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ScHARR School of Health and Related Research
Public Health Collaborating Centre

Systematic review of dietary and/or physical activity interventions for weight management in pregnancy

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About the ScHARR Public Health Collaborating Centre

The School of Health and Related Research (ScHARR), in the Faculty of Medicine, Dentistry and Health, University of Sheffield, is a multidisciplinary research-led academic department with established strengths in health technology assessment, health services research, public health, medical statistics, information science, health economics, operational research and mathematical modelling, and qualitative research methods. It has close links with the NHS locally and nationally and an extensive programme of undergraduate and postgraduate teaching, with Masters courses in public health, health services research, health economics and decision modelling.

ScHARR is one of the two Public Health Collaborating Centres for the Centre for Public Health Excellence (CPHE) in the National Institute for Health and Clinical Excellence (NICE) established in May 2008. The Public Health Collaborating Centres work closely with colleagues in the Centre for Public Health Excellence to produce evidence reviews, economic appraisals, systematic reviews and other evidence based products to support the development of guidance by the public health advisory committees of NICE (the Public Health Interventions Advisory Committee (PHIAC) and Programme Development Groups).

Contribution of Authors

Fiona Campbell was the author, Maxine Johnson, Josie Messina were additional reviewers. Louise Guillaume developed and undertook literature searches. Jason Madan provided economic modelling. Elizabeth Goyder, Jim Chilcott and Nick Payne were the senior leads.

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1 Glossary

Definitions

American Institute of Medicine (IOM) Guidelines on Weight Management in Pregnancy: Guidance that specifies target ranges for weight gain during pregnancy and guidelines for proper measurement (1990 and revised 2009). The 2009 guidelines as set out below differ from the previous ones in two ways. First, they are based on the WHO BMI categories rather than the previous categories from the Metropolitan Life Insurance tables. The 1990 IoM BMI categories were; < 19.8 kg/m^2, underweight; 19.8 to 26.0 kg/m^2 , normal weight; >26.0 to 29.0 kg/m^2 , overweight; and > 29.0 kg/m^2 obese. Second, the new guidelines include a specific and relatively narrow range of recommended gain for obese women.

Prepregnancy BMI	**BMI + (kg/m^2) (WHO)**	**Total Weight Gain Range (lbs)**	**Rates of Weight Gain* 2nd and 3rd trimester (mean range in lbs/wk)**
underweight	<18.5	28 - 40	1 (1-1.3)
Normal weight	18.5 - 24.9	25 - 35	1 (0.8 - 1)
Overweight	25 - 29.9	15 - 25	0.6 (0.5 - 0.7)
Obese (includes all classes)	≥ 30.0	11 - 20	0.5 (0.4 – 0.6)

Antenatal/prenatal: the period before the birth.

Body Mass Index: A key index for relating a person's body weight to their height. The body mass index (BMI) is a person's weight in kilograms (kg) divided by their height in meters (m) squared (kg/m^2).

Caesarean Section/Delivery: Also known as C-Section, is a surgical procedure which involves an incision through the mother's abdomen and uterus in order to deliver one or more babies.

Gestational diabetes: Carbohydrate intolerance of varying severity which is diagnosed in pregnancy and may or may not resolve after pregnancy.

Low birth weight: A baby weighing less than 2500 grams at birth.

Macrosomia: An infant weighing over 4000 grams at birth

Physical activity is any force exerted by skeletal muscle that results in energy expenditure above resting level (Caspersen et al. 1985). It includes the full range of human movement and can encompass everything from competitive sport and active hobbies to walking, cycling and the general activities involved in daily living (such as housework).

Physical activity is measured in terms of:

- the time it takes (duration)
- how often it occurs (frequency)
- its intensity (the rate of energy expenditure – or rate at which calories are burnt).

The intensity of an activity is usually measured either in kcals per kg per minute or in METs (metabolic equivalents – multiples of resting metabolic rate). Depending on the intensity, the activity will be described as: moderate-intensity or vigorous-intensity. Moderate-intensity activities increase the heart and breathing rates but, at the same time, allow someone to have a normal conversation. An example is brisk walking.

Pre-eclampsia: This is a significant rise in blood pressure during pregnancy, occurring after 20 weeks and associated with proteinurea. It is more common in first pregnancies, multiple pregnancies, with pre-existing hypertension, diabetes or renal disease, In the UK the diagnosis of pre-eclampsia includes an increase in blood pressure above 140/90 mmHG, oedema and detection of protein in the patient's urine. It may require admission to hospital and early delivery. The disease may be of mild, moderate or severe degree. The underlying pathophysiology is not fully understood, but pre-eclampsia is primarily a placental disorder associated with poor placental perfusion. This often results in a foetus which is smaller than expected because of the poor placental blood flow. (NICE, 2006)

List of Abbreviations

BMI: mass index

GWG: gestational weight gain

IoM: The American Institute of Medicine

NRS: non randomised studies

NA: not applicable

NR: not reported

OR: odds ratio

RR: risk ratio

RCTs: randomised control trials

2. Executive Summary

Overweight and obesity during pregnancy is associated with risks to women and their babies. The National Institute for Health and Clinical Excellence has been asked by the Department of Health to develop public health guidance to promote weight management in pregnancy.

2.1 Aims and Objectives

To undertake an assessment of the effectiveness and cost-effectiveness of weight management interventions for pregnancy. The following questions will be addressed:

- What types of dietary interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?
- What types of physical activity interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?
- What types of dietary interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?

- What types of physical activity interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?
- What are the most effective and cost-effective ways of measuring and monitoring weight gain in pregnancy? Are there any adverse effects?
- What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy?
- What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, their partners and families about diet, physical activity and weight management prior to pregnancy?
- What external factors influence the effectiveness of the intervention (such as content, delivery, setting, who is delivering the intervention, intensity, duration and target setting)?
- What internal factors influence the effectiveness, of the intervention (such as age, socio-economic status, ethnicity, medical history, physical activity, attempts at weight management, weight at onset of pregnancy and number of previous pregnancies, BMI at start of pregnancy)?

2.2 Methods Aims and Objectives

Systematic reviews to address the above review questions have been undertaken. A review of relevant existing economic literature and modelling work in progress are presented in a separate report.

2.3 Findings of review

2.3.1 Review of effectiveness

Five randomised controlled trials (RCTs), five non-randomised studies (NRS), two case series fourteen observational studies and two systematic reviews have been included in the review of effectiveness.

The RCTs included a total of 421 participants and were conducted in the USA (2 trials), Canada (1 trial), Belgium (1 trial) Denmark (1 trial). Two trials focused on

women who were classified as overweight or obese based on pre-pregnancy BMI. Interventions varied but a major component of all trials was dietary advice and counselling. The quality of the included trials is variable with only one trial using allocation concealment and only one trial was judged to be at lowest risk of overall bias. One trial was published as abstract and so limited information was available.

The NRS included a total of 1315 participants, 3 studies were conducted in Europe, one in the USA and one in Canada. Two studies focused on women who were classified as overweight or obese based on pre-pregnancy BMI. Four studies explored the effectiveness of interventions which included advice, education, guidance and counselling on diet. One study looked at the effects of intense and moderate exercise in pregnant women.

Two case series were included, one undertaken in Canada and one in Australia. One study examined the effects of an intervention for women who were classified as obese, experiencing infertility and wanting to become pregnant. One study examined the effects of the 'healthiest babies possible campaign.

Two relevant systematic reviews were included, published in 2007 and 2008. They identified two trials of interventions of interventions for the management of weight gain in pregnancy and two for women planning a pregnancy.

Fourteen observational studies are included that explore associations between diet, physical activity and weight gain in pregnancy. These include case control, cohort and survey study designs. Eleven were conducted in the USA, one in Germany, one in Sweden and one in the UK.

There was a dearth of evidence on effects of diet and physical activity for women planning a pregnancy. Only one case series was identified, undertaken in Australia, which examined the effects of an intervention for obese women experiencing infertility and wanting to become pregnant.

2.3.2 Findings from the Qualitative Review of acceptability and feasibility

Ten qualitative papers of varied design and quality have been identified in the review of factors influencing the effectiveness, acceptability and feasibility of interventions.

Two of the papers reported the same study, therefore nine studies were reviewed. All nine studies were carried out in the UK; therefore applicability is high. Some of the studies explicitly examined physical activity and/or eating behaviours during pregnancy, either relating to a specified intervention or advice. Other studies examined attitudes toward body size and body image issues. Information and advice from health professionals regarding optimal diet, physical exercise and weight management goals was found to be inconsistent in terms of accessibility and acceptability. Women also reported receiving confusing, as well as vague and often conflicting messages. Women are accessing information from sources such as family, friends and the media which is also conflicting. Interventions for managing weight in pregnancy were facilitated, or might have been improved by attending to particular needs of women. Younger age and large weight status were especially salient in terms of perceived stigma as well as information requirements. Women's views on being weighed routinely varied in terms of acceptability, with some women feeling disempowered by the negative assumptions of professionals. Perceived risk to mother and baby from insufficient diet or excessive physical activity was a particularly strong lay belief that influenced women's behaviours. Such beliefs could deter women from making lifestyle changes that might assist in managing their weight and was balanced with the need to manage weight. Attitudes to weight, diet and physical exercise pre-pregnancy were important factors during pregnancy. Women's eating and physical activity behaviours may or may not continue into pregnancy for a variety of reasons, and attitudes may shift as pregnancy progresses.

2.4 Evidence statements

What types of dietary interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?

What types of physical activity interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?

Evidence statement 1

There is weak evidence from one Australian based case series (Galletly *et al*.,1996) that obese women trying to become pregnant but experiencing infertility can achieve

a statistically significant reduction in BMI through a programme that includes regular physical activity, advice about healthy eating and group support.

- **What types of dietary interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?**
- **What types of physical activity interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?**

Evidence statement 2

There is inconsistent and inconclusive evidence from five randomised controlled trials (RCTs) (Asbee *et al.,* 2009 [+], Guelinckx *et al.,* 2008 [u, abstract only], Wolff *et al*.,,2008 [-], Hui *et al*., 2006 [-], Polley *et al.,* 2002[-]) and five non randomised studies (NRS) (Claesson *et al*., 2007 [+], Kinnunen *et al*., 2007[+], Gray-Donald *et al*., 2000 [-], Olson *et al*., 2004 [-], Kardel *et al*., 1998 [-]) on the effectiveness of dietary and/or physical activity interventions on weight gain in pregnancy.

Three studies; conducted in the US (Asbee *et al*., 2009 [+]), Denmark (Wolff *et al*., 2008 [-]) and Sweden (Claesson 2007 [+]), among women who were overweight or obese, reported that gestational weight gain was 2.6 kg to 6.7 kg less for women in the intervention group compared to the control. One USA based study among overweight women (Olson *et al*., 2004 [+]) reported a non-significant positive effect on gestational weight gain in the intervention group compared to control and one Canadian study (Hui *et al*., 2006 [-]) of women with a healthy pre-pregnancy BMI reported no difference in gestational weight gain between intervention or control. Two studies among women with a healthy BMI (Kinnunen *et al.,* 2007 [+], Polley *et al*., 2002 [-]), based in Finland and the USA respectively and one study among women who were obese (Guelinckx *et al.,* 2008 [u]) based in Belgium, reported greater gestational weight gain in the intervention group but the difference was not significant. One Canadian study among obese Cree women (Gray Donald *et al.,* 2000 [u]) found no evidence of an effect on gestational weight gain.

Evidence statement 3

There is weak evidence from 2 USA based and 1 Canadian RCT (Asbee *et al*., 2009 [+], Polley *et al*., 2002 [-], Hui *et al*., 2006 [-]) that interventions targeted at healthy weight (Polley *et al*., 2002 and Hui *et al.,* 2006) or overweight (Asbee *et al.,* 2009) pregnant women, encouraging a healthy diet and increased or regular physical

activity, supported by weight monitoring, reduces the proportion of women exceeding Institute of Medicine (1990) guidelines for healthy weight gain in pregnancy.

Evidence statement 4

There is weak evidence from two studies (Wolff *et al*., 2008 [-] and Claesson *et al*., 2007 [+]), conducted in Denmark and the USA amongst obese women that interventions promoting healthy eating and/or moderate physical activity leads to a reduction in weight retained post partum when compared with controls.

Evidence statement 5

There is inconsistent evidence from three RCTs conducted in the USA, Canada and Denmark (Asbee *et al*., 2009 [+], Hui *et al*., 2006[-], Wolff *et al*., 2008[-]) and three NRS conducted in Sweden, in a Cree community in Canada and in Norway (Claesson *et al*., 2007[+], Gray-Donald *et al*., 2000[-], Kardel 1998[-]) that women receiving diet and/or physical activity interventions have a reduced risk of a caesarean section delivery. The studies did not differ by pre-pregnancy BMI.

Evidence from two observational studies is also inconsistent. (Bungum *et al.,* (1999 [+] conducted in Germany) found that more active women were less likely to have a caesarean delivery compared to women described as sedentary, whereas Horns *et al*., 1994 [+]) conducted in the USA) found no association between physical activity and risk of a caesarean delivery.

Evidence statement 6

Three RCTs conducted in the USA, Denmark, and Canada (Polley *et al.,* 2002 [-], Wolff *et al*., 2008 [-], Hui *et al*., 2006 [-]) and 2 NRS conducted in Finland and in a Cree community in Canada (Kinnunen *et al*., 2007 [+] and Gray Donaldson *et al*., 2000 [-]) found no evidence to suggest that interventions among women who are a healthy weight (Hui *et al*., 2006, Polley *et al*., 2002) or obese (Wolff *et al*., 2008), focusing on healthy eating and moderate physical activity, adversely affect infant outcomes including birth weight, gestational age at birth, and the incidence of macrosomia. They were however not adequately powered to measure important adverse outcomes and so the evidence is insufficient to establish whether these interventions have adverse effects.

Evidence statement 7

There were no reported adverse effects associated with moderate physical activity and /or dieting during pregnancy. The evidence base is not sufficient to establish whether these interventions have no adverse effects.

What internal factors influence the effectiveness, of the intervention (such as age, socio-economic status, ethnicity, medical history, physical activity, attempts at weight management, weight at onset of pregnancy, number of previous pregnancies, and BMI at start of pregnancy)?

Evidence statement 8

There is inconsistent evidence from five RCT's (Asbee *et al.,* 2009 [+], Hui *et al.,* 2006 [-], Guelinckx 2008 [u], Polley *et al.,* 2002 [-], Wolff *et al.,* 2008 [-]) and from four NRS (Claesson *et al*., 2007 [+], Gray-Donald *et al*., 2000 [-], Olson *et al*., 2004 [+], and Kinnunen *et al.,* 2007 [+], that women with a pre-pregnancy BMI over 30 kg/m^2 (obese) gain less gestational weight in response to diet and physical activity interventions than women who are of a healthy weight or who are overweight.

Evidence statement 9

There is insufficient evidence to conclude that diet and physical activity interventions are more, or less, effective in more socially disadvantaged pregnant women.

Evidence statement 10

There is insufficient evidence to comment on the impact of ethnic group on intervention effectiveness.

Evidence statement 11

There is evidence from two US based observational studies (Olson and Strawderman 2003 [++] and Gunderson *et al*., 2004 (++) that women (including overweight women (Gunderson *et al*., 2004 (++)) who decreased physical activity in pregnancy experienced significantly greater gestational weight gain. Higher physical activity levels were associated with reduced weight gain.

Evidence statement 12

There is evidence from one US based observational study (Gunderson *et al*., 2004 [++]) that overweight women who consumed three or more servings of fruit and vegetables per day gained significantly less weight than those who consumed fewer servings during pregnancy.

Evidence statement 13

There is evidence from two US based (Gunderson *et al.,* 2004 [++], Mumford *et al* ., 2008 [+]) and one UK based observational studies, (Conway *et al*.,1999 [+]) that women across the BMI spectrum with a history of dieting and restrained eating behaviours showed a greater association with excessive gestational weight gain. Further evidence from Gunderson *et al*., 2004 [++)] suggests that other factors associated with excessive gestational weight gain include black race, never smokers, and high school education or less.

Evidence statement 14

There is evidence from one US based observational study (Cogswell *et al* .,1999 [+]) that not receiving advice regarding appropriate weight gain was associated with weight gain outside the recommended levels among women across the BMI spectrum.

What external factors influence the effectiveness of the intervention (such as content, delivery, setting, who is delivering the intervention, intensity, duration and target setting)?

Evidence statement 15

UK based qualitative evidence (Symon & Wrieden 2003 [+]) suggests that the development and attendance in dietary interventions for young women may be facilitated by taking into account women's age, social, educational and psychological needs as well as provision of incentives such as free food and access to a midwife.

What are the most effective and cost-effective ways of measuring and monitoring weight gain in pregnancy? Are there any adverse effects?

Evidence statement 16

One UK based qualitative study (Warriner 2000 [+]) retrospectively explored mothers views on monitoring during their pregnancy/ies.

Women reported feeling that interactions with health professionals in relation to routine weighing were not enabling, and that they felt a lack of control. Women tended to be given limited explanation or feedback on weighing practices, although they accepted professional advice and intervention (Warriner 2000, [+]).

Routine monitoring of weight may not be acceptable to any women anxious about their weight without their consent, meaningful explanation and feedback (Warriner 2000, [+]).

Evidence statement 17

Health professionals reported (Heslehurst *et al*., 2007b, [++]) that routine weighing of pregnant women was dependent on the location of the initial booking session, as NHS premises tended to have resources for weighing whereas this was more ad hoc in the community where scales may not be available and community midwives were not supplied with portable equipment. It was reported that even in NHS premises, equipment may not be suitable for weighing obese women.

What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, their partners and families about diet, physical activity and weight management prior to pregnancy?

Evidence statement 18

No UK based qualitative evidence was identified on the views, perceptions and beliefs of health professionals, women actively planning a pregnancy and their partners and families about diet, physical activity and weight management prior to pregnancy. However, there is UK based qualitative evidence to suggest that women's eating habits during pregnancy are related to pre-pregnancy dietary attitudes and behaviour. Weight and body shape concerns are affected by size prior to pregnancy (Fox & Yamaguchi 1997 [+]) Women's dietary restraint may be continued or relaxed during pregnancy (Warriner 2000 [+]).

What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy?

Evidence statement 19

Evidence from 3 UK based qualitative studies (Gross & Bee/ Clarke & Gross 2004, [++]), (Heslehurst *et al.,* 2007b [++]), (Wiles 1998 [++]) suggests that weight management information and advice from professionals is not received or assimilated by many women during pregnancy. Available information is often vague, confusing, contradictory, and is not linked to weight management.

Overweight women may feel they are not receiving relevant, tailored information about appropriate diet and weight gain during pregnancy (Wiles 1998, [+]).

Evidence statement 20

There is evidence from UK based qualitative research (Levy 1999, [+]; Heslehurst *et al.,* 2007b [++]) that women may be unaware of the potential effects of obesity during pregnancy (Heslehurst *et al.,* 2007b [++]) However, they may avoid information about their health if they find it distressing and will only action it when they feel the time is right for the well-being of themselves, their unborn baby and their partners (Levy 1999 [+]).

Evidence statement 21

There is evidence from UK based qualitative research (Heslehurst *et al.,* 2007b, [++]) that health professionals working in maternity units may feel they have insufficient time to discuss weight issues with women during pregnancy and consider that it is too late to give advice on weight management once a woman is pregnant. Health professionals themselves report that women's access to the information and advice on weight management is often ad hoc.

Evidence statement 22

Evidence from two UK based qualitative studies (Gross & Bee / Clarke & Gross 2004 [++], and Fox & Yamaguchi 1997 [+]) suggests that even relatively active women reduce their physical activity during pregnancy (although they are more likely to continue to be active at some level). One study (Gross & Bee /Clarke & Gross 2004, [++]) found that pregnant women decreased their activity levels based on advice from health professionals, or more commonly, on information they had read in books and magazines. Family members, friends, and even health trainers tended to discourage physical activity. Women balanced their fears of injury to themselves or harm to the baby with aims toward weight management. Women also reported reduced motivation, physical limitations due to larger size and tiredness during pregnancy and a lack of facilities. Another study reported that pregnant women may feel self-conscious when carrying out physical activity (Fox & Yamaguchi 1997 [+]).

Evidence statement 23

There is evidence from UK based qualitative research that women may change their eating behaviours during pregnancy due to cravings, increased hunger and to relieve nausea. Two studies found that women legitimate overeating by the fact of being

pregnant and that eating more is “part of being pregnant” (Johnson *et al.,* 2004, [++]), (Wiles 1998, [++]).

Evidence statement 24

There is evidence to suggest that women’s eating habits during pregnancy are related to pre-pregnancy dietary attitudes and behaviour. Women’s dietary restraint may be continued or relaxed during pregnancy (Warriner 2000, [+]). Some women may abandon their previous dietary restraint due to their belief that eating more is beneficial to the foetus (Fairburn & Welch 1990, [-]). There may be a perceived balance between the baby’s healthy development and women’s own weight management (Wiles 1998, [++]), in which the baby comes first.

Evidence statement 25

Evidence from one UK based qualitative study (Fox & Yamaguchi 1997, [+]) suggests that overweight women have a tendency to be more satisfied with their body image once pregnant as their size is perceived as legitimate, although others continue to feel stigmatised.

Evidence statement 26

Qualitative evidence from two UK based studies (Heslehurst *et al.,* 2007b, [++], Warriner 2000, [+] suggest there are communication difficulties between overweight women and health professionals. One study of health professionals found that they are often embarrassed to discuss issues of weight with overweight women, and that the women themselves were also embarrassed (Heslehurst *et al.,* 2007b, [++]). Such experiences may not be fixed, but may change over the course of a pregnancy.

One study (Heslehurst *et al.,* 2007b, [++]) explored the views of health professionals, some of which found it difficult to raise this issue sensitively. They reported a lack of guidance on this issue, though were aware of the risks and benefit so raising the issue. They were concerned that some women may stop attending antenatal appointments if they felt victimised.

3. Introduction

3.1 Aims and objectives

The aim of this study was to systematically review the evidence for effectiveness, acceptability and feasibility of dietary interventions and physical activity interventions for weight management in pregnancy. This review will explore the contextual factors that influence effectiveness of interventions. For example how the setting, the individual delivering the intervention, or personal and societal beliefs of weight management during pregnancy influence effectiveness. Socio-economic status and ethnicity of pregnant women in interventions will also be considered.

3.2 Research questions

- What types of dietary interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?
- What types of physical activity interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?
- What types of dietary interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?
- What types of physical activity interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?
- What are the most effective and cost-effective ways of measuring and monitoring weight gain in pregnancy? Are there any adverse effects?
- What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy?
- What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, their partners and families about diet, physical activity and weight management prior to pregnancy?
- What external factors influence the effectiveness of the intervention (such as content, delivery, setting, who is delivering the intervention, intensity, duration and target setting)?
- What internal factors influence the effectiveness, of the intervention (such as age, socio-economic status, ethnicity, medical history, physical activity, attempts at weight management, weight at onset of pregnancy and number of previous pregnancies, BMI at start of pregnancy)?

4. Background

Fifty percent of women of childbearing age are either overweight (that is, they have a body mass index BMI 25–29.9kg/m^2) or obese (that is, they have a BMI ≥30kg/m^2). Maternal obesity is related to socioeconomic deprivation and other inequalities within ethnic groups (Heslehurst et al. 2007a).

Pregnant women who are overweight or obese and their babies face an increased risk of complications during pregnancy and childbirth. For the mother, these risks include: impaired glucose tolerance and gestational diabetes. Gestational diabetes also leads to an increased risk of the mother developing type 2 diabetes in the future (Bellamy *et al*., 2009). There is also an increased risk of miscarriage, pre-eclampsia, thromboembolism and death. In addition, she is more likely to have an instrumental delivery or caesarean section. The baby faces a higher risk of macrosomia, congenital anomaly, obesity (in later life) and foetal death (Ramachenderan et al. 2008). There is also evidence that suggests that exposure to hyperglycemia in utereo, caused by gestational diabetes suffered by the mother, increases the risk of type 2 diabetes in her off spring (Pettitt *et al* 2008). A major report found that over half of mothers who died during pregnancy, childbirth or within 42 days of childbirth were either overweight or obese. It concluded that pregnant women with a BMI greater than 30kg/m^2 are more likely to die than women who had a BMI less than 30kg/$m^{2.}$ (Confidential Enquiry into Maternal and CHild Health 2007;Ramachenderan, Bradford, & McLean 2008).

At present in the UK, there is a lack of clear policy, or evidence to support policy, about the way in which normal weight, overweight and obese women's weight gain should be managed prior to and in pregnancy (Heslehurst *et al*., 2007b). The American Institute of Medicine (IOM) recently revised its recommendations on weight gain during pregnancy (Institute of Medicine 2009). The IOM recommends that obese women with a pre-pregnancy BMI greater than 30kg/m^2 should gain 5 to 9kg and that overweight women with a BMI of 26 to 29 kg/m^2 gain between 7.0 and 11.5 kg. It also recommends that women with a pre-pregnancy BMI in the "normal" range (18.5 to 24.9kg/m^2) should gain between 11.5 and 16kg (Institute of Medicine 2009). For those studies included in this review the findings will have been compared against the 1990 guidance and unless made clear these are the guidelines referred to in this systematic review. Women who gain weight within the IOM ranges are more likely to

have better maternal and infant outcomes than those who gain more or less weight (Viswanathan et al, 2008).

Women in the UK are at present advised not to try to diet while pregnant and to talk to their GP or midwife if they are concerned about their weight (Food Standards Agency 2008). The Royal College of Obstetricians and Gynaecologists and the American College of Obstetricians and Gynecologists (Artal and O'Toole 2003) recommend 30 minutes or more moderate physical activity per day for pregnant women. Women who were not physically active before pregnancy are advised to plan a safe exercise programme with their GP. About 30% of women of child-bearing age achieve the nationally recommended minimum level of activity (30 minutes of moderately-intense physical activity on five or more days a week (Department of Health 2004) (The Information Centre 2008).

Given the increasing prevalence and negative consequences of obesity in pregnancy managing weight before pregnancy and weight gain during pregnancy is important. There is a need for clear and consistent guidance and assurance that the most effective interventions are implemented to improve the health of women and their infants. For women planning a pregnancy and for those who are pregnant this may be an optimal time to inform and influence women to change their eating habits and levels of physical activity and thereby achieve a healthy weight. This need and opportunity has prompted the National Institute for Health and Clinical Excellence to commission this review in order to inform guidance on public health interventions for weight management in pregnancy.

5. Methods

5.1 Methods for identification of evidence

This review aims to systematically examine evidence for the effectiveness of weight management interventions during pregnancy. The research team, in collaboration with NICE, have identified a search strategy most suitable for this purpose.

5.1.1 Search Strategy

Systematic searches of relevant health related databases were undertaken by the ScHARR Information Specialist. A search strategy was drawn up and agreed with the NICE Information Specialist.

The search strategy searched for all types of evidence (i.e. there were no restrictions by study type to ensure that both quantitative and qualitative evidence was searched for). Searches were limited by year (1990-2008) and to human studies (where this option was available). The searches were undertaken in early December 2008.

The search strategy combined terms for pregnancy and terms for body composition, obesity and weight change. This set of "population" terms was then combined with terms for diet, exercise, physical activity advice and monitoring, giving four separate sets of results for each database. A sample search strategy for Medline and a list of the databases searched can be found in Appendix 1.

In addition to the systematic search, the following additional methods were utilised:

- Adding all of the references that were included in the Cochrane Protocol 'Interventions for preventing excessive weight gain during pregnancy' plus additional records retrieved through citation searching for all of these references (no search restrictions were applied)
- Cited reference search for included papers in the qualitative review in Web of Science Cited Reference search (no search restrictions were applied)

Searches for the cost-effectiveness review were undertaken at the same time as the effectiveness searches, using population terms only, with the same date restrictions in NHS EED via Wiley and Econlit via OVID SP. Where additional information

requirements were identified, targeted searches were undertaken for model parameters.

The search results for all searches (systematic and additional) were imported into Reference Manager and de-duplicated. Following this, the results were sifted by the systematic and qualitative reviewers.

5.1.2 Study selection

The sifting process, completed by three reviewers, identified 5862 citations. Relevant papers were retrieved and assessed and those fulfilling the criteria were included. During the process, all decisions were checked by a second reviewer with difference resolved by discussion. The following inclusion and exclusion criteria were used in selecting studies.

Inclusion

- pregnant women expecting a single baby
- women seeking preconception advice
- women actively planning a pregnancy
- Sub-groups (where evidence permitted) distinguished within studies are women who are of normal weight (BMI18.5 kg/m2 -24.9 kg/m^2), overweight (BMI 25 kg/m-29.9kg/m^2) or obese (BMI ≥30 kg/m^2).
- Studies have been defined by mean age, ethnicity, and settings

Exclusion

- Non-English studies
- Studies conducted in non OECD countries
- Studies including pregnant women expecting more than one baby (i.e. twins or triplets).
- Pregnant women who are underweight (BMI less than 18.5 kg/m^2)
- Women who have been diagnosed with pre-existing diabetes (type 1 and 2). However within the studies we would include women who have a history of impaired glucose tolerance, gestational diabetes and also if they develop these conditions whilst taking part in the study these would be important outcomes of interest.

5.2 Study description

5.2.1 Types of studies

- Randomised controlled trials examining dietary interventions and/or physical activity interventions
- Non-randomised studies examining dietary interventions and/or physical activity interventions
- Observational studies examining diet and / or physical activity as a factor associated with weight management in pregnancy
- Qualitative studies exploring women's experience of weight gain in pregnancy and barriers and facilitators of interventions designed to manage weight in pregnancy. The views and perceptions of health care professionals of weight management in pregnancy.

5.2.2. Types of participants

Included papers studied pregnant women planning a pregnancy or expecting a single baby with no pre-existing medical complications relating to pregnancy or weight management. In some studies, sub-groups were divided by weight status: normal weight, overweight or obese.

5.2.3 Types of intervention

- Dietary and or physical activity advice
- Personal one-to-one and group counselling
- Physical activity groups or classes
- Educational and informative literature given to pregnant women
- Monitoring by health professionals or self assessment
- Tracking of progress and tailoring programmes to meet current needs of pregnant women

5.2.4 Types of outcome

Outcomes relating to the mother (measurement tools used include both self-reported and validated instruments):

Weight-related outcomes

- Changes in body weight using measures such as BMI, self reported weight gain, professional weight measurement, and changes to weight status as per the IOM guidance on weight management in pregnancy
- Post partum weight retention

Dietary and physical activity outcomes

- Changes in dietary intake and levels of physical activity.
- Changes in knowledge and attitudes about appropriate weight management in pregnancy.

Other mother-related outcomes

- Measures of maternal psychological wellbeing, quality of life, and self-esteem
- Mode of delivery e.g. Cesarean section and instrumental delivery rates
- Antenatal complications including; pre-eclampsia, maternal glucose control and insulin resistance, the occurrence of gestational diabetes
- Initiation and duration of breast feeding
- Attendance and use of health and support service including antenatal care provision.

Outcomes relating to the infant

- Birth weight
- Occurrence of macrosomia and related complications
- Childhood obesity

5.3 Study appraisal

5.3.1. Criteria for appraising applicability

Three reviewers screened the titles of all papers identified by the search strategy. Criteria for inclusion and exclusion were applied to determine the relevance of each paper. During this process, the research team would discuss any discrepancies or difficulties with the paper screening process. Once the initial sift was completed, each reviewer checked the other reviewer's exclusions to ensure no relevant studies were missed. Reasons for study exclusion were recorded. Papers were coded into three

categories in reference manager software. Codes were established for rejected papers, accepted papers, and background material.

Full text copies of all potentially relevant papers were retrieved. A data extraction form was developed in consultation with clinical advisors and piloted. Data on quality, characteristics of participants, intervention and relevant outcomes were independently extracted by one reviewer and checked by the second reviewer. Qualitative papers were extracted by the qualitative lead, and themes were discussed and agreed with the two other members of the research team.

5.3.2 Quality assessment

Two reviewers assessed the quality of the RCTs and nonrandomised studies using a methodology checklist (National Institute for Health and Clinical Excellence, 2006) assessing risk of selection bias, performance bias, attrition bias and detection bias. This was done by looking at 7 key methodological domains; method of recruitment, method of randomisation, allocation concealment, blinding of participants, baseline comparability, intention to treat analysis and loss to follow-up.

Methodology checklists (Newcastle-Ottawa scale) were also used to assess the quality of cohort studies and case control studies. These assessed the internal validity of the studies by exploring potential bias in selection, comparability between groups, case definition (case control studies), ascertainment of exposure and outcome measurement. For all included studies an overall risk of bias score was given; ++ (very low risk of bias), + (low risk of bias), - (high risk of bias) and u (unclear risk of bias)

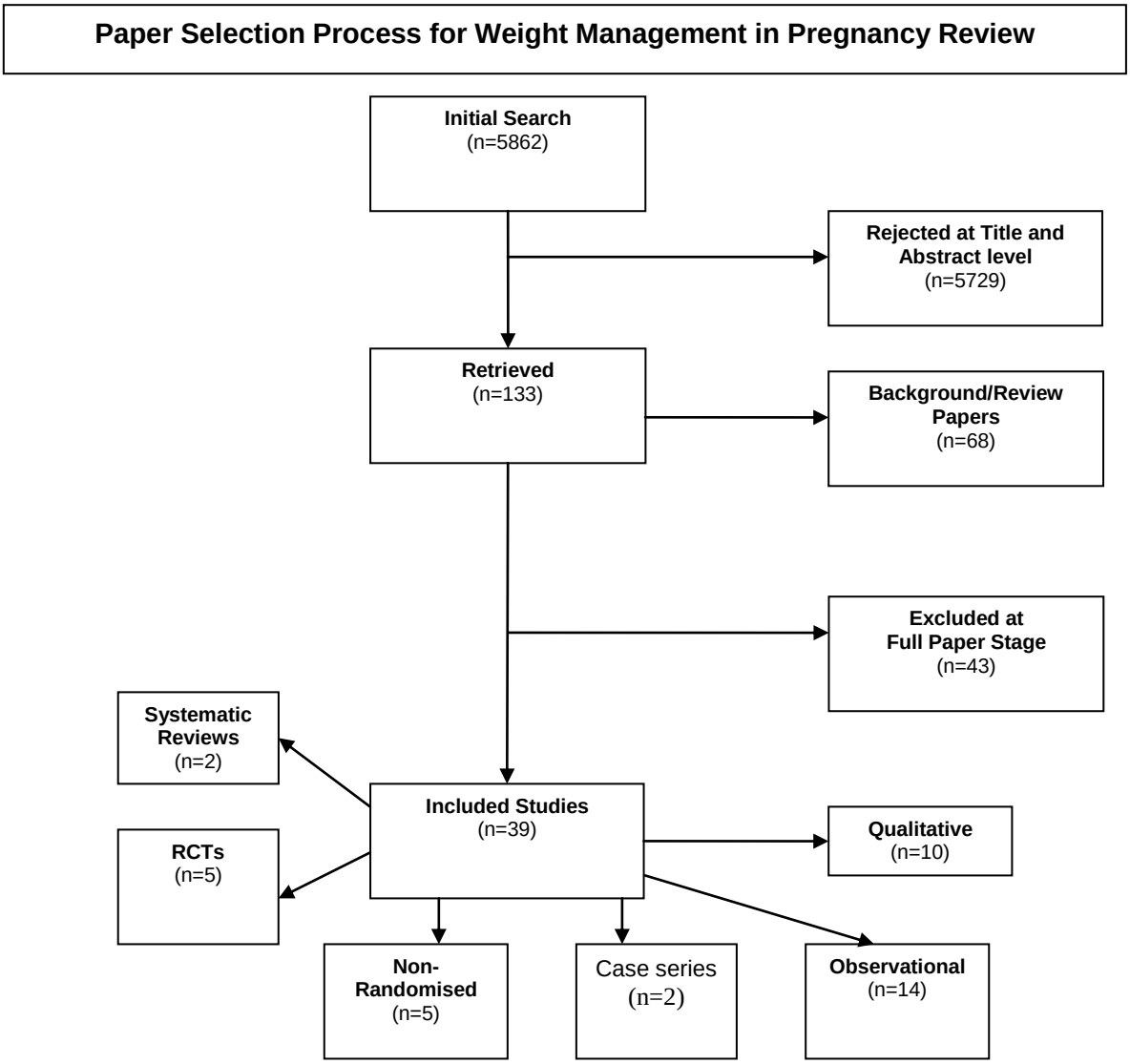
5.4 Data analysis

Data from RCTs and non-randomised studies (NRS) was combined in a meta-analysis where appropriate i.e. more than one trial with like populations, interventions and outcomes or where statistical heterogeneity measured using the I^2 was less than 50%. Where the I^2 score was over 50% the meta-analysis was judged to have significant heterogeneity (Deeks *et al.,* in 2008). Meta-analysis was undertaken using Cochrane Collaboration Review Manager 5.0 software (The Cochrane Collaboration 2008). A random effects model was used.

For outcomes where a meta-analysis was not appropriate the RCT and NRS results were presented, where possible, on a forest plot but without summary scores allowing a visual presentation of the effects of each included trial. A narrative summary of the findings was also given.

The quantitative and qualitative results were further synthesised into a matrix (Shepherd et al. 2006), comparing the factors that influence maternal weight gain in pregnancy alongside the quantitative studies and the nature of the interventions.

Figure 1: Flow chart of paper selection



6. Results – Intervention Studies

The results for the quantitative review will firstly present the findings of intervention studies (systematic reviews, RCTs, NRS and case series) followed by the findings of the observational studies.

6.1 Systematic Reviews

Two systematic reviews have explored the effectiveness of diet and lifestyle interventions on weight management in pregnancy (Dodd et al. 2008); (Bell et al. 2007). Dodd *et al*., (2008) limited their review to interventions occurring during pregnancy, while Bell *et al*., (2007) (abstract only available) included studies that also addressed weight management pre pregnancy and post partum in addition. Two RCTs were identified by both reviews for interventions during pregnancy, and two for interventions prior to pregnancy (see appendix 2.1).

6.2 Randomised controlled trials (RCTS)

6.2.1 Summary of Setting and Participants

Five RCT's were included and the number of participants in randomised control trials ranged from 50 to 120 with a total of 421. Of the five RCT studies, two trials were conducted in the USA (Asbee *et al.,* 2008; Polley *et al.,* 2002), one in Canada (Hui *et al*., 2002) one in Belgium (Guelinckx *et al*. 2008), and one in Denmark (Wolff *et al*., 2008). In three trials, women were recruited from obstetrics clinics or prenatal services or programmes (Asbee, 2009; Hui, 2006; Polley *et al.,* 2002). One trial recruited through a register of newly diagnosed pregnancies (Wolff, 2008). The Guelinckx *et al*. (2008) trial did not report recruitment (see appendix 2.2).

Baseline characteristics of participants in randomised controlled trials are summarised in Appendix 2.2. The mean age of the participants ranged from 25.5 to 29 years. Overall mean age of respondents across trials was 27.1 years. The mean pre-pregnancy BMI ranged from 22.6 to 34.7 kg/m^2. The average pre-pregnancy BMI was 28.2 kg/m^2. Only one study (Polley *et al*., 2002) reported previous pregnancies. Three studies reported educational attainment (Asbee *et al*., 2009; Hui *et al.,* 2006; Polley *et al,.* 2002). In one trial (Wolff *et al.,*. 2008), the sample consisted of all Caucasian women. Another trial (Polley *at al.,* 2002) over 50% of the women were Caucasian. In two studies there was a greater proportion of non-white minority women than white women (Asbee *et al*, 2009 and Hui *et al.*, 2006). One study (Guelinckx *et al.,* 2008) did not report data on ethnicity. Women were enrolled into

trials between 13.7 and 30 weeks of gestation. Baseline characteristics within the trials were comparable between intervention and control.

6.2.2 Description of Interventions

Interventions were complex, comprising different components for weight management during pregnancy, and these varied between studies. A major component of all trials was dietary advice and counselling. (See Appendix 2.2 for details on interventions). In three trials participants had direct contact with a dietitian during the trial period (Asbee *et al*., 2009; Hui *et al,.* 2006; Wolff *et al*., 2008). Four trials also offered advice on both diet and physical activity (Asbee *et al.*, 2009; Guelinckx *et al.,* 2008; Hui *et al.,* 2006; Polley *et al*., 2002). While physical activity was stressed as an important part of successful weight management, only one trial offered a structured group-based exercise session (Hui *et al.,* 2006). Monitoring of dietary and/or physical active progression occurred throughout all trials. However, Polley *et al.* (2002) was the only intervention to offer a stepped-care approach where participants were monitored on their weight management attempts and offered tailored advice and feedback based on their progress in the trial (see Appendix 2.2).

6.2.3 Quality Assessment of RCTs

Five trials were described as randomised, in three this was carried out adequately (Asbee *et al*., 2009, Polley *et al*., 2002 and Wolff *et al*.,2008) and in two (Guelinckx *et al*., 2008, Hui *et al*., 2006) the method used was not described. Only one (Asbee *et al.,* 2009) used allocation concealment. One trial (Guelinckx *et al*., 2008) did not report baseline comparability but there were no significant differences in the other included trials. One trial (Guelinckx *et al*., 2008) did not report loss to follow up and all described complete outcome data. Asbee *et al*., (2009) was judged to be at lowest risk of overall bias. Guelinckx *et al*. (2008) was only published in abstract form so little data was available. (see table 1)

Table 1: Quality assessment of RCTs

Study	Sample size	Recruitment	Randomisation	Allocation concealment	Blinding	Intention to treat	Baseline Comparability	Loss to follow up reported	Complete/ Valid Outcome Data	Grade
Asbee, 2009	100	Yes Recruited from clinics	Yes Computer generated	Yes Numbered envelopes	No	NR	Yes No significant differences	Yes	Yes	+
Guelinckx, 2008 (Abstract)	99	NR	YES Exact method not described	NR	NR	NR	NR	NR	YES Not fully reported, but mentioned in abstract	(u)
Hui, 2006	52	Yes Recruited from classes and clinic	Yes Exact method not described	No	No	NR	Yes No significant differences	Yes	Yes	-
Polley, 2002	120	Yes Recruited from clinics	Yes Split into cell. Stratified by weight and race	No	No	NR	YES No significant differences	Yes	Yes	-
Wolff, 2008	50	Yes Register of newly diagnosed pregnancies	Yes Computer randomised	No	No	NR	Yes No significant differences	Yes	Yes	-

U= unclear

6.3 Non-randomised studies (NRS)

6.3.1 Description of Setting and Participants

Five non randomised studies were included. The number of participants ranged from 42 to 560 with a total of 1315. The setting for studies was Sweden (Claesson et al. 2008), Canada (Gray-Donald *et al*. 2000), Finland (Kinnunen et al. 2007), Norway (Kardel et al. 1998) and USA (Olson et al. 2004)). In four studies, women were recruited from obstetrics clinics or prenatal services or programmes (Claesson *et al.,* 2008 Gray-Donald *et al.,* 2000; Kinnunen *et al*., 2007; Olson *et al.,* 2004). One study recruited through media and acquaintances (Kardel *et al*., 1998).

Baseline characteristics for non-randomised studies are summarised in appendix 2.3. The mean age of the participants ranged from 24.1 to 30 years. The mean age across trials that reported was 27.4 years. The mean pre-pregnancy BMI range of women in the included studies was 25 to over 40 kg/m^2. Two studies did not report previous pregnancies (Gray-Donald *et al.,* 2000; Kinnunen *et al*., 2007); while two studies (Claesson *et al.,* 2008 Olson *et al.*, 2004) reported that the majority of respondents had one or more previous pregnancies. Two studies reported that over half of the sample had a post secondary educational attainment (Kinnunen *et al*., 2007; Olson *et al*., 2004). Ethnicity was not specifically reported in the non-randomised studies, although the study by Gray Donald took place among a Cree community in Canada. Women were enrolled into studies between 10 weeks and 27 weeks. Baseline characteristics within two trials were comparable (Gray-Donald *et al*., 2000; Olson *et al.,* 2004), remaining studies indicated significant differences between intervention and control groups (Claesson *et al*., 2007; Kinnunen *et al.*, 2007, Kardel *et al.,* 1998).

6.3.2 Descriptions of Interventions

Four of the non-randomised studies included interventions with dietary and physical activity components (see Appendix 2.3). Advice, education, guidance, and counselling on diet were a part of all interventions. Dietary advice was provided by trained professionals such as midwives, nutritionists, or public health nurses. Structured physical activity options were offered to women in two studies. Claesson *et al.* (2007) offered aqua aerobic classes once or twice a week. Gray-Donald *et al.* (2000) offered exercise or walking groups. Two studies (Olson 2004 and Kinnunen *et al.,* 2007) encouraged women to take part in exercise without offering sessions. Monitoring of dietary and/or physical active progression occurred throughout all trials.

6.3.3 Quality Assesment of NRS

Four of the studies were judged to be representative of the source population while one (Kardel *et al*.,1998) recruited from local advertisements and from acquaintances and therefore potentially non-representative of the source population. There was no method used to reduce selection bias in the allocation of treatment and only one (Olson *et al.,* 2004) found no statistical difference in baseline characteristics between groups. Claesson *et al*. (2008) and Kinnunen *et al*. (2007) both adjusted for baseline differences in their analysis. Contamination bias was judged to be high in Kardel *et al.,* (1998). Two studies used historical control groups (Olson *et al.*, 2004 and Gray-Donald *et al.,* 2000) (See table 2) raising the possibility that different factors might have influenced women's behaviours in different time periods independently of the interventions, thereby reducing reliability of the study results.

Table 2: Quality assessment of NRS

Study	Population representative of the source population	Adequate Sequence Generation	Allocation concealment	Blinding	Incomplete outcome Data	Selective outcome reporting	Selection bias and risk of confounders	Contamination bias	Sample size	Grade
Claesson 2007	YES – recruited from clinics +	No – all pregnant women consecutively registered and controls -	No -	No -	Yes +	unclear	Baseline differences Adjustment made in the analysis ++	control group selected from two nearby cities +	315 ++	+
Kardel 1998	No – recruited from Newspaper ads and acquaintances -	No -	Subjects given choice of which groups to participate in -	No -	Yes +	unclear	Significant differences between groups – not adjusted for in analysis -	choice given on which group to participate in -	42	-
Olson 2004	YES - recruited from the population who registered for obstetric care +	No	No	No	Yes +	unclear	No differences ++	historical control group +	560 ++	-
Gray-Donald 2000	Yes – all Cree women receiving prenatal services	No	No	No	19/200 loss to follow-up	unclear	Baseline characteristics described – not statistical tests.	historical control group	219 ++	-

					ITT performed		-	+		
Kinnunen 2007	Yes – recruited from maternity clinics at first visit +	Three clinics volunteered to be intervention sites	No	No	No loss to follow-up – withdrawals from study recorded ++	unclear	Baseline characteristics described and variable included as confounding factors in the multivariable analyses ++	different clinics acted as control settings +	55	+

6.4 Case series

6.4.1 Description of setting and participants

Two studies were included; the total number of participants in the case series studies was 109. Studies were set in Australia (Galletly et al. 1996), and Canada (Mendelson et al. 1991). Participants were recruited from clinics or programs. Mendelson *et al*.1991 assessed the impact of an intervention programme (Healthiest Baby possible) on dietary changes and birth outcomes of underweight (BMI<20) and overweight (BMI over 28) expectant mothers. (Galletly *et al*., 1996) assessed the effect of diet and physical activity interventions and weight loss in women experiencing fertility problems

A description of the baseline characteristics for case series studies are summarised in appendix 2.4. The mean age was 27.1 years. BMI was reported in one study and pre-pregnancy weight was noted (Mendelson *et al.,* 1991). Neither study reported previous pregnancies (Galletly *et al*.,1996; Mendelson *et al.*, 1991). Education was reported in one study and 70% of respondents did not complete high school (Mendelson *et al.*, 1991). Ethnicity and gestational age at enrolment was not reported in any of the case series studies. Neither reported group comparability (Galletly *et al.*,1996; Mendelson *et al*., 1991).

6.4.2 Description of intervention

Mendelson *et al*. 1991 sought to assess the impact of the 'Healthiest Babies Possible Program' which was a prenatal intervention program set in Toronto, Canada and was designed to reduce the incidence of low birth weight babies. The program was implemented by a team of dietitians and public health nurses who conduct home visits and provide individual counselling. The dietitian's role included dietary assessment and advice as well as the dispensation of milk coupons for eligible clients. The objective of the programme was to improve health knowledge and behaviour of high-risk pregnant women.

Galletly *et al*.,(1996) assessed the impact of a 24 week program in Australian among 37 obese, infertile women, with a mean BMI of 37 kg/m^2. The programme included a weekly 1 hour exercise session followed by a group discussion with a psychiatrist, dietitian or reproductive medicine specialist. Group discussion topics included healthy eating patterns, developing coping strategies and the effects of obesity on

reproduction. The women did not undergo any fertility treatments during the 24 week programme.

6.4.3 Quality of case series

The quality of the included case series (Galletly *et al*., 1996; Mendelson *et al*., 1991) was graded using the NICE quality appraisal checklist (NICE, 2009). The absence of a control group in these studies means that no effect seen can be judged to result from the intervention. Neither study was conducted in the UK and therefore both have limited applicability to the UK setting. (See table 3)

Table 3: Quality assessment of case series

	Population			Method of allocation										Outcomes						Analyses						
	1.1	1.2	1.3	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	3.1	3.2	2.3	3.4	3.5	3.6	4.1	4.2	4.3	4.4	4.5	4.6	
Galletly, 1996	+	NA	NA	NA	++	NA	NA	NA	NA	NA	++	-	NA	++	+	++	+	NA	++	NA	NR	NA	++	++	++	NA
Mendelson, 1991	+	NA	NA	NA	+	NA	NA	NA	NA	NA	++	-	NA	++	+	++	+	NA	++	NA	NR	NA	++	++	++	NA

6.5 Maternal Outcomes of Intervention Studies

6.5.1 Gestational Weight Gain

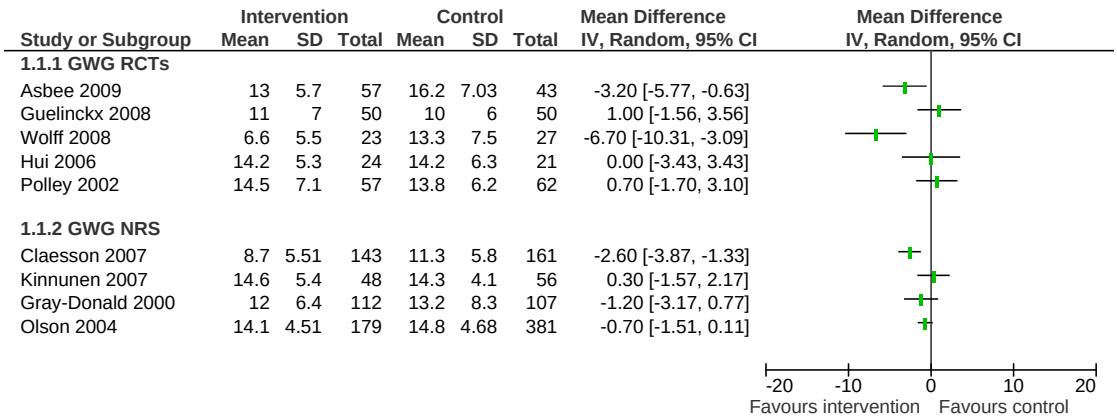
Gestational weight gain was measured in all of the included intervention studies. Gestational weight gain was calculated using self reported pre-pregnancy weight in 5 trials (Hui *et al.,* 2006, Wolff *et al.,* 2008, Polley *et al*., 2002, Asbee *et al*., 2009, Kinnunen *et al.,* 2008) and weight at initial antenatal visit or self reported weight if this was unavailable (Gray-Donald *et al.,* 2000, Claesson *et al*., 2007). One trial (Olson *et al.,* 2004) used either the weight measured at the first antenatal visit or used an adjusted weight if women joined the study during the second trimester to avoid potential biases associated with self reported weight measures. Final value weights were based on final weight before delivery. If this was greater than one month prior to delivery then weight at delivery was used in one trial (Polley *et al*.,2002). Two other trials reported the threshold for final weight as up to two weeks before delivery (Olson *et al*., 2004, Claesson *et al.,* 2007). Kardel *et al.,* (1998) measured body weight and skin fold thickness at weeks 17, 30, and 36 weeks post partum. The paper did not report how baseline pre-conception weight was recorded. Guelinckx *et al.,* (2008) did not report methods of measuring gestational weight gain. Gray-Donald *et al*., (2008) only included participants from a Cree Indian community in Canada and the findings are therefore not applicable to a UK setting.

Figure 2 presents a summary of the results for the included RCTs. The forest plot presents the studies in order of weight (greatest weight first). The weight is derived from the amount of information they contribute (more specifically, by the inverse variances of the effect estimates (Rev Man 5). This gives studies with more precise results (narrower confidence intervals) more weight. It can be seen that in two trials (Wolff *et al*., 2008 and Asbee *et al*., 2009) women in the control group had a significantly greater gestational weight gain than women receiving the intervention. In Wolff the control group gained a mean 6.70 kg (95% CI 2.78 to 10.62) kg more than women in the intervention group. In Asbee *et al*., (2009), women in the control group gained a mean 3.20 kg (95% CI 0.63 to 5.77) more than women receiving the intervention.

Kardel *et al*., (1998) explored the effects of high and medium intensity exercise in women who were already healthy and well-trained before pregnancy. They found a tendency for higher maternal weight gain in the high-intensity exercise group but a

trend for lower maternal skin-fold thickness in the high-intensity group compared with the medium intensity group.

Figure 2 Gestational Weight Gain - Summary Finding



6.5.2 Exceeding IoM guidance for healthy weight gain

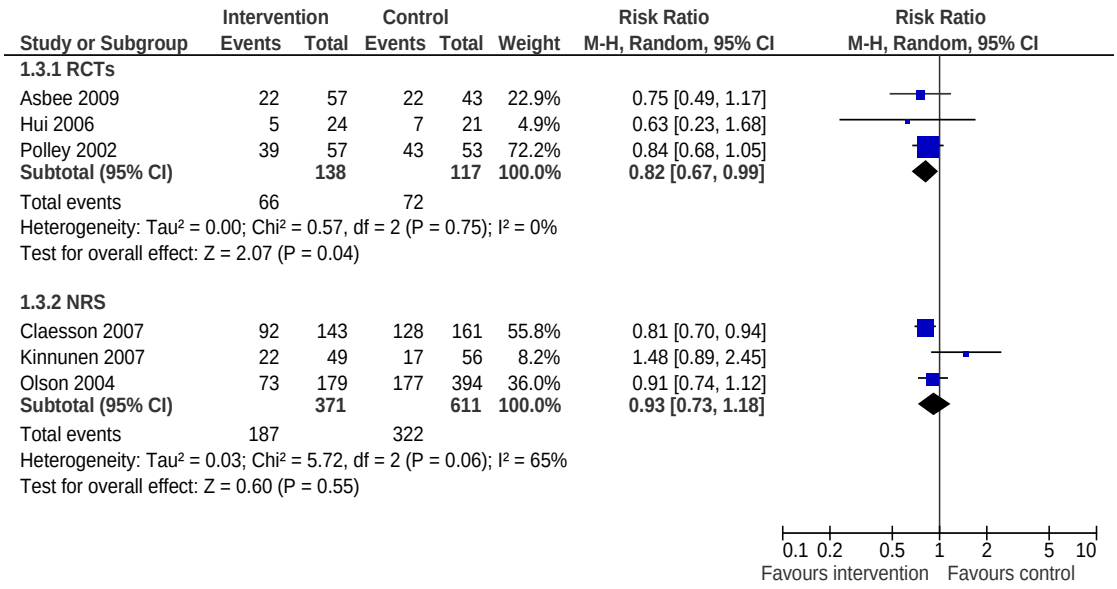
The American Institute of Medicine (IoM 1990) has stated recommendations for weight gain depending on pre-pregnancy BMI. For women with a pre-pregnancy BMI of >29kg/m^2, the recommended weight gain is at least 6.8kg during pregnancy. Three RCTs (Asbee *et al.,* 2009, Hui *et al.,* 2006, Polley *et al.,* 2002) and three NRS (Claesson *et al*., 2007, Kinnunen *et al.,* 2007, Olson *et al.,* 2004) measured the number of women who exceeded the IOM guidance for their BMI category. When the RCTs were pooled (see figure 3) there was a statistically significant effect favouring the intervention with 66/138 (47.8%) exceeding the IoM guidance in the intervention group compared with 72/117 (61.5%) in the control group – an absolute risk reduction of 13% (95% CI 1% to 24%) (RR 0.82, 95% CI 0.67 to 0.99). There was no significant heterogeneity in this meta-analysis.

There was considerable heterogeneity in the pooled result of the NRS. One study found a statistically significant effect in favour of treatment with 92/143 (64.3%) in the intervention arm exceeding the IoM guidelines compared with 128/161 (79.5%) in the control group.

It is notable that despite receiving the intervention the proportion of women in the intervention groups exceeding the recommended gestational weight gain was still between 21% and 68%.

Kardel (1998) did not report adherence to IoM guidance but the mean weight gain for both groups placed them within the recommended limits for gestational weight gain.

Figure 3: Number exceeding IoM Guidelines for healthy weight gain



6.5.3 Post-partum weight retention

Two RCTs (Wolff *et al.,* 2008 and Polley *et al.,* 2002) reported post-partum weight retention postpartum weight less pre-pregnancy weight). Wolff *et al.* (2008) measured weight at 4 weeks post partum. The intervention group (n=16) retained 6.9kg less weight than the control group (n=19) 4 weeks post partum (-4.5 vs 2.4 kg, 95% CI 2.5 to 11.2, p= 0.003) compared to the pregnancy weight. This outcome was based on 70% (35/50) of participants with similar rates of missing data in both arms. Polley *et al.* (2002) measured postpartum weight retention at 8 (s.d. 7.1) weeks and data were available for 67.3% (74/110) of the women. Mean post partum weight retention was 3.7 (s.d. 5.9) kg. Normal weight women in the intervention group retained less than those in the control group (4.4 kg vs 6.2 kg) and overweight women in the intervention group retained more than those in the control group (3.6 vs 0.3 kg); however neither of these differences reached statistical significance.

Three NRS (Claesson *et al.,* 2007, Olson *et al.,* 2004 and Gray-Donald *et al.,* (2000) reported retained weight postpartum. Olson *et al.* (2004) measured weight at one year post partum and found a statistically significant effect with less weight retained in the intervention group compared with those in the control group (0.59 kg vs 1.31 kg p = 0.04). Claesson *et al.* (2007) measured weight at 10 – 12 weeks and also

found a significant effect with less weight retained in the intervention group than the control group (-2.5 kg vs 0.75 kg p = <0.001). Gray-Donald *et al.* 2000 measured post partum weight retention at 6 weeks and in contrast found no statistically significant effect with intervention (6.1 kg vs 7.4 kg).

6.5.4 Behaviour Change

Two RCTs measured changes in diet and/ or exercise (Guelinckx *et al.,* 2008, Wolff *et al.,* 2008). Guelinckx *et al.* (2008) found a reduced total energy intake in the intervention groups compared to the control (p=0.033) which was measured using a 7 day food record. There were however no significant differences in mean gestational weight gain in the three groups. Wolff *et al.* assessed dietary changes using 7-day weighed food records at inclusion, 27 and 36 weeks. The women in the intervention group reduced their fat and carbohydrate percentages and increased the percentage of protein in their diet compared to the control group. The gestational weight gain was also significantly reduced in the women receiving the intervention compared to women in the control.

Three NRS measured changes in diet and/or exercise (Kinnunen *et al.,* 2007, Gray-Donald *et al.,* 2000, Olson *et al.,* 2004) recorded exercise and dietary intake using questionnaires. Olson *et al.* 2004 recorded self reported measures of dietary intake and exercise expenditure at recruitment, 30 weeks gestation and 6 weeks postpartum. They found no difference in eating or exercise behaviour Kinnunen *et al.* 2007 found that the intake of vegetables, fruit and berries, adjusted for confounders, increased by 0.8 portions/day more in the intervention group from baseline to 36-37 weeks gestation compared with the controls (p=0.004). Intake of high-fibre bread also increased amongst women in the intervention arm, when adjusted for confounders compared with the control group (p=0.04).Differences in the changes in the use of high sugar snacks or in the intake of energy was not significant between groups. There were no statistically significant differences observed between groups in physical exercise. Gray-Donald *et al.* (2000) study conducted in a Cree community in Canada measured energy intake and physical activity using 24 hour recall. The mean intake of energy and other nutrients at an average of 27 weeks gestation was similar for the intervention and control groups. Self-reported levels of physical activity were very low with 23% of women reporting sedentary behaviour in the control group and significantly higher percentage, 61% in the intervention group (p< 0.001).

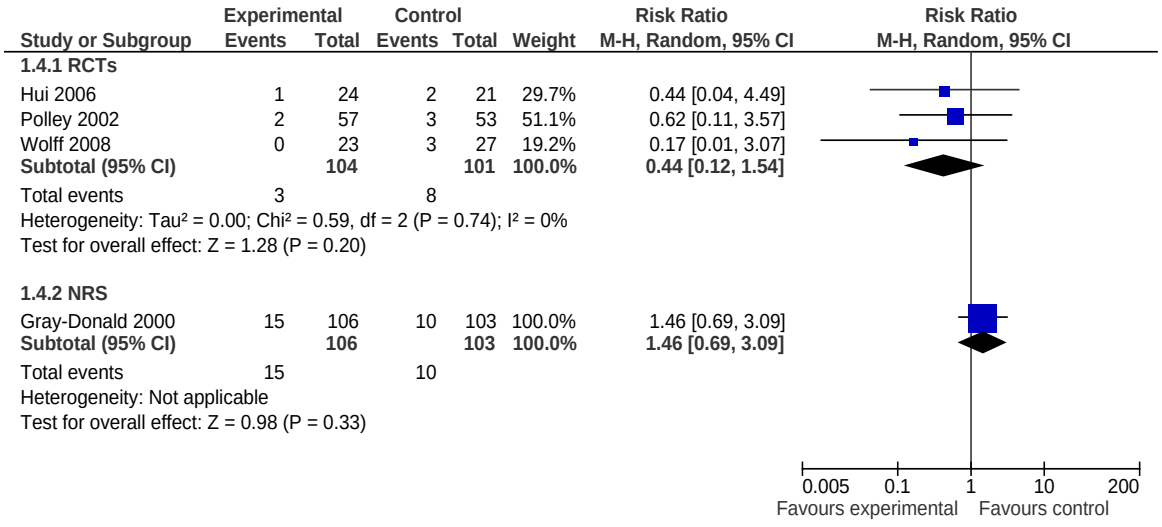
6.5.5 Adverse effects of exercise in pregnancy

None of the studies reported any adverse effects of the interventions. Kardel *et al.* (1998) explored the potential adverse effects of high and medium intensity exercise in pregnancy amongst women already well-trained physically. They found that exercise; medium intensity and high intensity training, involving muscle building, interval training and endurance training did not compromise foetal growth and development as judged by birth weight or by complications in the course of pregnancy or labour.

6.5.6 Gestational Diabetes

Rates of gestational diabetes were measured in three RCTs (Hui *et al.,* 2006, Polley *et al.,* 2002, Wolff *et al.,* 2008) and one NRS (Gray-Donald *et al.,* 2000). Fewer women in the intervention group appeared to develop gestational diabetes although this was not significant at the 5% level (RR 0.44, 95% CI 0.12 to 1.54). In the NRS Gray-Donald *et al.* (2000) found an effect favouring the control group although this did not achieve significance at the 5% level (RR 1.46, 0.69 to 3.09). See figure 4.

Figure 4: Gestational Diabetes



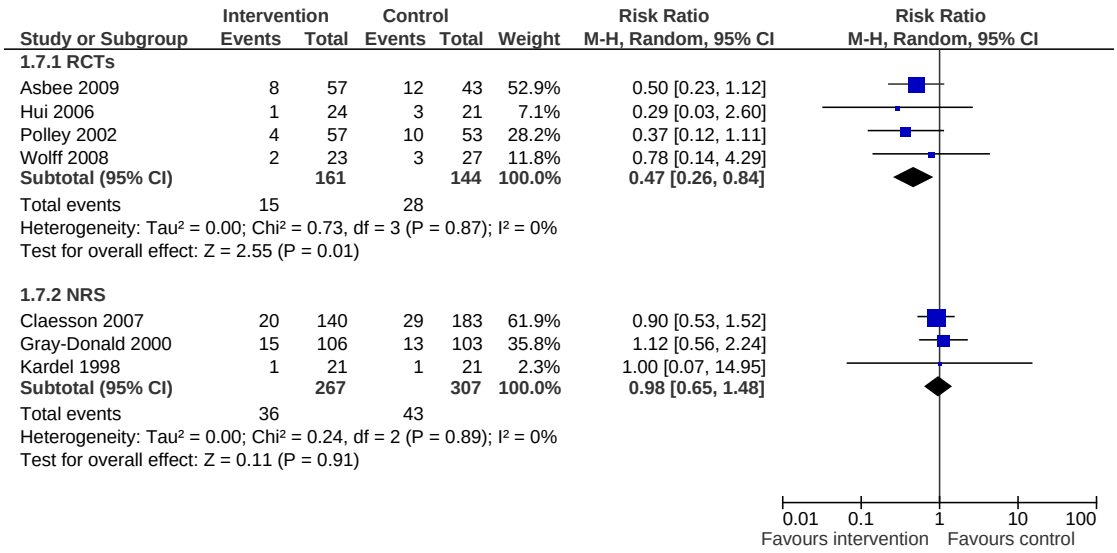
6.6 Birth Outcomes

6.6.1 Caesarean Section Rates

Four RCTs (Asbee *et al.,* 2009, Hui *et al.,* 2006, Wolff *et al.,* 2008) and three NRS (Claesson *et al.,* 2007, Gray-Donald *et al.,* 2000, Kardel 1998) reported the

caesarean section rate. When the data from the RCTs was pooled caesarean rates were 15/161 (9.3%) in the intervention and 28/144 (19.4%) in the control group – and absolute risk reduction of 10 % (95% CI 2 to 18%) (RR 0.47, 95% CI 0.26 to 0.84). In the NRS there was no significant difference in effect between intervention and control groups. See figure 5

Figure 5: Caesarean Section Rates

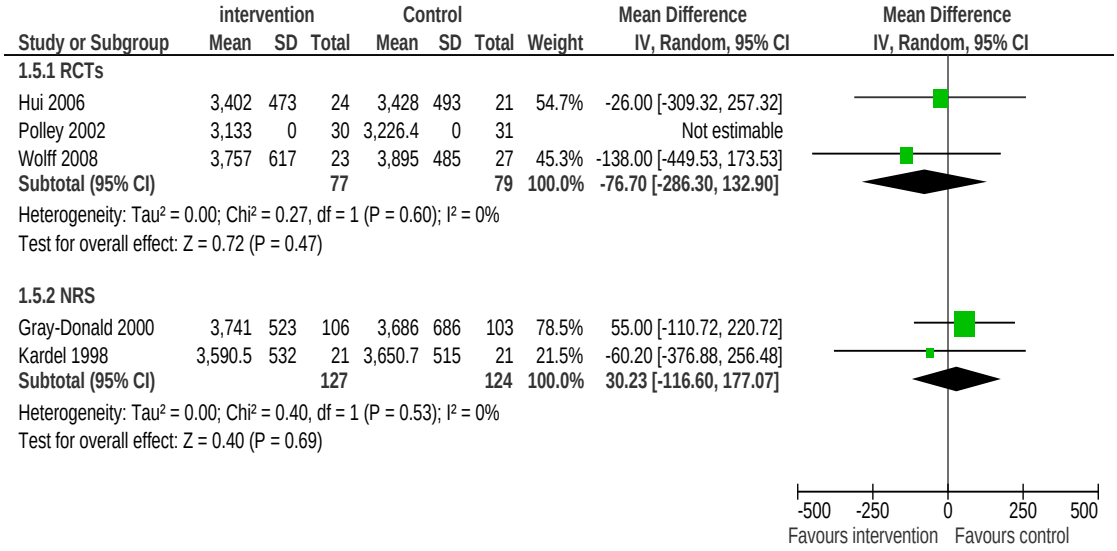


6.7 Infant related outcomes

6.7.1 Birth Weight

Infant birth weight was reported in three RCTs (Hui *et al.,* 2006, Polley *et al.,* 2002, Wolff *et al.,* 2008) and 2 NRS (Gray-Donald *et al.,* 2000, Kardel *et al.,*1998). There was no significant difference between intervention and control arms in any of the studies. See figure 6

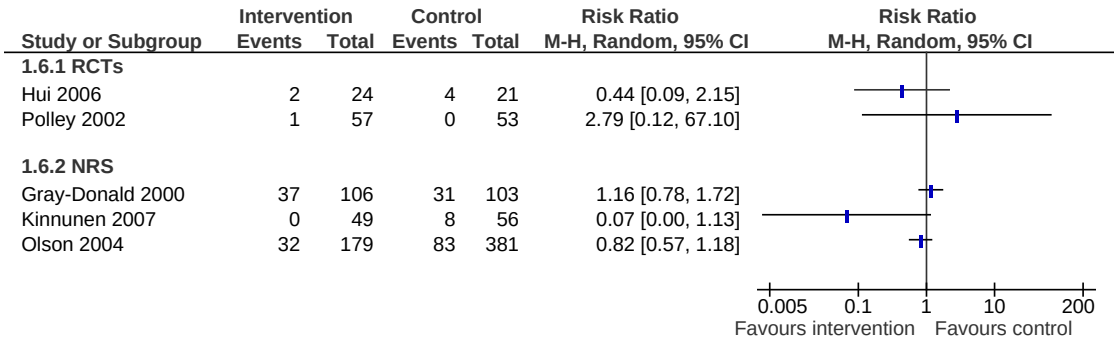
Figure 6: Infant birth weight



6.7.2 Macrosomia

Macrosomia (infants of birth weight greater than 4000 g) was reported in two RCTs (Hui *et al.,* 2006, Polley *et al.,* 2002) and two NRS (Gray-Donald *et al.,* 2000, Kinnunen *et al.,* 2007). No significant difference at the 5% level was found between intervention and control arms. See figure 7.

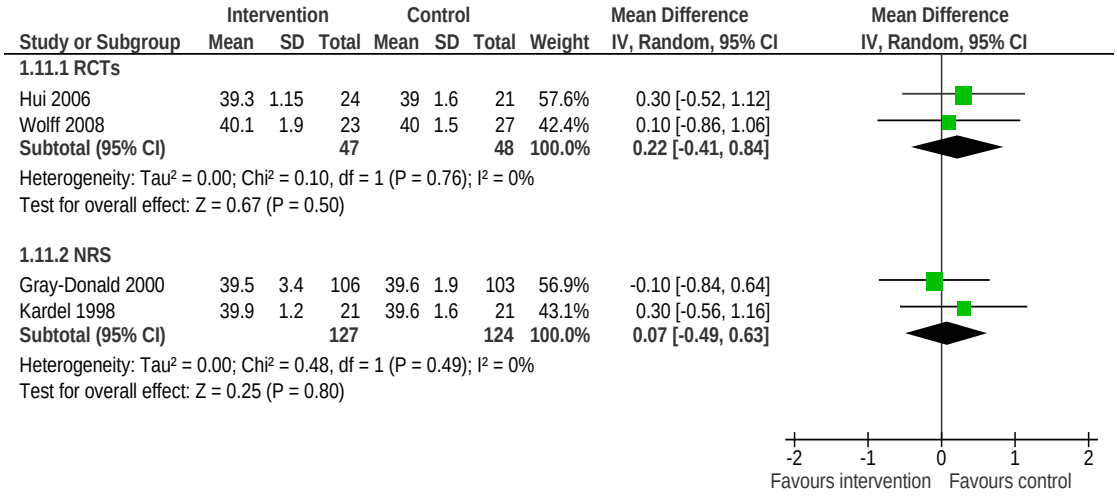
Figure 7: Macrosomia



6.7.3 Gestational age at birth

Two RCTs (Hui *et al.,* 2005 and Wolff *et al.,* 2008) and two NRS (Gray-Donald *et al.,* 2000, Kardel 1998) reported gestational age at birth. There was no significant difference between intervention and control groups. See figure 8

Figure 8: Gestational age at birth



6.8 Subgroup Analysis for RCTs and NRS

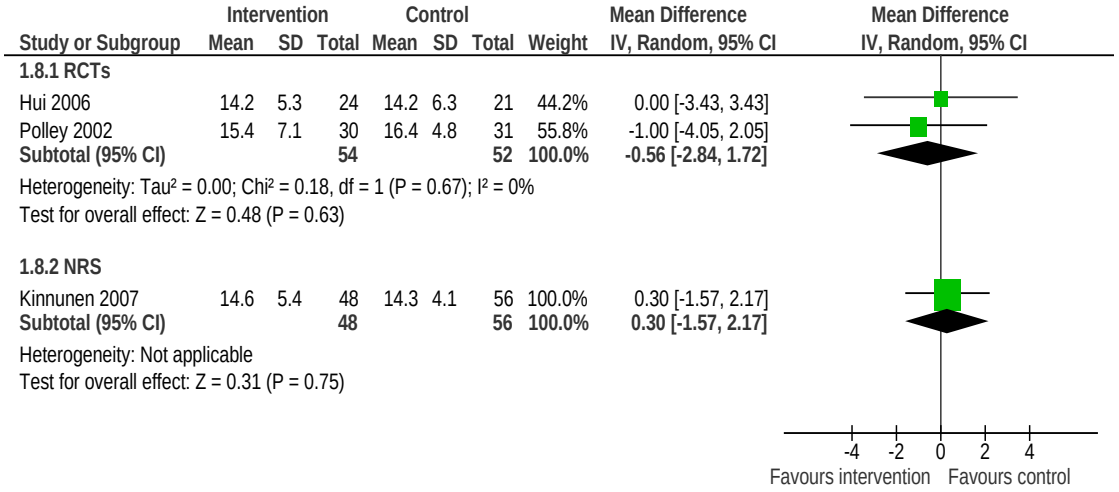
The number of RCTs and NRS available for subgroup analysis was limited for most outcomes except for gestational weight gain. The impact of different internal factors (i.e. factors that relate to the participants) and external factors (i.e. factors that relate to the intervention) are explored in relation to their impact on gestational weight gain.

6.8.1 Pre-pregnancy Weight

Pregnant women with normal (18.5 – 24.9 kg/m^2) pre-pregnancy weight

The mean pre-pregnant weights of participants in two studies (Hui *et al.,* 2005, and Kinnunnen *et al.,* 2007) were 24.5 and 23 kg/m^2 respectively categorising the women as normal weight. Polley *et al.,* (2002) divided her sample into subgroups of normal and overweight women. There were no differences in GWG between intervention and control groups. When pooled the results also showed no effect with treatment, there was no statistical heterogeneity in this meta-analysis. (See figure 9).

Figure 9: Pregnant women with normal (18.5 – 24.9 kg/m^2) pre-pregnancy weight

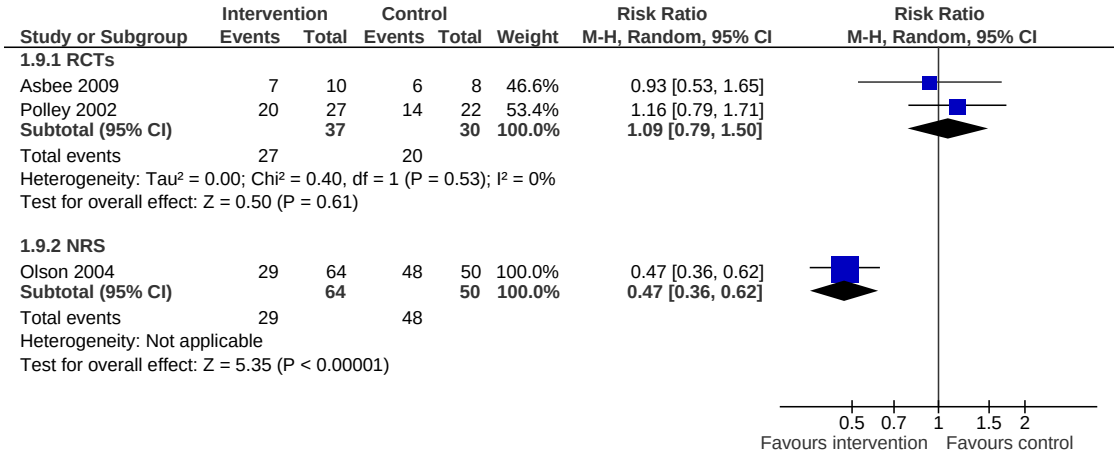


Pregnant women with overweight (25-29.9t kg/m^2) pre-pregnancy weight

Two randomised studies reported the numbers exceeding the IOM guidelines for healthy weight gain in pregnancy amongst women who were overweight pre-pregnancy. The pooled results showed 27/37 (73%) exceeded IOM guidelines in the intervention group and 20/30 (67%) exceeded the guidelines in the control group – an absolute risk difference of 6% (95% CI -16 to 28%) (RR 1.09 95% CI 0.79 to 1.50). These differences were not statistically significant.

One NRS (Olson *et al.,* 2004) found a positive effect with treatment 29/64 (45.3%) exceeded the guidelines in the intervention group, compared with 48/50 (96%) in the control group - a risk reduction of 51% (95% CI 37 to 64 %) (RR 0.47, 95% CI 0.36 to 0.62). See figure 10.

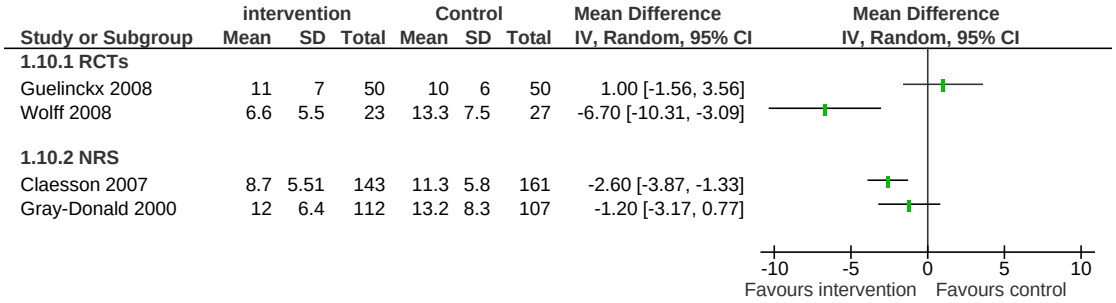
Figure 10: Pregnant women with pre-pregnancy weight of overweight (25-29.9t kg/m^2)



Four studies included only obese women. Two (Wolff *et al.,* 2008, Claesson *et al.,* 2008) showed a statistically significant reduced GWG in the intervention groups compared with the control group (-6.70 kg (95% CI -10.3 to -3.09) and -2.60 (95% CI -3.87 to -1.33). One NRS (Gray-Donald *et al.,* 2000) showed a positive effect but the result did not achieve statistical significance at the 5% level (Mean difference -1.20, 95% CI -3.17 to 0.77). One RCT (Guelinckx *et al.,* 2008), found a reduced energy and fat intake measured using a 7 day food record in the intervention group compared with a control group. There was however no statistically significant difference in gestational weight gain. This intervention was also the least intense, offering advice on healthy eating. See figure 11.

One case series (Galletly *et al.,* 1996), included women classified as obese (BMI >30 kg/m^2) and who were experiencing infertility but wished to become pregnant. The women in the intervention group experienced a significant weight loss 6.2 kg (S.D. 4.5, $p < 0.001$) after a program which included regular exercise, advice about healthy eating and group support.

Figure 11: Pregnant women with pre-pregnancy weight of obese (≥ 30 kg/m^2)



6.8.2 Socio economic status

There was not a consistent measurement and reporting of socio economic status in the included studies. Hui *et al.,* (2006), Polley *et al.,* (2002) and Gray-Donald *et al.,* (2000) recruited only from economically deprived populations. There was no statistically positive effect of the intervention in managing gestational weight gain in these studies

One RCT undertook a subgroup analysis based on income (Olson *et al.,* 2004) and found that the intervention was only effective amongst women on a low income and not amongst women with a high income. The impact of the intervention amongst women of low income was seen in both the overweight and normal BMI groups. Low-income women in the intervention group were only about 41% as likely to gain more weight in pregnancy than is recommended by IoM (1990) guidance compared with women in the control group (OR 0.41 95% CI 0.20 to 0.81). No effect of the intervention was detected in high – income women.

Two (Claesson *et al.,* 2007, Kinnunen *et al.,* 2007) studies comprised of groups from more advantaged populations where more than 50 % were in skilled employment or had received more than 12 years of education. One of these studies (Claesson *et al.,* 2007) found that gestational weight gain was significantly reduced in intervention compared to the control group (-2.60 kg, 95% CI -3.87 to -1.33). Kinnunen *et al.,* (2007) found no difference between groups. Wolff *et al.,* (2008) did not report participant's socioeconomic status, education level or income.

6.8.3 Ethnicity

The ethnic profile of participants was not reported in all studies and categorization of ethnic groups also differed between studies where it was reported.

Those with a higher proportion of ethnic groups represented amongst the study populations in Asbee *et al.,* 2009, Gray-Donald *et al.,* 2000 and Hui *et al.* 2006. In Asbee *et al.*'s (2009) study the majority of women were described as Hispanic (56%), 24% were described as African American, 13% were described as White, 4% were described as Asian and 2% as 'other'. This study found that those women in the intervention group gained less gestational weight than those in the control group (-3.20 kg (95% CI -5.77 to -0.63). In the study by Gray-Donald *et al.* (2000) all of the women were from the Cree community in northern Canada, a population which suffers a high prevalence of gestational diabetes mellitus and type 2 diabetes. There was no significant effect on gestational weight gain between groups as a result of the intervention. Hui *et al.* (2006) targeted socio-economically deprived pregnant women in Canada. Sixty-four percent of the participants were described as from a 'visible minority'. Gestational weight gain did not differ between intervention and control group.

Three studies had a smaller proportion of participants from ethnic groups (Olson *et al.,* 2004, Polley *et al.,* 2002, and Wolff *et al.,* 2008). In Olson *et al.* (2004) 96% were described as White, in Polley *et al.,* (2002) 61% were described as white and 39% were black and in Wolff *et al.,* (2008) all participants were described as Caucasian. Studies by Olsen *et al.* (2004) and Polley *et al.* (2002) were carried out in America, the study by Wolff *et al.,* (2008) was carried out in Denmark. There was no significant difference in gestational weight gain seen between intervention and control groups in the studies by Olson *et al.* (2004) and Polley *et al.* (2002). Wolff *et al.* (2008) did however find a significant effect with the intervention with a mean reduction of 6.70 kg in the intervention group compared to the control group (-6.70 kg CI -10.31 to -3.09).

The under-reporting of ethnicity and differences in categorisation of ethnic groups does not allow us to discern differences in effect based on membership of ethnic group.

6.8.4 Intervention Intensity

Seven features of the interventions were selected for comparison between studies, these included; the use of regular weighing and graphical reporting of weight gain to the mother, the involvement of a professional such as a dietitian during the delivery of the intervention, more than 5 contacts between the mother and professionals delivering the intervention, an intervention tailored to each individual and taking into account their specific needs, the provision of an exercise class, the use of a food diary by the participant mother to measure changes and using more than one way of delivering information. Each feature was then graded zero, one + or two ++ with a higher score indicating the inclusion of the feature. See tables 4 and 5. The purpose of this scheme was to try and numerically quantify and then compare the intensity of the interventions used in the studies. This is not a validated grading system and should be viewed cautiously. The forest plot (Figure 12) was then ordered with the study with the most intense intervention at the top. There does not appear to be a relationship between intervention intensity and effectiveness, with both the most intense and least intense interventions showing no statistical difference between groups (at the 5% level).

Table 4: Intervention Intensity - RCT

	Regular weighing and graph	**Professional**	**> 5 contacts in 9 months**	**Tailored**	**Exercis class**	**Food diary**	**Multiple ways of conveying info**	**Extra**	**Total**
Hui	++	++	++	++	++	++	++	Activity diary	16
Polley	++	++	++	++			++	Stepped care approach	12
Wolff	++	++	++	++		++			10
Asbee	* ++	once	At routine visits	*++					5
Guelinckx						++			2

All received advice regarding a healthy diet

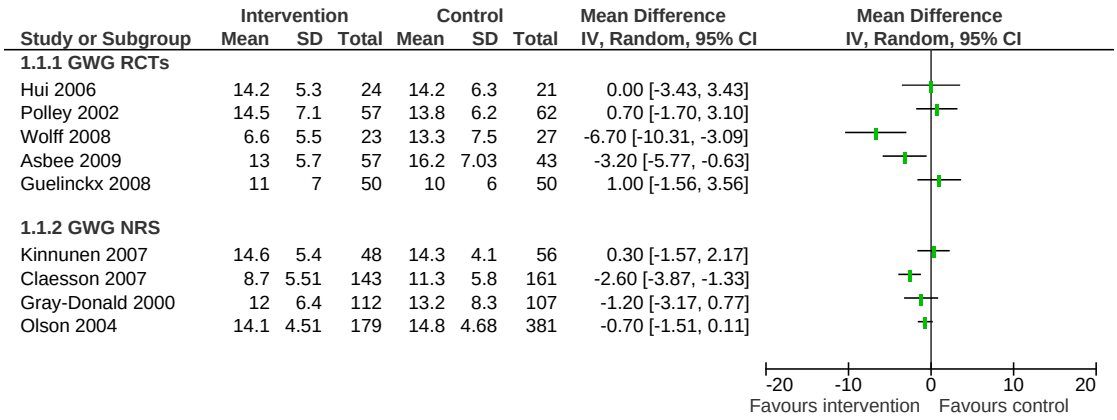
Table 5: Intervention Intensity - NRS

	Regular weighing and graph	Professional	> 5 contacts in 9 months	tailored	Exercise class	Food diary	Multiple ways of conveying info	Extra	Total
Kinnunen 2007	+	Specially trained public health nurses ++	++	++	++	++	++	Follow-up notebook – progress recorded and reviewed	15
Claesson 2007	+	Specially trained midwives ++	++	++	++		++	Motivational talk in early pregnancy	13
Gray Donald 2000		++	++	++	++	+	++	Nutritionists lived and worked in community	13
Olson	++	Health care providers	++	++			++		8

6.8.5 Interventions for women planning a pregnancy

Galletly *et al.* (1996) reported the findings of a case series which included women classified as obese (mean BMI 37kg/m^2) and who were experiencing infertility but wished to become pregnant. The women experienced a significant weight loss 6.2 kg (S.D. 4.5, $p < 0.001$) and 2.4kg/m^2 reduction in BMI (S.D. 1.7, $p<0.001$) after a program which included regular exercise, advice about healthy eating and group support. The study reported significant improvements in a range of psychological measures, including self esteem, anxiety and depression but there was no significant correlation between change in psychological measures and change in weight or BMI. Changes in diet and activity were not reported. 29 of the 37 women became pregnant during the follow up period (21 to 36 months). Birth and maternal outcomes not reported.

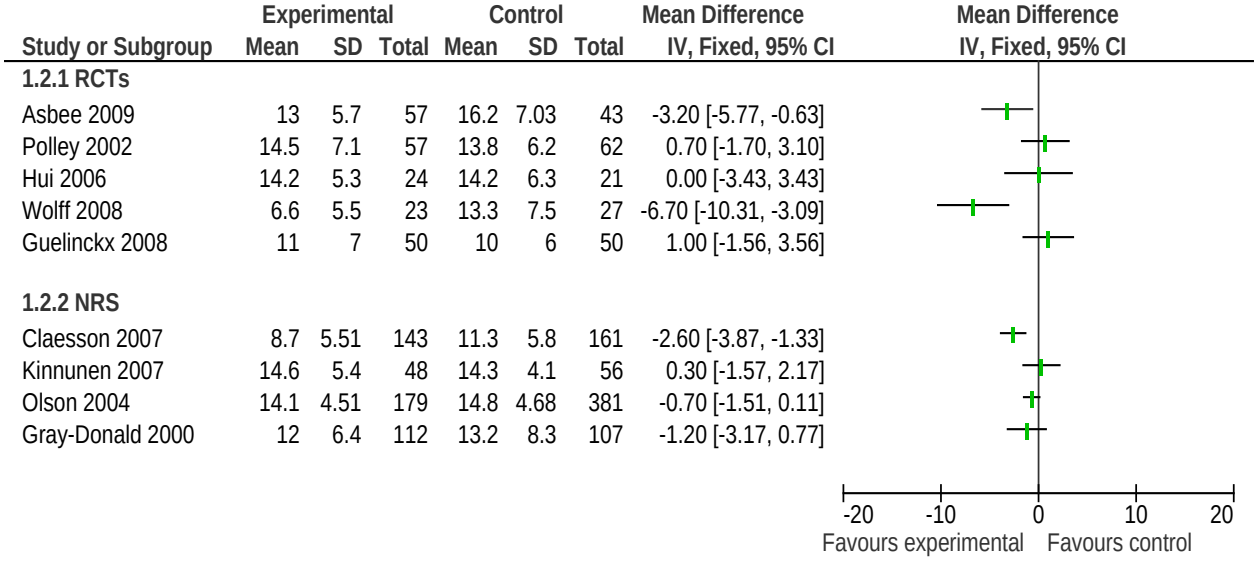
Figure 12: Studies ranked on descending intensity of intervention



6.8.6 Impact of methodological quality

The methodological quality of each included study was reviewed according to methods described for both the randomised and non-randomised studies (see section 5.3.2). This data was then used to describe the studies and also to rank and place them in descending order with the more rigorously designed studies listed first. See tables 1 and 2 and figure 13.There does not appear to be a consistent pattern of effect for gestational weight gain based upon the quality of study design.

Figure 13: Interventions ranked on study quality



6.8.7 Loss to follow-up and withdrawal from intervention - RCTs

Four trials (Asbee *et al.,* 2009, Hui *et al.,* 2006, Wolff *et al.,* 2008, Polley *et al.,* 2002) reported overall loss to follow- up of 30.6%, 13.5%, 19.7%, and 8.3% respectively. Hui *et al.* 2006 and Asbee *et al.* 2009 did not report the loss to follow-up by treatment

arm so the impact of the intervention on withdrawal rates cannot be estimated. None of the reasons given for loss to follow-up in the Asbee *et al.* 2009 trial related to the nature of the intervention and included (delivered at outside institution, obtained prenatal care after 16 weeks of gestation and delivered prematurely). In Hui *et al.,* 2006, all seven of those lost to follow – up withdrew from the trial because of the time commitment involved in participating in the study. In the trial by Polley *et al.* 2002, 9.8%% (6/61) withdrew from the intervention arm although 5 were not lost to follow-up but chose not to receive the intervention. In Wolff *et al.* 2008, those lost to follow-up withdrew either because they lacked time to participate or because of disappointment at being randomised to the control group.

6.8.8 Loss to follow-up and withdrawal from intervention - NRS

Kinnunen *et al.,* (2007) reported the highest proportion of women lost to follow-up with 29% and 11.1% in the intervention and control arms respectively. Reasons for withdrawing from the study included the nature of the study in 7.2% of women in the intervention arm and 6.3% of women in the control arm. Other reasons for being lost to follow-up included miscarriage, relocation, pregnancy or health related problems and life situation. Gray-Donald *et al.,* (2000) reported that 11.6% and 13.1% or women in intervention and control groups respectively dropped out of the study and were lost to follow-up. 2.3% of women withdrew after experiencing miscarriage but the reasons were not given for the other women lost to follow-up. Claesson *et al.,* (2007) reported that 3.1% of participants in the intervention and 7.2% of participants in the control group withdrew and were lost to follow-up but the reasons were not reported. Olson *et al.,* (2004) reported lost to follow-up at one year. 11.7% of women were lost from the study intervention arm because of a weight related or pregnancy related illness, a second birth or lack of data. 5.8% of control participants were reported to have been lost for the same reasons. One woman withdrew from the Kardel and Kase (1998) study due to the time consuming nature of the intervention.

6.9 Results - Observational Studies

6.9.1 Description of Setting

Fourteen observational studies were included, the number of participants in the observational studies ranged from 101 to 2237 (see Appendix 2.5). Eleven studies were conducted in the USA, (Horns et al. 1996;Keppel et al. 1993;Mumford et al. 2008;Olson et al. 2003;Sternfeld et al. 1995;Symons Downs and Hausenblas 2007). One, (Lof et al. 2008) was conducted in Sweden, one (Bergmann et al. 1997) in Germany and one (Conway et al. 1999) in the UK. In six studies, women were recruited from obstetric clinics, prenatal services, or hospital delivery logs (Campbell *et al.,*. 2001; Horns *et al.,*. 1996; Lof *et al.,*.2008; Mumford *et al.,*. 2008; Olson *et al.,*. 2003; Sternfeld *et al.,*. 1995;) One trial (Bungum *et al.,*. 2000) recruited through hospital-based childbirth education classes and a private fitness centre. Three recruited women during conduct of a survey (Cogswell *et al.,* 1996, Cogswell *et al.,* 1999, Tafffel *et al.,* 1993).

6.9.2 Description of purpose

This review limited its inclusion of observational studies to those that explored the relationship between physical activity and/ or dietary behaviours and weight gain in pregnancy.

6.9.3 Description of baseline characteristics

Details of the included observational studies are described in evidence tables found in Appendix 2.5. The majority of participants were aged between 20 to 30 years. Women under 20 years represented a small proportion of participants in studies where age profile was reported. The mean BMI range at enrolment to the studies was 21 to over 25 kg/m^2; however five trials did not report pre-pregnancy BMI (Horns *et al.,*. 1996; Lof *et al.,*. 2008; Mumford *et al.,*. 2008; Olson *et al.,*. 2003; Sternfeld *et al.,*. 1995). In Gunderson's study (2004) none of the women were overweight at baseline. Six studies reported just about half of respondents are nulliparous (Bungum *et al.,*. 2000; Lof *et al.,*. 2008; Mumford *et al.,*. 2008; Olson *et al.,*. 2003; Sternfeld *et al.,*. 1995, Taffel *et al.,* 1993). Participants in a study by Horns *et al.* (1996) were all primiparous. Campbell *et al.* (2001) had a sample of just under 40% primiparous status. All Studies indicated that many participants had some form of post secondary education. Four studies did not report ethnicity (Bergmann *et al.,* 1997, Campbell *et al.,* 2001; Lof *et al.,* 2008; Olson *et al.,* 2003). In studies that did report ethnicity, majority of participants were white (Bungum *et al.,* 2000; Cogswell *et al.,* 1996, Cogswell *et al.,* 1999, Conway *et al.,* 1999, Gunderson *et al.,* 2004, Horns

et al., 1996; Mumford *et al.,* 2008; Sternfeld *et al.,* 1995, Symons Downs & Hausenblas 2007, Taffel *et al.,* 1993). Six studies reported gestational age at enrolment with a range from 12 to over 34 weeks (Campbell *et al.,* 2001; Cogswell *et al.,* 1996; Conway *et al.,* 1999; Horns *et al.,* 1996; Mumford *et al.,*. 2008; Symons & Hausenblas 2007). One study only recruited pre-pregnant women (Gunderson *et al.,* 2004).

6.10 Quality Assessment of Observational Studies

The major challenges of observational studies which can bias the results include the risk of selection bias that occurs when there are systematic differences between the study groups in factors related to the outcome. A second challenge is their inability to control for all extraneous factors (confounders) that might be associated with the outcome and might differ between the study groups and finally bias that is introduced by differential loss to follow-up because of migration, death or drop-outs. Specifically for case-control studies, bias can occur as individuals with the outcome are more likely to recall risk factors differently to those without the outcome. These aspects of the included studies design are described in table 17.

The Newcastle-Ottawa Quality Assessment Scale (Wells, 2009) was used for this analysis.

Table 6: Quality Assessment of Observational Studies

Cohort Studies

	Representativeness of the exposed cohort	Selection of the non exposed cohort	Ascertainment of exposure	Demonstration that outcome of interest was not present at start of study	Comparability of cohorts on the basis of the design or analysis	Assessment of outcome	Was follow-up long enough for outcomes to occur	Adequacy of follow-up of cohorts	Summary Quality score
Bungum, 1999	+	+	+	+	+	+	++	++	+
Bergmann, 1997	++	++	-	++	+	++	++	+	++
Cogswell, 1996	-	-	-	++	++	-	++	-	-
Cogswell, 1999	++	++	-	++	_	+	++	+	+
Conway, 1999	+	+	-	++	++	+	++	+	+
Gunderson, 2004	++	++	+	++	++	++	++	-	++
Horns, 1996	+	+	-	++	+	+	++	++	+
Löf, 2008	++	++	-	++	++	++	++	++	++
Mumford, 2008	-	-	-	++	++	++	++	-	+
Olson, 2003	++	++	+	+	T++	++	++	+	++
Sternfeld, 1995	-	-	-	+	.++ .	++	++	-	-
Symons,	++	+	-	+	++	++	+	-	+

2007									
Taffel, 1993	+	+	-	-	++	++	+	-	-

Case control studies

	Is the case definition adequate	Representativeness of the cases	Selection of Controls	Definition of Controls	Comparability of cases and controls on the basis of the design or analysis*	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non response rate	Summary of Quality Score
Campbell *et al.,* 2001	+	+	+	+	+	+	+	853 agreed to participate 529 returned questionnaires	+

6.10.1 Associations - Non-interventional observational studies

Fourteen observational studies (Bungum *et al.,* 1999, Bergmann *et al.,* 1997, Campbell & Mottola 2001, Cogswell *et al.,* 1996, Cogswell *et al.,* 1999, Conway *et al.,* 1999, Gunderson *et al.,* 2004, Horns *et al.,* 1994, Löf *et al.,* 2008, Mumford *et al.,* 2008 Olson *et al.,* 2003, Sternfeld *et al.,* 1995, Symons Downs & Hausenblas 2007, Taffel *et al.,* 1993) were included in the review. Two explored the association between physical activity and caesarean deliveries (Bungum *et al.,* 1999, Horns *et al.,* 1994), four with birth weight (Campbell & Mottola 2001, Horns *et al.,* 1994, Sternfeld *et al.,* 1995, Syons Downs & Hausenblas) and three with gestational weight gain (Horns *et al.,* 1994, Löf *et al.,* 2008, Olson & Strawderman 2003). Mumford *et al.,* (2008) and Conway *et al.,* (1999) looked at preconception dieting practices and gestational weight gain. Cogswell *et al.* (1996) conducted a survey of weight loss attempts by pregnant women. Two surveys (Cogswell *et al.,* 1999 and Taffel *et al.,* 1993) explored the advice given to pregnant women regarding weight loss. One case control study (Gunderson *et al.,* 2004) explored the role of childbearing in women becoming overweight.

The association between physical activity and caesarean deliveries was mixed. Bungum *et al.* (1999) found that women active (n=44) during the first 2 trimesters of pregnancy were significantly less likely to have a caesarean delivery compared to women who were categorised as sedentary (n= 94) (16% vs 28% p=0.023). In contrast Horns *et al.,* (1994) found that active women (exercising at least five times per week for at least 15 continuous minutes) (n=53) were not significantly more likely to have a caesarean delivery compared to women who reported having no regular physical activity over 15 continuous minutes (n=48) (25% vs 32 % p=0.62).

Birth weight was not associated with women's physical activity level prior to conceiving or in any trimester (Sternfeld *et al.,* 1995) or between active and sedentary women (Horns *et al.,* 1994). In contrast Campbell & Mottola (2001) found that structured exercise (i.e. exercise programs undertaken for the purpose of exercise e.g. aerobics) ≥5 times per week increased the odds of giving birth to a low birth-weight infant (adjusted OR 4.61 (95% CI 1.73 to 12.32). Lof *et al.,* (2008) also found that women exercising at a high level during the third trimester in pregnancy had 0.10kg/week less weight gain than women with low or medium PAL. Symons

Downs & Hausenblas (2007) compared women who had exercised in the third trimester of pregnancy with those who did not exercise in the third trimester. They found no significant difference in BMI between the two groups of women but that women who exercised during their third trimester delivered significantly longer and heavier babies compared to women not exercising during their third pregnancy trimester

Horns *et al.* (1994) found that women classified as active gained less gestational weight than those described as sedentary although the difference is not statistically significant. Olson & Strawderman (2003) found that decreased physical activity in pregnancy was associated with significantly greater gestational weight gain (1.24 kg p=<0.01). They also found that women who consumed three or more servings of fruit and vegetables per day gained significantly less weight (-0.83 kg p=<0.05) than those who consumed fewer servings during pregnancy.

Mumford *et al.* (2008) found that restrained eating behaviours such as women with a history of dieting were associated with weight gains above the IoM (1990) recommendations for normal, overweight and obese women, and weight gains below the recommendations for under-weight women (see glossary page 6 for BMI categories) . Conway *et al.* (1999) also compared the dietary behaviours during pregnancy of women classified as restrained eaters to those classified as unrestrained eaters on the basis of pre pregnancy dietary habits. Dietary intakes of both groups were remarkably similar during pregnancy. The restrained eaters, however, consumed significantly more alcohol than the unrestrained eaters in both early and late pregnancy. Restrained eaters were significantly less likely to experience weight gains within the recommended range for their pre-pregnancy BMI. They gained either more or less weight than recommended. Dietary restraint appears to have undesirable influences on eating and weight gain during pregnancy. A survey (Cogswell *et al.,* 1996) estimated the prevalence and correlates of attempted weight loss among a geographically diverse group of pregnant women. They found that a minority of women who reported being pregnant also reported trying to lose weight (3.7%). Pregnant women who reported both drinking alcohol in the past month and currently smoking had the highest prevalence of attempted weight loss (12.7%) followed by women in their first trimester (9.4%), women with reported diabetes (9.0%) and women with very high BMIs (6.9%).

Bergman *et al.* (1997) compared the energy intake of women with low, medium and high BMI to investigate factors related to weight gain. They found that women at the highest level of BMI were significantly less often in the high energy intake category than women at the medium or low level of BMI. Women at the highest level of BMI gained significantly less weight than women at the medium or low levels of BMI. Women with a low daily energy intake gained less during pregnancy and there was no difference in birth weight in the three groups. Dietary intake was estimated using a weighed 7 day food record. Bergmann *et al.* (1977) conclude that a lower caloric diet may help to accomplish a lower weight gain during pregnancy in overweight women without increased risk of low birth weight infants.

In both surveys (Taffel *et al.,* 1993, Cogswell *et al.,* 1999) 73% of women reported receiving advice about pregnancy weight gain. Only 47% (Cogswell *et al.,* 1999) received advice that corresponded with the 1990 IOM recommendations for appropriate weight gain. Both surveys found a positive correlation between maternal weight gain and optimum weigh gain advice. Receiving no advice was associated with weight gain outside the recommendations.

Gunderson *et al.* (2004) evaluated over a 10 year period whether childbearing leads to development of overweight in women and to evaluate the role of other known risk factors. For the majority of women initiation of childbearing is associated with development of overweight. In multivariate adjusted models risk was increased for: black vs white race (OR 3.49; 95% CI: 2.59 to 4.69), never smokers (OR 2.66 95% CI 1.80 to 3.93), frequent weight cycling (OR 1.45 CI: 1.03 to 2.04) and high school education or less (OR 2.21 95% CI 1.50 to 3.26). Factors that reduced risk were: current smokers (OR 0.41, 95% CI 0.17 to 0.96) and having the highest physical activity quartile (OR 0.62 95%CI 0.43 to 0.90).

6.11 Discussion

The evidence of effectiveness for interventions designed to manage weight gain in pregnancy by targeting both pregnant women and women planning a pregnancy is inconclusive. Two RCTs (Asbee *et al.,* 2009, Wolff *et al.,* 2008) and one NRS (Claesson *et al.,* 2007) found that the intervention was effective in reducing gestational weight gain. This finding was not, however replicated in three other RCTs (Guelinckx *et al.,* 2008, Hui *et al.,* 2006 and Polley *et al.,* 2002) or three NRS

(Kinnunen *et al.,* 2007, Gray-Donald *et al.,* 2000,and Olson *et al.,* 2004), where the intervention did not have a statistically significant effect upon gestational weight gain.

Conflicting trial results were also found for retained gestational weight gain and dietary and physical activity behaviour change and there was no conclusive evidence of effectiveness attributable to the interventions.

Four RCTs (Asbee *et al.,* 2009, Hui *et al.,* 2009, Polley *et al.,* 2002, and Wolff *et al.,*, 2008) did find that there was a combined significant reduction in caesarean section rates with fewer occurring in the intervention arm (RR 0.47 95% CI 0.26 to 0.84). This may also be influenced by greater contact with health professionals during pregnancy for women in the intervention group. It may also relate to increased levels of exercise amongst women in the intervention groups although the observational studies do not all support a link between increased physical activity in pregnancy and reduced chance of a caesarean delivery (Horns et al 1994). Infant birth weight, gestational age and incidence of macrosomia were not changed as result of the intervention.

Characteristics of participants; i.e. pre-pregnancy weight, ethnicity or socioeconomic status did not appear to influence the effectiveness of the intervention. Nor did they appear to be influenced by characteristics of the study including; setting, quality of study design and intensity of the intervention. The relatively small number of included studies with small sample sizes may indicate that there is, at present, insufficient evidence to demonstrate an effect on gestational weight gain or may indicate that there are substantial barriers in incorporating lifestyle changes sufficient to result in reducing gestational weight gain.

Associations between physical activity and or dietary behaviour patterns were explored by looking at fourteen included observational studies, non-intervention studies. Physical activity and its impact on pregnancy outcomes and infant birth weight were mixed. Greater levels of physical activity in pregnancy have been associated with reduced risks of having a caesarean delivery (Bungum *et al.,* 1999) but this may be confounded by characteristics of groups of women who exercise more than other groups of women. Another study did not find such an association (Horns *et al.,* 1994). High levels of physical activity (more than 5 times a week of intense exercise) increased the odds of giving birth of a low birth-weight infant. In

contrast women who continued to exercise during their third trimester were more likely to have longer and heavier babies than women who did not exercise during the third trimester of pregnancy. Women most likely to experience significant weight gain during pregnancy were most likely to be those with a history of restrained eating behaviours (Bergman *et al.,*1997). Advice and information provided to women was often not consistent with existing guidance (Cogswell *et al.,* 1999). There was no consistent evidence of any harmful effects of dietary interventions.

7 Qualitative Review

What are the views, perceptions and beliefs of health professionals, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy?

7.1 Quantity and quality of research available

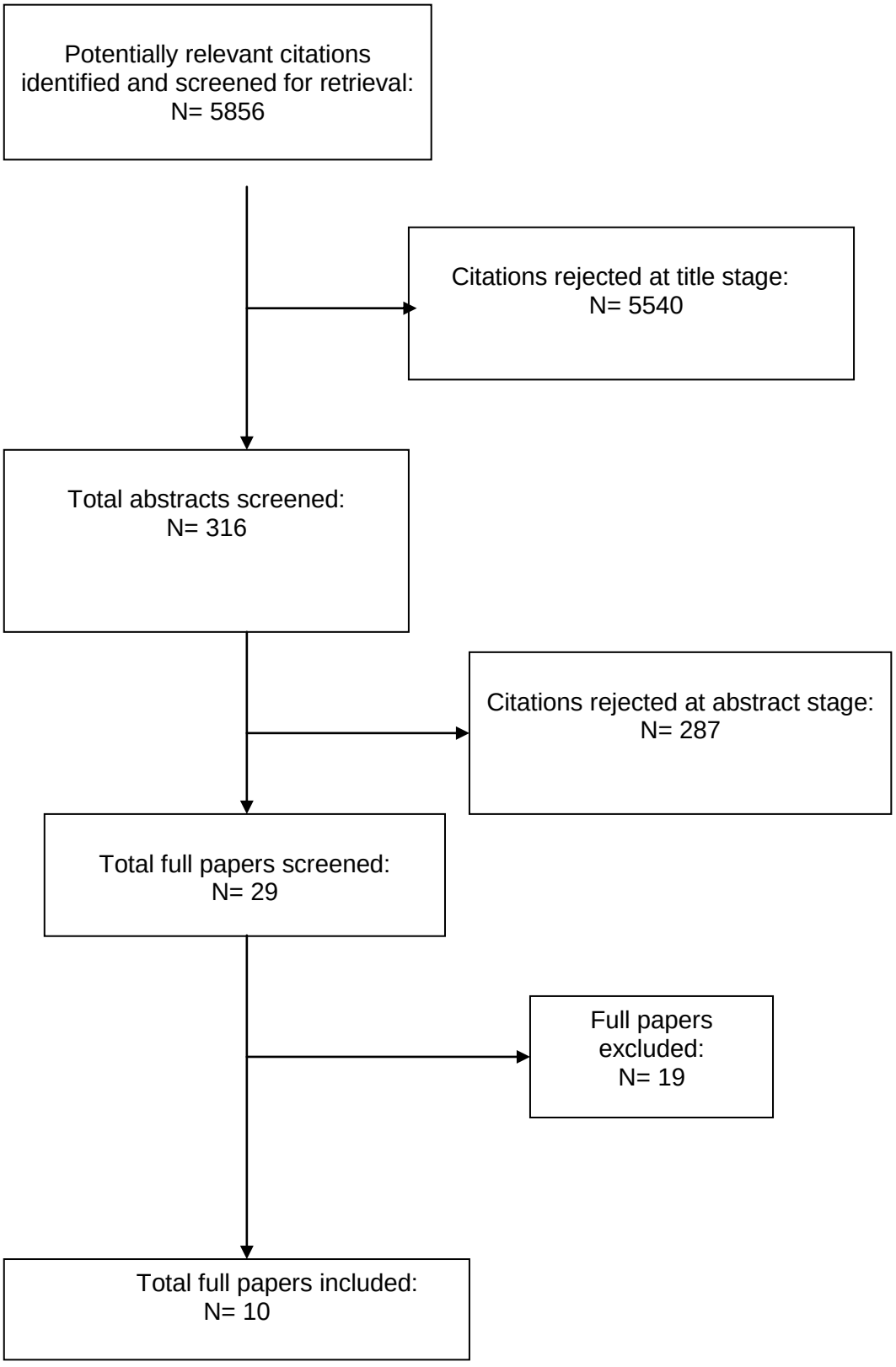
7.1.1 Quantity of available evidence

As a result of the searches undertaken to address the review question relating to the effectiveness, acceptability, accessibility and delivery of interventions that prevent weight gain, and their impact on effectiveness in managing weight in pregnant women, a total of 5856 citations were identified. Following removal of duplicates, and screening for inclusion (see Figure 14), 5540 were rejected at the title stage, yielding 316 abstracts for screening; 287 abstracts were rejected upon examination. In addition, papers that were included in the quantitative review of effectiveness were screened by FC and JM for content relevant to this question, though no such content was found that met the inclusion criteria.

Content pages of the journals 'Midwifery' and 'British Journal of Midwifery' were then examined in addition to database searches. 29 full papers were retrieved, and citation lists on retrieved papers were examined for potential papers. Hand-searching and citation list searches led to the inclusion of a further 2 UK studies. Full-text versions of potentially relevant non-UK studies were examined and excluded as they added no additional information and were less applicable to UK health delivery. The 19 full-text papers considered and excluded after close scrutiny are presented in Appendix 4, together with the justification for their exclusion. In all, 10 UK qualitative peer-reviewed published papers were included in the review of views, perceptions and beliefs, though 2 of these papers reported the same study and have therefore

been combined in terms of data extraction so as to include all reported relevant data from both papers but without duplication of data.

Figure 14: Flow chart of study inclusion and exclusion in review of factors affecting the acceptability, accessibility and delivery of interventions for weight management in pregnancy.



7.1.2 Quality of included research

For the review of views, perceptions and beliefs of health professionals, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy.

It was necessary to identify relevant qualitative studies and studies that contained qualitative information on views. Searches for this question identified a range of studies of varying quality that directly or indirectly included explorations of views, experiences and beliefs. Quality was assessed using the quality assessment tool for qualitative studies included in the NICE Methods Manual (National Institute for Health and Clinical Excellence 2006). This tool included 14 main quality assessment criteria specific to qualitative studies. Overall ratings were then given as follows:

++ All or most of the criteria have been fulfilled

+ Some of the criteria have been fulfilled

- Few or no criteria fulfilled

Priority was given to studies that were most relevant to the research question in order to best inform current UK practice. Ten relevant UK papers that reported on 9 studies were retrieved. This review excluded non-UK studies to optimise the relevance and applicability of included evidence, as well as feasibility of the review. Three of the studies included were of very good quality (++), 6 were of good quality (+), and 1 was deemed of poor quality (-) mainly because of lack of method detail but was included for its contribution to findings where better quality evidence was not available.

7.2 Critical review and synthesis of information

7.2.1 Key characteristics of included studies

A range of qualitative evidence was reviewed for factors that might influence implementation of interventions to manage weight gain in pregnancy. Heterogeneity in study design, whilst all qualitative, was moderately high, ranging from the use of open-ended questionnaires, through interviews, and focus groups. One study was supplemented with belief scales; though this method is based on quantitative measures it was not excluded from data extraction since the findings were closely related to the qualitative findings within the same study and the combination of these

methods enhanced interpretation. Failure to include this information would render the review incomplete (Dixon-Woods M et al. 2004). However the quantitative findings here are reported in narrative form to maintain the qualitative element of this part of the review. Analytic methods for qualitative data in the included studies ranged from thematic analysis to more in-depth Interpretative Phenomenological Analysis (IPA) and Foucauldian Discourse Analysis (FDA) techniques. Only one included study explored the views of health professionals. The remainder focused on views, beliefs and experiences of service users; in this case a fairly homogeneous population of women in differing stages of gestation, and in one study, retrospective accounts from women post-partum. Women studied differed in terms of age, weight status, gestational period, and in some cases ethnicity and socio-economic status, though studies varied considerably in their reporting of participant characteristics. Settings were also fairly homogeneous, most women being recruited from ante-natal clinics. One study evaluated an NHS-run educational class. Health professionals were recruited from general maternity settings, including community health. Geographical areas varied within the UK.

7.2.2 Analysis of findings from included studies

Qualitative data from each study included in this review was extracted and recorded as true to the script as possible to prevent misrepresentation. Details of the included studies and findings are described in evidence tables found in Appendix 2.6. Findings were scrutinised repeatedly to identify recurrent themes within statements and quotes from participants and author's interpretations of the data. As studies varied in design, context, and to some extent population characteristics, these factors were accounted for during analysis. It was important to keep the context in mind whilst attempting to look for commonalities across studies. There are several known but relatively new and evolving methods of synthesising qualitative evidence (Dixon-Woods M, Agarwal S, Young B, & Sutton A 2004). For this review an approach similar to thematic synthesis (Thomas J and Harden A 2008) was utilised. Findings from all the included studies are described separately in narrative form to maintain the integrity of each study and to place each study in relation to the others. Themes from the findings are then presented as further separate narratives that aggregate the findings under thematic headings. Themes are then explored for contradictory cases and contextual differences, which are discussed to include possible influences on the outcomes.

7.2.3 Reported Outcomes: Views, perceptions and beliefs of health professionals, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy.

Included studies either explicitly examined physical activity and/or eating behaviours during pregnancy, relating to a specified intervention or advice, or attitudes toward body size and body image issues. Information and advice from health professionals regarding optimal diet, physical exercise and weight management goals was found to be inconsistent in terms of accessibility and acceptability. Women also reported receiving vague and often conflicting messages. Women are accessing information from sources such as family, friends and the media which is also conflicting. Interventions for managing weight in pregnancy were facilitated, or might have been improved by attending to particular needs of women. Younger age and large weight status were especially salient in terms of perceived stigma as well as information requirements. Women's views on being weighed routinely varied in terms of acceptability, with some women feeling disempowered by negative assumptions of professionals. Perceived risk to mother and baby from insufficient diet or excessive physical activity was a particularly strong lay belief that influenced women's behaviours. Such beliefs could deter women from making lifestyle changes that might assist in managing their weight. Attitudes to weight, diet and physical exercise pre-pregnancy were important factors during pregnancy. Women's eating and physical activity behaviours may or may not continue into pregnancy for a variety of reasons, and attitudes may shift as pregnancy progresses.

7.3 Overall narrative summary of review findings by theme

Views, perceptions and beliefs of health professionals, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy.

7.3.1 Views, perceptions and beliefs of interventions aimed at weight management in pregnancy

Accessibility and acceptability of information and advice

Information and advice relating to weight management was reported to come from 3 main sources; health care professionals, family and friends, and the media. Evidence from the included studies suggests that access to adequate and relevant information and advice was somewhat ad-hoc. The following presents the issues that authors reported in relation to sources of advice.

Advice and information from health care professionals:
Evidence suggests that advice and information is not received or assimilated as consistently or regularly as might be expected. (Clarke PE and Gross H 2004) and (Gross H and Bee PE. 2004) reported that only 18% of their sample had received advice directly from health professionals involved in their care, and that advice was provided to the majority of these women during early clinic appointments, with frequency of provision declining over time. This was supported by Wiles in her study of overweight women (Wiles and Wiles 1998). Views of health professionals were included in only 2 of the included studies (Heslehurst *et al*., 2007b; Warriner, 2000), highlighting the lack of available evidence from this sector.

Women also reported that the information they received was often unclear, and that recommendations for optimal behaviour was confusing and contradictory. A large number of women read books and leaflets provided through the health service, though messages from these and even verbal information were reported as being vague:

"The books I've read have been very vague. They recommend swimming and yoga but little else. There's no black and white about what you should and shouldn't do so I don't, I can't follow it at all." (Clark & Gross; Gross & Bee 2004)

In the Heslehurst study, health professionals reported that the only dietary information provided to women was the NHS patient information booklet, and that this focuses on healthy and safe eating during pregnancy rather that weight management issues *per se.* This was supported by women interviewed in a study by Wiles (1998); 20 out of 37 reported that they had received any advice, and this was usually about nutrition and portion size. However, in the same study, women reported that they expected to gain weight should they act out recommended dietary behaviours such as consuming more protein.

Weight management was addressed in a less than consistent way. Professionals reported that women were often unaware of the potential effects of obesity during pregnancy (Heslehurst *et al*., 2007b). However, professionals were often embarrassed to initiate a discussion around weight management due to the perceived and real sensitivities of some women who are overweight or obese.

Professionals reported cases of women feeling victimised and consequently moving their care to another unit.

Feelings of victimisation were therefore seen as a potential threat to women and the future of their care. It is conceivable that a woman may miss important aspects of her antenatal care if she feels too uncomfortable to attend. Levy (1999) used a Grounded Theory approach to examine processes that women use when dealing with maternal health information. She found that women use information in a way to protect the interests of themselves, their baby and partner during this time of change. Whilst the study does not directly examine issues of weight management, this topic did arise among women's concerns. Self-protection may prevail in situations where women are faced with information that is unwanted due to its distressing nature. In order to protect, Levy (1999) posits that women avoided, delayed, or actively pursued information. It is therefore possible that despite attempts of health professionals to provide advice and information, some women may not have taken the opportunity to engage with this until later, or indeed at all.

In contrast, women may actively have pursued information relevant to their 'group', for instance those who have a BMI above 'normal' range. In the Wiles study (1998), women were all overweight, and considered that for this reason the information they received on weight management was not relevant as it recommended gains of no more than 12.5 kg, a possibly unrealistic aim for these women who considered themselves as special cases. In Levy's study, women also sought *personalised* information such as figures and requirements specific to their own case, with less than satisfactory results:

"It was vague, I felt, very vague. There doesn't seem to be an answer to it really, it's 'Oh, well, don't worry about that, the doctors won't worry about the weight…but I am still concerned about it" (Levy 1999)

(Warriner S 2000)) also found that women reported a lack of explanation for weighing practices, and feedback from those practices. One woman stated that being told that one's weight was 'fine' or 'perfect' was too vague to hold much meaning.

From the evidence it was clear that health professionals could appear either under or oversensitive to the concerns of women who may be embarrassed or concerned about their weight, with unsatisfactory consequences for women in terms of conveying important or relevant information.

Advice and information from family and friends:

Some women reported that most of the information and advice they received came from family and friends, particularly later into pregnancy. There was active discouragement of physical activity from these sources (Clarke & Gross; Gross & Bee 2004), and one participant reported how her mother was cooking more quantity of meat and larger portions for her now that she was pregnant (Wiles 1998).

Advice and information from the media:
In contrast, Johnson *et al.* describe how one woman recognised the pressure from media images to 'get back to normal' following pregnancy. (Johnson et al. 2004).

No UK evidence was found that directly assessed the impact of the media on weight management issues for pregnant women.

Accessibility and acceptability of interventions
In addition to issues that influence how women access information and advice, some studies explored the impact, accessibility, acceptability and delivery of dietary interventions as well as the acceptability of monitoring strategies such as regular weighing.

One study that specifically evaluated a nutritional intervention for pregnant teenagers found recruitment to be more difficult than expected (Symon and Wrieden 2003). Young women were reluctant to travel to other areas of their home town, despite travel expense re-imbursement, for fear of feeling like an 'outsider'. Attrition was mainly due to work and study commitments. However, some of those that continued to attend the practical sessions involving cooking healthy food seemed to benefit from increased knowledge and skills; many of the girls were novices in this regard. The sessions also provided a forum to meet other girls of the same age – older women might have 'judged' the age at which they had become pregnant – as well as to speak freely to midwives who were present about their pregnancy concerns.

In terms of weighing practices, the routine weighing of women appeared to be more apparent during clinics on NHS premises. Health professionals reported that the practice of weighing was more ad hoc in the community, where midwives had to rely on weighing equipment found in the home (Heslehurst.N et al. 2007b). Warriner (2000) found that women differed in their expectations, and in their expressions of acceptability of routine weighing. Concerns included lack of an attempt to obtain consent for what was often seen as an intervention, as well as lack of explanation for why weighing was taking place. Women reported feeling a lack of control in this respect, with one woman stating that it was like 'handing your body over to these people'. There was report of assumptions by health professionals that an intervention will happen regardless of women's preferences, and that this assumption was couched in language that trivialised the importance of such an assumption, such as use of the word 'just':

'…right, just pop on the scales…' (Warriner, 2000)

Routine weighing was reassuring for some women, and anxiety-provoking for others, with some women initiating unhealthy eating behaviours in order to gain or lose weight prior to antenatal visits.

Evidence from these studies suggests that information, monitoring and interventions need to take into account the specific requirements of those for whom they are intended. In two studies, teenagers and overweight women discussed issues that, if addressed, increased the acceptability of the intervention. There may be a need for mobile equipment to enable weighing, if this is acceptable to women, within the community.

7.3.2 Views, perceptions and beliefs of weight gain and weight gain management in pregnancy

Weight management requires balancing the intake of calories with levels of activity, therefore the main interventions and behaviours that might affect weight management during pregnancy are around diet and physical activity. In addition, monitoring of and attitudes toward weight may affect the way that women engage with weight management. The following examines these themes in relation to evidence from included qualitative studies.

Physical Activity

Gross and Bee (2004) explored the role of physical activity as a part of women's lives, and as a means of managing weight. There was a general decline in activity during pregnancy, even for women who regularly took part in exercise and sport prior to becoming pregnant, though these women were more likely to continue being active at some level. None of the women reported increasing their activities. Certain risks and dangers were associated with physical activity that might affect them, such as injuries, whilst none of the participants discussed potential benefits. From 16 weeks gestation, rest was considered to be more important than exercise; in addition, responses on the FHLC scale[11] were associated with levels of activity, leading the authors to suggest that women were also concerned about the effects of physical exercise on their unborn babies. Feared consequences were effects on the baby's physical development, potential miscarriage, and premature birth. The authors highlight the fact that negative attitudes toward exercise during pregnancy contrast with those generally held by the rest of the population. This may be one reason that women reported receiving contradictory advice about optimal activity levels.

Women who were more motivated to continue being physically active reported difficulties. Lack of available classes at suitable times, lack of outside facilities, and the unwillingness of trainers to encourage women to exercise due to insufficient insurance cover were cited as reasons for reduction in activity. Women were also discouraged from carrying out usual daily tasks by people around them, resulting in potential resentment or, for some, relief. However, women are also discouraged from physical activity by their own sense of impairment. Feeling uncomfortable and restricted, with tasks taking up more time or becoming impossible as women's movements necessarily slowed down could be a source of loss (Johnson, Burrows, & Williamson 2004), frustration, boredom and lack of motivation For others, pregnancy was an excuse to take it easy, to opt out of tasks that they disliked (Gross H & Bee PE. 2004).

Limited but good quality UK evidence suggests that physical activity during pregnancy generally declines due to increased physical size and therefore restraint, contradictory influences and advice from others, fear of risk to self and unborn baby,

[1] The fetal health locus of control (FHLC) scale is an 18-item instrument used to measure expectancies regarding locus of control for maternal health behaviour. The FHLC is used to facilitate predictions of factors that could contribute to compliance with health-related recommendations during pregnancy.

lack of facilities, and lack of motivation. Such reduction could lead to excessive weight gain as well as a reduction in general physical, social and psychological well-being. In addition, the design of interventions that encourage physical activity would need to take into account the barriers that might prevent women from participating, as well as the facilitators that might encourage participation.

Diet

In addition to changes in levels of physical exercise, women also reported changes in eating habits during pregnancy. Hunger increased for some women and decreased for others in a study by Fairburn (1990), feelings of fullness were common toward the end of pregnancy. Most women reported an increased intake of food during pregnancy than before they became pregnant. Reasons for the increase include relief of nausea, eating 'little and often' to prevent feeling over-full, and the belief that eating more is beneficial for the baby.

Women also reported cravings, and 11 women in this study stated that they had experienced episodes of over-eating to relieve hunger, negative mood, or in response to abandonment of previous dietary restraint. Several of these women gained over 20kg during pregnancy. There were varied responses to their weight gain from feeling unconcerned to fears that they may not be able to lose the weight they had gained. Over half of the women had dieted prior to pregnancy; these women showed more concern about their shape and weight during pregnancy and about regaining their previous weight following pregnancy.

There was also evidence of ambivalence toward eating behaviour; some women in the study by Wiles (1998) realised that over-eating could lead to weight gain that might remain following pregnancy, but also legitimated their eating habits because pregnancy is a temporary state. There was a balance to be maintained between eating enough to provide adequate nutrition for the baby and not eating so much as to gain excessive weight:

"I asked him [her GP] about calories, like how many should I have through the day, so that I didn't have any less than I should but at the same time that I didn't put on too much weight" (Wiles 1998)

Some women reported that they had been advised to eat more foods such as milk and cheese that they previously would have restricted due to the fat content. However, they put the nutritional requirements of their unborn baby first. Women varied in how much control they felt in achieving an appropriate balance.

Pregnant teenagers in two Scottish cities that had participated in a nutritional intervention aiming to encourage healthy eating had little previous experience of cooking or knowledge about nutrition (Symon & Wrieden 2003). One girl reported that in addition, her varying appetite during pregnancy was a barrier to cooking. The girls generally had little faith in their cooking abilities as well as a low motivation to cook, since it was so easy to microwave a ready meal instead. The intervention increased knowledge, skills and confidence to cook and encouragement to eat healthily for a few of the girls that participated in the scheme; others did not change their habits significantly, or stuck to one new recipe that they had learnt. Facilitators that were included in the intervention in terms of diet were the ability to take food home that had been prepared free of charge, and the simplicity of the recipes chosen for the sessions and accompanying booklet.

Included studies highlighted the emphasis of healthy eating in dietary advice given to pregnant women. This is understandable since healthy eating would logically result in weight management as well as nutritional well-being for both mother and baby, and weight, as already discussed, was often a sensitive topic. In addition, women require that their weight be managed rather than reduced during pregnancy. However, women were reported to lack knowledge about how much and of which foods to consume, and advice was often not related to weight management.

There was a parallel between physical activity and dietary issues in that women were attempting to maintain a balance between their own weight management and the safety and needs of their unborn child. In addition, women at certain stages of pregnancy were facing barriers to carrying out physical activity and dietary advice. Constraints to physical exercise in later stages included increased body size and tiredness, whilst changes in appetite, feelings of fullness and nausea affected eating behaviours.

In these respects, women were often behaving differently from their pre-pregnancy state, and so pregnancy may be regarded as a temporary and unique situation in terms of addressing weight. This theme is expanded upon in the next section, which identifies evidence related to attitudes toward weight, weight management, body size and bodily changes during pregnancy.

Weight and body image

A major theme found in the evidence reviewed was attitude to the changes in body size and shape that pregnancy conferred on the women interviewed. To a great extent these attitudes were subject to individual context, but were related to women's weight, attitudes to body size and drive to maintain weight prior to pregnancy. Women who reported no change in body image perceptions during pregnancy generally had positive body images, and a lack of concern with weight prior to conception.

In contrast, negative attitudes to body change were mainly reported by women of normal weight, who perceived their new pregnant shape as less physically attractive, uncontrollable, attention-provoking, and limiting in respect to certain activities (Fox and Yamaguchi 1997). Johnson *et al.* (2004) described this construction as 'transgressing the dominant ideals of feminine beauty', that is, slender. Women in their sample used negative language such as 'fat', 'frumpy', 'bloated' to describe their pregnant state.

Some overweight women who felt stigmatised by their size prior to pregnancy, experienced feelings of increased stigma or embarrassment whilst pregnant (Fox & Yamaguchi 1997; Heslehurst *et al.,* 2007b). In one study, all the women interviewed were overweight; they varied in the extent of control felt over managing their weight (Wiles 1998). Some women in this study saw pregnancy as transient though with the prospect of having to face the challenge of losing weight after the birth. Others actively monitored their weight and dietary intake in order to support their pregnancy but not to gain excess weight. Some however reported feeling that they had little control over their weight gain whether they were pregnant or not, that they had a weight problem, and that weight gain was inevitable and even desirable during pregnancy.

Women in some studies reported that significant others such as family, and health professionals implied that they were fat (Johnson *et al.,* 2004; Warriner 2000; Wiles 1998) and not attempting to exert as much control as they might over their weight. These remarks resulted in feelings of disillusionment or were resisted by legitimating weight gain due to being pregnant.

Positive attitudes to bodily change were mainly experienced by overweight women (Fox & Yamaguchi 1997) who felt the relief from stigma and the pressure to diet. Pregnancy was seen as an excuse to be large, as socially acceptable and therefore conferring a sense of confidence that had been lacking in their non-pregnant state. One woman described feeling special and less self-conscious, that others would see her pregnant stomach rather than her overweight. Health professionals reported that a significant number of mainly younger women did not have an issue with their overweight, which for them was seen as normal (Heslehurst *et al*., 2007b).

A minority of women of average weight also reported positive attitudes to bodily change, particularly if pregnancy increased the body shape to more rounded, shapely proportions (Fox & Yamaguchi 1997); (Johnson, Burrows, & Williamson 2004); (Fairburn 1990) than before. Johnson *et al.* describe how, in addition to slenderness, having large breasts is portrayed as sexually attractive in our culture. They suggest that smaller women may have a positive attitude to bodily change if pregnancy leads to breast enlargement, and women feel more attractive because of this. They also point out that the extent of bodily satisfaction during pregnancy is not a static entity; rather it is a shifting and dynamic experience over time, depending on stage of gestation and limitations to usual behaviour such as sex, physical activity and expression through clothing.

There is evidence that weight and body shape concerns are affected by size prior to pregnancy, and more importantly, the way that women perceive their usual and changed shape in respect to their own and other's ideals. Implications from this evidence relate to the way that size is referred to and experienced. Whilst media figures such as 'Posh Spice' were alluded to in one included study, no UK published papers were found that specifically addressed media coverage or influence. One Australian paper was retrieved (Handfield 1996) but excluded because it was non-UK, dated, and was mostly concerned with aspects of pregnancy other than weight

management. It did however include one passage from a magazine that implied weight gain to be a natural occurrence, ('programmed'), particularly in the hip and thigh area.

7.3.3 Pregnancy as transitional, transgressional and transient

Views and interpretations from several of the included studies signify pregnancy as transitional. Becoming pregnant could incur changes in lifestyle behaviour (Clarke & Gross; Gross & Bee; Fairburn & Welch; Wiles) concern with weight (Fairburn & Welch; Wiles) as well as perceptions of body image and status (Fox & Yamaguchi; Fairburn & Welch; Johnson *et al.;* Wiles). Transitional experiences varied between women depending on pre-pregnancy perceptions and behaviour, and outside influences.

Johnson *et al.* interpret the transition as also a transgression, from the emphasis on ideal femininity as aesthetic to that of reproductive. In other words, women may, for a period of time, disregard perceived pressure to appear slim and beautiful, and instead emphasise their new status of mother-to-be, with an associated and acceptable lapse in weight concern.

That pregnancy is a transient occurrence is subjectively described by women in their desire to get 'back to normal' following pregnancy (Johnson *et al.;* Warriner; Wiles). This desire is often accompanied by fear that regaining one's former size and shape might not be a simple task. Women varied in their sense of control over weight management generally, with the post-partum period often being seen as a particular challenge.

7.4 Narrative synthesis of review findings presented by study subgroups

Views and experiences of professionals

Only one included study explored the views of health professionals (Heslehurst 2007b); these were around the impact of obesity on UK maternity services. The main relevant points here were the ad-hoc provision of dietary information and its lack of integration with weight management advice. In addition, women and staff could be embarrassed to discuss weight issues, creating a barrier for potential helpful intervention.

Views and experiences of women

Age

Most of the studies included pregnant women of any child-bearing age. Within these, age did not appear to be a factor in the findings. One study focussed on teenagers and highlights that this group require special attention to issues such as judgemental attitudes, and when developing interventions their needs might include location, costs, social interaction, and the presence of health professionals in an informal setting.

Weight status

Some of the studies paid particular attention to the weight status of participants. One study included only women of above average weight (Wiles 1998), and found that this group felt that their needs were not catered for in terms of relevant information on weight management. The study highlighted how women of above average weight differ in their feelings of control over their weight. Another study compared that body image change in overweight women with women of average weight, discussed how pregnancy increased or decreased feelings of satisfaction with the body, and how this related to weight status (Fox & Yamaguchi 1997). Positive effects of pregnancy on body image were legitimation of large size and increased shapeliness of smaller bodies, both of which increased women's confidence. Negative effects were continuation of stigma over their large size, and losing a trim figure.

Parity

Five of the studies were carried out with women expecting their first child and/or experiencing their first pregnancy. The remaining studies that sampled service users used mixed samples or did not specify parity. None of the studies discussed parity in relation to the findings.

Gestation Period

One study highlighted that attitudes toward bodily changes were dynamic and shifted with time through pregnancy (Johnson *et al.,* 2004). For example, initial excitement could turn to distress at losing one's figure, and then change to satifsfaction with a more obviously pregnant shape.

Ethnicity

One study that compared bodily changes in women of average and overweight stated that in contrast to some studies that found black American women to be more satisfied with a heavier body size, their sample did not show such effects (Fox & Yamaguchi 1997). Rather, the 22% of the sample that stated their ethnic origin as black were just as likely as white participants to experience a positive change during pregnancy if they were overweight and a negative change if they were of average weight.

None of the remaining included studies discussed findings in relation to ethnicity.

Socio-economic status (SES).

One study evaluated a nutritional education intervention for low-income pregnant teenagers (Symon & Wrieden 2003), finding that allowing the women to take the prepared food home free of charge was an incentive to participating in the intervention. However, providing travel costs did not appear to affect recruitment.

Despite some of the remaining included papers specifying the SES characteristics of the sample, this aspect was not discussed in the findings.

7.5 Additional background information

It is possible that some of the evidence described above is now dated, and that issues reported by participants have since been addressed, or that attitudes have altered with time. Exploration of current available written information to women draws attention to 'The Pregnancy Book' (DH 2007), which is available free to first time parents in the UK. 'Eating healthily' is one of the main health promotion messages. In terms of weight management, women are advised to limit their intake of foods with a high fat content. Typical weight gain during pregnancy is stated as 10 – 12.5kg, with variations according to pre-pregnancy weight. Reported risks of excessive weight gain include increased blood pressure, though the authors of the booklet advise against attempting to diet. Women are advised to contact a health professional should they be concerned about their weight.

In terms of physical activity, women are encouraged to remain active and fit in order to cope with labour as well as helping to get back into shape after the birth. Normal daily activity such as walking, dancing and sport are encouraged for as long as the woman feels comfortable. Women are discouraged from exhausting themselves, and are informed that they may need to slow down as pregnancy progresses. Sudden onset of atypical strenuous exercise is not advised during this time; rather, women are encouraged to partake in regular activity, drink sufficient fluids, and if exercise is strenuous or new, to make sure that instructors are properly qualified. A section on exercises that women can carry out as part of their daily routine is included, though these are mainly aimed at strengthening muscles and joints as well as improving circulation.

The Food Standards Agency publishes leaflets, including 'Eating while you are pregnant', and the web-site also offers nutritional advice that summarises the advice given in 'The Pregnancy Book'. (DH 2007) With reference to the findings that 2 women claimed to have attended weightwatchers whilst pregnant (Warriner 2000), exploration of the current 'Weightwatchers UK' website (accessed 25.05.09) shows that this organisation actively disallows women from continuing to be members once pregnant. However, some companies may allow women who are pregnant to enter into weight management research trials

Gross and Pattison (2007) provide potential explanations as to why women may not receive advice, or deny that they have received advice in their book "Sanctioning Pregnancy". They state that if advice does not fit lay health models, they are less likely to be taken up:

"…the form and content of the advice, the language used and directions for how to act on the advice have to be understood and integrated into what the woman knows and believes" (p.89)

They maintain that women who are most likely to seek out advice are better educated and of higher socio-economic status. Such women are also the most likely to attend regular ante-natal sessions, implying that those most needing advice are less likely to attend and therefore are less accessible to the advice that midwives

have to offer. In addition, the authors state that women who are overweight report that they have been given advice to heed to weight gain limits that exceed the IOM (1990) recommended 11.4 – 15.9kg. One explanation for this is that reported behaviour fits with reported advice, i.e., women sanction their behaviour by appealing to official advice that is consistent with that behaviour.

As has already been highlighted, health professional views and beliefs were lacking in the available UK qualitative evidence, pointing to a gap in research in this area. Results from a UK quantitative survey of 435 currently practicing midwives carried out by Ellison and Holliday (1997) showed wide variation in attitudes to maternal weighing dependent on setting, as well as the age and educational attainment of practitioners. Midwives who were younger and had more advanced qualifications were more sceptical of routine weighing, and those working in community and integrated practices were more aware of the imprecision of weight measurements.

An unpublished local UK study (Edmonds *et al.,* 2008) reported the findings of one focus group (7-10 participants) and face-to-face interviews with two practitioners working with pregnant women, as well as focus groups with 2 groups of pregnant women (5-8 in each group). Findings highlight discrepancies between the views of professionals, who maintain that advice and services have been provided, and women, who maintained that advice and services were limited. Findings are difficult to report here in detail due to the lack of detail in the report (i.e. the views of practitioners regarding barriers to women eating a healthy diet do not distinguish between pregnant and post-partum women).

7.6 Discussion

Ten qualitative papers of varied quality have been identified as relevant for this key question. Two of the papers reported the same study, therefore nine studies were reviewed. All nine studies were carried out in the UK, therefore applicability is high. However, the studies varied in year of publication and it is possible that new research carried out at the present time would provide evidence that differs from that reviewed.

In addition, evidence here is not presented as comprehensive in terms of covering all possible issues; further UK research is required for this. In particular, there was a gap

in the literature pertaining to the views of health professionals. Also, despite comments made by authors relating to media influence, no UK studies were found that addressed this issue. However the review presents UK evidence available at a point in time and therefore provides an insight into the issues that affect women and health professionals in this country engaged in managing weight during pregnancy.

The studies suggest that pregnancy is a time when women experience changes in their attitudes toward their bodies as the body changes over time. Changes can vary from positive to negative and can change across the duration of pregnancy, but tend to favour larger women due to perceived relaxation of prior pressure to diet, and stigma. Health professionals can be too? sensitive or insensitive to women's body experiences regarding weight that they do not communicate health messages appropriately.

Interventions for managing weight in pregnancy therefore are facilitated by taking account of the needs of women who vary in their attitude to weight, diet and physical exercise. The needs of overweight women and younger girls are particularly pertinent. Information and advice from health professionals regarding optimal diet, physical exercise and weight management goals is inconsistent in accessibility and acceptability, as well as vague and often conflicting messages. Women are accessing information from other sources which is also conflicting and often unhelpful in terms of managing weight in a healthy manner.

Carrying out advice on diet and physical activity is limited by physical and psychological effects of a developing pregnancy, as well as lack of knowledge, resources and facilities. Any interventions that are developed to meet the weight management needs of pregnant women would be helped by addressing the specific requirements of women of different ages and circumstances experiencing pregnancy, overweight and a range of bodily experiences associated with these phenomena.

8. Synthesis of qualitative and quantitative evidence

To what extent do interventions address the factors that influence gestational weight gain – a synthesis of the qualitative and quantitative systematic reviews

Table 7: Synthesis Matrix

Views on factors that influence weight management in pregnancy	Interventions
Diet and Exercise - factors external to the individual	
Access to adequate and relevant information and advice was somewhat ad-hoc. Information from health professionals was often vague or contradictory	All of the intervention studies except Kardel & Kase (1997) addressed this factor by delivering interventions that provided clear and consistent advice to pregnant women often using different methods to reinforce health messages.
Women accessed information and advice relating to weight management from 3 main sources; health care professionals, family and friends, and the media	None of the studies sought to influence the other sources of information that influence women's behaviour in pregnancy. Nor did they describe methods of supporting women who may be hearing conflicting messages from differing sources.
There were practical barriers to exercise with women finding that gyms did not encourage participation by pregnant women.	The focus of the interventions was at the level of the individual and did not seek to influence beliefs regarding pregnancy and the need to maintain exercise as a part of effective weight management in pregnancy in the wider community
A lack of exercise provision actually targeting pregnant women with midwifery support	Four studies offered exercise classes as part of the intervention (Hui *et al.,* 2006, Kinnunen *et al.,* 2007, Claaesson 2007, and Gray Donald 2000).
Diet and exercise factors specific to the individual	
Appetites and food preferences were disrupted in pregnancy	Apart from Guelinckx *et al.,* (2008) all of the interventions offered tailored advice which may have incorporated women's preferences
For some who were already overweight before pregnancy, pregnancy was a time when they felt it was legitimate to be overweight and their self esteem was higher as a result.	Individually targeted interventions will not challenge the cultural values surrounding body shape, though they may assist women in making informed choices and in resisting unhelpful discourses.
Women's attitudes and behaviours in relation to diet and physical activity during pregnancy are associated with – pre-pregnancy attitudes and behaviour to diet and exercise	Only one case report described an intervention for overweight women trying to get pregnant (Galletly *et al.,.,.* 1996). All of the other interventions specifically targeted interventions during pregnancy.
For some women pregnancy is a time when women feel it is legitimate to relax on self-imposed dietary limitations and weight gain can be dealt with later.	This was not reported in the interventions described.
For some women weight gain in pregnancy is regarded as a norm and excessive weight gain can be addressed once they are no longer pregnant.	Use of regular monitoring of weight and plotting of weight on graphs combined with stepped care would challenge this view

Women's experiences of and attitudes to body image fluctuate during pregnancy.	It may be difficult to map the timing of interventions effectively onto the fluctuating subjectivities of pregnant women.
Conflicting lay beliefs A perception that eating was a way of protecting the baby and a woman should be 'eating for two'	The interventions will have addressed the mothers lay beliefs but not the beliefs of important significant others who will give conflicting messages.
There were many barriers to exercise in pregnancy including physical discomfort experienced by women, important lay messages about the need for rest and pregnancy offering a legitimate reason for not being active. Perceived risks associated with exercise might be appropriate (facilitator) or inappropriate (barrier) compared to guidance.	The barriers to exercise were only partially addressed by the interventions. They conveyed messages about the safety of exercise in pregnancy and some offered classes for women to attend.

A further synthesis of both the qualitative and quantitative evidence reveals areas of divergence, i.e. factors that have been shown to be important in influencing maternal weight gain but are not addressed by the interventions. These include other sources of information and strong lay beliefs surrounding diet and exercise in pregnancy which offer quite conflicting advice to that given by health professionals. Pregnancy may also represent a brief period when women feel it is legitimate to be overweight and can relax dietary restrictions. Significant barriers were identified that prevent women exercising that are both attitudinal and practical. There were also areas of convergence, i.e. areas where factors that influence maternal weight gain were addressed by the interventions, such as poor or contradictory information delivered by health professionals. The interventions did address this by delivering clear and often tailored guidance.

The pattern of convergence and divergence between the interventions and the factors identified in the qualitative studies may explain the mixed results seen in the outcomes of the interventions studies. No clear pattern of effectiveness emerged and this would suggest that other important factors are influencing maternal weight gain in pregnancies which are not being sufficiently addressed in the interventions reviewed here.

9. Discussion

This systematic review of quantitative evidence, drawing on randomised controlled trials, non-randomised studies, case series, systematic reviews and observational studies found that there is insufficient evidence to determine whether there are dietary and/or physical activity interventions can moderate gestational weight gain in pregnant women. The evidence is mixed and weak with inconsistent findings between studies describing similar interventions. None of the intervention studies were conducted in the UK and their findings may not be applicable to the UK context. Most of the interventions combined tailored dietary and exercise advice given in a range of formats such as verbal and written, delivered by a specially trained professional. Weighing and monitoring was also done to reinforce health messages and tailor the advice. The effect of the intervention on longer term retention of weight gained in pregnancy was poorly reported and only one study (Olson *et al.,* 2004) followed women up for one year. The effect of the intervention on this outcome was also mixed. Only two studies (Kinnunen *et al.,* 2007, Gray-Donald *et al.,* 2000) measured changes in exercise and there was no change found with the intervention. There did not appear to be any effect of the interventions on the incidence of macrosomia (infant weighing over 4000 g), infant birth weight or number of weeks gestation. There did appear to be fewer caesarean deliveries amongst women who were in the intervention groups however this evidence was also mixed with contradictory findings in the non-randomised studies. Although there was a trend of decreased incidence of gestational diabetes as a result of the interventions this change was not statistically significant and may reflect the lack of effect in preventing excessive gestational weight gain in the study population.

Ten qualitative papers of varied quality have been identified as relevant for this key question. Two of the papers reported the same study, therefore nine studies were reviewed. All nine studies were carried out in the UK, therefore applicability is high. However, the studies varied in year of publication and it is possible that new research carried out at the present time would provide evidence that differs from that reviewed.

The studies suggest that pregnancy is a time when women experience changes in their attitudes toward their bodies as the body changes over time. Changes can vary from positive to negative and can change across the duration of pregnancy, but tend to favour larger women due to perceived relaxation of prior pressure to diet, and

stigma. Health professionals can be so sensitive or insensitive to women's body experiences regarding weight that they do not communicate health messages appropriately.

Interventions for managing weight in pregnancy therefore are facilitated by attending to the needs of women who vary in their attitude to weight, diet and physical exercise. The needs of overweight women and younger girls are particularly pertinent. Information and advice from health professionals regarding optimal diet, physical exercise and weight management goals is inconsistent in accessibility and acceptability, as well as vague and often conflicting messages. Women are accessing information from other sources which is also conflicting and often unhelpful in terms of managing weight in a healthy manner.

Carrying out advice on diet and physical activity is limited by physical and psychological effects of a developing pregnancy, as well as lack of knowledge, resources and facilities. Any interventions that are developed to meet the weight management needs of pregnant women are facilitated by addressing the specific requirements of women of different ages and circumstances experiencing pregnancy, overweight and a range of bodily experiences associated with these phenomena.

A further analysis of the quantitative and qualitative evidence demonstrates that there are areas that impact on gestational weight gain that the interventions do not address. These gaps may account for the mixed pattern of effectiveness between studies seen in this review. They also highlight areas for potential development of interventions and additional research. Interventions that tackle the beliefs and attitudes of the wider community may be appropriate in ensuring women are not receiving mixed messages while pregnant. Interventions to increase exercise and healthy eating prior to women becoming pregnant may be better received by those that intervene when women are pregnant. Interventions that tackle the practical barriers women face to exercise when pregnant such as lack of access to gyms should also be evaluated

Evidence here is not presented as comprehensive in terms of covering all possible issues, for example further UK research is required to extend the evidence base concerning health professional views, as well as women's satisfaction with interventions.. However the review presents available UK evidence and therefore

provides an insight into the issues that affect women and health professionals in this country engaged in managing weight during pregnancy.

Weakness of the review

We limited our inclusion criteria to English language reports which may have resulted in bias, although a comprehensive recent study (Egger et al. 2003) has shown that non-English language studies tend to show larger treatment effects and to be of lower methodological quality. The evidence is derived from a very small sample of studies with only five randomised controlled trials and only one was considered to be at low risk of bias. It is also notable that none of the intervention studies were conducted in the UK and therefore their applicability to a UK setting must be considered. The evidence base is therefore weak and should be viewed cautiously.

10. Evidence statements

What types of dietary interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?

What types of physical activity interventions are most effective and cost effective for weight management in women planning a pregnancy? Do they have any adverse effects?

Evidence statement 1

There is weak evidence from one Australian based case series (Galletly *et al.,* 1996) that obese women trying to become pregnant but experiencing infertility can achieve a statistically significant reduction in BMI through a programme that includes regular physical activity, advice about healthy eating and group support.

- **What types of dietary interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?**
- **What types of physical activity interventions are most effective and cost effective for weight management in pregnancy? Do they have any adverse effects?**

Evidence statement 2

There is inconsistent and inconclusive evidence from five randomised controlled trials (RCTs) (Asbee *et al.,* 2009 [+], Guelinckx *et al.,* 2008 [u, abstract only], Wolff *et al.,* 2008 [-], Hui *et al.,* 2006 [-], Polley *et al.,* 2002[-]) and five non randomised studies (NRS) (Claesson *et al.,* 2007 [+], Kinnunen *et al.,* 2007[+], Gray-Donald *et al.,* 2000 [-], Olson *et al.,* 2004 [-], Kardel *et al.,* 1998 [-]) on the effectiveness of dietary and/or physical activity interventions on weight gain in pregnancy.

Three studies; conducted in the US (Asbee *et al.,* 2009 [+]), Denmark (Wolff *et al.,* 2008 [-]) and Sweden (Claesson 2007 [+]), among women who were overweight or obese, reported that gestational weight gain was 2.6 kg to 6.7 kg less for women in the intervention group compared to the control. One USA based study among overweight women (Olson *et al.,* 2004 [+]) reported a non-significant positive effect on gestational weight gain in the intervention group compared to control and one Canadian study (Hui *et al.,* 2006 [-]) of women with a healthy pre-pregnancy BMI reported no difference in gestational weight gain between intervention or control. Two studies among women with a healthy BMI (Kinnunen *et al.,* 2007 [+], Polley *et al.,* 2002 [-]), based in Finland and the USA respectively and one study among women who were obese (Guelinckx *et al.,* 2008 [u]) based in Belgium, reported greater gestational weight gain in the intervention group but the difference was not significant. One Canadian study among obese Cree women (Gray Donald *et al.,* 2000 [u]) found no evidence of an effect on gestational weight gain.

Evidence statement 3

There is weak evidence from 2 USA based and 1 Canadian RCT (Asbee *et al.,* 2009 [+], Polley *et al.,* 2002 [-], Hui *et al.,* 2006 [-]) that interventions targeted at healthy weight (Polley *et al.,* 2002 and Hui *et al.,* 2006) or overweight (Asbee *et al.,* 2009) pregnant women, encouraging a healthy diet and increased or regular physical activity, supported by weight monitoring, reduces the proportion of women exceeding Institute of Medicine (1990) guidelines for healthy weight gain in pregnancy.

Evidence statement 4

There is weak evidence from two studies (Wolff *et al.,* 2008 [-] and Claesson *et al.,* 2007 [+]), conducted in Denmark and the USA amongst obese women that interventions promoting healthy eating and/or moderate physical activity leads to a reduction in weight retained post partum when compared with controls.

Evidence statement 5

There is inconsistent evidence from three RCTs conducted in the USA, Canada and Denmark (Asbee *et al.,* 2009 [+], Hui *et al.,* 2006[-], Wolff *et al.,* 2008[-]) and three NRS conducted in Sweden, in a Cree community in Canada and in Norway (Claesson *et al.,* 2007[+], Gray-Donald *et al.,* 2000[-], Kardel 1998[-]) that women receiving diet and/or physical activity interventions have a reduced risk of a caesarean section delivery. The studies did not differ by pre-pregnancy BMI.

Evidence from two observational studies is also inconsistent. (Bungum *et al.,* (1999 [+] conducted in Germany) found that more active women were less likely to have a caesarean delivery compared to women described as sedentary, whereas Horns *et al.,* (1994 [+] conducted in the USA) found no association between physical activity and risk of a caesarean delivery.

Evidence statement 6

Three RCTs conducted in the USA, Denmark, and Canada (Polley *et al.,* 2002 [-], Wolff *et al.,* 2008 [-], Hui *et al.,* 2006 [-]) and 2 NRS conducted in Finland and in a Cree community in Canada (Kinnunen *et al.,* 2007 [+] and Gray Donaldson *et al.,* 2000 [-]) found no evidence to suggest that interventions among women who are a healthy weight (Hui *et al.,* 2006, Polley *et al.,* 2002) or obese (Wolff *et al.,* 2008), focusing on healthy eating and moderate physical activity, adversely affect infant outcomes including birth weight, gestational age at birth, and the incidence of macrosomia. They were however not adequately powered to measure important adverse outcomes and so the evidence is insufficient to establish whether these interventions have adverse effects.

Evidence statement 7

There were no reported adverse effects associated with moderate physical activity and /or dieting during pregnancy. The evidence base is not sufficient to establish whether these interventions have no adverse effects.

What internal factors influence the effectiveness, of the intervention (such as age, socio-economic status, ethnicity, medical history, physical activity, attempts at weight management, weight at onset of pregnancy, number of previous pregnancies, and BMI at start of pregnancy)?

Evidence statement 8

There is inconsistent evidence from five RCT's (Asbee *et al.,* 2009 [+], Hui *et al.,* 2006 [-], Guelinckx 2008 [u], Polley *et al.,* 2002 [-], Wolff *et al.,* 2008 [-]) and from four NRS (Claesson *et al.,* 2007 [+], Gray-Donald *et al.,* 2000 [-], Olson *et al.,* 2004 [+], and Kinnunen *et al.,* 2007 [+], that women with a pre-pregnancy BMI over 30 kg/m^2 (obese) gain less gestational weight in response to diet and physical activity interventions than women who are of a healthy weight or who are overweight.

Evidence statement 9

There is insufficient evidence to conclude that diet and physical activity interventions are more, or less, effective in more socially disadvantaged pregnant women.

Evidence statement 10

There is insufficient evidence to comment on the impact of ethnic group on intervention effectiveness.

Evidence statement 11

There is evidence from two US based observational studies (Olson and Strawderman 2003 [++] and Gunderson *et al.,* 2004 (++) that women (including overweight women (Gunderson *et al.,* 2004 (++)) who decreased physical activity in pregnancy experienced significantly greater gestational weight gain. Higher physical activity levels were associated with reduced weight gain.

Evidence statement 12

There is evidence from one US based observational study (Gunderson *et al.,* 2004 [++) that overweight women who consumed three or more servings of fruit and vegetables per day gained significantly less weight than those who consumed fewer servings during pregnancy.

Evidence statement 13

There is evidence from two US based (Gunderson *et al.,* 2004 [++], Mumford *et al.,* 2008 [+]) and one UK based observational studies, (Conway *et al.,* 1999 [+]) that

women across the BMI spectrum with a history of dieting and restrained eating behaviours showed a greater association with excessive gestational weight gain. Further evidence from Gunderson *et al.,* 2004 [++)] suggests that other factors associated with excessive gestational weight gain include black race, never smokers, and high school education or less.

Evidence statement 14

There is evidence from one US based observational study (Cogswell *et al.,* 1999 [+]) that not receiving advice regarding appropriate weight gain was associated with weight gain outside the recommended levels among women across the BMI spectrum.

What external factors influence the effectiveness of the intervention (such as content, delivery, setting, who is delivering the intervention, intensity, duration and target setting)?

Evidence statement 15

UK based qualitative evidence (Symon & Wrieden 2003 [+]) suggests that the development and attendance in dietary interventions for young women may be facilitated by taking into account women's age, social, educational and psychological needs as well as provision of incentives such as free food and access to a midwife.

What are the most effective and cost-effective ways of measuring and monitoring weight gain in pregnancy? Are there any adverse effects?

Evidence statement 16

One UK based qualitative study (Warriner 2000 [+]) retrospectively explored mothers views on monitoring during their pregnancy/ies.

Women reported feeling that interactions with health professionals in relation to routine weighing were not enabling, and that they felt a lack of control. Women

tended to be given limited explanation or feedback on weighing practices, although they accepted professional advice and intervention (Warriner 2000, [+]).

Routine monitoring of weight may not be acceptable to any women anxious about their weight without their consent, meaningful explanation and feedback (Warriner 2000, [+]).

Evidence statement 17

Health professionals reported (Heslehurst *et al.,* 2007b, [++]) that routine weighing of pregnant women was dependent on the location of the initial booking session, as NHS premises tended to have resources for weighing whereas this was more ad hoc in the community where scales may not be available and community midwives were not supplied with portable equipment. It was reported that even in NHS premises, equipment may not be suitable for weighing obese women.

What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, their partners and families about diet, physical activity and weight management prior to pregnancy?

Evidence statement 18

No UK based qualitative evidence was identified on the views, perceptions and beliefs of health professionals, women actively planning a pregnancy and their partners and families about diet, physical activity and weight management prior to pregnancy. However, there is UK based qualitative evidence to suggest that women's eating habits during pregnancy are related to pre-pregnancy dietary attitudes and behaviour. Weight and body shape concerns are affected by size prior to pregnancy (Fox & Yamaguchi 1997 [+]) Women's dietary restraint may be continued or relaxed during pregnancy (Warriner 2000 [+]).

What are the views, perceptions and beliefs of health professionals, women actively planning a pregnancy, pregnant women, their partners and families about diet, physical activity and weight management in pregnancy?

Evidence statement 19

Evidence from 3 UK based qualitative studies (Gross & Bee/ Clarke & Gross 2004, [++]), (Heslehurst *et al.,* 2007b [++]), (Wiles 1998 [++]) suggests that weight

management information and advice from professionals is not received or assimilated by many women during pregnancy. Available information is often vague, confusing, contradictory, and is not linked to weight management.

Overweight women may feel they are not receiving relevant, tailored information about appropriate diet and weight gain during pregnancy (Wiles 1998, [+]).

Evidence statement 20

There is evidence from UK based qualitative research (Levy 1999, [+]; Heslehurst *et al.,* 2007b [++]) that women may be unaware of the potential effects of obesity during pregnancy (Heslehurst *et al.,* 2007b [++]) However, they may avoid information about their health if they find it distressing and will only action it when they feel the time is right for the well-being of themselves, their unborn baby and their partners (Levy 1999 [+]).

Evidence statement 21

There is evidence from UK based qualitative research (Heslehurst *et al.,* 2007b, [++]) that health professionals working in maternity units may feel they have insufficient time to discuss weight issues with women during pregnancy and consider that it is too late to give advice on weight management once a woman is pregnant. Health professionals themselves report that women's access to the information and advice on weight management is often ad hoc.

Evidence statement 22

Evidence from two UK based qualitative studies (Gross & Bee / Clarke & Gross 2004 [++], and Fox & Yamaguchi 1997 [+]) suggests that even relatively active women reduce their physical activity during pregnancy (although they are more likely to continue to be active at some level). One study (Gross & Bee /Clarke & Gross 2004, [++]) found that pregnant women decreased their activity levels based on advice from health professionals, or more commonly, on information they had read in books and magazines. Family members, friends, and even health trainers tended to discourage physical activity. Women balanced their fears of injury to themselves or harm to the baby with aims toward weight management. Women also reported reduced motivation, physical limitations due to larger size and tiredness during pregnancy and a lack of facilities. Another study reported that pregnant women may feel self-conscious when carrying out physical activity (Fox & Yamaguchi 1997, [+]).

Evidence statement 23

There is evidence from UK based qualitative research that women may change their eating behaviours during pregnancy due to cravings, increased hunger and to relieve nausea. Two studies found that women legitimate overeating by the fact of being pregnant and that eating more is "part of being pregnant" (Johnson *et al.,* 2004, [++]), (Wiles 1998, [++]).

Evidence statement 24

There is evidence to suggest that women's eating habits during pregnancy are related to pre-pregnancy dietary attitudes and behaviour. Women's dietary restraint may be continued or relaxed during pregnancy (Warriner 2000, [+]). Some women may abandon their previous dietary restraint due to their belief that eating more is beneficial to the foetus (Fairburn & Welch 1990, [-]). There may be a perceived balance between the baby's healthy development and women's own weight management (Wiles 1998, [++]), in which the baby comes first.

Evidence statement 25

Evidence from one UK based qualitative study (Fox & Yamaguchi 1997, [+]) suggests that overweight women have a tendency to be more satisfied with their body image once pregnant as their size is perceived as legitimate, although others continue to feel stigmatised.

Evidence statement 26

Qualitative evidence from two UK based studies (Heslehurst *et al.,* 2007b, [++], Warriner 2000, [+] suggest there are communication difficulties between overweight women and health professionals. One study of health professionals found that they are often embarrassed to discuss issues of weight with overweight women, and that the women themselves were also embarrassed (Heslehurst *et al.,* 2007b, [++]). Such experiences may not be fixed, but may change over the course of a pregnancy.

One study (Heslehurst *et al.,* 2007b, [++]) explored the views of health professionals, some of which found it difficult to raise this issue sensitively. They reported a lack of guidance on this issue, though were aware of the risks and benefit so raising the

issue. They were concerned that some women may stop attending antenatal appointments if they felt victimised.

11. Appendices

Appendix 1: Search Strategy

Sample Search Strategy

1. (pre-pregnancy or prepregnancy).ti,ab.
2. *Pregnant Women/
3. *Pregnancy/
4. pregnan*.ti,ab.
5. maternal.ti,ab.
6. gestational.ti,ab.
7. (pre-natal or prenatal).ti,ab.
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. *Weight Gain/
10. *Obesity/
11. *Overweight/
12. *Body Mass Index/
13. obes*.ti,ab.
14. weight gain*.ti,ab.
15. weight change*.ti,ab.
16. weight loss*.ti,ab.
17. body mass index.ti,ab.
18. bmi.ti,ab.
19. 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18
20. 8 and 19
21. *diet/
22. *energy intake/
23. diet*.ti,ab.
24. calori*.ti,ab.
25. energy.ti,ab.
26. nutrition*.ti,ab.
27. (food adj2 intake).ti,ab.
28. 21 or 22 or 23 or 24 or 25 or 26 or 27
29. Exercise/
30. exercis*.ti,ab.
31. (physical adj2 activit*).ti,ab.
32. 29 or 31 or 30

33. *counseling/
34. *health education/
35. (health adj2 promotion*).ti,ab.
36. counsel?ing.ti,ab.
37. advi*.ti,ab.
38. support*.ti,ab.
39. information.ti,ab.
40. media.ti,ab.
41. 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40
42. monitor*.ti,ab.
43. assess*.ti,ab.
44. weighing.ti,ab.
45. (adipos* adj2 measur*).ti,ab.
46. (body adj2 composition).ti,ab.
47. mid arm circumference.ti,ab.
48. waist hip ratio*.ti,ab.
49. 42 or 43 or 44 or 45 or 46 or 47 or 48
50. 20 and 28
51. limit 50 to (humans and yr="1990 - 2008")
52. 20 and 32
53. limit 52 to (humans and yr="1990 - 2008")
54. 20 and 41
55. limit 54 to (humans and yr="1990 - 2008")
56. 20 and 49
57. limit 56 to (humans and yr="1990 - 2008")

List of databases

ASSIA via CSA
British Nursing Index via OVID SP
Cinahl via OVID SP
Cochrane – Central via Wiley
Cochrane – DARE via Wiley
Cochrane – HTA via Wiley
Cochrane - NHS EED via Wiley
Cochrane Database of Systematic Reviews via Wiley

Econlit via OVID SP

Embase via OVID SP

Maternity and Infant Care via OVID SP

Medline via OVID SP

PyscINFO via OVID SP

Science Citation Index via Web of Science

Social Science Citation Index via Web of Science

Appendix 2: Data Extraction Sheets

2.1 Systematic Reviews

	Title	Date of publication	Inclusion and Exclusion Criteria	Included Studies
Bell 2007 (abstract only)	Maternal obesity: when should we intervene: A systematic review of lifestyle interventions in women before, during and after pregnancy	2007	RCTS of diet and physical activity interventions which included maternal weight as a primary outcome measure.	7 RCTs (2 recruited women prepregnancy, 2 during pregnancy and 3 postpartum). Included papers not named in abstract.
Dodd 2008	Dietary and lifestyle interventions to limit weight gain during pregnancy for obese or overweight women: A systematic review	2008	RCTs with data reporting outcomes for pregnant women and their infants, who are overweight or obese who received dietary and lifestyle interventions (alone or in combination) during pregnancy to limit weigh gain, with the intention of improving maternal, fetal and infant health outcomes who were compared with women who did not receive these interventions.	2 RCTs Narrative synthesis. Included Polley (2002) and Rae (2000) which previously excluded as focus on women with gestational diabetes.

2.2 RCT Studies

Study Details	Participant characteristics	Intervention Characteristics	Results	Comments
Asbee *et al.*, 2009 (+) **Study design:** RCT **Location*:*** USA **Recruitment:** The randomized controlled trial included women who presented to the Resident Obstetric Clinic in Charlotte, North Carolina, for prenatal care between October 2005 and April 2007. Participants were stratified based on BMI (calculated based on participants' self-report of pre-pregnancy weight and height measured in clinic) into three categories. Group 1 included underweight and normal-weight patients (BMI less than 26). Group 2 included overweight patients (BMI between 26 and 30). Group 3 included	**Number of patients**: 144 (100 analysed) I: 57 C:43 **Mean Age***:* 26.6 **Pre-pregnancy BMI** 25.5 Previous Pregnancies: wt gain across parous status reported in text **History of physical activity**: NR **History of weight management**: NR **Gestational age** at enrolment: 13.7 weeks **Education**: n High school graduate or less=67 High school graduate or more=33 **Ethnicity**: n African American: 24 Asian: 4 White: 13 Hispanic: 56 Other: 2 (more details available in paper, but no statistical significance between groups) **Baseline comparability:**	**Intervention:** intervention group underwent a complete history and physical examination with specific attention paid to pre-pregnancy weight, current weight, height, and BMI. Standardized counselling session, including information on pregnancy-specific dietary and lifestyle choices. The counselling consisted of recommendations for a patient-focused caloric value divided in a 40% carbohydrate, 30% protein, and 30% fat fashion. Patients were instructed to engage in moderate-intensity exercise 3-5 times per week. Received information on the appropriate IOM weight gain Each participant met with the dietitian only at the time of enrolment. At each routine obstetrical appointment, the participant's weight was measured using a balance beam scale and charted on an IOM Gestational Weight Gain Grid in front of the participant. The health care provider (physician or nurse practitioner)	**WEIGHT OUTCOME MEASURES** **Total Weight Gain (kg)** m sd n I: 28.7 12.5 57 C: 35.6 15.5 43 p value= .01 **Exceeded IOM guidelines at some point in pregnancy** n N % I: 22 57 38.6 C: 22 43 51.2 p value=.21 **Exceeded IOM guidelines at some point in pregnancy by category** Normal weight n N % I: 11 57 20 C: 13 43 31.2 Over weight n N % I: 40 57 70 C: 32 43 75 Obese n N % I: 38 57 66.7 C: 34 43 80 **DIET AND EXERCISE OUTCOME MEASURES** Exercise NR Diet or Calorie intake: NR	Nulliparous women gained significantly more weight than parous participants (36.5 (14.5) compared to 27.7 (12.7) lbs p=less than 0.01 No statistically significant differences were noted between the groups in adherence to IOM guidelines, rate of caesarean delivery, preeclampsia, gestational diabetes mellitus, operative vaginal delivery, or vaginal lacerations.

<table>
<tr>
<td>obese patients (BMI higher than 30).

After this stratification, the patients were assigned randomly to either the control group or to the intervention group

QUALITY
Randomisation: computer-generated random allocation. Study randomization was numbered and sealed in an opaque envelope. Randomization occurred in consecutive order at the time of the new obstetrical visit.

Allocation Concealment: NR

Blinding: NR

Intention to treat:

Loss to follow-up:
Not pregnant: 1

BMI greater than 40 kg/m2: 2
Delivered at outside institution: 8
Obtained prenatal care after 16 weeks of gestation: 2
Fewer than 4 prenatal visits: 13</td>
<td>No statistically significant difference was detected in demographic composition between groups. the study arms were not statistically different with respect to age, pre-pregnancy weight, height, and BMI

Inclusion Criteria
• prenatal care established at 6–16
• weeks of gestation
• age 18–49 years
• all prenatal
• care received at the Resident Obstetrics Clinic
• English-speaking, Spanish-speaking, or both
• singleton pregnancy.

Exclusion Criteria:
• Prenatal care established at more than 16 weeks of Gestation
• non–English-speaking or non–Spanish speaking
• multiple pregnancy
• BMI higher than 40
• pre-existing diabetes, untreated thyroid disease, hypertension requiring medication or other medical
• conditions that might affect body weight
• delivery at institution</td>
<td>informed the participant whether her weight gain was at the appropriate level. If her weight gain was within the IOM guidelines, the patient was praised and encouraged to continue her current diet and exercise regimen. If her weight gain was not within the IOM guidelines, the participant’s diet and exercise regimen was reviewed and she was advised on increasing or decreasing her intake and increasing or decreasing exercise.

Control:
Routine prenatal care, including an initial physical examination and history, routine laboratory tests, and routine visits per American College of Obstetricians and Gynecologists standards. The only counseling on diet and exercise during pregnancy was that included in our standard prenatal booklet

At each routine obstetrical appointment, the participant’s weight was measured using a balance beam scale and recorded in the medical chart. The health care provider did not counsel the participant regarding any changes in diet or lifestyle.</td>
<td>INFANT OUTCOME MEASURES

Weeks gestation at delivery NR
Infant birth weight (g) NR
Low birth weight (under 2500g) NR
Macrosomia (over 4000g) NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES

Caesarean
<table>
<tr><th></th><th>n</th><th>N</th><th>%</th></tr>
<tr><td>I:</td><td>8</td><td>57</td><td>14</td></tr>
<tr><td>C:</td><td>12</td><td>43</td><td>28</td></tr>
</table>
p value= 0.09

Pre-term delivery NR
Preeclampsia NR
Maternal hypertension NR
Gestational diabetes NR
Diabetes NR

Weight retention – final weight kg by adherence to IOM guidelines
<table>
<tr><th></th><th>m</th><th>sd</th><th>N</th></tr>
<tr><td>Not adherent to IOM</td><td>194.4</td><td>29.3</td><td>44</td></tr>
<tr><td>IOM adherent</td><td>159.3</td><td>26.4</td><td>56</td></tr>
</table>
p value= less than 0.01

Breast-feeding rates NR
Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
</table>

Pre-existing medical condition: 1 Delivered prematurely: 9 Not delivered as of analysis n=8	other than Carolinas Medical Center-Main • pregnancy ending in premature delivery (less than 37 weeks) • limited prenatal care (fewer than four visits).			

Guelinckx *et al.*, 2008 (u) (Abstract) **Study design:** RCT **Location*:*** Belgium **Recruitment:** NR **Length of Follow Up:** NR **Quality** Randomisation: Yes, method not described Allocation concealment: NR Intention to treat: NR Loss to follow up: NR	**Number of patients:** 99 obese pregnant women **Mean Age*:*** 29 (4) **Previous Pregnancies:** **Pre-pregnancy BMI:** 33.5 (4.0l) **History of physical activity:** NR **History of weight management:** NR **Education:** NR **Ethnicity:** NR **Gestational age at enrolment:** NR **Baseline comparability:** NR **Inclusion Criteria:** NR **Exclusion Criteria: NR**	**Intervention:** 2 intervention groups: Group A: receiving nutritional advice through a purpose-designed brochure Group B: additionally receiving active lifestyle education Nutritional habits were evaluated every trimester by means of three 7-day food records and compared with a **Control:** Group C: Standard care group/control	**WEIGHT OUTCOME MEASURES** **Total Weight Gain (kg)** m sd n A: 11 7 NR B: 10 6 NR C: 10 7 NR p value= NR There were no significant differences in mean (SD) weight gain Exceeded IOM guidelines at some point in pregnancy: NR Percentage total weight gain exceeded IOM guidelines : NR **DIET AND EXERCISE OUTCOME MEASURES** **Exercise** NR **Diet or Calorie intake** After the intervention, total energy intake was lower in groups A and B than in the controls (p=0.033). This effect was mainly due to a decreased fat intake in the 2 intervention groups versus control group (p=0.008). dietary habits at the start of the study did not reach recommended values, but were comparable between the groups. **INFANT OUTCOME MEASURES**	The hypothesis is that nutritional advice through a brochure or active education results in reduced GWG These preliminary results show that nutritional advice improves dietary habits of obese women (reduced energy and fat intake), but had no significant effect on GWG or birth weight.

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>Infant birth weight: Birth weight of the babies was comparable.
Weeks gestation at delivery NR
Low birth weight (under 2500g): NR
Macrosomia (over 4000g):NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES (all NR)

Pre-term delivery
Caesarean
Preeclampsia
Maternal hypertension
Gestational diabetes
Weight retention
Breast-feeding rates
Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
<tr>
<td>Hui et al., 2006 (-)

Study design: RCT

Location: Canada

Recruitment:
Attendees in Healthy Start for Mom and Me prenatal class, and local clinic

Length of Follow-up: Post-gestational visit

QUALITY
Randomisation: yes
Allocation Concealment: NA
Blinding: NR
Intention to Treat: NR</td>
<td>Number of patients: 52

Mean Age: 26.2

Previous Pregnancies:

Pre-pregnancy BMI: 24.5

History of physical activity: NR
History of weight management: NR

Education (years): 12.6

Ethnicity:
Visible minority 63.8%
Aboriginal: 46.7 %

Gestational age at enrolment: 20-30 weeks

Baseline comparability: Yes</td>
<td>Intervention:
Weekly group-based exercise sessions (delivered by personal trainer) and at home exercise sessions (take home video) recommended exercise 3-5 times per week
Monitoring of heart rate,, pedometer, and activity diary by student research assistants
Session with dietitian to recall dietary habits
Software to help analyse dietary patterns and gestational weight gain
Personalised diet advice based on dietitians recommendations

Control:
Standard care: basic exercise advice that</td>
<td>WEIGHT OUTCOME MEASURES

Total Weight Gain (kg)
<table>
<tr><th></th><th>m</th><th>sd</th><th>n</th></tr>
<tr><td>I:</td><td>14.2</td><td>5.3</td><td>24</td></tr>
<tr><td>C:</td><td>14.2</td><td>6.3</td><td>21</td></tr>
</table>
p value= 1.00

Excessive Weight Gain
<table>
<tr><th></th><th>n</th><th>N</th><th>%</th></tr>
<tr><td>I:</td><td>5</td><td>24</td><td>21</td></tr>
<tr><td>C:</td><td>7</td><td>21</td><td>33</td></tr>
</table>
p value= .70

Percentage total weight gain exceeded IOM guidelines: NR

DIET AND EXERCISE OUTCOME MEASURES

Physical Activity Level:
<table>
<tr><th></th><th colspan="3">Base</th><th colspan="3">End of study</th></tr>
<tr><th></th><th>m</th><th>sd</th><th>n</th><th>m</th><th>sd</th><th>n</th></tr>
<tr><td>I</td><td>1.17</td><td>0.87</td><td>24</td><td>1.96</td><td>0.20</td><td>24</td></tr>
<tr><td>C</td><td>1.52</td><td>0.68</td><td>21</td><td>1.48</td><td>0.68</td><td>21</td></tr>
</table>
</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td>Loss to follow-up:
Drop out due to school/work commitments: n= 7</td>
<td>Inclusion Criteria:
Less than 26 weeks gestation
No pre-existing diabetes
Permission from GP

Exclusion Criteria:
Muscular disorders that effected physical activity</td>
<td>consisted of a simple statement that women should exercise regularly but given no instructions. Information package about national recommendations for dietary intake during pregnancy</td>
<td>Diet or Calorie intake: NR

INFANT OUTCOME MEASURES

<u>Weeks gestation at delivery</u>
m sd n
I: 39.3 1.15 24
C: 39 1.64 21
p value= 0.86

<u>Infant birth weight (g)</u>
m sd n
I: 3402 473 24
C: 3428 493 21
p value/confidence interval

<u>Macrosomia (over 4000g)</u>
n N %
I: 2 24 8
C: 4 21 19
p value 0.79

Low birth weight (under 2500g): NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES

<u>Caesarean (other delivery complications/tools)</u>
n N %
I: 1 24 4
C: 3 21 14.3
p value= 0.91

<u>Gestational diabetes</u>
n N %
I: 1 24 4
C: 2 21 10</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td></td>
<td>p value= 0.50

Pre-term delivery: NR
Preeclampsia NR
Maternal hypertension: NR
Diabetes: NR
Weight retention: NR
Breast-feeding rates: NR
Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
<tr>
<td>Polley et al., 2002 (-)

Study design: RCT

Location: USA

Setting: in a regularly scheduled clinic

QUALITY
Randomisation:
▪ randomly assigned to the standard care control group or to the intervention stratified by BMI category (normal weight vs overweight) and self-reported race (black vs white).

Allocation Concealment: NR

Blinding: NR

ITT: Yes including all participants</td>
<td>Number of patients: 120

Mean Age: 25.5 (s.d 4.8)

BMI:
Based on self reported height and weight at last menstrual period.

Ethnicity:
39% black
61% white

Previous Pregnancies:
▪ 47% first pregnancy
▪ 30% second pregnancy
▪ 17% third pregnancy
▪ 6%>third pregnancy

Education:
▪ 45% high school or less
▪ 42% vocational training or some college
▪ 9% college graduate
▪ 4% graduate training

Recruitment:
▪ Pregnant women before 20 weeks gestation
▪ From an obstetric clinic for
▪ low-income women at a hospital</td>
<td>Intervention:
▪ Stepped-care behavioural intervention: education and feedback about weight gain, and stressed modest exercise and healthy, low-fat eating

▪ written and oral information in the following areas: (a) appropriate weight gain during pregnancy; (b) exercise during pregnancy (c) healthful eating during pregnancy.

▪ Delivered by master's and doctoral level staff with training in nutrition or clinical psychology

▪ Newsletters prompting healthy eating and exercise habits were mailed biweekly.

▪ personalized graph of their weight gain.</td>
<td>Total Weight Gain (kg)
Total weight gain was based on self-reported pre-pregnancy weight and weight at the last clinic visit prior to delivery.
<table>
<tr><td>Normal weight</td><td>m</td><td>sd</td><td>n</td><td>m</td><td>sd</td><td>n</td></tr>
<tr><td></td><td>baseline</td><td></td><td></td><td>Total</td><td></td><td></td></tr>
<tr><td>I:</td><td>62.1</td><td>6.1</td><td>30</td><td>15.4</td><td>7.1</td><td>30</td></tr>
<tr><td>C:</td><td>59</td><td>6.9</td><td>31</td><td>16.4</td><td>4.8</td><td>31</td></tr>
</table>
<table>
<tr><td>Over weight</td><td>m</td><td>sd</td><td>n</td><td>m</td><td>sd</td><td>n</td></tr>
<tr><td></td><td>baseline</td><td></td><td></td><td>total</td><td></td><td></td></tr>
<tr><td>I:</td><td>83.6</td><td>6.7</td><td>27</td><td>13.6</td><td>7.2</td><td>27</td></tr>
<tr><td>C:</td><td>91.8</td><td>19.6</td><td>22</td><td>10.1</td><td>6.2</td><td>22</td></tr>
</table>
P=<0.001 main effect f BMI category

<u>Exceeded IOM guidelines at some point in pregnancy</u>
<table>
<tr><td>Normal weight</td><td>n</td><td>N</td><td>%</td></tr>
<tr><td>I:</td><td>19</td><td>30</td><td>93.5</td></tr>
<tr><td>C:</td><td>29</td><td>31</td><td>63.3</td></tr>
<tr><td></td><td>P=<0.05</td><td></td><td></td></tr>
<tr><td>Over weight</td><td>n</td><td>N</td><td>%</td></tr>
<tr><td>I:</td><td>20</td><td>27</td><td>74.1</td></tr>
<tr><td>C:</td><td>14</td><td>22</td><td>63.6</td></tr>
<tr><td></td><td>P0.09</td><td></td><td></td></tr>
</table>
<u>Percentage total weight gain exceeded IOM guidelines</u>
<table>
<tr><td>Normal weight</td><td>n</td><td>N</td><td>%</td></tr>
<tr><td>I:</td><td>10</td><td>30</td><td>33</td></tr>
</table>
</td>
<td></td>
</tr>
</table>

available at the post-pregnancy or post partum assessments **Loss to follow-up:** ▪ 110/120 (92%) were followed through the end of their pregnancy ▪ 3/120 miscarried ▪ 6/120 moved out of the area ▪ 1/120 asked to withdraw from the study. ▪ 5 in the intervention group requested withdrawal from the study but gave consent for continued monitoring via record review and were retained for all analyses. ▪ The final sample of 110 women included 57 in the treatment group (30 normal weight, 27 overweight) ▪ 53 in the control group (31 normal weight, 22 overweight).	▪ Subjects were recruited into four cells: normal and overweight, black and white. (39% black 61% white) **Gestational age at recruitment:** 14.5 (sd 3.1) weeks **Baseline comparability:** Yes **Exclusion Criteria:** ▪ Underweight women (BMI<19.8) ▪ younger than 18 years ▪ first prenatal visit was >12 weeks gestation ▪ high-risk pregnancy (i.e. drug abuse, chronic health problems, previous complications during pregnancy, current multiple gestation).	▪ weight changes within the appropriate ranges were informed that they were gaining the expected amount of weight ▪ those gaining too little were told to check with their physician for guidance outside the scope of this study. ▪ weight gains exceeding the recommended levels were given additional individualized nutrition and behavioural counselling ▪ weight was measured at every clinic visit using a digital or balance beam scale. ▪ exercise intervention focused on increasing walking and developing a more active lifestyle. ▪ Between visits women were contacted by phone to discuss progress towards the goals set at the previous visit **Control:** usual care/ standard nutrition counselling: well-balanced dietary intake and advice to take a multivitamin/iron	C: 18 31 58 Over weight n N % I: 16 27 59 C: 7 22 32 Overall BMI category by treatment interaction, P <0.01; treatment effect among normal-weight women, P <0.05; treatment effect among overweight women, P ¼0.09. No significant effects of race on the percentage of women with excessive weight gains (p=>0.3) nor did race interact with treatment group or BMI category **Post partum weight retention – 8 (s.d. 7) weeks** Normal weight m sd n I: 4.4 5.4 18 C: 6.2 4.5 21 Over weight n N % I: 3.6 5.6 16 C: 0.3 7 19 **DIET AND ACTIVITY** **Physical activity:** Energy expenditure was measured using the Paffenbarger exercise questionnaire. No differences between groups in exercise levels at recruitment (p=0.059). Changes in exercise level from recruitment to 30 weeks (p >0.8) were not related to treatment condition or BMI (p=>0.8) **Diet or Calorie intake:** Fat consumption at recruitment: 55.9 g per day. All groups decreased their fat consumption from these foods from baseline to 30 weeks except normal-weight women in the control condition. (P=>0.2)	

		supplement. No information or counselling was provided by the research staff.	**CHILD OUTCOMES:** **Outcome** | Normal Weight I (n=30) | C (n=31) | Over weight I (n=27) | C (n=22) **Weeks gestation at delivery** | 39.5 | 39.1 | 39.4 | 39.1 **Infant birth weight (g)** | 3133 | 3226.4 | 3282.8 | 3349.0 **p>0.8** **Low birth weight** | 4 | 3 | 1 | 2 **Macrosomia** | 1 | 0 | 0 | 0 **MATERNAL OUTCOMES:** **Outcome** | Normal Weight I (n=30) | C (n=31) | Over weight I (n=27) | C (n=22) **Pre-term delivery** | 5/30 (17%) | 2 | 2 | 3 **Caesarean** | 2 | 4 | 2 | 6 **Preeclampsia** | 0 | 0 | 2 | 3 **Maternal hypertension** | 2 | 4 | 4 | 4 **Gestational diabetes** | 0 | 2 | 2 | 1 Quality of Life: NR Attendance and use of health services: NR	

Wolff *et al.*, 2008 (-)

Study design: RCT

Location*:* Denmark

Recruitment: register of newly diagnosed pregnancies

Length of Follow Up: 4 weeks postpartum

QUALITY

Randomisation: computerized Randomization

Allocation Concealment: NR

Blinding*:* NR

Intention to treat: ?

Loss to follow-up:
I: 5 drop outs
C: 8 drop outs and 3 gestational diabetes

Number of patients: 50

Mean Age*:* 28

Previous Pregnancies: NR

Education: NR

Pre-pregnancy BMI: 34.7

Pre-pregnancy weight (kg): 96

History of physical activity: NR

History of weight management: NR

Ethnicity: all Caucasian

Gestational age at enrolment: 15.5 weeks

Baseline comparability: No significant differences in baseline characteristics between the two groups

Inclusion Criteria: Non-diabetic Caucasian obese pregnant women

Intervention:
10 consultations of 1 hour each with a trained dietitian during the pregnancy each with a trained dietitian during the pregnancy.

Women were instructed to eat a healthy diet according to the official Danish dietary recommendations.

The energy intake was restricted based on individually estimated energy requirements and estimated energetic cost of fetal growth.

Seven-day weighed food records were obtained at inclusion, and at 27 and 36 weeks of gestation in both groups.

Control:
The control group had no consultations with the dietitian and had no restrictions on energy intake or gestational weight gain.

WEIGHT OUTCOME MEASURES

Total Weight Gain (kg)

	m	sd	n
I:	6.6	5.5	21
C:	13.3	7.5	22

Mean difference of 6.7kg. 95% CI on the difference: 2.6-10.8kg, p=0.002)

Total Weight Gain (kg) throughout pregnancy

	15 wks			27 wks			36 wks		
	m	sd	n	m	sd	n	m	sd	n
I:	0.4		23	2		22	5.1		21
C:	1.7		26	6		25	10.5		22

P= 0.01

Exceeded IOM guidelines at some point in pregnancy: NR
Percentage total weight gain exceeded IOM guidelines: NR

DIET AND EXERCISE OUTCOME MEASURES

Exercise NR

Diet or Calorie intake (kj-1))

	At Inclusion			27 wks			36 wks		
	m	sd	n	m	sd	n	m	sd	n
I:	8619	2246	23	7319	1817	22	7491	2259	21
C:	9223	1829	26	9867	2057	25	9548	1721	22

p value: 0.01

INFANT OUTCOME MEASURES

Weeks gestation at delivery:

	m	sd	n
I:	40.1	1.9	23
C:	40	1.5	27

p = NR

Infant birth weight (g):

The weight (fasting with voided bladder and light clothing),height, blood pressure, and heart rate were measured at inclusion and at 27 and 36 weeks of gestation.

Fasting blood samples for measurements of serum insulin, serum leptin, and blood glucose at inclusion and at 27 and 36 weeks of gestation.

Dietary supplements were supplied to all participants to ensure a sufficient intake of vitamins and trace elements with special emphasis on iron and folic acid intake.

All participants followed the routine clinical schedule with

				additional ultrasound measurement of fetal growth at 30, 33, and 36 weeks of gestation. Pre-pregnancy weight, maternal weight development from 36 weeks of gestation until delivery, and 1st, 2nd, and 3rd week postpartum, was reported by self-administered questionnaires.

	m	sd	n
I:	3757	617	23
C:	3895	485	27

P: NR

Low birth weight (under 2500g): NR
Macrosomia (over 4000g): NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES

Pre-term delivery: NR

Caesarean:

	n	N	%
I:	2	23	9
C:	3	27	11

P: NR

Preeclampsia:

	n	N	%
I:	0	23	0
C:	1	27	4

P: NR

Maternal hypertension:

	n	N	%
I:	4	23	4
C:	4	27	15

P: NR

Gestational diabetes:

	n	N	%
I:	0	23	0
C:	3	27	10

P: NR

Diabetes: NR

			Weight retention at 45 weeks(kg) **(weight gain from pre pregnancy weight)** m sd n I: -3.8 C: 2.1 p = 0.01 **Changes in Insulin Levels (pmol/l)** At Inclusion: m sd n = I: 0 23; C: 0 27 27 wks: m sd n = I: 8 22; C: 26 46 36 wks: m sd n p= 0.022 at 36 wks p=0.040 at 27 wks Breast-feeding rates: NR Quality of Life: NR Attendance and use of health services: NR	

2.3 Non-Randomised Studies

Study Details	Participant characteristics	Intervention Characteristics	Results	Comments
Claesson *et al.*, 2007 (+) **Study design**: case-control **Objective:** To minimise obese women's total weight gain during pregnancy to less than 7 kg and to investigate the delivery and neonatal outcome **Location*:*** Sweden Recruitment: All obese pregnant women consecutively registered between November 2003 and December 2005 at the antenatal clinic in Sweden **Length of follow up:** 10-12 weeks postpartum **QUALITY** Randomisation: NA Allocation Concealment: NA Blinding*: NA* Intention to treat: NR	**Number of patients:** Case: 160 Control: 208 **Mean Age*:*** Case: 29.7 Control: 30.2 **Previous Pregnancies:** Case: 0 children: 65 Greater than 1 child: 90 Control: 0 children: 92 Greater than 1 child: 101 **Pre-pregnancy BMI:** Case: 30-34.9: 100 35-39.9: 36 Over 40:19 Control: 30-34.9: 127 35-39.9: 42 Over 40: 24 **History of physical activity**: NR **History of weight management:** NR **Education**: NR **Ethnicity:** NR	**Intervention:** Extra visits with a specially trained midwife. Motivational interview/talk in early pregnancy, with the aim of motivating the obese pregnant woman to change her behaviour and to obtain information relevant to her needs. Midwifes worked according to the following schedule: • Assessment of the pregnant woman's knowledge of obesity as a risk factor for the pregnancy, birth and the child. • If the woman lacked sufficient knowledge, she was offered the information and given accurate facts. • The woman was also informed about the potential consequences of different behaviours associated with eating and food intake; written information was supplied if needed. • The woman was invited to a 30-minute individual session every week. The session	**WEIGHT OUTCOME MEASURES** **Total Weight Gain (kg)** m sd n I: 8.7 5.51 143 C: 11.3 5.8 161 p value= 0.001 NOT adjusted for socio-demographic variables **Total Weight Gain (kg)** m sd n I: 7.52 15.4 143 C: 9.78 16.24 161 p value= 0.001 adjusted for socio-demographic variables Exceeded IOM guidelines at some point in pregnancy: NR Percentage total weight gain exceeded IOM guidelines: NR **DIET AND EXERCISE OUTCOME MEASURES** Exercise: NR Diet or Calorie intake: NR **INFANT OUTCOME MEASURES** Weeks gestation at delivery: NR **Infant birth weight (g):** m sd n I: 3688 680.7 155	The rate of obesity in the pregnant populations during the recruitment period was 8.4% in the city of Linko¨ping and 7.3% in the two control cities

<table>
<tr>
<td>Loss to follow-up:

Drop outs: 5 cases, 15 controls (no reasons given)</td>
<td>Gestational age at enrolment: approximately 10-12 weeks gestation

Baseline comparability:

There was a significant difference in socio-economic groups (P = 0.044).

The index group had a lower weight gain during pregnancy compared with the control group (P < 0.001).

The women in the index group had lost weight at the postnatal check-up compared with the registered weight in early pregnancy (P < 0.001), while there was no significant difference in weight among the controls (P < 0.086).

Inclusion Criteria:
NR

Exclusion Criteria:
• Inability to understand Swedish
• a pre-pregnant diagnosis of diabetes, thyroid dysfunction or a psychiatric disease treated with neuroleptic drugs
• miscarriage or a legal abortion</td>
<td>included weight control and supportive talk.
• All women who attended the programme were also invited
to an aqua aerobic class (once or twice a week), especially
designed for obese women.

Control:
To constitute a control group, all obese, pregnant women (BMI ‡ 30 kg/m^2, n = 437) consecutively registered during the same period at the ANCs in two nearby cities with surroundings were approached</td>
<td>C: 3678.9 571.3 195
p value=0.893

Low birth weight : NR
Macrosomia: NR
Child obesity : NR

Neonatal outcomes such as birth weight, gestational age and mode of delivery did not differ between the groups

MATERNAL OUTCOMES

Pre-term delivery NR

Caesarean (non-elective)
n N %
I: 20 140 14.3
C: 29 183 15.8
p value= 0.698

Instrumental Delivery
n N %
I: 14 140 10
C: 18 183 9.8
p value= 0.96

Preeclampsia: NR
Maternal hypertension: NR
Gestational diabetes: NR
Diabetes: NR
Weight retention: NR
Breast-feeding rates: NR

Weight retention 10-12 weeks postpartum
m sd n
I: -2.5 5.88 150
C: 0.75 5.34 1.62
p value= <0.001

Breast-feeding rates: NR
Diabetes: NR</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td></td>
<td>• moving out of the area.</td>
<td></td>
<td>Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
<tr>
<td>Gray-Donald et al., 2000 (-)

Study design: Non-Randomised

Location: Canada

Recruitment:
All Cree women receiving prenatal services prior to 26 weeks' gestation were eligible

Length of Follow Up: 6 weeks postpartum

QUALITY

Randomisation: No
Allocation Concealment:
No
Blinding: No

Intention to treat:

Loss to follow-up:
Miscarriage: 5
Drop out numbers indicated on outcome measures where available, but reasons not given</td>
<td>Number of patients: 219

Mean Age: 24.1

Previous Pregnancies: NR

Pre-pregnancy BMI: 30.2

Pre-pregnancy weight (kg): 80

History of physical activity: NR

History of weight management: NR

Education: NR

Ethnicity: Women in northern Quebec of the Cree communities. Specific ethnicity not reported

Gestational age at enrolment: 17.8 weeks

Baseline comparability: yes

Inclusion Criteria:
women receiving prenatal services
prior to 26 weeks gestation

Exclusion Criteria:
pre-gestational diabetes</td>
<td>Intervention:
• Local radio broadcasts
• Pamphlets about nutritional choices and encouraging breastfeeding
• Supermarket tours and cooking demonstrations
• Exercise/walking groups
• Individual counselling

Nutritionists lived and worked in 2 communities, the time in each community being proportional to workload.

The nutritionists received training in cultural beliefs concerning diet, developed and adapted local teaching aids and worked with a team of health care workers, including a community nutritionist.

Dietary advice was related to improving the intake of dairy products and fruit and vegetables, while decreasing the intake of high-energy foods with little nutritional value such as soft drinks, fruit drinks and French fries, and staying within guidelines for weight gain during pregnancy.</td>
<td>WEIGHT OUTCOME MEASURES

<u>Total Weight Gain (kg)</u>
m sd n
I: 12 6.4 112
C: 13.2 8.3 107
p value= 0.29

Exceeded IOM guidelines at some point in pregnancy: NR

DIET AND EXERCISE OUTCOME MEASURES

Exercise NR

Average Daily Energy kj intake (between 24 and 30 weeks' gestation)
m sd n
I: 11558 3244 99
C: 11090 4239 93
p value= NR, but stated as not significant

INFANT OUTCOME MEASURES

<u>Weeks gestation at delivery</u>
m sd n
I: 39.53 3.42 106
C: 39.56 1.87 103
p value NR

<u>Infant birth weight (g)</u>
m sd n
I: 3741 523 106
C: 3686 686 103
p value NR

<u>Low birth weight (under 2500g)</u>
n N %
I: 3 106 3</td>
<td>Maternal weight at 6 weeks post partum (88.1 kg [SD 16.8] v. 86.4 kg [SD 19.0]).

Women recruited between July 1995 and March 1996 served as controls, whereas women identified between April 1996 and January 1997 made up the intervention group.

Participants were compared with nonparticipants living in their communities at the same time. All participants were included in the intention-to-treat approach to the analysis.</td>
</tr>
</table>

		Dietary data were obtained by having each woman recall everything she had eaten within the previous 24 hours at 24–30 weeks' gestation and a second time at 6 weeks post partum. **Control:** Study participants were seen by the dietitian for dietary evaluations at 24–30 weeks gestation and at 6 weeks post partum. Data on weight gain and glucose values were collected by the clinic staff following routine procedures.	C: 2 103 2 p value NR **Macrosomia (over 4000g)** n N % I: 37 106 35 C: 31 103 30.1 p value NR Childhood Obesity: NR **MATERNAL OUTCOME MEASURES** **Caesarean** n N % I: 15 106 14.2 C: 13 103 12.6 p value: NR **Gestational diabetes** n N % I: 15 106 14.2 C: 10 103 8 p value: NR **Weight retention postpartum – 6 weeks** m s.d N I: 6.1 6.7 62 C: 7.4 8.5 75 p value: NR Breast-feeding rates n N % I: 54 62 87.1 C: 62 75 82.7 p value: NR Pre-term delivery NR Preeclampsia NR Maternal hypertension NR	

<table>
<tr><td></td><td></td><td></td><td>Diabetes NR
Quality of Life: NR
Attendance and use of health services: NR</td><td></td></tr>
<tr><td>Kardel et al., 1998 (-)

Study design: case-control

Objective:
Effects of high and medium intensity exercise on the foetus and labour and infant outcomes

Location: Norway

Recruitment:
newspaper ads and by acquaintances

Length of Follow Up:
6 weeks after delivery

QUALITY
Randomisation: NA
Allocation Concealment: NA
Blinding: NR
Intention to treat: NA

Loss to follow-up:
1 drop out due to lack of time after birth of baby</td><td>Number of patients:
high intensity group: 21
medium intensity group: 21

Mean Age:
high intensity group: 28.8 (2.3)
medium intensity group:26.7

Previous Pregnancies:
high intensity
no previous children: 15
2 or more previous: 6
medium intensity
no previous children: 19
2 or more previous: 2

Pre-pregnancy Weight: kg (s.d)
high intensity group: 59.4 (6.3)kg
medium intensity group: 63 (8.9) kg

Height (cm):
high intensity group:168.5 (5.1)
medium intensity group: 170.6 (4.8)

History of physical activity:
all participants have been physically active ranging from 3-22 years:

high intensity group: 15.3 years</td><td>Group 1
high intensity exercise programme
muscle, interval, and endurance training

Group 2:
medium intensity exercise programme
muscle, interval, and endurance training</td><td>WEIGHT OUTCOME MEASURES

<u>Total Weight Gain (kg)</u>
<u>m sd n</u>
med 65.8 9.3 20
high 64.4 6.1 20
p value=

Exceeded IOM guidelines at some point in pregnancy: NR
Percentage total weight gain exceeded IOM guidelines: NR

DIET AND EXERCISE OUTCOME MEASURES

<u>Exercise hr/week</u>
<u>m sd n</u>
Med 6.2 nr 21
high 8.6 nr 20
p value: NR

Diet or Calorie intake NR

INFANT OUTCOME MEASURES

<u>Weeks gestation at delivery</u>
<u>m sd n</u>
Med 39.9 1.2 21
high 39.6 1.6 21
p value: NR

<u>Infant birth weight (g)</u>
<u>m sd n</u>
Med 3590.5 532 21
high 3650.7 515 21
p value nr

Low birth weight (under 2500g): NR</td><td>Apgar scores reported</td></tr>
</table>

<table>
<tr>
<td></td>
<td>medium intensity group: 12.6 years

History of weight management: well trained women

Education: NR

Ethnicity: NR

Gestational age at enrolment:
greater than 20 weeks

Baseline comparability: significant differences between groups. women in the high intensity group were older and higher energy expenditures, training time, and training sessions

Inclusion Criteria: NR

Exclusion Criteria:
abnormal pregnancies
twins or multiple infants</td>
<td></td>
<td>Macrosomia (over 4000g): NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES

<u>Caesarean</u>
<table><tr><th></th><th>n</th><th>N</th><th>%</th></tr><tr><td>Med</td><td>1</td><td>21</td><td>4.8</td></tr><tr><td>high</td><td>1</td><td>21</td><td>4.8</td></tr></table>P NR

<u>Instrumental Delivery</u>
<table><tr><th></th><th>n</th><th>N</th><th>%</th></tr><tr><td>med</td><td>3</td><td>21</td><td>14.3</td></tr><tr><td>high</td><td>2</td><td>20</td><td>10</td></tr></table>P value: NR

<u>Weight 6 weeks after labour</u>
<table><tr><th></th><th>m</th><th>sd</th><th>N</th></tr><tr><td>Med</td><td>64.6</td><td>9.3</td><td>20</td></tr><tr><td>high</td><td>63.2</td><td>6.1</td><td>19</td></tr></table>P : NR

Pre-term delivery: NR
Preeclampsia: NR
Maternal hypertension: NR
Gestational diabetes: NR
Breast-feeding rates: NR
Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
</table>

<table>
<tr>
<td>Kinnunen et al., 2007 (+)

Study design: Non-Randomised

Objective: effects of counselling on diet and exercise on physical activity rates and prevention of excess weight gain

Location: Finland

Recruitment: 6 maternity clinics in Finland. Recruited by public health nurses when women enrolled at clinics.

Length of Follow Up: 37 weeks into pregnancy

QUALITY
Randomisation: clinics and women were non-randomised
Allocation Concealment: N
Blinding: No
Intention to treat: ?

Loss to follow-up:

Miscarriage: 2
Relocation: 7
Life situation: 4
This study: 9
Unknown: 2
Pregnancy or health: 3</td>
<td>Number of patients: 126

Mean Age: 28.2

Previous Pregnancies: NR

Pre-pregnancy BMI: 23

History of physical activity: NR

History of weight management: NR

Education:
Basic/Secondary: I: 27 C: 20
Postsecondary: I:20 C: 36

Ethnicity: NR

Gestational age at enrolment:
At least 8 weeks. Varied.

Baseline comparability:
No. Intervention group was younger, more smokers, less educated, higher pre-pregnancy BMIs

Inclusion Criteria:
Pregnant women with no earlier deliveries

Exclusion Criteria:
• Under 18
• Diabetes 1 or 2, but not gestational diabetes
• Twins
• Problematic pregnancy
• Substance abuse</td>
<td>Intervention:
• 3 intervention clinics with a public health nurse.
• Information on IOM guidelines.
• Physical activity and diet counselling.
• 1 primary physical activity session and 4 booster sessions.
• Recommendations for physical activity during pregnancy.
• Booster sessions to check progress.
• Optional controlled exercise sessions 45-60min.
• 1 primary diet session, 3 booster sessions.
• Nurse assessed diet and made recommendations.

Control:
• Standard maternity care
• 3 control clinics; 6 nurses
• Counselling on diet and physical activities</td>
<td>WEIGHT OUTCOME MEASURES

<u>Total Weight Gain (kg)</u>
<table>
<tr><th></th><th>m</th><th>sd</th><th>n</th></tr>
<tr><td>I:</td><td>14.6</td><td>5.4</td><td>49</td></tr>
<tr><td>C:</td><td>14.3</td><td>4.1</td><td>56</td></tr>
</table>
p value= 0.77

<u>Exceeded IOM guidelines at some point in pregnancy</u>
<table>
<tr><th></th><th>n</th><th>N</th><th>%</th></tr>
<tr><td>I:</td><td>22</td><td>49</td><td>46</td></tr>
<tr><td>C:</td><td>17</td><td>56</td><td>30</td></tr>
</table>
p value= nr

Percentage total weight gain exceeded IOM guidelines NR

DIET AND EXERCISE OUTCOME MEASURES

<u>Exercise Minutes per week</u>
<table>
<tr><th></th><th>Base</th><th>20 Wks</th><th>37 Wks</th></tr>
<tr><td>I:</td><td>2180</td><td>1650</td><td>1400</td></tr>
<tr><td>C:</td><td>1900</td><td>1600</td><td>1500</td></tr>
</table>
P value nr

Diet or Calorie intake: NR

INFANT OUTCOME MEASURES

<u>Low birth weight (under 2500g)</u>
<table>
<tr><th></th><th>n</th><th>N</th><th>%</th></tr>
<tr><td>I:</td><td>0</td><td>49</td><td>0</td></tr>
<tr><td>C:</td><td>1</td><td>56</td><td>1.8</td></tr>
</table>
No statistical significance

<u>Macrosomia (over 4000g)</u>
<table>
<tr><th></th><th>n</th><th>N</th><th>%</th></tr>
<tr><td>I:</td><td>0</td><td>49</td><td>0</td></tr>
<tr><td>C:</td><td>8</td><td>56</td><td>14.3</td></tr>
</table>
</td>
<td></td>
</tr>
</table>

	• Psychiatric illness • Non-finish language • Planned change of address within 3 months		or 15 p value 0.006 Weeks gestation at delivery: NR Infant birth weight (g): NR Childhood Obesity: NR **MATERNAL OUTCOME MEASURES** **Gestational diabetes** n N % I: 6 14 42.9 C: 1 11 9.1 *only a smaller subset of participants. See page 890 Pre-term delivery: NR Caesarean NR Preeclampsia: NR Maternal hypertension: NR Diabetes: NR Weight retention : NR Breast-feeding rates: NR Quality of Life: NR Attendance and use of health services: NR	
Olson, 2004 (-) **Study design:** non randomised controlled trial (historical controls) **Location:** USA **Recruitment:** Recruited from those who registered for obstetric care at hospital and primary care clinic systems	**Number of patients**: 560 (517 available for analysis) **Mean Age***:* NR **Ethnicity**: 96% white **Previous Pregnancies:** Nulliparious: 230/560 (41.1%) Primaparous: 329/560 (58.8%) **Early pregnancy BMI:** Normal 421/560 (75.2%)	**Intervention:** Intervention was designed to encourage gain weight within the IOM range. 2 major components: • a clinical component, including guidance about and monitoring of gestational weight gain by health care providers using new tools in the obstetric chart, • a by-mail patient	**WEIGHT OUTCOMES** **Total Weight Gain (kg)** m sd n I: 14.1 4.51 179 C: 14.8 4.68 381 p value= 0.09 **Percentage total weight gain exceeded IOM guidelines (kg)** n N % I: 73 179 41 C: 177 394 45 p value= 0.3 **Percentage total weight gain exceeded IOM guidelines (kg)**	12 women who participated in the first study (control group) were also included in the second study (intervention group).

For the intervention group, only women with normal(19.8-26.0) and high (26.1-29.0) pre -pregnancy BMI were recruited.
The control group consisted of women with normal and overweight BMI from an earlier observational study of postpartum weight retention

Length of Follow Up: 1-year postpartum

QUALITY
Randomisation: nonrandomised into groups
Allocation Concealment: NR
Blinding*:* NR

Loss to follow-up:

21 were excluded from analyses of weight retention at 1-year postpartum because of weight related illness, pregnancy, a second birth, or lack of a1-year weight.
22 were eliminated from the control group for the same reasons. Thus, at 1-yearpostpartum, 158 intervention subjects

med (range)
I: 23.1 (20.0 – 26.0) n=131
C: 22.6 (19.8 – 26.0) n=290
Overweight 139/560 (24.8%)
I: 27.2 (26.0 – 22.0)
C: 27.2 (26.1 – 29.0)

History of physical activity: NR

History of weight management: NR

Education:
<12 yrs: 196/517 (37.9%)
>12 yrs: 363/517 (70.2%)

Gestational age at enrolment: eligible for analysis if they entered prenatal care before the third trimester

Baseline comparability: Yes

Inclusion Criteria:
- 18 years or older at delivery
- no medical condition that might impact bodyweight (some examples include untreated thyroid disease, insulin-requiring diabetes, hypertension requiring medication)
- were mentally competent to give informed consent,
- planned to deliver

education program.

Women were mailed:
- Questionnaires that collected data on behavioural variables in the first or second trimester of pregnancy, at 6 months, and 1-year postpartum.
- Health education booklets with tips for healthy eating and exercise in pregnancy.
- Newsletters with simple motivating and action oriented messages about gestational weight gain, physical activity and diet.

Both materials had been pre-tested and judged to be readable an helpful.

Postcards sent with newsletters which women encouraged to return encouraging women to set behavioural goals.

After delivery, obstetric records were audited for data on biologic and socio-demographic variables.

Body weight and height were measured according to study protocols by health care providers at antenatal visits and at 1-year postpartum.

income

	low			high		
	n	N	%	n	N	%
I:	22	67	33	45	112	40
C:	84	162	52	87	212	41
			<0.01			

Percentage total weight gain exceeded IOM guideline (weight subgroup)

Normal BMI/Low income				Over weight/low income		
	n	N	%	n	N	%
I:	14	49	29	8	18	44
C:	54	119	45		43	72
p value= 0.05				p value= 0.04		

Normal BMI/high income				Over weight/high income		
	n	N	%	n	N	%
I:	24	82	29	21	30	70
C:	54	165	33	33	47	70
p value=0.07				p value=		

Weight Retention at 1 year

	m	sd	n		
I	0.59 kg	4.75	179		
C	1.31	5.60	381		
	P=0.04				

More than 2.27 kg retained at one year postpartum

	all	Low/ normal wt	Low income and overwt	High income and normal wt	High income/ overwt
I	31%		2.5.5%	24%	
C	38%		55%	36%	

and 359 control subjects were available for analysis.	locally and keep the infant • gave birth to a live, singleton, term infant.	**Control:** Historical control group from previous observational study	

P=	0.11	1.98	0.04	0.07	1.98

DIET AND PHYSICAL ACTIVITY

Exercise NR
Diet or Calorie intake: NR

INFANT OUTCOMES

Infant outcomes (post natal/long term)

Outcome	Normal Weight	
	I (n=179)	C (n=381)
Weeks gestation at delivery	NR	
Infant birth weight (g)	3610	3621
Low birth weight **	2	3
Macrosomia*	32	83
Child obesity	NR	

p value/confidence interval NR
* over 4000g
**under 2500

MATERNAL OUTCOMES

Mother Outcomes (antenatal) NR

Outcome		
	I (n=)	C (n=)
Pre-term delivery	-	
Caesarean	-	
Preeclampsia	-	
Maternal hypertension	-	
Gestational diabetes	-	

p value/confidence interval

			Mother Outcomes (post natal/long-term outcomes) Outcome I (n=179) C (n=381) Weight retention kg 0.59 (4.75) 1.31 (5.6) Breast-feeding rates NR Diabetes NR p value= 0.14 Quality of Life: NR Attendance and use of health services: NR	

2.4 Case-Series Studies

Study Details	Participant characteristics	Intervention Characteristics	Results	Comments
Galletly *et al.*, 1996 (not graded) **Study design**: non-experimental, descriptive **Objective:** improve pregnancy rates among infertile obese women. **Location*:*** Australia **Recruitment:** referred by their treating clinic **Length of Follow Up:** 21-36 months Follow-up was available for 36 months (group l) 27 months (group 2) 22 months (group 3) **Loss to follow-up:** 21 women dropped out. five women did not complete the program as they became pregnant while attending the group, other remaining women changes to work or social	**Number of patients:** 37 obese infertile women **Mean Age*:*** 31.3 (4.6) **Previous Pregnancies:** NR **Pre-pregnancy BMI:** 37 **History of physical activity**: NR **History of weight management**: NR **Education**: NR **Ethnicity**: NR **Gestational age** at enrolment: NA **Baseline comparability:** NR **Inclusion Criteria**: NR **Exclusion Criteria**: NR	**Intervention:** The program lasted for 24 weeks: • Attend hospital for 2 hours per week for program • The group program consisted of an hour of exercise,followed by a one hour group session with either the psychiatrist, the dietitian, or the reproductive medicine specialist. • Group discussion on topics such as coping with the psychological impact of infertility, developing healthy eating patterns, and the effects of obesity on reproductive physiology • The psychiatric input included information and group discussions about the psychological impact of infertility, identifying abnormal eating behavior, and developing alternative coping strategies. • Group cohesion, interaction, and	**WEIGHT OUTCOME MEASURES** Total Weight at start (kg) m sd n Base 98.5 18.7 37 p value= nr BMI at start m sd n Base 37 6.7 37 p value= nr Total Weight Loss (kg) m sd n I: 6.2 4.5 37 p value=0.001 BMI reduction at end m sd n Base 2.4 1.7 37 p value= 0.001 Exceeded IOM guidelines at some point in pregnancy NR Percentage total weight gain exceeded IOM guidelines NR **DIET AND EXERCISE OUTCOME MEASURES (ALL NR/NA)** Exercise NR Diet or Calorie intake NR **INFANT OUTCOME MEASURES (ALL NR)** Weeks gestation at delivery Infant birth weight (g)	Twenty-nine women became pregnant during the follow-up period (21–36 months). No fertility treatments during 24 weeks of programme. There was a significant improvement in all psychological measures. Self-esteem rose from a mean score of 19.3 f 6.4 to 21.3 -t 4.9 ($p < 0.01$). Mean anxiety scores decreased from 6.7 + 3.3 to 5.6+-3.4 ($p < 0.011$, and mean depression scores reduced from 4.1 -t 2.8 to 2.2 f 1.9 ($p < 0.001$). The mean score on the GHQ reduced from 3.9 + 6.2 to 1.5 * 3.5

circumstances. No differences in drop outs		support were encouraged. The dietitian stressed the need to develop lifelong healthy eating patterns, rather than undertake drastic calorie reduction diets. This approach to weight loss has been shown to be associated with raised self-esteem and reduction in depression. The reproductive medicine specialist explained the hormonal effects of obesity, and provided information about infertility and treatment procedures. **Groups:** 1. The first group (N = 10) consisted of women who were not achieving ovulation despite the use of large doses of hMG. 2. The second group (N = 10) consisted of women who had completed at least one cycle of IVF treatment. Prior to entering the group, these women had undertaken a total of 66 cycles of IVF treatment, resulting in three pregnancies and one live birth.	Low birth weight (under 2500g) Macrosomia (over 4000g) Childhood Obesit **MATERNAL OUTCOME MEASURES (ALL NR)** Pre-term delivery Caesarean Preeclampsia Maternal hypertension Gestational diabetes Weight retention Breast-feeding rates Quality of Life Attendance and use of health services	($p < 0.02$). There was a correlation between the change in self-esteem and depression scores ($p < 0.11$, self-esteem and GHQ scores ($p < 0.011$, self-esteem and anxiety scores ($p < 0.51$, and depression and GHQ scores ($p < 0.1$). There was no significant correlation between change in psychological measures and change in weight or BMI. Similarly, there was no difference in initial weight, BMI, or psychological scores, or in the amount of change in these measures, between women who became pregnant and those who did not.

		3. Third group (N = 17). Women with infertility due to a number of different causes were included in the		
Mendelson *et al.*, 1991 (not graded) **Study design:** retrospective non-experimental **Objective:** assess impact of intervention programme on dietary changes and birth outcomes of underweight (BMI under 20) and overweight (BMI over 28) expectant mothers **Location*:*** Canada **Recruitment:** active clients in the program and archives from old clients **Length of Follow Up:** Until birth, but postpartum visit occurred **QUALITY** Randomisation: NA	**Number of patients:** Under weight: 43 Over weight: 29 **Mean Age*:*** 22.9 **Previous Pregnancies:** NR **Pre-pregnancy weight (kg):** Under weight: 46.2 (sd 5.09) Over weight: 89.4 (sd 18.7) **History of physical activity:** NR History of weight management: NR **Education:** not completed high school:70% completed high school: 26% Post secondary: 4% **Ethnicity:** NR **Gestational age** at enrolment: NR	**Intervention:** • Healthiest baby possible (HBP) programme • Dietitian home visits • HPB completion with 1 post partum visit • 24 hour food diary recalls • 6 or more recalls per client Control: No comparative group was available	**WEIGHT OUTCOME MEASURES** **Total Weight Gain (kg)** m sd n Under 13.84 5.15 43 over 10.22 6.74 29 p value= 0.01 Exceeded IOM guidelines at some point in pregnancy: NR Percentage total weight gain exceeded IOM guidelines: NR **DIET AND EXERCISE OUTCOME MEASURES** **Exercise:** NR **Diet or Calorie intake:** Changes in food scores during the intervention programme revealed significant improvements p value/confidence interval 0.01 Over weight woman had the most dramatic improvement; however both groups achieved similar improvements by the end of the intervention **INFANT OUTCOME MEASURES** **Infant birth weight range (g)** Range under 2211-	

Allocation Concealment: NA Blinding: NA Intention to treat: NA Loss to follow-up: NR	**Baseline comparability:** Clients in the program differ significantly than women not in the program. Clients are younger, single, not as educated, and lacking economic resources **Inclusion Criteria:** above or below BMI ranges of 20-27 part of HBP programme		5613 over 1843-5301 p value: NR **Low birth weight (under 2500g)** n N % under 6 43 14 over 2 29 6.9 p value: NR **Macrosomia (over 4000g)** n N % Under 2 43 4.7 over 2 29 6.9 p value : NR Weeks gestation at delivery: NR Childhood Obesity: NR **MATERNAL OUTCOME MEASURES** Pre-term delivery: NR Caesarean: NR Preeclampsia: NR Maternal hypertension: NR Gestational diabetes: NR Weight retention: NR Breast-feeding rates: NR Quality of Life: NR Attendance and use of health services: NR	

2.5 Observational Studies

Study Details	Participant characteristics	Characteristics of two groups	Results	Comments
Bergmann *et al.*, 1997 (++) **Study design:** Longitudinal **Purpose:** To investigate whether BMI is related to energy intake during pregnancy and whether BMI, energy intake and other factors are related to net weight gain **Location***:* Germany **Recruitment:** The target population of this study consisted of all pregnant women in a small rural area **Length of Follow Up** End of pregnancy	**Number of patients:** 156 **Mean Age*:*** ≤21 y n =45 22-26 y n= 63 ≥27 y n = 48 **Previous Pregnancies:** Parity = 0 n= 87 Parity ≥ 1 n = 69 **Education: (years):** General school only n=17 Vocational school n= 95 Trade, medical school, university n=44 **Ethnicity:** nr **Inclusion Criteria:** Pregnant women with a singleton pregnancy, no medical complications at first clinic visit and onset of pregnancy less than 12 weeks before the first prenatal visit	Medium BMI group 20-24 kg/m^2 (n=75) Low BMI (n=40) High BMI (n=41)	Women at the highest level of BMI were significantly less often in the high energy intake category than women at the medium or low level of BMI (15% vs 36% and 48%). Net weight gain during pregnancy was independently influenced by BMI status and energy intake. Women at the highest level of BMI gained significantly less weight (4.2KG) from first to third trimester than women at the medium or low levels of BMI (weight gains of 6.2 kg and 5.9 kg respectively . Women with a low daily energy intake gained 4.6 kg during pregnancy, while women with medium and high energy intakes gained 6.0 kg and 6.1 kg respectively. Examination of net weight gain simultaneously across BMI and parity groups revealed a much lower net weight gain among multigravid women at the highest BMI level (3.3 kg). The mean birth weight in the three BMI groups did not differ and was not influenced by age, marital status, education , parity or smoking. The authors conclude that a lower caloric diet may help to accomplish a lower weight gain during pregnancy in overweight women without increased risk of low birth weight infants.	
Bungum 1999 (+) **Study design:** observational – cohort study retrospective **Location*:*** USA	**Number of patients:** 164 recruited. 137 included in analysis 27 lost excluded **Mean Age*:*** Active n=44 29.6 (3.3) Sedentary n= 93 28.4 (4.6)	Participants self reported the average number of times they had engaged in selected physical activities at least 3 times per week for at least 20 minutes during each trimester	**WEIGHT OUTCOMES** BMI Baseline: Active m 21.5, sd (3.1), n 44; Sedentary m 23.1, sd (3.85), n 93; p value= NS Change: Active 5.61, 1.5, 44; Sedentary 5.94, 2.1, 93	

Objective: Assess differences in rates of caesarean vs vaginal delivery among women who were physically active during the first two trimesters of pregnancy and those who were not. A secondary objective was to investigate the association of maternal physical activity during pregnancy and newborn birth weight.

Recruitment and Length of Follow Up:

Data were collected over an 8 week period during the spring of 1997

When was data collected:
Initial data collected before the delivery and a follow-up phone call was made approx 2 weeks after the expected delivery date. The first data collection involved participant completion of a 31

Previous Pregnancies: nulliparous

Pre-pregnancy BMI:
Active: 21.5 (3.1)
Sedentary: 23.1 (3.85)

Pre-pregnancy weight:
Active: (lb) 130.4 (21.5)
Sedentary: 138.9 (26.3)

History of physical activity:
Active: nr

History of weight management: nr

Education: (years):
Active 15.9 (1.5)
Sedentary: 15.1 (1.7)

Gestational age at enrolment:
NR

Baseline comparability:
Group differences small but active women has slightly more years of education and had lower pre-pregnancy BMIs

Ethnicity: predominantly white n=112 82%)

Inclusion Criteria
- Non -smokers
- Expecting a singleton birth
- Aged 17 to 40 years at the time of delivery.

Active
Exercising at least three times per week for 20 minutes per session, during the first two trimesters of pregnancy.

44 women who were active during pregnancy participated in various types of exercise. These included brisk walking (n=33, 75%) and aerobics/exercise class (n=15; 34.1%).

The majority of the participants who were active during pregnancy also had been active before pregnancy (n=35; 79.5).

Sedentary
37 (39.8%) had exercised at least 3 times a week before becoming pregnant.

INFANT OUTCOMES

Infant outcomes (post natal/long term)

Outcome (dichotomous)	Active (n=44)			Sedentary (n=93)			
	N	n	%	N	n	%	
Low birth weight Macrosomia Child obesity	No significant difference						

MATERNAL OUTCOMES

Mother Outcomes (antenatal) Dichotomous

Outcome	Active (n=44)			Sedentary (n=93)			
	n	N	%	n	N	%	
Pre-term delivery							
Caesarean	7	44	16%	26	93	28%	p = 0.023
Preeclampsia							
Maternal hypertension							
Gestational diabetes							

Quality of Life: NR
Attendance and use of health services : NR

item written survey. The survey included information about age, ethnic background, marital status, a brief medical history, and anticipated due date. During the follow-up telephone call, mothers were asked the date of birth, birth weight, gender, the number of weeks of gestation, the mother's weight, gender, number of weeks of gestation, mother's weight at the last check-up before giving birth, whether the labour had been induced, whether an episiotomy had been performed, forceps, vacuum extraction, epidural or method of birth. **How recruited*:*** women who attended hospital-based childbirth education classes or a private fitness center that offered a prenatal aerobic exercise program.	**Exclusion Criteria** • Gestational diabetes • Preeclampsia • High blood pressure • Abnormal bleeding during pregnancy • More than 23 weeks gestation			

Campbell *et al.*, 2001 (+) **Study design:** case control. Self completed questionnaire completed 2 weeks postpartum **Objective:** investigate impact of exercise and occupational activity on birth weight **Location***:* Canada **Recruitment:** delivery room logs. Approached on first day postpartum **Length of Follow Up**: post partum survey	**Number of patients:** 164 cases 365 controls **Mean Age***:* NR **Previous pregnancies:** 37.4% primiparous **Pre-pregnancy BMI:** (n=523) <21: 161 (30.6%) 21-25: 223 (42.4%) ≥25 142: (27.0%) **Self-described pre-pregnancy fitness level** (n=528) Do not know 28 (5.3%) Less than average 79 (15.0%) Average 298 (56.4%) Greater than average 123 (23.3%) **History of weight management:** NR **Education**: 64.4% had a post-secondary education **Ethnicity:** NR **Gestational age** at enrolment: ≥34 weeks **Baseline comparability:** matched subjects by maternal age and postcode **Inclusion Criteria:** NR	**Case:** Case subjects were those with birth weights at <15th percentile for gestational age. The choice to use this criterion was based on the following three considerations: 1. The choice of any cut-off point on the distribution of birth weights is arbitrary, and we were seeking to compare smaller with larger babies. 2. The 15th percentile is more practical than the 10th percentile in terms of sample size accrual. 3. It is reasonable to assume that the "effect size" introduced by physical activity will be modest, and therefore using a 15th percentile cut-off point will facilitate detection of a modest impact on birth weight. The birth weight distributions used for identifying the cut-off points were Canadian birth weight for gestation distributions **Control:** Control subjects were the	**WEIGHT OUTCOME MEASURES (all NR)** Total Weight Gain (kg) Exceeded IOM guidelines at some point in pregnancy Percentage total weight gain exceeded IOM guidelines **DIET AND EXERCISE OUTCOME MEASURES** Diet or Calorie intake NR **Exercise:** Relative to those who participated in structured exercise 3 or 4 times per week during the third trimester, the odds of lower birth weight were substantially increased for those who exercised ≥5 times per week (adjusted odds ratio, 4.61; 95% confidence interval, 1.73-12.32) and modestly increased for those at the other extreme, who engaged in structured exercise ≤2 times per week (adjusted odds ratio, 2.64; 95% confidence interval, 1.29-5.39). Further analysis Mottola and Campbell 2003: Factors associated with quitting a regular structured exercise program by trimester 3 were having children (OR = 1.67; 1.05, 2.67), a pre-pregnancy BMI of ≥ 25 (OR = 1.79; 1.04, 3.13) and higher weight gain. **INFANT OUTCOME MEASURES (all NR)** Weeks gestation at delivery Infant birth weight (g) Low birth weight (under 2500g) Macrosomia (over 4000g) Childhood Obesity **MATERNAL OUTCOME MEASURES (all NR)** Pre-term delivery Caesarean Preeclampsia Maternal hypertension Gestational diabetes Weight retention Breast-feeding rates	Not all participants answered every question The only exercise variable that reached significance was structured exercise frequency in the third trimester.The odds of giving birth to a low birth-weight infant were substantially increased for those who engaged in structured exercise ≥5 times per week (adjusted odds ratio, 4.61; 95% confidence interval, 1.73-12.32) and were modestly increased for those who exercised <3 times per week (adjusted

	Exclusion Criteria: NR	2 infants with weights at ≥15th percentile, whose births occurred most closely in time to the birth of the case subject and whose mothers were matched by maternal age stratum (<35 and ≥35 years) and by the first 3 digits of the postal code	Quality of Life Attendance and use of health services	odds ratio, 2.64; 95% confidence interval, 1.29-5.39) relative to those who exercised 3 or 4 times per week (optimal outcome). The other factors of importance, once controlled for other factors, were maternal height, pre pregnancy body mass, pregnancy weight gain, smoking in the third trimester, and nulliparity. There were no statistically significant interactions

Cogswell *et al.*,, 1996 (-) **Study design:** Cross sectional telephone survey **Purpose:** To estimate the prevalence and correlates of attempted weight loss among a geographically diverse group of pregnant women in the US **Location*:*** USA **Recruitment:** women who reported that they were pregnant at the time of the survey	**Number of patients:** 1794 **Mean age:** 18-19y n= 122 (6.8%) 20-34y n= 1494 (83.2%) 35-45y n= 178 (9.9%) **Ethnicity:** White: 1423 Black : 178 Hispanic: 112 Other: 12 **Education:** < High school: 151 High school: 668 > High school 975 **Exclusion criteria:** **Gestational age** Women who reported not knowing or being unsure of their pregnancy status **Enrolment:** 1st trimester: 321 (17.9%) 2nd trimester: 692 (38.6%) 3rd trimester: 781 (43.5%) **Prepregnancy BMI:** Low: 210 (11.7%) Medium: 1036 (57.7%) High: 277 (15.4%) Very high: 271 (15.1%) **Parity:** NR	Survey	A minority (3.7%) of women who reported being pregnant also reported trying to lose weight. However, pregnant women who reported both drinking alcohol in the past month and currently smoking had the highest prevalence of attempted weight loss (12.7%) followed by women in their first trimester (9.4%), women with reported diabetes (9.0%) and women with very high BMIs (6.9%). After adjustment for survey design and other characteristics, women in their first trimester were four times more likely to attempt weight loss than those in the third trimester. These results suggest that weight loss attempts among women who report being pregnant are uncommon, but are more likely to occur in the first trimester and possible among women who smoke and drink, have diabetes or are very overweight.	

Cogswell *et al.*, 1999 (+) **Study design** Mail panel questionnaire **Purpose:** To evaluate whether advice on pregnancy weight gain from health care professionals, women's target weight and actual weight gain corresponded with the 1990 IoM recommendations **Location*:*** USA **Recruitment:** Prenatal intake questionnaires were mailed to 3155 households that had pregnant women. **Length of Follow Up**	**Number of patients:** Number reported their pre-pregnancy weight and heights n = 2237 And their actual weight gains n = 1661 **Mean Age*:*** < 17y n= 94 (4.2%) 17-34y n= 1910 (85.4%) 35+ n= 234 (10.5%) **Ethnicity:** White: 2147 (96%) Black: 58 (2.6%) Other: 31 (1.4%) **Education: (years):** <12y: 91 (4.1%) 12y: 658 (29%) 13+y: 1489 (66.6%) **Gestational age** at enrolment: NR **Baseline comparability:** **Exclusion criteria:** • Expected delivery date more than 3 months away or that their infant had already been born. • Infants born less than 5 lb or multiple infants, medical problems that affected feeding, the mother or infant died or the infant was born too early for the neonatal questionnaire to be	No advice n=594 Less than recommended n= 225 Recommended n= 1056 More than recommended n=362	27 % of the women reported that they had received no medical advice about pregnancy weight gain. Among those who received advice, 14% had been advised to gain less than the recommended range and 22% had been advised to gain more than recommended. The odds of being advised to gain more than recommended were higher among women with high BMIs and with very high BMIs compared with women with average BMIs. Black women were more likely than white women to report advice to gain less than recommended. Advised and target weight gains were associated strongly with actual weight gain. Receiving no advice was associated with weight gain outside the recommendations.	

<table>
<tr>
<td></td>
<td>administered on time.
• If questionnaire was missing data on the neonatal questionnaire or did not respond to questions regarding weight gained during pregnancy</td>
<td></td>
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<tr>
<td>Conway et al., 1999
(+)

Study design:
Longitudinal prospective study

Objective:
To explore the relationship between dietary restraint and appropriateness of weight gain during pregnancy .

Location:
UK

Recruitment:
Participants were recruited through a large London hospital. Letters inviting women to take part in a study of dietary habits during pregnancy were sent to women with information about their first antenatal appointment.</td>
<td>Number of patients:
74 met the inclusion criteria, data from 62 is presented

Mean Age:
Restrained eaters: 31.2y n=32
Unrestrained eaters: 30.6 y n=30

Previous Pregnancies:
4 in each group expecting second babies
Remainder expecting their first

Pre-pregnancy BMI:
Restrained eaters: 22 (2.40)
Unrestrained eaters: 20.7 (1.96)

Education (years):
The vast majority of participants were married and belonged to non-manual socioeconomic status groups

Ethnicity: all Caucasian</td>
<td>Groups of restrained and unrestrained eaters formed using the Revised Restraint Scale (RRS) to ascertain eating habits prior to pregnancy. The restrained eaters had a significantly higher mean BMI prior to pregnancy and reported having used more of the eleven methods of weight control listed that the unrestrained eaters.</td>
<td>Dietary intakes of both groups were remarkably similar. However the restrained eaters consumed significantly more alcohol than the unrestrained eaters in both early and late pregnancy.

Restrained eaters were significantly less likely to experience weight gains within the recommended range for their pre-pregnancy B<I (p= 0.026). They gained either more or less weight than recommended. Dietary restraint appears to have undesirable influences on eating and weight gain during pregnancy.

*1 Total weight gain during pregnancy 9kg)
*2 Residual weight gain following delivery (kg)
<table>
<tr><td></td><td colspan="2">Restrained eaters n= 32</td><td colspan="2">Unrestrained eaters</td><td>P - value</td></tr>
<tr><td></td><td>mean</td><td>s.d.</td><td>mean</td><td>s.d.</td><td></td></tr>
<tr><td>*1</td><td>15.2</td><td>4.87</td><td>16.2</td><td>4.01</td><td>0.420</td></tr>
<tr><td>*2</td><td>8.5</td><td>5.18</td><td>6.9</td><td>3.94</td><td>0.121</td></tr>
</table>
Length of gestation did not vary between groups and there was no significant differences between the mean birth weight of the infants born to the restrained and unrestrained groups of women.</td>
<td></td>
</tr>
</table>

Length of Follow Up: Participants were seen on four separate occasions during their pregnancy. **Data collection:** Questionnaire and 7 day weighted diet record. Participants were given a postal form on which to record their weight at the end of their pregnancy and pregnancy outcome data was obtained from computerised hospital records	.			
Gunderson *et al.*, 2004 (++) **Study design:** Cohort study **Purpose:** To prospectively evaluate whether childbearing leads to development of overweight in women and to evaluate the role of other known risk factors. **Location*:*** USA **Recruitment:** Recruited form a larger cohort study **Length of Follow Up** 1986 – 1996 subjects	**Number of patients:** 998 **Mean Age*:*** 18-30 years **Ethnicity:** Black: 32.8% White: 67.1% **Previous Pregnancies:** All nulliparous **Pre-pregnancy BMI:** None were overweight at baseline **History of weight management:** Dietary intake and history of weight cycling were measured at baseline. **Education (years):**	**Became overweight** Black: 175/328 (53%) White: 183/670 (27%) **Not overweight** Black: 153/328 (46.6%) White: 487/670 (72.6%) Relative odds for incident overweight (BMI ≥ 25k/m^2) associated with parity change (0,1 or 2+) and risk factors were estimated using discrete-time survival models adjusted for baseline and time-dependent covariates.	For the majority of women initiation of childbearing is associated with development of overweight. In multivariate adjusted models risk was increased for: black vs white race (OR 3.49; 95% CI: 2.59 to 4.69) never smokers (OR 2.66 95% CI 1.80 to 3.93) frequent weight cycling (OR 1.45 CI: 1.03 to 2.04 high school education or less (OR 2.21 95% CI 1.50 to 3.26) factors that reduced risk were: current smokers (OR 0.41, 95% CI 0.17 to 0.96) highest physical activity quartile (OR 0.62 95%CI 0.43 to 0.90	

examined at baseline and in follow-up years 2,5,7,10	High school or less Black: 122/328 (37.2%) White: 112/670 (16.7%) 4+ years of college Black: 68/328 (20.7%) White: 358/670 (53.4%) **Inclusion criteria:** • Premenopausal • nulliparous • normal weight BMI < 25 kg/m^2.			

Horns *et al.,* 1994 (+) **Study design**: non-experimental, descriptive **Objective:** describe the relationship between exercise and physiological outcomes of mothers and newborns during the last trimester **Location*:*** USA **Recruitment:** convenience sample. Obstetrics private practice and Lamaze classes **Length of Follow Up**: soon after delivery	**Number of patients:** 48 Sedentary 53 active **Mean Age*:*** Sedentary: 27.2 (3.8) Active: 28.4 (4.1) **Previous Pregnancies:** All subjects primiparous **Pre-pregnancy BMI**: NR **History of physical activity:** NR **History of weight management**: NR **Education: n (%)** *Sedentary:* High school- 8 (15) Some college- 19 (36) BA/BS- 21 (40) Post bachelor- 5 (9) *Active:* High school- 6 (12) Some college 11 (23) BA/BS- 18 (38)	**Active Group:** Performed activities continuously for at least 15-30 minutes 14 women were active at least 3 times per week for at least 15 continuous minutes 28 women were active at least 5 times per week for at least 15 continuous minutes Brisk walking was popular with 47% of women, followed by swimming and dance by less than 10% of women **Sedentary Group:** Those who performed activities for less than the suggested time. 47 women reported no regular physical activity over 15 continuous minutes	**WEIGHT OUTCOME MEASURES** **Total Weight Gain (kg)** m sd n Sedentary 17.3 5.9 53 Active 16.3 5.3 48 p value= Exceeded IOM guidelines at some point in pregnancy NR Percentage total weight gain exceeded IOM guidelines NR **DIET AND EXERCISE OUTCOME MEASURES** Exercise NR Diet or Calorie intake NR **INFANT OUTCOME MEASURES** **Weeks gestation at delivery** m sd n Sedentary 39.2 4.3 53 Active 39.9 1.4 48 p value NR **Infant birth weight (g)** m sd n Sedentary 3467 434 53 Active 2496 486 48	Apgar scores reported for vaginal delivery and caesarean

<table>
<tr>
<td></td>
<td>Post bachelor- 12 (25)

Ethnicity: n (%)
Sedentary:
White- 50 (94)
Non-White- 3 (6)
Active:
White- 43 (90)
Non-White-5 (10)
Gestational age at enrolment: 32 weeks

Baseline comparability:
Similar in terms of age, marital status and ethnicity. Differ in terms of education.

Inclusion Criteria:
• 20-30 years of age
• No pre-existing medical conditions
• 32 weeks of gestation or more

Exclusion Criteria: NR</td>
<td></td>
<td>p value/confidence interval

Low birth weight (under 2500g) NR
Macrosomia (over 4000g) NR
Childhood Obesity: NR

MATERNAL OUTCOME MEASURES

Pre-term delivery
Caesarean
<table><tr><td></td><td>n</td><td>N</td><td>%</td></tr><tr><td>Sedentary</td><td>17</td><td>48</td><td>32</td></tr><tr><td>Active</td><td>12</td><td>53</td><td>25</td></tr></table>p value 0.62

Preeclampsia NR
Maternal hypertension NR
Gestational diabetes NR
Weight retention NR
Breast-feeding rates NR
Quality of Life: NR
Attendance and use of health services: NR</td>
<td></td>
</tr>
<tr>
<td>Löf 2008 (++)

Study design: prospective cohort study

Location: Sweden

Objective: To assess the relationships between pre-</td>
<td>Number of recruits: 223

Mean Age:32 (4)

Nulliparous: 148 (66%)

Pre-pregnancy weight: 23.8 (3.3)</td>
<td>Physical activity
Women were classified as having a low, medium or high pre pregnancy PAL

PAL is the ratio between total and basal energy expenditure.</td>
<td>Total Weight Gain (kg)

<table><tr><td></td><td>Low PAL</td><td>Medium PAL</td><td>High PAL</td></tr><tr><td>2nd trimester</td><td>No diff</td><td>No diff</td><td>No diff</td></tr><tr><td>3rd trimester</td><td></td><td></td><td>0.10kg/week less weight than women with medium PAL or low PAL (p=0.06)</td></tr></table>BMI was inversely associated with GWG during the second trimester (-</td>
<td></td>
</tr>
</table>

pregnancy physical activity (PAL) level, BMI and GWG during the second and third trimester and to determine the effects of pre-pregnancy PAL, BMI and GWG on birth weight **Recruitment:** at maternity units in Stockholm **Length of Follow Up:** to delivery	**Education (years):** university degree 132 (59%) **Ethnicity:** NR **Inclusion Criteria:** Women seeking prenatal care before gestational week 12 **Exclusion Criteria:** NR	Weight measured in gestational weeks 12, 25 and 33 using SECA scales.	0.06kg/week for an increase in maternal BMI of 5 kg/m^{2}p=0.005). However, during the third trimester we found a positive association between BMI and GWG. Therefore, an increase of 5 kg/m^2 in BMI was associated with a 0.05kg/week higher GWG (p=0.03) Excessive GWG ranged from 53% among obese women during the second trimester to 87% among overweight women during the third trimester. Both high BMI and total GWG were linked to high birth weight Pre-pregnancy PAL and BMI play only a minor role in explaining the variation in GWG therefore identification of other determinants of GWG is urgently needed.	
Mumford 2008 (+) **Study design:** observational – cohort study. prospective **Objective:** To determine whether a history of pre-conceptual dieting practices and restrained eating was related to higher weight gains in pregnancy and whether this differed by pregravid BMI status. **Location*:*** USA	**Number of recruits:** 1,223 **Mean Age*:*** majority aged between 20-30 years **Nulliparous:** 599/1223 (49%) **Pre-pregnancy weight:** Underweight: 171/1223 (14%) Normal: 624/1223 (51%) Overweight: 135/1223 (11%) Obese: 294/1223 (24%) **History of physical activity: NR**	To assess behaviour associated with restrained eating, such as history of dieting, concern about eating too much food and weight fluctuations the Revised Restraint Scale was used. Two subscales also used, the Concern with dieting subscale and weight cyclers subscale calculated by summing scores from questions regarding typical weight fluctuation in the non pregnancy state. For each scale comparisons were	Observed weight gain exceeded the expected by 52%. Restrained eating behaviour were associated with weight gains above IOM recommendations. The effect of restrained eating on maternal weight gain varied by BMI status. Restrained eaters and dieters in the normal, overweight, and obese categories tended to gain in excess of recommendations whereas underweight women gained less when compared to women who did not display restrained eating behaviours. Estimated weight gain and 95% confidence intervals from adjusted multiple linear regression models for three restrained eating subscales.	Pre-pregnancy weight was self-reported at screening and weight was measured at each subsequent prenatal visit. Total gestational weight gain was then calculated by subtracting pre-pregnancy weight from the weight at the last prenatal visit.

<table>
<tr>
<td>Recruitment:
Women were recruited from both public and private prenatal clinics. Study staff recruited women at their second prenatal visit (mean gestation age of 14weeks) and before 20 weeks gestation.

Length of Follow Up: NR</td>
<td>History of weight management:
51% classed as dieters pre-pregnancy

Education: (years):
High school (20%)
Some college (47%)
College graduate and beyond (33%)

Gestational age at enrolment:
NR

Ethnicity:
White: (73%)
African American (19%)
Other (8%)

Inclusion Criteria: NR

Exclusion Criteria:
Younger than 16 years
Non-English speaking
Not planning to continue care of deliver at the study site
Carrying multiple gestations</td>
<td>made between women with scores above and below the median.</td>
<td>Total Weight Gain (kg)
<table>
<tr><th></th><th colspan="3">Restrained eaters</th><th colspan="3">non-restrained eaters</th><th></th></tr>
<tr><th></th><th>m</th><th>CI</th><th>n</th><th>m</th><th>CI</th><th>n</th><th>P value</th></tr>
<tr><td>underweight</td><td>14.42</td><td>12.44-16.40</td><td>34</td><td>15.40</td><td>14.33-16.47</td><td>128</td><td>0.388</td></tr>
<tr><td>normal</td><td>18.03</td><td>17.25-18.81</td><td>252</td><td>15.53</td><td>14.84-16.23</td><td>323</td><td>0.000</td></tr>
<tr><td>overweight</td><td>16.37</td><td>15.03 – 17.71</td><td>78</td><td>14.78</td><td>12.89-16.66</td><td>45</td><td>0.168</td></tr>
<tr><td>obese</td><td>12.53</td><td>11.62-13.44</td><td>21</td><td>10.60</td><td>9.04-12.16</td><td>61</td><td>0.030</td></tr>
</table>
<table>
<tr><th></th><th colspan="3">Dieters</th><th colspan="3">Non-dieters</th><th></th></tr>
<tr><th></th><th>m</th><th>CI</th><th>n</th><th>m</th><th>CI</th><th>n</th><th>P value</th></tr>
<tr><td>underweight</td><td>14.11</td><td>12.44-15.79</td><td>56</td><td>15.10</td><td>13.83-16.38</td><td>113</td><td>0.293</td></tr>
<tr><td>normal</td><td>16.99</td><td>15.98–18.00</td><td>299</td><td>15.26</td><td>14.30-1.23</td><td>315</td><td>0.000</td></tr>
<tr><td>overweight</td><td>16.25</td><td>14.74-17.75</td><td>81</td><td>13.50</td><td>11.83-15.18</td><td>54</td><td>0.007</td></tr>
<tr><td>obese</td><td>12.83</td><td>11.73-13.93</td><td>180</td><td>10.33</td><td>8.97-11.70</td><td>113</td><td>0.001</td></tr>
</table></td>
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<tr>
<td>Olson 2003 (++)

Study design:
Prospective cohort study

Purpose:
Women followed from early pregnancy until 2 years postpartum.</td>
<td>Number of recruits:
622 healthy adult women who gave birth to live singleton infants. Subjects were recruited from all women who registered for prenatal care in a hospital and primary care clinic system serving a 10-county area of Upstate</td>
<td>Change in activity since pregnant

Change in amount of food eaten in pregnancy

Number of fruits and vegetables per day in</td>
<td>Participants exceeding IOM guideline:
<table>
<tr><th>Initial BMI</th><th>Participants exceeding IOM guideline n (%)</th></tr>
<tr><td><19.8 low</td><td>6 (11.1)</td></tr>
<tr><td>19.8 – 26.0 normal</td><td>108 (36.9)</td></tr>
<tr><td>26.1-29.0 high</td><td>65 (70.7)</td></tr>
<tr><td>>29.0 obese</td><td>64 (41.0)</td></tr>
<tr><td>Total</td><td>243 (40.8)</td></tr>
</table>
Only 38% of women gained an amount of weight in pregnancy that was</td>
<td>Body weight and height were measured following study protocols. GWG and early pregnancy BMI were calculated using the initial weight measured at the first prenatal visit for 547 women who entered</td>
</tr>
</table>

Data were collected through mailed questionnaires and an audit of the medical record. To examine modifiable behavioural and psychosocial factors along with relatively non-modifiable biomedical and sociodemographic characteristics in relation to GWG. **Location*:* USA** **Recruitment:** from the population of women who registered for obstetrical care in a hospital and primary care clinic system serving a 10 county area. **Length of Follow Up:** 2 years	New York **Mean Age*:*** majority between 20-30 **Nulliparous:** 257/622 (41.3%) **Ethnicity:** NR **Inclusion Criteria:** • Entered prenatal care before the third trimester • Aged 18 years or over • Planned to deliver within the local hospital and keep the baby • Were healthy and mentally competent • Only women who gave birth to live singleton infants	pregnancy	within the range recommended by the IoM. In this research we examined three behaviours related to GWG; food intake, physical activity and cigarette smoking. Decreased physical activity in pregnancy was associated with significantly greater gestational weight gain (2.74 lb p<0.01) than maintaining or increasing physical activity. Consuming much more and les food during pregnancy than prior to pregnancy were associated with greater (3.67 lb p<0.001) and less (-3.16lb, p<0.05) gestational weight gain respectively compared with maintaining similar levels of food intake. Women who consumed three or more serving of fruits and vegetables per day gained significantly less weight (-1.82 lob p<0.05) than those who consumed fewer servings during pregnancy. Low social support among now, normal and obese BMI women was associated with significantly more weight gain (2.81 lb p<0.01 than that of their counterparts with average or high social support gained significantly less weight (-3.11 lb; p=0.15) relative to high BMI women with average or high social support.. Family income of less than 185% the federal poverty line were approximately 2.6 times more likely to exceed the top of the IOM gestational weight gain range than women with higher incomes.. Income was not as important as influence on gestation weight gain among women who reported that they increased their food intake substantially during pregnancy.	the study during the first trimester and for the 75 who joined the study in the second trimester of their pregnancies their initial weight was adjusted to the 9 to 11 week interval.

Sternfeld 1995 (-) **Study design:** Prospective cohort design **Objective:** To follow a cohort of women throughout their pregnancy to determine the relationship of aerobic exercise, performed at or above a minimal conditioning level to birth weight, symptoms of pregnancy and other pregnancy outcomes. **Location*:*** USA **Recruitment:** Women were recruited from the population of women seen for an initial prenatal visit at a large prepaid health maintenancy organization in the USA. Participants were self selected. **Length of Follow Up:** up till birth	**Number of recruits:** 529 enrolled and 388 women included in the final analyses. **Mean Age*:*** 31.7 (5) **Nulliparous:** 51.5% **Pre-pregnancy weight: NR** **History of physical activity: NR** **History of weight management:** **Education: (years):** 59.5% college graduates **Gestational age at enrolment: NR** **Ethnicity:** 77.1% white 10.3% African-American 7% Asian American 5.7% Hispanic **Inclusion Criteria:** Participants were recruited from the population of women seen for an initial prenatal visit **Exclusion Criteria: NR**	Women were questioned about their exercise at three different times during pregnancy, using a quantitative exercise history. Frequency, duration and mode of aerobic exercise were recorded and for each time period women were categorized into one of the following exercise groups: 1. Level 1= aerobic exercise, excluding vigorous walking at least three times a week for at least 20 min a time. 2. Level II- aerobic exercise at least three times a week and 20 min at a time only if vigorous walking is included. 3. Level III = consisted of women participating in aerobic exercise including walking at least once a week, but less than levels I and II. 4. Level IV were the women doing no aerobic exercise or doing it less than once a week.	Mean birth weight was statistically unrelated to level of exercise pre-conceptially or in any trimester. Gestational age, weight gain and other pregnancy outcomes were not associated with exercise level. However, pregnancy symptoms were inversely associated with level of exercise, women who exercise more earlier in pregnancy reported fewer discomforts later in pregnancy p= 0.01.	

Symons Downs & Hausenblas, 2007 (+) **Study design** Longitudinal study **Purpose:** To a)prospectively examine women's third trimester exercise intention and behaviour using the theory of planned behaviour (TPB) and b) to examine group differences across the TPB constructs, BMI, and birth outcomes for women exercising and not exercising during their third trimester. **Location*:*** USA **Recruitment:** Women asked at their first prenatal visit if they would like to participate in a study examining their exercise thoughts and feelings during their pregnancy and postpartum. **Length of Follow Up** Participants were sent surveys in first and second and third trimester. 62 returned the second trimester	**Number of patients:** 62 **Mean Age*:*** 30.44 (sd 4.64) **Previous Pregnancies:** nr **Education (years):** 88.7% had a college education 59.7% % worked full-time 75.8% % had a family income of $40,000 or higher **Ethnicity:** 91.9% Caucasian 3.2% Asian 1.6% African American 3.3% 'other' **Gestational age** at recruitment: < 30 weeks	Exercising in third trimester (n=41) Not exercising in third trimester (n=18)	No significant difference was observed for third trimester BMI between women exercising and not exercising during their third trimester. BMI compared to women not exercising during their third trimester of pregnancy. Women exercising during their third trimester delivered significantly longer and heavier babies compared to women not exercising during their third pregnancy trimester. No significant difference in reporting the number of total complications during labour/delivery was found between women exercising vs not exercising.	

survey representing a 70% response rate from the second trimester and a 50% response rate from the first trimester.				
Taffel *et al.*, 1993 (-) **Study design** Survey **Purpose:** Information for the 1988 National Maternal and infant Health Survey makes it possible to examine changes in medical advice on weight gain during the 1980's, to see how closely medical advice in 1988 matched the then current standard of 22 to 27 pounds as well as the new 1990 IoM guidelines and to determine how closely pregnant women heeded the medical advice given them. **Location*:*** USA **Recruitment:** Postal questionnaires and telephone	**Number of patients:** 2181 **Ethnicity**: White: 1575/1771 (88.9%) Black:119/1771 (6.7%)		12% of white mothers reported advice that did not meet the minimum standard in effect in 1988 and 19% reported advice that did not meet the minimum 1990 IOM guideline for their weight and height. A significantly higher proportion of black mothers reported advice of less than 22 pounds (33%) or the IOM minimum (34%). The far more frequent inappropriate advice reported by black than white mothers cannot be explained by differences in BMI, age, education , parity, marital status or site of care. Compliance with advice was almost the same for black and white mothers: more than 70% gained at least 22 pounds when this was the reported weight gain advice.	

interviews from a sample of women who had registered live births in the USA in 1988				

2.6 Qualitative Studies

	Study Details	Participant characteristics	Intervention /Method Characteristics	Results	Comments
1	(++) **Clarke & Gross** **Gross & Bee** **Design:** Interviews Interview & survey **Location:** UK **Year:** 2004 **Funding:** Not specified **Aims:** To examine the potential effect of low-risk pregnancy on women's recreational activity patterns and to explore pregnant women's beliefs and information sources regarding physical exercise participation.	**Sample:** 51 **Age:** <20 =7 (12%) 21-24 = 19 (33%) 25-29 =14 (23%) 30-34 = 15 (27%) 40+ =2 (4%) Range 15.7 to 38.2 years (mean 26.3 SD 5.2) **Previous pregnancies:** No previous pregnancy = 40 (70%) Previous miscarriage = 10 (18%) Termination = 7 (12%) **Marital Status:** Married = 37 (65%) Cohabiting = 8 (14%) Single = 12 (21%) **Education:** Up to 16 years = 32 (55%) 16-18 years = 14 (25% Tertiary / professional = 11 (19%)	**Data Collection:** Interviews at 16, 25, 34, and 38 weeks gestation lasting 1.5 hours (recorded) Survey using Baecke questionnaire, 10-item maternal beliefs scale and the fetal health locus of control (FHLC) scale. Open-ended questions included. **Data analysis:** Open-ended questions were analysed by sorting the data into emergent themes.	**Physical activity before pregnancy** 46% (80%) reported that they generally enjoyed physical activity prior to pregnancy 36 (63%) reported engaging in some form of sport or exercise activity before becoming pregnant (of these, 28 weekly participation in moderate intensity). **Physical activity during pregnancy** No women reported increasing their physical activity during pregnancy Those who reported participating on 2 or more occasions at interview scored sig higher on pre-pregnancy Baecke sporting index (mean score 3.14 SD 0.57) compared to those that stopped exercise during pregnancy (2.67 SD 0.40), and lower on internal dimension of the FHLC (34.06 SD 4.61). **Factors influencing physical activity** Between 16 and 38 weeks gestation, 36 (63%) women reported having ceased or reduced exercise due to physical limitations; 30 (52%) said they were responding to advice and 18 (32%) referred to risks or dangers that they believed to be associated with such activity. 7 (13%) cited a reduced motivation for exercise and 3 (5%) referred to difficulties in finding an appropriate facility or area in which to exercise. Most women cited more than one factor. *Risk:*	These two papers are reporting on the same study, therefore findings are presented together to prevent duplication.

				18 referred to risk; 16 of whom (88%) provided specific details: Participation in exercise would lead to an increase in falls or muscular strain (11) Concern for the health of their unborn baby (5) – 2 with physical development, 2 with risk of miscarriage, 1 with premature birth (tailored activity to place needs of baby before their own (see quote)) **Importance of physical activity** At 16 weeks, 45 (81%) rated getting a good night sleep as very important (many as important as not smoking or drinking) Only 11 / 14 women rated active living and exercise as important (19% / 25%); sleep was rated as more important than both ($p<0.001$ in both cases). **Sources of advice** Positive responses to this question declined over time; 96% indicated they had received advice at least once during their pregnancy, 49% on three or more occasions. 38 women at 16 weeks gestation (67%) reported reading as their main method of acquiring information. Main sources included free publications issued at antenatal clinics (e.g. the Pregnancy Book, HEA 1999) and commercial books and magazines. 10 women (18%) reported receiving advice directly from the health professionals involved in their care. Analysis of open-ended questions suggested that information from all these sources was often unclear. 22% of	

				women reported that they had often been met with a confusing array of recommendations. (see quotes re contradictory advice from different health professionals and vagueness of advice within books). By 25-38 weeks gestation, most of the advice received came from family and friends (47% at 16 weeks, 51% at 25 weeks, 35% at 34 weeks, 39% at 38 weeks). Those who reported receiving advice in this way tended to be older, with more years education and a higher pre-pregnancy activity level. On each occasion, family discouragement of activity vastly outweighed family encouragement. At 25 weeks gestation 59% of the women reporting that they received advice from family and friends indicated they had mostly been discouraged from being more active. At 34 and 38 weeks this proportion had risen to 85% and 80% respectively.	

2	(-) **Fairburn & Welch** **Design:** Interviews **Location:** UK **Year:** 1990 **Funding:** Not specified **Aims:** To describe the changes in eating habits and attitudes to shape and weight which occur in pregnancy. To determine whether there was a difference with respect to these changes between those women who have previously been concerned about their shape and weight and eating and those who have not.	**Sample:** 50 Primigravidae inpatients on post-natal wards; birth within previous 3 days. **Age**: mean 25.3 years (SD = 5.3) range 18-37 Married = 42 (84%) Single = 8 **Social class**: I = 0; II = 24%; IIIa = 52%; IIIb = 12%; IV = 8%; V = 4% **Mean BMI pre-pregnancy:** mean 21.9 (SD = 3.1) 3 had BMI > 25; 3 had BMI < 20 None had a history of anorexia nervosa; 4 had history of bulimia nervosa (DSM-III-R) but none met this criteria in the 3 months prior to pregnancy. **Mean weight gain** = 14.1 kg (SD = 4.1kg, range 6-25kg).	**Data Collection:** Semi-structured interviews (average 40 mins). Focus on eating habits and attitudes to shape and weight. Personal and family history taken as well as history of features suggestive of an eating disorder	**Changes in eating and weight during pregnancy** Almost all women reported that their 'hunger' changed during pregnancy – nature and timing of this extremely variable with no consistent pattern. Two women described a sustained increase in hunger which persisted throughout pregnancy, and 2 others reported a sustained decrease. Fullness after eating normal portions was common, particularly in the last trimester. 70% experienced significant nausea in the first trimester, though this did not result in vomiting. In 12% the nausea persisted into the 2nd trimester, and in one woman into the third. Variable amounts were eaten, relating to changes in hunger. Most women reported eating more during pregnancy than in the past. There were 3 explanations for increased frequency of eating: 1) it relieved nausea, 2) to relieve feeling of fullness later in pregnancy ('little and often'), 3) many women believed their baby would be healthier if they ate more often. In 70% there was an increase in the range of foods eaten. Those mostly added were milk, liver, fruit, vegetables. These were eaten in the belief that they would promote the baby's health. 75% of those who drank alcohol prior to pregnancy abstained whilst pregnant and the majority significantly reduced their intake. 55% of those who smoked stopped during pregnancy and most of the remainder reduced their consumption. Dietary cravings were described by 44%, usually for one specific food. 50% reported dietary aversions.	

				Three women chose to diet during pregnancy to limit weight gain and one was advised by the doctor to lose weight. One woman described episodes of substantial overeating which were associated with a sense of loss of control (history of bulimia but not in 3 months prior to pregnancy). 11 other women reported episodes of overeating but with no associated sense of loss of control. Several of these women gained over 20kg during pregnancy. Three explanations were given: 1) sustained increase in hunger; 2) eating in response to negative mood; 3) as response to abandonment of previous dietary restraint. 46% described being unconcerned about their weight increase; 24% were distressed; 30% described a lessening of their usual concerns about their weight. 72% feared they would not be able to return to their normal weight. 38% had no specific plans to lose weight and thought their weight would naturally return to its usual level. Of the remainder, 68% planned to exercise and 50% planned to diet. 54% had previously dieted to modify their shape or weight. The mean weight of this group was similar to the non-dieting group (22.6 (SD=3.6) and 21.0 (SD=2.0) respectively). And they gained equivalent amounts during pregnancy. All 3 women who dieted during pregnancy belonged to the dieting group as did 9 of the 12 who reported significant episodes of over-eating. 75% of those concerned about gaining an excessive amount were from the dieting group. The dieting group reacted more negatively to the changes in their shape, with a few reacting positively. 88% of those planning to diet after	

				the birth belonged to the dieting group.	
3	(+) **Fox & Yamaguchi** **Design:** Free-response questionnaires **Location:** UK **Year:** 1997 **Funding:** Not specified **Aims:** To examine the relationship between pre-pregnancy body weight and body image change in primigravid women	**Sample:** 76 Women attending antenatal classes and midwifery centres **Ethnicity:** White = 57 (75%) Black = 16 (21%) Indian Asian = 3 (4%) **Employment:** Professional = 6 (8%) Intermediate = 20 (26%) Skilled non-manual = 3 (4%) Skilled manual = 3 (4%) Partly skilled = 1 (1%) Unskilled = 17 (22%) Unemployed or not in paid employment = 12 (16%) **Pre-pregnancy BMI:** Normal weight n=42; mean 21.55 (range 20-24) Overweight n=34; mean 29.24 (range 25-39) **Weeks gestation:** Normal weight n=42; Mean 35 (range 30-41) Overweight n=34; Mean 36 (range 30-42) **Pre-pregnancy to current weight gain:** Normal weight n=42; Mean 11.95 (range 9-15) Overweight n=34; Mean 12.27 (range 10.4-14.5) **Age:** Normal weight n=42; Mode 18-27	**Data Collection:** Anonymous questionnaire. Open-ended questions on how women felt generally about their current appearance and body shape, and why these feelings differed from pre-pregnancy feelings. Quantitative data through modified Body Shape Questionnaire (BSQ - validated) 34 item scale concerning body shape over past 4 weeks in areas such as clothing, socialising and eating. 6-point scale 'never experiencing' to 'always experiencing'. Modified after piloting to increase applicability to pregnancy. **Data analysis:** Change in body image: identification of broad themes	Almost all women who experienced no body image change had a positive image of themselves. In explaining this stability, an important aspect was the acceptance of physical changes as a natural event in pregnancy. Also, a lack of concern with weight before pregnancy was evident. (quote: 'never been worried about my weight') . Women who experienced body image change gave accounts of self-consciousness, physical attractiveness, and body weight. **Explanations of negative body image change:** Among women of normal weight, feelings of self- consciousness were common- believed that they were subject to increased public scrutiny. Quote: ' I have never been very big..everyone is looking at me…' Feeling that body weight was no longer under their own control: ' I have always been a certain shape and maintained my weight…' Feeling less physically / sexually attractive: 'I never think to myself 'you look good today'…' For some, these feelings led to self-imposed restrictions in social and physical activities: 'I went to lots of aerobic classes but now I feel too self-conscious..' Such feelings were also evident in overweight women who experienced negative change, though the spiralling social stigma was important: ' feel even more conscious of my body…' **Explanations of positive body image change:** Mainly by overweight women, feeling less self-conscious and more pos about public scrutiny:	

		Overweight n=34; Mode 18-27		'now I am pregnant, strangers smile at me as if I am someone special. They look at my stomach and not me…' A feeling of freedom from the stigma of being overweight and the pressure to diet: '…now I have a wonderful excuse to be big.' 'pregnancy is socially acceptable but being fat is not' Many felt their bodies had become more physically attractive through pregnancy which led to feelings of confidence: ' …it is becoming rounder but beautifully shaped' Minority of normal weight women also felt increased wonder and attractiveness as their bodies developed: 'I love my new shape…I prefer having some shape and curves'. Some also shared the freedom from dieting and concern about weight gain.	
4	(++) **Heslehurst** **Design:** Interviews **Location:** UK **Year:** 2007b **Funding:** The North East Public Health Observatory **Aims:** To gain a detailed understanding of healthcare professionals' perceptions of the impact that caring for obese pregnant women has on maternity services.	**Sample:** 33 Clinical members of staff within all 16 maternity units in the North East area of England. Staff included midwives, consultant obstetricians, specialist registrars, dietitians, physiotherapists, specialist nurses, clinical ward and service managers, community practitioners. In particular, staff who had special interest in maternal obesity were given priority.	**Data Collection:** Interviews with one (face-to-face) or more member of staff (focus group or discussion meeting). Members of staff with a special interest who could not attend any of these were encouraged to e-mail information. Two researchers were present as far as possible where 2 or more participants were involved. Low-structure, broad subjects (same ones in each interview for consistency, though sequence varied between interviews) used as prompts.	**Booking appointments:** Location of the first antenatal visit determined whether or not the maternal height and weight were directly measured or self-reported. If NHS location, they were usually measured if equipment was present, whereas home bookings tended to rely on self-reported weights and heights. Community midwives do not have portable equipment to take accurate measurements. Focus group confirmed that bariatric equipment available at hospitals and GP practices but not always at home bookings – 'ad-hoc'. **Equipment:** Specific problems were discussed around the availability of appropriate equipment for obese mothers. Specifically, having equipment with maximum expansion or weight load. **Care requirements:**	

			Piloted in one unit. Detailed notes made during interviews, which were e-mailed to participants for verification. A confirmatory focus group was held to discuss final themes and ensure data saturation. **Data analysis:** Systematic thematic content analysis (Burnard 1991) adapted from Grounded Theory approach. Two researchers developed category systems independently and then the 2 systems were discussed and compared with the results from a third researcher to develop a final category system. Transcripts were coded using the final list of categories and checked independently. Coded statements were grouped into broader categories which identified recurring themes.	All units had policies for routine referrals for consultant-led care when mother obese. The BMI cut-off for referral varies between units from 30-50 kg/m^2. Six units changed their policy as the caseload over BMI 30 was too great (changed to 35). All units stated they had individual care plans for obese mothers referred for consultant-led care. **Complications and restrictions:** Many were significant throughout the entire pregnancy, including antenatal, labour, post-delivery. Restricted options for delivery. Patient dignity and embarrassment – varies between mothers (2 units). Some women tend to be embarrassed about their weight, whereas others do not see it as a problem during their pregnancy – non-recognition of the fact that they are overweight – quite often younger women – peer are the same. Lack of awareness of the effects of being obese when pregnant, the complications that might arise, the restrictions to care, and potential effects on the outcomes of pregnancy – embarrassing for staff to approach the issue, how to handle the situation without making the mother feel uncomfortable – getting the balance. Women have felt victimised and moved to another unit. **Current and future management of care:** NHS patient information booklet was the only form of dietary info in majority of units (11). Generally addresses healthy and safe eating rather than weight gain or specific dietary requirements related to BMI. With regard to info about diet and weight gain, some units stated that advice was likely to be inconsistent and ad hoc (7)., and of the units	

5	(++) **Johnson *et al.*** **Design:** Interviews **Location:** UK **Year:** 2004 **Funding:** Not specified **Aims:** To provide more useful insights on the impact of bodily changes during the transition to motherhood (previous research has been contradictory), using IPA.	**Sample:** 6 Women between 33-39 weeks gestation. Ages between 26-34 4 educated to > degree level 1 British Asian, 5 White 6 married and living with husbands	**Data Collection:** In-depth interviews **Data analysis:** IPA (Interpretative Phenomenological Analysis) – concerned with individual's view of the world (in this case, lived experiences of being pregnant) FDA (Foucauldian Discourse Analysis) – reveals discursive resources within a particular culture and the ways in which these set up subject positions (in this case, how bodily changes are constructed and the impacts that these constructions may have on women's ways-of-being)	**The experience of bodily changes:** The dynamic nature of body satisfaction during pregnancy: The 6 women spoke of becoming less satisfied with their bodies as pregnancy progressed, though this was varied, complex, and changing. **Discursive constructions and discourses of the pregnant body:** Pregnancy as transgressing dominant ideals for feminine beauty: Women used negative terminology to describe their pregnant body ('fat', 'frumpy', 'bloated') and spoke of others describing them as fat. This reflects a representation of the female body as ideally slender; this is argued to be culturally and historically specific. **Contexts and Positioning:** The women spoke of message from significant others that they were getting fat – resistance was made by maintaining that becoming pregnant means getting bigger. **Implications:** Grappling with alternative constructions of being pregnant as legitimating eating and being large, and the pressure to return to an ideal size.	
7	(+) **Levy V** **Study design:** Interviews **Location:** UK **Year:**1999 **Funding:** Not specified	**Sample:** Women attending antenatal clinics in a variety of maternity settings in England All British, Caucasian apart from 1 woman of Chinese origin. All women except 1 were in a supportive relationship. Age range 20 – 38 years.	**Data Collection:** Observation and tape recordings of 'booking' interviews between women and midwives. These were transcribed and data considered to be related to decision making was analysed, and also used to trigger conversation in the follow up interviews. In-depth interviews (30-70	Core category = **"Maintaining Equilibrium"** Women sought and dealt with information in such a way as to protect and keep in balance the interests of herself, the baby, her partner, and others during a period often involving considerable change. Three other substantive categories: **Regulating information** This concerned: • Avoiding the pursuit of information. • Delaying; the time might not be right for women to address a particular topic	

	Aims: To map the process involved when women make informed choices during pregnancy	Occupations: Housewives, bank clerk, secretaries, local government officer, farmer, publishing representative. 5 primigravada 9 one child 3 two children 3 three children 3 four children	mins) within 2 weeks of the initial interaction. Women were asked what they had perceived to be happening at various points during their booking interview, as well as general views related to choice and decision making. Interviews were tape recorded and transcribed verbatim. **Data analysis:** Grounded Theory	• Pursuing; this could be straightforward if not distressing or if perceived to be beneficial, or it may be done with some ambivalence. **Contextualising information** This concerned: • Legitimising information • Personalised information **Actioning** • Women did not always find it easy to state or achieve their wishes. Conferred power had an effect on this, and depended upon the attitudes of midwives and other health professionals. • Asserting; enabled to openly express their choices with confidence that they and their choices would be respected. • Playing the game • Taking it as it comes • Handing Over; women tended to hand over decision making in an emergency during which their equilibrium was severely threatened, and there was little time to negotiate. Power was also relinquished if the woman was not prepared to challenge the midwife or whilst she was in labour.	
8	(+) **Symon & Wrieden** **Study design:** Interviews and group discussion **Location:** UK **Year:**2003 **Funding:** Not specified	**Sample:** Young women age 16-18, 119 invited, 24 indicated that they would attend, and of these 16 did so. Cited reasons for non-attendance were practical (distanced, work and educational commitments). 11 attended initial weekly food preparation sessions, with 5 present at the final session.	**Intervention:** Group activity - nutrition education programme - delivered by trained midwives to pregnant teenagers. Midwives were considered to be a useful resource to the teenagers in terms of accessing additional information. Neither had a formal teaching qualification. Programme included	**Recruitment and access:** Those few that attended were pleased they had done so; financial remuneration did not seem to be a deciding factor. The location may have been a deterrent, though those who attended either lived nearby or could access the centre by bus. It was suggested that teenagers bring a friend along in order to assist in settling. One girl was influenced by her boyfriend as he was concerned about her eating behaviour.	

	Aims: To assess the feasibility of nutritional education intervention sessions for pregnant teenagers	All had been informed that a group interview would take place at the conclusion of the series. A further 5 attended the one-day course (n=10). All 10 indicated that they were prepared to be interviewed. Pregnant teenagers attending one or more educational session (incomplete for 2 teenagers): • 4 lived with one or both parents, none lived alone. • 4 lived in a flat, 2 in a terraced house, 1 in a detached house. • 1 property was owner-occupied, 4 were local council rented, 3 privately rented. • 7 were unemployed, 1 had a part-time job. • 2 had no formal qualifications, 6 achieved Standard Grade (school leavers) qualifications.	information, behavioural approaches, motivational strategies. Written material - including recipes, leaflets on food safety, shopping, eating well in pregnancy - supplemented the activities. **Data Collection:** Interviews took place in 3 groups; the teenagers from the 2 sets of sessions were asked to combine for one interview (maternity centre), the other 2 interviews took place at the community centre. The discussion was allowed to develop naturally over the course of the interactive interviews. **Data analysis**: Phenomenological approach (Heidegger 1962). Open text analysis produced a sense of the whole, identifying significant statements and themes of which the meanings were articulated and synthesised to produce a consistent and explanatory statement	The prospect of free food was also an incentive. **Nutritional Habits:** • Some girls indicated that they rarely cooked at home, particularly those still living with parents, or those close enough to visit for meals. • Appetite whilst pregnant could affect motivation to cook (can't be bothered, no confidence). • Some took food and recipes home and cooked them there. One girl reported eating fruit and vegetables following the course, whereas she didn't eat them prior to the course. She was shopping differently and buying less chocolate. • For some, however, changes were limited, typically trying one new recipe; others were more adventurous as the recipes were seen as simple compared with the ones found in magazines. **Acceptability of the sessions:** • Atmosphere was kept informal during the sessions; compared to Home economics classes at school, the sessions were reported as being more relaxed with time to 'get on with it'. • Other positive aspects were that the cooking, and therefore the mess was outside their own kitchen, and that all the girls were of a similar age with no-one older 'looking down on you'. • Older women were viewed as potentially judgemental about behaviour, clothes, and being pregnant at a young age. One girl cited criticism she had received from others. • The classes were therefore seen as a social opportunity. The opportunity to discuss their pregnancy with the midwives was also valued.	

9	(+) **Warriner** **Study design:** Interviews & Focus Groups **Location:** UK **Year:**2000 **Funding:** Not specified **Aims:** To examine how the experience of being weighed throughout pregnancy affects women	**Sample:** 10 interviewed, 6 in focus group (we are not told whether any of these are the same women). Convenience sample from women attending 2 separate mother and toddler groups (self-selected) No baseline characteristics given	**Data Collection:** Interview schedule with prompts. Tape recorded and transcribed; notes made throughout. **Data analysis:** Qualitative content analysis to identify themes and patterns (Polit & Hungler 1995)	**Eating habits** • A number of women described pressure to control their non-pregnant dietary intake – 2 reported attending weight-watching groups throughout their pregnancies. • Pregnancy as a license not to worry about weight (legitimate reason for weight gain). • A number of women saw eating as a way of promoting the health of their babies. • Some women were dissatisfied with their post-partum weight, whilst others accepted an increase in weight and shape. • Varied attitudes to eating in pregnancy – may come from pre-pregnancy views (the more control exerted prior to pregnancy, the more likely this tended to continue into pregnancy). However, often control is relaxed during pregnancy. **Consent, information and control** • Being asked whether they wanted to be weighed or not for some women demonstrated their lack of control – "..you almost hand over your body to those people.." • Women reported that they expected this to happen, and accept what the professionals are saying and doing. • Informed consent based on open communication and leading to empowerment was more of an ideal. Even when kind and caring, enabling information was not forthcoming. • Only one woman remembered being given information as to why she was being weighed. For others it was not given, and weighing was seen as routine. • Professionals may not give adequate feedback following weighing; e.g. comments such as weight gain is 'fine' or	

				'perfect' (unhelpful). • Language: Limited information as 'verbal asepsis' (Kirkham 1983) – use of the word 'just' ("…he says: right, just pop on the scales…"). Assumption of health professional that patient will be weighed. Language used to reinforce control and maintain unequal power relations ("…this is too much for one week…") – being 'rapped on the knuckles'.	
10	(++) **Wiles** **Study design:** Interviews **Location:** UK **Year:**1998 **Funding:** Not specified **Aims**: To examine the beliefs of women above average weight about appropriate levels of weight gain in pregnancy	**Sample**: 37 Overweight pregnant women of >30 weeks gestation. All white and able-bodied. Age range = 16-35 years No. of children ranged from 0-3 30 (81%) lived with partners in independent households. 6 lived with parents 1 lived alone 25 (67%) came from social classes III-V Weight range 70-138kg prior to pregnancy (mean 91kg). Mean pre-pregnancy BMI = 32 Weight change at 30 weeks: 2 women lost weight Up to gains of 33kg None were referred to a dietitian and all were given the same recommendations re weight gain.	**Data Collection:** Interpretative qualitative based on Grounded Theory. **Data analysis:** Transcripts were read several times and coded , then themes were identified which were pursued in subsequent interviews. Further analysis clarified these themes.	**Dietary advice** 20 women reported having received advice about diet or weight gain from health professionals (usually midwife or GP), 7 of whom had asked for the advice. Women reported being given advice at the first 'booking' appointment when diet was discussed in some detail, but that this was rarely followed up at later appointments unless they initiated it. The advice usually focussed on diet, e.g. size of meals and particular foods rather than explicitly about weight gain. Dietary advice was not necessarily about restricting weight gain, rather, the nutritional needs of mother and baby. **Advice about weight gain** Only 5 women reported being given specific advice about keeping weight gain to a minimum, and only 1 was told what the appropriate level of weight gain should be. There was a widespread view that the advice given in antenatal literature about appropriate levels of weight gain was not relevant for them. Weight gains of up to 12.5kg as	

				recommended, were viewed as appropriate for women without 'weight problems', but these women viewed themselves as special cases. **Control of weight** Control was a central theme. It related to the extent to which women felt they had the ability to control their weight gain during pregnancy, and their desire to re-gain their pre-pregnancy weight following pregnancy.	

Appendix 3: Table of Excluded Studies

Authors	Title	Journal	Ref	Reason for Exclusion
Althuizen E, van Poppel MN, Seidell JC, *et al.,*.	Design of the New Life(style) study: a randomised controlled trial to optimise maternal weight	*BMC Public Health*	2006;6:168	No outcome data
Bhargava A, Bhargava A.	Modeling the effects of maternal nutritional status and socioeconomic variables on the anthropometric and psychological indicators of Kenyan infants from age 0-6 months.	*Am J Phys Anthropol*	2000;111: 1.89-104.	Setting: Kenya
Brown HL, Watkins K, Hiett AK, Brown HL, Watkins K, Hiett AK.	The impact of the Women, Infants and Children Food Supplement Program on birth outcome.[see comment].	*Am J Obstet Gynecol*	1996;174: 4.1279-1283.	Design not appropriate
Calfas KJ,	Postpartum weight retention: A mother's weight to bear? [References].	*Am J Prev Med*	2007;32: 4.Apr-357	editorial
Carmichael S, Abrams B, Selvin S, Carmichael S, Abrams B, Selvin S.	The association of pattern of maternal weight gain with length of gestation and risk of spontaneous preterm delivery	*Paediatr Perinat Epidemiol*	1997;11: 4.392-406.	Not relevant to weight management
Casanueva E, Legarreta D, az-Barriga M, *et al.,*.	Weight gain during pregnancy in adolescents: evaluation of a non-nutritional intervention.	*Rev Invest Clin*	1994;46: 2.157-161	Setting: Mexico
Casanueva E, Marin A, Gelis P, *et al.,*.	Changes in weight during pregnancy and lactation in adolescents. Evaluation of a nonnutritional intervention.	*Ann N Y Acad Sci*	1997;817:353-355.	Setting: Mexico
Copper RL, DuBard MB, Goldenberg RL, Oweis AI.	The Relationship of Maternal Attitude Toward Weight-Gain to Weight-Gain During Pregnancy and Low-Birth-Weight.	*Obstetrics and Gynecology*	1995;85: 4.590-595.	No intervention. Associational data not relevant
Covington DL, Peoples-Sheps MD, Buescher PA, Bennett TA, Paul MV.	An evaluation of an adolescent prenatal education program.	*AM J HEALTH BEHAV*	1930;1998 Sep-Oct; 22: 5.323-333.	Design not appropriate
Cox JT, Phelan ST.	Nutrition during pregnancy.	*Obstetrics and Gynecology Clinics of North America*	2008;2008 Sep; 35: 3.369-383.	Purpose: Review article - not systematic
(Clapp, III and Little	Effect of recreational exercise on	*Medicine and Science in Sports and*	vol. Feb; 27, no.	Review – not

1995)	pregnancy weight gain and subcutaneous fat deposition	*Exercise*	2, pp. 170-177.	systematic review
Davies K, Wardle J,	Body image and dieting in pregnancy.	*J Psychosom Res*	1994; 38: 8.787-799.	Discussion paper
Dipietro JA, Millet S, Costigan KA, *et al.,*.	Psychosocial influences on weight gain attitudes and behaviors during pregnancy.	*J AM DIET ASSOC*	2003;103: 10.1314-1319.	No relevant associational data
Durnwald CP, Ehrenberg HM, Mercer BM, Durnwald CP, Ehrenberg HM, Mercer BM.	The impact of maternal obesity and weight gain on vaginal birth after cesarean section success.	*Am J Obstet Gynecol*	2004;191: 3.954-957.	Observational study looking at impact of weight gain on vaginal birth after caesarean section.
(Fowles et al. 2005)	First trimester predictors of diet and birth outcomes in low-income pregnant women	*Journal of Community Health Nursing*	vol. 22, no. 2, pp. 117-130	Exclude – focus is on low birth weight
Galtier F, Raingeard I, Renard E, *et al.,*.	Optimizing the outcome of pregnancy in obese women: from pregestational to long-term management. [Review] [53 refs].	*Diabetes Metab*	2008; 34: 1.19-25.	Review article – not systematic
Garg A, Kashyap S, Garg A, Kashyap S.	Effect of counseling on nutritional status during pregnancy.	*Indian J Pediatr*	2006;73: 8.687-692.	Setting: India
Grandi CL.	Nutrition assessment during pregnancy. A new weight chart.	*Medicina (B Aires)*	2007;67: 6 II.2007	Lang: Spanish Purpose was to develop new weight chart for pregnancy
(Gunderson et al. 2000)	The relative importance of gestational gain and maternal characteristics associated with the risk of becoming overweight after pregnancy",	*International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*,	vol. 24, no. 12, pp. 1660-1668.	Observational study relevant to weight gain after pregnancy
Hammer RL, Hinterman C.	Exercise and dietary programming to promote maternal health fitness and weight management during lactation.	*Journal of Perinatal Education*	1935;1998; 7: 2.12-26.	Review (not systematic) and post natal
Harris HE, Ellison GTH, Clement S.	Do the psychosocial and behavioral changes that accompany motherhood influence the impact of pregnancy on long-term weight gain?	*Journal of Psychosomatic Obstetrics and Gynecology*	1999;20: 2.65-79.	Psychological impacts
Herrera-Perdigon J, Hopkins E, Marcalle	Weight gain in high-risk pregnant women:	*CLIN EXCELLENCE*	1915;2005 Winter;	Country

M, Brooten D, Youngblut JM, Lizardo ML.	comparison by primary diagnosis and type of care.	*NURSE PRACT*	9: 4.195-201.	
(Hegaard et al. 2007)	Leisure time physical activity during pregnancy and impact on gestational diabetes mellitus, pre-eclampsia, preterm delivery and birth weight: a review.,	*Acta Obstetricia et Gynecologica Scandinavica*	vol. 86, no. 11, pp. 1290-1296.	Review – non systematic
Honest H, Bachmann LM, Ngai C, *et al.,*.	The accuracy of maternal anthropometry measurements as predictor for spontaneous preterm birth--a systematic review. [Review] [24 refs].	*Eur J Obstet Gynecol Reprod Biol*	2005;119: 1.11-20.	Review – not systematic
Hulsey TC, Neal D, Bondo SC, *et al.,*.	Maternal prepregnant body mass index and weight gain related to low birth weight in South Carolina.	*South Med J*	2005;98: 4.411-415.	Observational study Purpose Effects of low weight gain
Kaseb F, Kimiagar M, Ghafarpoor M, Valaii N.	Effect of traditional food supplementation during pregnancy on maternal weight gain and birthweight.	*International Journal for Vitamin and Nutrition Research*	2002;72: 6.389-393.	Setting: Tehran
Kiel DW, Dodson EA, Artal R, *et al.,*.	Gestational weight gain and pregnancy outcomes in obese women: how much is enough?[see comment].	*Obstet Gynecol*	2007;110: 4.752-758.	Observational Risks of excessive weight gain on pregnancy outcomes
Kinnunen TI, Aittasalo M, Koponen P, *et al.,*.	Feasibility of a controlled trial aiming to prevent excessive pregnancy-related weight gain in primary health care.	*BMC Pregnancy Childbirth*	2008;8:37	No outcome data
(Mottola and Campbell 2002)	Exercise in the postpartum period: practical applications.	*Current Sports Medicine Reports*,	vol. 1, no. 6, pp. 362-368	Same study as Campbell 2001
(Olafsdottir et al. 2006)	Maternal diet in early and late pregnancy related to weight gain and birth outcome	*Int.J Obes.(Lond)*	vol. 30, no. 3, pp. 492-499	Setting: Iceland
Ojofeitimi EO, Ogunjuyigbe PO, Oni GA, *et al.,*.	The effects of maternal nutrition on pregnancy outcomes in Osun State, Nigeria.	*AFRICA J NURS MIDWIFERY*	1914;2006; 8: 2.25-34.	Setting: Nigeria
Rees C.	The nutritional status of women in the first trimester of pregnancy attending an inner-city antenatal department in the UK.	*J Royal Society Promotion Health*	2005;2005 Sep. 125: 5.	Observational study examining nutritional status of women in pregnancy. No intervention
(Rossner and	"Physical activity and prevention and	*Medicine & Science in*	vol. 31, no. 11 Suppl, p. S560-	Review – not

Rossner 1999)	treatment of weight gain associated with pregnancy: current evidence and research issues",	*Sports & Exercise*,	S563.	systematic review
Sachdeva R, Mann SK, Sachdeva R, Mann SK.	Impact of nutrition education and medical supervision on pregnancy outcome.	*Indian Pediatr*	1993;30: 11.1309-1314.	Setting: India
Santos IAS.	Aerobic exercise and submaximal functional capacity in overweight pregnant women: a randomized trial.	*Obstetrics and Gynecology*	2005;vol 106, no 2, August 2005, pp 243-249.:	Country: Brazil
Schauberger CW, Rooney BL, Brimer LM, Schauberger CW, Rooney BL, Brimer LM.	Factors that influence weight loss in the puerperium.	*Obstet Gynecol*	1992;79: 3.424-429.	Post-natal
Schieve LA, Cogswell ME, Scanlon KS, Schieve LA, Cogswell ME, Scanlon KS.	Trends in pregnancy weight gain within and outside ranges recommended by the Institute of Medicine in a WIC population.	*Matern Child Health J*	1998;2: 2.111-116.	Observational study - no exploration of association between diet/exercise and weight gain
Seligman LC, Duncan BB, Branchtein L, *et al.,*.	Obesity and gestational weight gain: cesarean delivery and labor complications.	*Rev Saude Publica*	2006;40: 3.457-465.	Setting: Brazil
Serci I.	Midwifery basics: diet matters (4). Weight gain in pregnancy.	*Pract Midwife*	1912;2008 Jan; 11: 1.29-33.	Review article – not systematic
Stevenson L	Exercise in pregnancy. Part 1: Update on pathophysiology. [Review] [26 refs].	*Can Fam Physician*	1997;43:97-104.	Review article – not systematic
Taffel SM.	Association between maternal weight gain and outcome of pregnancy. (Research).	*Journal of Nurse Midwifery*	1000;31: 2.	Associational data not relevant
Torrance E, Torrance E.	Is the repeated weighing of pregnant women necessary?	*Nurs Times*	1996;92: 49.28-29.	Discussion article
Wells CS, Schwalberg R, Noonan G, *et al.,*.	Factors influencing inadequate and excessive weight gain in pregnancy: Colorado, 2000-2002.	*Matern Child Health J*	2006;10: 1.55-62.	Observational study looking at factors influencing inadequate and excessive weight gain. Diet and exercise not variables that were measured. For use as background

Qualitative Studies

	Author, Date, Country, Title	Reason for exclusion	Comments
1	**Abraham *et al.*,.,. 1994 Australia** Attitudes to body weight, weight gain and eating behaviour in pregnancy	Non-UK Only one short paragraph relevant to question – supports UK data	
2	**Black 2008 Canada** Understanding prenatal weight gain in first nations women.	First Nation population – not generalisable to UK health service	
3	**Cameron *et al.*,.,. 1996 US** Weight, self-esteem, ethnicity, and depressive symptomatology during pregnancy among inner-city women	Non-UK. Specific to Afro-Caribbean women in US and association with depression symptoms	
4	**Claesson *et al.*,.,. 2006 Sweden** Consumer satisfaction with a weight-gain intervention	Non-UK setting Quantitative	
5	**Clark & Ogden 1999 UK** The impact of pregnancy on eating behaviour and aspects of weight concern	Quantitative. No views though data does examine body satisfaction and eating behaviour. No new data, mainly supports qualitative studies.	Data on body (dis)satisfaction and diet restraint requires unpicking as results vary depending on sample
6	**Davies & Bath 2001 UK** The Maternity information concerns of Somali women in the United Kingdom	UK - Useful as background – not concerned with weight management	
7	**Davies & Bath 2001 UK** Interpersonal sources of health and maternity information for Somali women living in the UK	UK -Useful as background – not concerned with weight management	
8	**Davies & Wardle 1994 UK** Body image and dieting in pregnancy	Quantitative. No views though data does examine body satisfaction and dieting behaviour. No new data, mainly supports qualitative studies.	Data on body (dis)satisfaction and diet restraint requires unpicking as results vary depending on sample
9	**Devine *et al.*,.,. 2000 US** Continuity and change in women's weight orientations and lifestyle practices through pregnancy and the postpartum period: the influence of life course trajectories and transitional event	Relevant though no new data to UK studies and specific to US health service. May be useful for combining with post-partum evidence later	
10	**Dundas & Yarbro 2000 US** Nutrient intake and attitudes of pregnant women concerning their weight gain	Non-UK setting Quantitative	
11	**Everette 2007 US** Gestational weight and dietary intake during pregnancy: Perspectives of African American women.	Focussed on low maternal weight	
12	**Evenson *et al.*,.,. 2008 US** Perceived barriers to physical activity	Non-UK No new information to that in UK studies; environmental	

	among pregnant women	info specific to US	
13	**Goodwin 2000 Australia** Pregnancy: Does it change exercise participation?	Non-UK Little rich data. No new information to that in UK studies	
14	**Handfield & Bell 1996 Aus** What are popular magazines telling young women about pregnancy, birth, breastfeeding and parenting?	Relevant title but no data specific to this question	
15	**Kinnunen *et al.*,,. 2008 Finland** Feasibility of a controlled trial aiming to prevent excessive pregnancy-related weight gain in primary health care	Included in quantitative review	
16	**Nyman *et al.*,,. 2008 Sweden** Obese women's experiences of encounters with midwives and physicians during pregnancy and childbirth	Relevant though no new data to UK studies and specific to Swedish health service	
17	**Ojofeitimi *et al.*,,. 2006 Nigeria** The effects of maternal nutrition on pregnancy outcomes in Osun State, Nigeria.**,**	Article not available despite world wide search.	
18	**Stevens-Simon & Nakashima Andrews 1993 US** Weight gain attitudes among pregnant adolescents	Quantitative – attitudes to weight gain scale.	
19	**Thornton *et al.*,,. 2006 US** Weight, diet, and physical activity-related beliefs and practices among pregnant and postpartum Latino women: the role of social support	Specific to particular community – little generalisable evidence	

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