration of Study: 12mths **No of Subjects:** 20

Thank you for your letter dated 28th September 2014 notifying the Committee of amendment no 1 dated 28/09/2014 as follows:

- Change of inclusion criteria: to include parental self-identification that their child was above average weight at birth or who feel that their child has grown quickly in the first year.

and the following revised documents were received:

Parents' experiences of caring for babies born at above average weight: a qualitative study.

1. Research Protocol, Version 2.0, 28th September 2014.
2. Participant Information Sheet Version 2.0, 28th September 2014.
3. Consent form, Version 2.0: date 28th September 2014
4. Recruitment Poster version 2.0: 28th September 2014

These have been reviewed and are satisfactory and amendment no 1 dated 28/09/2014 is approved.

Approval is given on the understanding that the Conditions of Approval set out below are followed.

1. You must follow the protocol agreed and inform the Committee of any changes using a notification of amendment form (please request).

The University of
Nottingham

2. This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.

3. An End of Project Progress Report is completed and returned when the study has finished. Please request a form.

Yours sincerely

Dr Clodagh Dugdale
Chair, Nottingham University Medical School Research Ethics Committee

Appendix 8

The University of Nottingham

Direct line/e-mail
+44 (0) 115 8232561
Louise.Sabir@nottingham.ac.uk

Faculty of Medicine and Health Sciences

Research Ethics Committee
School of Medicine Education Cen
B Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham
NG7 2UH

18th May 2015

Deborah Ashton
PhD Student
c/o Professor Cris Glazebrook
Head of Division of Psychiatry
Room B12, B Floor Institute of Mental Health
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB

Dear Deborah

Ethics Reference No: E15082013 SoM Psychiat **– please always quote.**
Study Title: Parent's experiences of caring from babies born at above average weight: a qualitative study.
Academic Supervisors in Charge: Professor Cris Glazebrook, Head of Psychiatry, Institute of Mental Health, Professor Penny Standen, Division of Rehabilitation and Ageing, School of Medicine
Student Investigators: Deborah Ashton, PhD Student, Division of Psychiatry, School of Medicine. Kathryn Kimber, BMedSci 3rd Year Project Student, School of Medicine.
Duration of Study: 1/9/2013-31/08/2016
No of Subjects: 20-40 (18+ Years)

Thank you for your letter dated 9th May 2015 notifying the Committee of amendment no 2: 9th May 2015 as follows:

- Addition of North Derbyshire as a recruitment area
- Addition of Kathryn Kimber, BMedSci 3rd Year project as a researcher
- Time extension of 12 months to complete this phase of the study

and the following revised documents were received:

- Protocol draft 2.0/Final version 1.1 9th May 2015

These have been reviewed and are satisfactory and the study amendment no 2: 9th May 2015 is approved.

Approval is given on the understanding that the Conditions of Approval set out below are followed.

1. You must follow the protocol agreed and inform the Committee of any changes using a notification of amendment form (please request a form).

2. You must notify the Chair of any serious or unexpected event.

Appendix 8

The University of Nottingham

3. This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.

4. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely

Dr Clodagh Dugdale
Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Appendix 8

The University of Nottingham

Faculty of Medicine and Health Sciences

Research Ethics Committee
School of Medicine Education Centre
B Floor, Medical School
Queen's Medical Centre Campus
Nottingham University Hospitals
Nottingham
NG7 2UH

Direct line/e-mail
+44 (0) 115 8232561
Louise.Sabir@nottingham.ac.uk

17th June 2016

Deborah Ashton
PhD Student
c/o Professor Cris Glazebrook
Head of Division of Psychiatry
Room B12, B Floor Institute of Mental Health
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB

Dear Deborah

Ethics Reference No: E15082013 SoM Psychiat **– please always quote.**
Study Title: Parent's experiences of caring from babies born at above average weight: a qualitative study.
Academic Supervisors in Charge: Professor Cris Glazebrook, Head of Psychiatry, Institute of Mental Health, Professor Penny Standen, Division of Rehabilitation and Ageing, School of Medicine
Student Investigators: Deborah Ashton, PhD Student, Division of Psychiatry, School of Medicine. Taimia Nomani, BMedSci 3rd Year Project Student, School of Medicine.
Duration of Study: 1/9/2013-31/08/2016
No of Subjects: 20-40 (18+ Years)

Thank you for your letter dated 16th June 2016 notifying the Committee of amendment no 3: 16th June 2016 as follows:

- Addition of Taimia Nomani, BMedSci 3rd Year project as a researcher.

These have been reviewed and are satisfactory and the study amendment no 3: 16th June 2016 is approved.

Approval is given on the understanding that the Conditions of Approval set out below are followed.

1. You must follow the protocol agreed and inform the Committee of any changes using a notification of amendment form (please request a form).
2. You must notify the Chair of any serious or unexpected event.
3. This study is approved for the period of active recruitment requested. The Committee also provides a further 5 year approval for any necessary work to be performed on the study which may arise in the process of publication and peer review.
4. An End of Project Progress Report is completed and returned when the study has finished (Please request a form).

Yours sincerely

pp LSabir

Professor Ravi Mahajan
Chair, Faculty of Medicine & Health Sciences Research Ethics Committee

Critical Appraisal Skills Programme

10 questions to help you make sense of qualitative research

How to use this appraisal tool

Three broad issues need to be considered when appraising a qualitative study:

Are the results of the study valid?	(Section A)
What are the results?	(Section B)
Will the results help locally?	(Section C)

The 10 questions on the following pages are designed to help you think about these issues systematically. The first two questions are screening questions and can be answered quickly. If the answer to both is "yes", it is worth proceeding with the remaining questions.

There is some degree of overlap between the questions, you are asked to record a "yes", "no" or "can't tell" to most of the questions. A number of italicised prompts are given after each question. These are designed to remind you why the question is important. Record your reasons for your answers in the spaces provided.

These checklists were designed to be used as educational pedagogic tools, as part of a workshop setting, therefore we do not suggest a scoring system. The core CASP checklists (randomised controlled trial & systematic review) were based on JAMA 'Users' guides to the medical literature 1994 (adapted from Guyatt GH, Sackett DL, and Cook DJ), and piloted with health care practitioners.

For each new checklist a group of experts were assembled to develop and pilot the checklist and the workshop format with which it would be used. Over the years overall adjustments have been made to the format, but a recent survey of checklist users reiterated that the basic format continues to be useful and appropriate.

Referencing: we recommend using the Harvard style citation, i.e.:

Critical Appraisal Skills Programme (2017). CASP (insert name of checklist i.e. Qualitative Research) Checklist. [online] Available at: *URL*. Accessed: *Date Accessed.*

Screening Questions

1. Was there a clear statement of the aims of the research? ☐ Yes ☐ Can't tell ☐ No

HINT: Consider
- What was the goal of the research?
- Why it was thought important?
- Its relevance

2. Is a qualitative methodology appropriate? ☐ Yes ☐ Can't tell ☐ No

HINT: Consider
- If the research seeks to interpret or illuminate the actions and/or subjective experiences of research participants
- Is qualitative research the right methodology for addressing the research goal?

Is it worth continuing?

Detailed questions

3. Was the research design appropriate to address the aims of the research? ☐ Yes ☐ Can't tell ☐ No

HINT: Consider
- If the researcher has justified the research design (E.g. have they discussed how they decided which method to use)?

4. Was the recruitment strategy appropriate to the aims of the research? ❑ Yes ❑ Can't tell ❑ No

HINT: Consider

- If the researcher has explained how the participants were selected
- If they explained why the participants they selected were the most appropriate to provide access to the type of knowledge sought by the study
- If there are any discussions around recruitment (e.g. why some people chose not to take part)

---

5. Was the data collected in a way that addressed the research issue? ❑ Yes ❑ Can't tell ❑ No

HINT: Consider

- If the setting for data collection was justified
- If it is clear how data were collected (e.g. focus group, semi-structured interview etc.)
- If the researcher has justified the methods chosen
- If the researcher has made the methods explicit (e.g. for interview method, is there an indication of how interviews were conducted, or did they use a topic guide)?
- If methods were modified during the study. If so, has the researcher explained how and why?
- If the form of data is clear (e.g. tape recordings, video material, notes etc)
- If the researcher has discussed saturation of data

---

6. Has the relationship between researcher and participants been adequately considered? ❑ Yes ❑ Can't tell ❑ No

HINT: Consider

- If the researcher critically examined their own role, potential bias and influence during
  (a) Formulation of the research questions
  (b) Data collection, including sample recruitment and choice of location
- How the researcher responded to events during the study and whether they considered the implications of any changes in the research design

7. Have ethical issues been taken into consideration? ❑Yes ❑Can't tell ❑No

HINT: Consider
- If there are sufficient details of how the research was explained to participants for the reader to assess whether ethical standards were maintained
- If the researcher has discussed issues raised by the study (e.g. issues around informed consent or confidentiality or how they have handled the effects of the study on the participants during and after the study)
- If approval has been sought from the ethics committee

8. Was the data analysis sufficiently rigorous? ❑Yes ❑Can't tell ❑No

HINT: Consider

- If there is an in-depth description of the analysis process
- If thematic analysis is used. If so, is it clear how the categories/themes were derived from the data?
- Whether the researcher explains how the data presented were selected from the original sample to demonstrate the analysis process
- If sufficient data are presented to support the findings
- To what extent contradictory data are taken into account
- Whether the researcher critically examined their own role, potential bias and influence during analysis and selection of data for presentation

9. Is there a clear statement of findings?

☐Yes ☐Can't tell ☐No

HINT: Consider

- If the findings are explicit
- If there is adequate discussion of the evidence both for and against the researchers arguments
- If the researcher has discussed the credibility of their findings (e.g. triangulation, respondent validation, more than one analyst)
- If the findings are discussed in relation to the original research question

10. How valuable is the research?

HINT: Consider

- If the researcher discusses the contribution the study makes to existing knowledge or understanding e.g. do they consider the findings in relation to current practice or policy?, or relevant research-based literature?
- If they identify new areas where research is necessary
- If the researchers have discussed whether or how the findings can be transferred to other populations or considered other ways the research may be used

Appendix 10

The University of Nottingham

Parents' experiences of caring for babies who have experienced rapid weight gain: a qualitative study.

CALLING ALL MUMS AND DADS

DO YOU HAVE A BABY UNDER THE AGE OF 1? HAS YOUR BABY UPWARDLY CROSSED ONE OR MORE CENTILE LINES ON THEIR WEIGHT CHART?

Appendix 11

The University of Nottingham

Research Study

Calling all Parents, Can you help?

Do you have a baby under 1 year?

Was your baby over 8lb 8oz at birth?

Or has your baby grown quickly crossing centile lines on their birth chart?

Can you spare up to one hour?

YES!

We would love to hear from you

Please complete the information overleaf and hand it into
Reception at your Children's Centre

Name:____

Address:____

____

____

Post code:______________________________________

Telephone Number:______________________________

Email:____

Best Time to Contact:___________________________

Or contact:

Thank you

The University of Nottingham

Participant Information Sheet

(Draft Version 1.1 / Final version 1.0: date 26 May 2013)

Title of Study: Parents' experiences of caring for babies born at above average weight: a qualitative study.

Chief Investigator: Professor Cris Glazebrook
Co Investigators: Professor Penny Standen
Deborah Boyle

We would like to invite you to take part in our research study. Before you decide we would like you to understand why the research is being done and what it would involve for you. One of our team will go through the information sheet with you and answer any questions you have. Talk to others about the study if you wish. Ask us if there is anything that is not clear.

What is the purpose of the study?

This study is part of Debbie Boyle's postgraduate student's research training. She is interested to explore the experiences of feeding and caring for babies born larger than average size. We know that some babies gain a lot of weight whilst in the womb and for some children this early weight gain can increase their risk of being overweight when they start school.

By interviewing parents we hope to be able to understand what sort of support and information parents of larger babies need. The results of the study will be published and will help Health Professionals make changes to services in order to reduce the occurrence of childhood obesity.

Why have I been invited?

You are being invited to take part because you contacted the Research Team to express your interest in taking part in this study.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form If you decide to take part you are still free to withdraw at any time and without giving a reason. This would not affect your legal rights.

What will happen to me if I take part?

Approximately 10 days after you receive this information, a researcher will contact you to ask whether you want to help with the study.

If you decide that you would like to help, then an appointment will be made to see you at home.

During this home visit, the researcher will obtain your informed consent.

An interview between you and the researcher will then take place which will last approximately one hour. This interview will be recorded.

Once the interview is finished the recorded interview will be downloaded onto a secure password protected computer. The interview will then be typed up in full to make a written copy of the interview. At this stage all identifiable information will be removed.

Expenses and payments
Participants will be paid an inconvenience allowance in the form of a £10 gift voucher to participate in the study.

What are the possible disadvantages and risks of taking part?
The main disadvantage is that you will give up approximately an hour of your time but we hope that you will enjoy talking about your infant to the researcher. We can see no risks in taking part in this study.

Participation in the study will require up to one hour of your time.

What are the possible benefits of taking part?
We cannot promise the study will help you but the information we get from this study may help shape children's health care provision in the future.

What if there is a problem?
If you have a concern about any aspect of this study, you should ask to speak to the researchers who will do their best to answer your questions. The researchers contact details are given at the end of this information sheet. If you remain unhappy and wish to complain formally, you can do this by contacting NHS Complaints. Details can be obtained from your hospital.

Will my taking part in the study be kept confidential?
We will follow ethical and legal practice and all information about you will be handled in confidence.

If you join the study, some parts of the data collected for the study will be looked at by authorised persons from the University of Nottingham who are organising the research. They may also be looked at by authorised people to check that the study is being carried out correctly. All will have a duty of confidentiality to you as a research participant.
All information which is collected about you during the course of the research will be kept **strictly confidential**, stored in a secure and locked office, and on a password protected database.

Your personal data (address, telephone number) will be kept until the end of the study so that we are able to contact you about the findings of the study (unless you advise us that you do not wish to be contacted). All research data will be kept securely for 7 years. After this time your data will be disposed of securely. During this time all precautions will be taken by all those involved to maintain your confidentiality, only members of the research team will have access to your personal data.

What will happen if I don't want to carry on with the study?
Your participation is voluntary and you are free to withdraw at any time, without giving any reason, and without your legal rights being affected. If you withdraw then the information collected may still be used in the project analysis unless you request that it is withdrawn.

What will happen to the results of the research study
This study forms part of a research protocol undertaken as part of a Degree of Doctor of Philosophy and as such will be included in the thesis.

The results will be published in a health specific scientific journal and will be presented at relevant professional conferences.

Who is organising and funding the research?
This research is being organised and funded by the University of Nottingham.

Who has reviewed the study?
This study has been reviewed and given favourable opinion by University of Nottingham Faculty of Medicine and Health Sciences Research Ethics Committee.

Further information and contact details

Chief Investigator: Professor Cris Glazebrook
Head of Division of Psychiatry
Room B12, B Floor Institute of Mental Health
Jubilee Campus
Wollaton Road
Nottingham
NG8 1BB
Phone: 0115 823 0420

Appendix 13

The University of Nottingham

CONSENT FORM
(Draft Version 2.0 / Final version 1.0: 26 July 2014)

Title of Study: Parents' experiences of caring for babies who have experienced rapid weight gain: a qualitative study.

Chief Investigator – Professor Cris Glazebrook

Name of Researcher:

Name of Participant:

Please initial box

1. I confirm that I have read and understand the information sheet version number; 1.0 dated. 23/06/2013 for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐

3. I understand that relevant sections of the data collected in the study may be looked at by authorised individuals from the University of Nottingham, the research group and regulatory authorities where it is relevant to my taking part in this study. I give permission for these individuals to have access to these records and to collect, store, analyse and publish information obtained from my participation in this study. I understand that my personal details will be kept confidential. ☐

4. I understand that the interview will be recorded and that anonymous direct quotes from the interview may be used in the study reports. ☐

5. I agree to take part in the above study. ☐

________________________	______________	____________________
Name of Participant	Date	Signature
________________________	______________	____________________
Name of Person taking consent	Date	Signature

2 copies: 1 for participant, 1 for the project notes

Appendix 14

Safety Office

Reviewed: 17 July 2012

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Health and Safety Arrangements for Lone Working

1. Statement

1.1. The University acknowledges that there may be implications for its employees, students, visitors and contractors when working alone. Suitable risk assessments shall be carried out to identify the risks to lone workers and safe working arrangements shall be introduced to minimise the risks as far as is reasonably practicable.

1.2. Those who may be at risk shall be provided with information and training as appropriate in order to minimise the risks when working remotely from colleagues or other persons and/or outside normal working hours.

1.3. The University seeks to ensure that all relevant health and safety guidance issued by the Health and Safety Executive is complied with. There is no general legal prohibition on working alone but the University acknowledges that there are some specific legal prohibitions affecting a small number of well-established dangerous situations such as working with live electrical conductors and entry into confined spaces.

1.4. The arrangements described in this policy are considered by the University to be best practice in this area and therefore ones that schools/departments are expected to follow. Where this guidance does not cover a particular situation, further advice may be sought from the Safety Office.

2. Application

2.1 This guidance applies to work that is specifically intended to be carried out unaccompanied or without immediate access to another person for assistance.

2.2 Lone working can occur:

- During normal working hours at a remote location either within the normal workplace or off site (normal working hours are considered to be that part of the day when workplace occupancy is such that the presence of the others in the vicinity is likely),
- When working outside normal working hours.

2.3 The aim of the document is to raise awareness of the hazards that may be associated with lone working and to advise schools/departments on the factors to be considered in assessing lone-worker situations in order to minimise the risks and provide a safe working environment as far as is reasonably practicable.

2.4 Different lone working situations exist in different areas of the University and therefore there is no one solution to minimising the risks. Examples of lone working situations at the University include working alone in laboratories, workshops, offices, information desks; peripatetic maintenance workers; security officers on patrol; during fieldwork activities and work in the community; early workers such as cleaners and agricultural workers.

2.5 An individual who has either visual or audible communication with another person would generally not be considered as working alone. The presence of others in the vicinity, such as neighbouring rooms, would also be considered as allowing immediate access to another person for assistance for normal risk activities.

2.6 Although the guidance does apply to lone working in offices, it is understood that the risks are usually minimal and are likely to be related to the location of the work as opposed to the process being carried out. A generic risk assessment would be sufficient with any arrangements for safe working written into the School/Departmental Safety Policy.
To cover such situations as employees working late in an office environment at their own discretion, a standard risk assessment is given in Appendix 1 (http://www.nottingham.ac.uk/safety/documents/lone-working-Appendix-RA.xls - first worksheet**) to demonstrate the standard control measures that should be in place.**

2.7 This guidance document does not deal specifically with fieldwork, please refer to the University's guidance: (http://www.nottingham.ac.uk/safety/documents/fieldwork-policy.pdf).

3. Responsibility for Lone Working Procedures

3.1 The Head of School or Department is responsible for ensuring that arrangements are in place to enable safety during lone working. In particular lone working situations should be identified, risk assessments carried out for these and adequate control measures introduced.

3.2 Individuals are responsible for complying with the control measures arising out of the risk assessment.

4. The Risk Assessment Process

4.1 The reasons for assessing the risks of working alone are to establish:

- Whether the work can be done safely by an unaccompanied person;
- The arrangements necessary to ensure that an individual is not exposed to greater risks than normal when working alone.

4.2 Special attention is needed when assessing lone working because the risks inherent in such work are exacerbated by the lack of the normal channels of support, e.g. first aid provision. Working alone by definition means there will be no direct supervision. The training provided to those working alone, and the level of competence that they will need to demonstrate before being allowed to do so, are therefore especially important.

Appendix 15

CODE BOOK

THEME ONE - POSITIVE CONNOTATION ASSOCIATED WITH HIGH WEIGHT

DEFINITION: Infant's larger size recognised as a positive attribute by parents.

1. Parents justifying baby's higher birth weight

Definition: Parents providing a reason/s to justify their infant's higher weight.

Indication: Parents indicating their infant's increased weight can be justified by various reasons (e.g. weight in proportion with length, genetics: other bigger babies in family, late gestation, baby bump).

Exclusions: Parents ambiguous of infant size

Positive occurrence: *He's (father) very tall and fairly broad he's 6 2. I think and yeah fairly sturdily built (laughter) so yeah she was always going to be she was never going to be a petite dainty little thing I don't think (P12).*

Negative occurrence: *They said she was normal size for a girl – she wasn't too big, she wasn't too small (P08).*

2. A bigger child is more desirable

Definition: Indication that a larger baby is more desirable in appearance, physical characteristics or development.

Indication: Parents stating benefit/s associated with being a bigger baby or demonstrating they are pleased with their baby's size (e.g. by the use of affectionate nicknames descriptive of bigger size).

Exclusions: Parents referring to preferring a baby of a smaller size.

Positive occurrence: *"Chunky monk" (P07).*

Negative occurrence: *I kind of was envious of all my friends little petite babies with skinny arms and legs because they seemed more baby-like and new-born and I had this enormous child already. (P03)*

Appendix 15

THEME TWO - Weight gain is perceived as positive and an indication of successful feeding

DEFINITION: Perception that weight gain is a positive indicator of an infant's health or growth and can be used to monitor how well feeding is progressing.

Indication: Parents pleased with weight gain, or the converse for weight loss. Mention of change in weight to monitor how well feeding is going, with weight gain associated with successful feeding. Change in weight

may be suggested by reference to a change in position/ progression on the centile chart.

Exclusions: Reference to change in weight without the parent's interpretation of it. Parents unconcerned about weight loss, parents indifferent or have a negative association with weight gain.

Positive occurrence: *The fact that she was just sky-rocketing in weight... she only ever lost 1/2 oz after birth and then put on gave me a lot of confidence that yes I was producing milk, it was of decent quality to nourish her, and let's go (P03).*

Negative occurrence: *I think the weight can vary at this stage so much because of illnesses. (P02).*

Appendix 15

THEME THREE – PARENTS UNDERSTANDING OF FEEDING BABY

1. The need to feed on demand

Definition: Idea that babies are fed on demand

Indication: Parents describe feeding child with no fixed pattern, just whenever the baby seems to want it

Exclusions: Feeding patterns are determined by a clock/routine

Positive occurrence: *I breastfed on demand really so I would say in the sense where other people would have that they feed whenever he asked I just fed him which seemed like every minute of the day to start with and I feel that perhaps that's why he's a big boy (P09).*

Negative occurrence: *"She still, still has 3 hourly feeds throughout the day" (P08)*

2. Parents beliefs that you cannot over feed a breast fed infant

Definition: Parents believe that babies who are breast-fed will know when they are full and cannot be overfed

Indication: Indication that parents considered it impossible to overfeed their breastfed baby

Exclusions: Any comment that suggests parents were worried about overfeeding a breastfed baby

Positive occurrence: *She's a breastfeeding baby, you are told that they can't over feed so and they know when they're full (P11).*

Negative occurrence: *I shouldn’t give in and do it (breastfeed) for you here just because I'm here. I'm not a fridge (P21).*

3. Feeding to soothe

Definition: Parents recognise that they may feed baby to soothe or help sleep rather than solely to satisfy hunger

Indication: Indication that feeding may be used to soothe an upset baby even if baby isn’t hungry, or to help baby sleep

Exclusions: Indication that feeding is only used to satisfy hunger

Positive occurrence: *It wasn’t really that oh he’s hungry now, it was just oh er I just need to breastfeed him now for whatever reason it was (P24).*

Negative occurrence: *I think he won’t eat if he’s not hungry (P02).*

THEME FOUR – PARENTS WEANING DESCISIONS

1. Parents manipulation of weaning guidance

Definition: Adherence to WHO weaning guidelines vary, either due to parents being unaware, interpreting them wrongly or not agreeing with them.

Indication: Any mention of what parents believe the correct weaning guidelines are, and if they followed these.

Exclusions: Parents followed WHO guidelines correctly

Positive occurrence: *I know that they recommend to wait until 6 months but it was only a couple of weeks before (P01).*

Negative occurrence: *We're waiting until at least 26 weeks as per NHS recommendations (P03).*

2. Weaning in response to infant cues

Definition: Parents explain decisions to wean early with cues from infant falsely suggesting early readiness

Indication: False early readiness cues (infant following food, expressing interest in food or ability to eat food) used to justify decisions to wean early

Exclusions: Early weaning cues taken from recommended guidelines

Positive occurrence: *I knew that he was getting more interested in food, and looking at us while we was eating, he was grabbing at things, and putting them in his mouth, so I just thought you know, I'd try him on it (P16).*

Negative occurrence: *I waited for the signs that his head control was really good so he wasn't bobbing umm he could sit up... well not on his own but if you place him in a certain position he doesn't fall... his hand to mouth co-ordination (P01).*

3. Bigger baby requires modified weaning.

Definition: Parents believed that weaning early was required because of infant's bigger size

Indication: Indication that decision to wean early linked to bigger size of infant

Exclusions: Weaning age has nothing to do with infant size

Positive occurrence: *He's having baby porridge, 'cause obviously he's a big baby and 'cause he was just constantly wanting to feed on to me… Only a little bit, just 'cause he needed something else." (P05) "He wouldn't have been able to cope until he's 6 months! He'd be wasting away! (P05)*

Negative occurrence: I'm I underfeeding her? Am I overfeeding her? Is she going to be fat? Is she going to be scrawny?" (P22)

4. Parents seeking information

Definition: Parents referring to information either from their own research or given to them by others to guide their decisions.

Indication: Parents speaking about the use of written information (e.g. books, internet, guidelines, leaflets) to guide them in making decisions. Research used to justify advice given by another individual.

Exclusions: Feeding decision guided by people. Reference to advice from individuals, such as friends, family or HCPs.

Positive occurrence: *I'd done a bit of reading… and sort of a bit as I was looking at weaning, the you know, the research suggesting that actually 6 months isn't just about him being ready to swallow, it's all about the gut (P20).*

Negative occurrence: *I would have stuck out till six months with him but mums like promise me… because she was convinced the only reason him wasn't sleeping through was because he hasn't… been getting any solids and he was hungry. Um and I'm like no… no, the health visitor say it's not that um and so I would have stuck it out but mum was just kind of needling and needling and I'm like alright then (P22).*

Appendix 16

Anonymised interview transcript

Interview 1 – LD 3rd December 2014
Married Couple – White Child

I: How big was baby when he was born?

P: He was 8lb 5 when he was born . . . but in the (picks up red book) and then he crossed the two centiles from being born within the first few weeks so wasn't born huge but he's crossed straight away the centiles from so in kilos he was born (at term) at 3.7kg but by two weeks he was 4.5kg and then at 8 weeks old he was 6. Something so in these weeks he's gone right and he's now above (centiles) and is now well above the 99th

(Red book focused . . . direct questioning used)

I: is he your first baby?

P: Erm yes, yes

I: Does anyone else live with you?

P: My partner, his Dad

I: And are you currently work?

P: Er no I've taken maternity leave so a year's maternity leave,

I: So you have taken the whole and not splitting it between you?

P:No No erm no I didn't give dad that option (laughter)

I: So what is your job?

P: Erm I'm a teacher,

I: What ages?

P: I'm now a special needs teacher but a primary school teacher but gone into special needs so I teach 3 to 10 3 to 11 year olds at XXXX with profound and multiple learning difficulties so but it's awesome

I: Absolutely, and what does Dad do?

P: He's an electrician

I: A busy household then

P: Hes at work now hes on late shift

I: When you were pregnant did you have any dating scans did you go for the routine dating scans?

P: I did yeah yeah I had both of those yeah

I: Did the sonographer say anything about

P: No No nothing no mention of his size or anything like that just that everything was normal normal sized baby

I: What was your plan to feed him when he was born?

P: To breastfeed him

I: And did you?

P: Yes and I still breastfeed now at 6 months

I: Well done you

P: Hes solely breastfed and I intend to breastfeed him until hes a year old erm and only give him formula milk as a erm if my Mum has to look after him and I carn't be there at once a week or not even that as a backup so yeah hes still solely breastfed but Ive just started weaning him

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I: What sort of delivery did you have?

P: Erm he was C section in the end an emergency C section we attempted normal delivery because he was a week overdue and I was inducted and then his heart rate went down so they emergency C sectioned me after trying everything and every way to pull him out he didn't come out so erm I think it was because he was back to back I don't know he just wouldn't come out

I: (soothing)

P: (Cuddles + plays with baby)

I: So how did you feel about having an emergency section?

P: Absolutely fine erm I wanted him safe and happy and well in this world and I just said do what you need to do whatever er because of the children I work with I know what can happen if they don't come out healthy erm quick enough and they took him away for a long time in my eyes a long time looking for things looking for the perfect thing for 10 minutes (4:56) so if they'd have not c sectioned me how long would he have been in distress and hes fine so I'm happy other people would have called it traumatic but to me it was whatever I didn't care as soon as he came in the world and I'd do it again the same

I: Do you remember those first weeks?

P: Yeah we went to Germany we went down South when he was 2 weeks old and we went to Germany when he was 3 weeks old so as soon as he was born we just went travelling and visiting family so it was great his Dad had time off

I: So who has the German connection?

P: His Dad's German

I: Right Ok

P: So we will be there at Christmas

I: Did you notice if your families in the UK and your partners in Germany had any difference in advise that you were given?

P: Erm not at all because nobody really said anything to me it's only through my friends here I never went oh did we go to Germany yeah just before the end of my pregnancy I never really spoke to anybody there and none of his family really bothered us in that sense or gave us any advise so they pretty much left us alone and nobody's really anything all I know is about the gas and air in Germany is not allowed they don't give gas and air in hospitals

I: Right

P: That's the only thing I've found that's any different they don't . . . apparently . . . for the nurses safety I think or something like that

I: When baby was born and things settled down and then the midwives take baby away to weigh and measure what were your thoughts on how heavy he was?

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P: I didn't really now I didn't have any expectation really he was bigger than I thought because I was 7lb 11 when I was born and I thought that's what he would be the association of my 7lb baby so I knew he was a bit bigger I just thought arrr but he was just all arms and legs he didn't look

big to me do you know what I mean errm I don't think I realised I had a big baby until maybe he started not fitting in the after the first week he wouldn't fit the first clothes that was only when I realised that he was big and then he literally couldn't wear any of those so he filled more of the 3 months clothes straight away but before he was even a month old I couldn't fit him into 0-3 month clothes anymore and that's when it dawned on me that he was big I think I don't think I'd realised to start with that he was a big baby it was more later on

I: You were 7 11 does your partner now how heavy he was?

P: Yeah he was born less than me he was smaller than him but still fairly big I think he was something like (Red Book) my partners 6ft 3 and so he was long when he was born I did not weigh as much as baby when I was a year old I wasn't as big as he is now so erm (partner) was only 3.6 kilos which was 7 15 something like that so he was a little bit bigger but he wasn't big like he was

(Watching baby play – first time lifting bum off the floor)

I: So you started to breastfeed did you establish a routine?

P: I breastfed on demand really so I would say in the sense where other people would have that they feed whenever he asked I just fed him which seemed like every minute of the day to start with and I feel that perhaps that's why hes a big boy hes long but if he he knows when he's hungry and he either stay on and feed for and its been all the way the same thing for a long time or hell just have a little drink and then get on with

whatever hes whatever he wants . . . (stops to breast feed baby) so I basically breastfed on demand (10:02) rather than I'm not a person who has much of a routine myself to be honest so erm

I: In the earlier weeks feeding did you have particular clues that you thought he was particularly hungry because there is a lot to is he tired, hungry does he need his nappy changing?

P: Like he does now rooting with the rooting basically yeah and now that he came move you pick him up then he sticks his head downwards and he just goes down for your boob so erm I would say because on demand feeding so I would think maybe most of the time boob cured everything he's never really cried yeah he's never been a baby that's cried at all and even now the only time he cries that's the noise he makes you heard them (<demonstrates>) he doesn't cry and he doesn't scream erm at night if you put him in the cot and he doesn't want to be there or he wakes in the night and cries erm and boob solves everything nothing else will yeah and just that he wants to I don't know whether it's the closeness that or the feeding so maybe sometimes feeding is part of it is comfort he feeds sometimes for comfort but I've just because he's been happy I've allowed him to and it didn't bother me erm so if he was really hungry he'll then feed for a long time erm and if it was just comfort he'd just have a drink and then stop but when he was little he would probably feed every two hours at least you know sometimes every hour so when we went away to Germany when he was 3 weeks old he basically spent most of his time attached to me somebody would have a cuddle and he'd whinge so I'd take him back and he'd want to feed again erm that could be why he's big because he's you know because not knowing him being my first and boob solves all problems so I've just let him feed when he wants to really erm and then he'll as soon as he's had a drink he's happy and he'll go on his merry way . . . (won't you) and play erm so I think that's how I felt then was that it meant that he was a contented baby in that sense erm because I have friends who bottle fed erm and their babies would scream but they've had their bottle and they are not due a bottle for 3 hours so they have to you know shake um walk around and you know jolly them on erm and so I just always though you want a drink carry on but obviously within that not knowing how much he's ever drunk until the (mother [redacted]) obviously enough

I: if you were to compare little man with his friends who bottle feed is there any difference in health have you noticed any difference in health?

P: Erm he had a sickness bug but that’s all he has really had he’s been bright eyed from the moment he came out he’s been bright eyed and bushy tailed the photos of him when he was little 2 weeks old and he’s like that (<demonstrates>) you know not that sleepy baby whatever he’s been really healthy yeah in that he hasn’t really had any problems I think a bit snufflely when he was first born but I think that’s because he born c section yeah health wise I have a friend whose it’s a bit of a mix I have a friend who has mixed fed her baby from being small and she’s had loads

of colds and all sorts of things and XXXX hasn’t they say it’s the best thing cause it’s for their immune system so erm you just breastfeeding made him happy he doesn’t he just doesn’t cry really he just doesn’t need to you’re a good lad aren’t you? He has a whinge like I’m hungry but now as he’s got bigger he’ll we’ve been out today I’ve fed him twice you know so he goes quite a while but the problem is during the night that he feeds the most I’ve started to get back about 5 hours sleep before he wakes I don’t mind if I don’t get more than 5 hours maybe 6 hours at night but for the last 3 weeks after he was poorly because he caught this sickness bug erm he feeding every 2 hours so was like he can’t (not loose) because he’s constantly you know even if it wasn’t a lot he’d wake up really screaming like in pain erm pick up out of the cot and give him a feed and 5 minutes he’d be back to sleep again but he’d do that every 2 hours so (talks to baby)

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I: So tell me about your first foods tell me about your weaning journey?

P: He's for a long time I went to a weaning group weaning class so I've been to like weaning group thing at the Children's Centre to find out what to do for him and g*et al*l the information from about 5 months old I decided I was waiting till he was six months but when he hit 5 months he we I started sitting him with us while we had dinner and things like that and if I was eating he was trying to grab your food and things and I thought alright you're getting interested let's try a few bits of carrot or apple I'd filled up the freezer with ice cubes of things to taste (<talks to baby>) (calls baby "chunky monk") so I filled my freezer with little vegetables that we eat and that kind of thing and started just trying him with little and he literally ate nothing like a cube and he'd get quite (pulls a face) that's like poison he wasn't really interested then after about 2 weeks I found he liked bananas he eat bananas and things so I would give him bananas porridge and things and still very tiny portions and then he was poorly and so I stopped feeding solids and then for 2 weeks having little tastes of stuff but looking back now I don't think he was at 5 months he was as ready as he is now he then was sick and I didn't feed him for 2 weeks because he had projectile vomiting he'd got a bug off one of his friends so I just breast fed him and gave him water and then after that because after it came back in the middle of the next week so I stopped again and made sure he was clear and then I've just started again and he is eating like a horse but there is no advise out there for how much I should be giving him for his weight because he's the size of a 9 month old you know or a 12 month old actually erm you know for some average 12 month old should I be giving him a small portion should I be giving him what a one year old be eating that's what I find when I've asked the health visitors what sort of size a lot of the time he would be eating more than I give him he's not I find whatever I put in the pot he will eat so if I don't know because I've never put a massive portion out for his dinner but somethings I think really have you really just eaten have you eaten the bowl with porridge fruit and most of his and I feed most of

his food vegetable are the most of his thing but that worries me because I want to keep an eye on his weight him what if now he has fruit veg porridge rice at the moment and no real there is nothing definitely not having any sugar or nonsense of stuff like that I'm making sure that he only has stuff that I cook and I've just today bought some of those pouches from that's just got fruit and veg in them to take to Germany for the journey there and back because so that I know that I got something to hand so weaning's been fine and he will eat anything the boys eats prunes figs avocado everything on the list and it goes in there and you like it don't you now but I don't know about portion sizes what is a portion a good portion for a baby of his size that's what I do worry about

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I: With the breast feeding you breast fed on demand what are you doing about weaning meals?

P: With weaning he has breakfast with me lunch with me and then in the evening now 2 days ago I started giving him 3 times a day, porridge he eats at breakfast and we eat together if papas here at lunch time we have lunch together and then at the evening meal in a bit probably once you've gone I'll give him chicken and vegetable casserole cooked for tea tonight (talks to baby "you're a people person aren't you

I: You go to your Wednesday Mummy group, are the babies the same age?

P: He's the 4th in line I think, there's ten of them

I: So how is his development compared to his peers? Do you compare at all?

P: He's very much the same as the seven month old he see when we go out I put him on the floor I'm not and he can crawl roll over all those kind of things he's probably the same or ahead of them (21.14) in that sense because I put him on his tummy all the time and always have done so the only one a seven month old child his friend is like him in what they can do he's not quite so sturdy sitting up but so I think he definitely is we're should be (talks to baby you like to blow raspberries on mummy's leg)

I: Is there anything unique with your relationship your feeding relationship with your Son?

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P: XXXX (Partner) doesn't seem to understand him the way I do XXXX is amazing with him as a Dad but he speaks to me and I know what he is saying yeah this is a hungry, this is a I need changing this is . . . so I think I understand when he's hungry because now he's sat here now and he's as happy as Larry hes moaning a little bit there I can pick him up and give him what a couple of minutes

Erm so I feel we've got a really strong bond through me breast feeding him and (sorts out baby) we are close the some of the other Mums seem to get a little bit stressed about feeding because we've had lots of conversations about them I've had no worries about his feeding at all ever he feeds he has I don't stress about it if he wants a drink he has a drink

they're like they've drunk a bottle they've not drunk a bottle why won't he take it now I've stopped breastfeeding cause they fussy on the boob when their out so when we are out and he wants breastfeeding and he pulls off and hes looking around I just put myself away and then wait 10 minutes and then he'll go (makes the noise) like I'm hungry again so in that sense I've seen myself a little bit differently because I'm not bothered about feeding wherever erm so yeah that's unique I think I'm quite relaxed about his feeding in that sense I've not had any stress that hes not drinking enough or you know what should I be doing my friends have had a lot of stress over erm whether their gaining enough weight or that kind of thing erm so yeah does that make sense?

I: It does it makes a lot of sense . . . You introduced bays centile as a way to monitor feeding . . . do you feel that the centiles are used to monitor baby's growth and therefore baby's health within your group of friends?

P: Yeah because there a bit stupid really they make people I feel fine cause hes gone up and hes stayed there yeah from friends in the group whose some babies who have not fed properly have dropped yeah or their on . . . I think now the babies are a little bit older and the mums are settling down and sort of thinking its ok their following the centile its fine that's where they're going but I think its caused quite a lot of stress that line erm centile thing to look at because you're thinking where should they be you know there on this centile and that centile all the ten eleven

babies that my ten friends are all different every single one of them is small big whatever you know hes the biggest of cause out of all of them but equally a little girl whose just is a month older than him yeah she only weights 14lbs but she's perfectly formed and doing really well yeah and I think it can be quiet hard and as a group we talk about it doesn't matter where your child is as long as they're going in the right direction I think a lot we've all asked each other a lot of questions I say but should he be this big yeah is there something wrong with him why is he twice the size of your child whose a month older than him so I've asked that question and I got a text so when you talk about that there has

been lots of talk in our group about the centiles and a lot of worry between parents about where their children are erm and we've done a lot of reassuring that actually look they're all doing fine there all progressing the way they should be that's what you should be looking at rather than worrying erm I got a text message from my doctor saying I needed to take him to the doctors because the nurse wanted to talk to me about his weight and I rang up and said what do you mean you've made me an appointment for my son to see the nurse about his weight don't know that's all it says on the system the lady said I said there is nothing wrong with my son tell her I'm not turning up I'm not coming I don't want to talk to her about his weight and it got me upset I was thinking yeah he is so much bigger than all my other friend kids does she think that there is something wrong with him that she's not told me so he had to go for his injections done his last
set of injections so I thought hang on a second so I took him to the health visitor and she said no there is nothing wrong with him he is following his centile hes just a big boy there is no worries hes healthy hes making the milestones so in the same sense my friends who've got small babies they started worrying me because I'd got an appointment for what do they think hes got a thyroid problem or something you know I don't know you know because you worry you want them to be right you want so I'm not sure the centile charts are that positive I don't know it's just something I've got and I don't know whether erm is

it a true reflection of where the look at them supposedly in aw well he might be 6 foot 4 if he carries on where hes going the only positive thing I use them for is that I know in what season if he follows the line hes going what clothes to buy yeah that's what I use it for I've just been out and bought the next size up thinking actually after Christmas in winter he is still gonna be he'll be in the next size clothes erm but apart from that what benefit have I got from it don't know erm but hes following the line yeah erm but if my experience hadn't been the way it was and me being who I am and I think that the centile charts can sometimes cause you to be a bit cause a bit of trauma yeah it's not people try and fit to that kind of thing when you read in there (red book) that they've crossed two centiles then well worry and he has and he doesn't even fit on the chart now so in theory hes not one of the hundred children because hes above the top line erm I think I would worry if he went if he didn't follow now and he started going up
when I started feeding him so that's a good thing for me to sort of see that hes here and we've followed this that there is some line to go along when I get him weighed and hes followed that but I presume if I got him weighed even if that chart wasn't there that the health visitor would say something?

I: I don't know that is one of the things we are looking at . . . So from yourself if you found little man was shooting up what do you think you would do feeding wise?

P: I have a look at the content because if hes a hungry yeah there is no point in distressing him in terms of like giving him in my eyes like saying well you can only have a tiny portion if he to make him happy I’d look at I’d probably want to ask to say what sort of fat count content I’m still breastfeeding him and he still feeding lots and having lots of milk I’d probably want it balanced so the things I gave him would maybe cut out so much sort of erm of the porridgey things or the fats not putting butter I don’t need to put butter and fats in his yoghurts erm or having so much dairy and things like that I’ve started introducing letting flavours tastes of it but I wouldn’t perhaps make his calorie content of the meals I give him smaller cause that what’s makes what you do with them ***** intit that’s all I can think erm because I can’t stop the breast milk so if he wants to feed I don’t want to bottle feed erm and he does feed less now now I’ve started giving him food obviously he won’t lie I can give him his dinner erm and won’t really then want to drink so much but I think hes calorie

intake is reduced or reduce the breastfeeding yeah one thing or another if he does go up erm try get him to presumably the best would be is to still keep like an eye and more night breastfeed and reduce the day time breastfeed maybe I would be torn I’m not quite sure what I would do cause you want him to the whole point is to get him on solid food so perhaps the foods not the issue it's perhaps the breastfeeding the milk it's a minefield as a first time mum I might even feel it as a second time third time because all kids are different aren't they erm the main thing for me that hes healthy and his weight doesn't affect his health yeah that's what hes a big boy all over hes tall he is chunky but equally I see chunky little babies erm but no I think and again you can see his weight not stopping his development is it so it's not stopping him doing anything he wants erm cause I thought it was gonna but his in line with all the other babies and my first so and a happy chap

I: Are you happy for me to turn the tape off

P: Yeah