PANO RG
Physical Activity Nutrition Obesity Research Group

Prevention of excessive gestational weight gain:
An evidence review to inform policy and practice

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TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

ACOG	Australian College of Obstetrics & Gynaecologists
AOR	adjusted odds ratio
BMI	body mass index
CDC	Centres for Disease Control
EGWG	excessive gestational weight gain
GWG	gestational weight gain
IGWG	inadequate gestational weight gain
IOM	Institute of Medicine (US)
LGA	large for gestational age
OR	odds ratio
RR	relative risk
SES	socio-economic status
SGA	small for gestational age
UK	United Kingdom
US	United States
WHO	World Health Organization

EXECUTIVE SUMMARY

In the context of the obesity epidemic, gestational weight gain (GWG) or weight gained during pregnancy has come under scrutiny. While appropriate weight gain must remain the key message for expectant mothers, excessive gestational weight gain (EGWG), *regardless of pre-pregnancy weight status*, places mother and child at risk of immediate obstetric and neonatal and longer-term negative health consequences, including overweight and obesity.

The most comprehensive and recent evidence-based guidelines on appropriate weight gain during pregnancy are those published by the US Institute of Medicine, which categorise GWG recommendations according to pre-pregnancy body mass index (BMI) for singleton and twin pregnancies. These guidelines have been adopted in the US and Canada, and are referred to in a number of documents in Australia, although they have not been formally endorsed in Australia. Further research is needed to inform specific GWG ranges for women with a pre-pregnancy BMI ≥35.0 kg m^{-2} and ≥40.0 kg m^{-2} and women of different cultural backgrounds.

Reported rates of overweight and obesity among women entering pregnancy in Australia vary from 20% to 43%; although actual rates are likely to be higher, particularly in rural regions. Prevalence of class II and class III obesity among pregnant women has increased. Prevalence of EGWG in Australia has been reported in various studies to be between 38% and 67%. Population sub-groups at higher risk of EGWG include Aboriginal women, women with a low education and younger women. Weight factors associated with EGWG include: pre-pregnancy overweight/obesity, high early pregnancy BMI, previous EGWG, and incorrect self-assessment of pre-pregnancy weight status. Other factors affecting EGWG include the provision of inaccurate weight gain advice by maternity care providers, and a number of maternal psychosocial factors. Various dietary factors have been associated with EGWG; however, the research related to the impact of physical activity (PA) on EGWG is limited. Food insecurity may be associated with higher EGWG.

A large number of reviews which summarise the evidence base on interventions to prevent EGWG have been published in recent years. Programs delivered in antenatal care aimed at modifying dietary and PA behaviours to promote appropriate GWG, are, on average, effective in reducing total GWG by a clinically important amount for all women regardless of pre-pregnancy BMI; however, they tend to be of an intensive nature which is not always acceptable to busy pregnant women. Regular weighing of women in antenatal care and monitoring women's GWG according to recommended guidelines is generally considered to be important, although potential negative effects of regular weighing, e.g. on emotional well-being and/or inadequate GWG, are unknown. A substantial number of trials assessing the effectiveness of various approaches to the promotion of appropriate GWG, including regular weighing, are currently underway in Australia and will inform the evidence base.

Awareness of appropriate GWG among Australian women is low. Women are entering pregnancy overweight due to poor uptake of pre-pregnancy health activities, inaccurate self-categorisation of weight, and unsuccessful weight loss attempts. Australian women are more likely to be aware of the maternal rather than neonatal complications of EGWG. Weight gain during pregnancy is often viewed as transient and okay, a chance to 'let go'.

Assumptions exist such as feeling able to eat with fewer limitations; and being overweight is deemed more socially acceptable during this period. Further, pregnant women with persistent nausea or vomiting or lower back pain, particularly those who are obese, are at risk of not exercising during pregnancy.

Although many health professionals are aware of the adverse consequences of overweight/obesity in pregnancy, it is not clear whether this acknowledgement extends to EGWG or is only related to those women who enter pregnancy overweight/obese. Awareness of existing guidelines for the management of obesity in pregnancy is low and there are no guidelines for health professionals regarding the management of weight in pregnancy more generally. In addition, few staff are trained in the management of weight gain during pregnancy. Health professionals are reluctant to raise the issue of weight for fear of offending overweight or obese pregnant women.

In Australia, and internationally, provider advice regarding GWG is inconsistent; few weigh women regularly, many do not weigh at all or only at the first visit, and many are only likely to weigh, provide advice and refer women who present at first visit as overweight/obese; and few set GWG targets. Many pregnant women receive no weight gain advice from their provider. Advice to gain above the recommendations, particularly among obese pregnant women, is common. Few health professionals provide healthy eating and exercise advice to pregnant women. There are practical limitations within the General Practice setting in Australia regarding the provision of support for GWG, and most GPs would prefer support and input from allied health practitioners.

A number of recommendations are made with respect to policy, practice and research. Policy foci include: the development and dissemination of guidelines and protocols regarding the management of weight during pregnancy; training of maternity care providers in communicating to pregnant women of all pre-pregnancy BMIs regarding appropriate GWG; and routine surveillance of GWG. Practice recommendations include: the delivery of antenatal evidence-informed support on diet and PA, particularly to high risk women; an examination of health structures for the provision of support and referral services; the use of social marketing to educate and inform social and cultural norms regarding diet, physical activity and weight during pregnancy; and the implementation of community support of PA for pregnant women. There are a number of opportunities for further research to inform policy and practice on this issue and some of these are indicated in this report.

1   INTRODUCTION

CONTEXT

Gestational weight gain (GWG) refers to weight gained during the antenatal period or pregnancy or the time between falling pregnant and giving birth. Weight gain is essential during this life stage, the result of a growing foetus as well as increases in maternal body tissues, volume of blood and extracellular fluid required to support foetal growth. However gaining more weight than is appropriate for pregnancy, often termed 'excessive gestational weight gain' (EGWG), has been associated with adverse short-term obstetric complications and longer-term negative health effects for the mother and the child; associated with increased health costs.

Pregnancy is an opportune time to prevent weight gain and improve the health of women and their children, as many women are concerned about the health of their developing babies and are in frequent contact with health care providers [1, 2]. It is also a prudent time in which to prevent excessive weight gain, as EGWG carries an increased risk of overweight and obesity in later life for women and their offspring.

PURPOSE AND SCOPE

This report was commissioned by the NSW Ministry of Health, Division of Population and Public Health, to support evidence-informed policy and planning with regard to obesity prevention in NSW. The report provides an overview and summary of the evidence base regarding the prevention of EGWG and the promotion of appropriate GWG. It provides a rationale for taking action, indicates barriers to preventing EGWG, provides a critique of the interventions evidence, and makes a substantial number of recommendations for policy, practice and research in this area.

Specifically this review:
➢ Provides an account of the:
   – clinical recommendations regarding appropriate GWG and the extent of the adoption of such guidelines
   – existence and dissemination of recommendations for diet and physical activity (PA) during pregnancy
➢ Summarises the adverse health outcomes, particularly the long-term weight implications, associated with EGWG for the mother and child
➢ Indicates the prevalence of overweight and obesity during pregnancy and EGWG in NSW and Australia, and indicates determinants of EGWG
➢ Critically appraises the systematic evidence base regarding ways in which to intervene to prevent EGWG
➢ Describes the barriers to the provision of weight gain advice to pregnant women and the prevention of EGWG
➢ Provides a number of recommendations for promising approaches to prevent EGWG applicable for implementation in NSW, Australia; with an indication of some implementation considerations.

2   APPROPRIATE WEIGHT GAIN DURING PREGNANCY

The weight gain that occurs during pregnancy is attributable to the growth of foetal and maternal tissues (placenta, uterus, breast, and fat stores) and fluids (blood, amniotic, and extracellular). The gaining of inadequate or excessive weight (beyond that required for the developing foetus) during pregnancy is associated with a number of poor neonatal, child and maternal health consequences. As such, health and medical bodies have sought to define the appropriate amount of weight gain to recommend to pregnant women, in order to optimise obstetric and antenatal care outcomes. This chapter summarises available international and Australian guidelines concerning appropriate weight gain during pregnancy.

INTERNATIONAL GUIDELINES

Evidence-based guidelines for appropriate GWG were published in 2009 by the Institute of Medicine (IOM) in the United States (US) [3]. These guidelines are endorsed by the American College of Obstetricians and Gynaecologists (ACOG) [4, 5] and have been cited, although not specifically endorsed, in other recent obstetric and antenatal practice guidelines in the United Kingdom (UK) [6] and Australia [7].

The current 2009 IOM recommendations, presented in Table 1, are based on obeservational data. These were used to inform the range in GWG associated with the least risk of adverse pregnancy outcomes, and that were deemed by the IOM to be of greatest concern (caesarean delivery, postpartum weight retention, preterm birth, infant birth size, and childhood obesity) [3]. For example, considering infant birth size alone, gaining less weight than recommended may increase the likelihood for small-for-gestational age (SGA) infants but may also reduce the likelihood of large-for-gestational age (LGA) infants. Conversely, gaining more weight than recommended may increase the likelihood for LGA but reduce the likelihood of SGA [8].

Table1 Recommendations for total weight gain and rate of weight gain during pregnancy according to pre-pregnancy body mass index (BMI) (singleton pregnancies), Institute of Medicine, 2009

Pre-pregnancy BMI	Recommended Total Weight Gain	*Recommended Rates of Weight Gain in 2nd & 3rd Trimester [a] Mean (range)*
Underweight < 18.5kg/m²	**12.5 – 18 kg**	*0.51 (0.44 – 0.58) kg/week*
Healthy weight 18.5 – 24.9kg/m²	**11.5 – 16 kg**	*0.42 (0.35 – 0.50) kg/week*
Overweight 25.0 – 29.9kg/m²	**7 – 11.5 kg**	*0.28 (0.23 – 0.33) kg/week*
Obese [b] ≥ 30.0kg/m²	**5 – 9 kg**	*0.22 (0.17 – 0.27) kg/week*

[a] Calculations assume a 0.5 – 2.0 kg weight gain in the first trimester
[b] Insufficient evidence to provide separate recommendations for obesity classes I, II and III

Data informing the guidelines were derived from developed countries, predominantly the US, and as a result, the authors recommend the guidelines *"...are not intended for use in areas of the world where women are substantially shorter or thinner than American women or where adequate obstetric services are unavailable"* [3]. As such, separate recommendations are not provided for women of different ethnic or racial backgrounds [3]. Given the debate around what is considered a healthy adult BMI for Asian-Pacific populations [9], this further limits the applicability of the IOM GWG recommendations for women from this region.

The 2009 IOM guidelines are a revision of earlier guidelines published by the IOM in 1990 [10]. Both sets of guidelines categorise GWG recommendations according to pre-pregnancy Body Mass Index (BMI); however, the BMI cut-points used in the 2009 guidelines were based on World Health Organization classifications [9], while those used in the 1990 guidelines were derived from the Metropolitan Life Insurance tables [10].

Other key revisions include a narrower range in the GWG recommended for women categorised as obese pre-pregnancy, and the removal of separate recommendations for black women, adolescents, and women of short stature, due to a lack of evidence to substantiate the need for separate recommendations [3]. However, the guidelines may be recommended to women with Gestational Diabetes Mellitus (GDM) [3].

Compared with the 1990 IOM guidelines, the revised 2009 guidelines have been shown to classify a larger proportion of women as having gained too much gestational weight (or having EGWG) [11]. This is due to the different BMI cut-points used, which classify more women into a higher BMI category, subsequently requiring them to gain less gestational weight than would have previously been recommended [11]. A further consideration is the application of the 2009 IOM guidelines to adolescents. Compared with IOM guidelines, the Centres for Disease Control and Prevention (CDC) growth charts for young women aged 2-20 years classify fewer women as underweight on the basis of pre-pregnancy BMI [12]. Such discordance in guidelines would lead to more pregnant adolescents being recommended a larger amount of GWG, which raises the question of whether this would lead to EGWG. Yet, as recognised by the IOM, this is unlikely to be of consequence given *"...younger adolescents often need to gain more to improve birth outcomes"*. Hence, separate recommendations for adolescents are not stipulated in the guidelines [3].

In the US, health care providers have been identified as the primary body for implementation of the IOM guidelines, given their role in providing holistic, individualised care to women throughout their pregnancy [13]. It is recommended that guidance on gestational weight gain is provided throughout the course of pregnancy, beginning with raising awareness of the guidelines and their importance in terms of health outcomes for the mother and infant prior to pregnancy. In the first trimester of pregnancy, it has been suggested that women are shown a chart illustrating appropriate weight gain for their pre-pregnancy BMI, and subsequently have their weight gain monitored using these charts. This should be done with sensitivity to natural fluctuations in body weight throughout pregnancy and reinforcing the message that pregnancy is not a time for dieting or weight loss.

In the UK, no evidence-based guidelines have been officially adopted to inform recommended ranges for GWG [6]. Instead, UK-based antenatal care guidelines focus on

encouraging all women to have a healthy pre-pregnancy BMI and to maintain a healthy diet and regular PA during and after pregnancy. For women with a pre-pregnancy BMI ≥ 30.0 kg/m^2 they also encourage them to reduce their weight and educate them on the increased health risks associated with a high pre-pregnancy BMI [6, 14]. Repeated weighing of women during pregnancy is specifically not recommended, unless clinical management is likely to be influenced or if nutrition is of concern [6].

While the IOM guidelines are the most frequently cited to inform appropriate GWG, the Society of Obstetricians and Gynaecologists of Canada guidelines on obesity in pregnancy [15] refer to a set of recommendations for GWG originally published by Cunningham et al. [16]. These guidelines are directly comparable to those published by the IOM, except that a total GWG of 7 kg is recommended for pre-pregnant obese women, compared with the 5 – 9 kg range recommended by the IOM [3].

At the time of publication, the IOM 2009 recommendations stated there was insufficient evidence to provide separate recommendations for obesity classes I (*30.0 – 34.9kg/m^2*), II (*35.0 – 39.9kg/m^2*) and III (*≥ 40.0kg/m^2*). Table 2 illustrates the ranges in total GWG that have been recommended by other researchers [17-19], according to obesity classes I, II and III, compared to the range recommended by the IOM [3].

Table 2 Recommendations for total weight gain during pregnancy by obesity classes I, II and III (singleton pregnancies)

Pre-pregnancy BMI	Total Weight Gain			
	Kiel et al., 2007 [c]	*Bodnar et al., 2007* [d]	*Crane et al. 2009* [e]	*IOM, 2009*
Obese class I *30.0 – 34.9kg/m^2*	4.5 – 11.3 kg	9.1 – 13.5 kg	6.7 – 11.2 kg	5 – 9 kg
Obese class II *35.0 – 39.9kg/m^2*	0.0 – 4.1 kg	5.0 – 9 kg	6.7 – 11.2 kg	5 – 9 kg
Obese class III *≥ 40.0kg/m^2*	-4.1 – 0.0 kg	2.2 - <5.0 kg [f]	<6.7 kg	5 – 9 kg

It is important to note that the IOM has criticised the ranges suggested by authors in Table 2, as analyses were not weighted for the frequency or severity of outcomes [3]. In light of the mixed results for risk of adverse pregnancy outcomes among women of varying obesity class, the ACOG recommends that, for women categorised as overweight or obese (on the basis of their pre-pregnancy BMI) with an appropriately growing foetus, there is insufficient evidence to support advising women to gain more weight so as to meet the IOM recommended guidelines [4].

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[c] Missouri, US, 1990 – 2001
[d] Pittsburgh, US, 2003 – 2008
[e] Newfoundland and Labrador, Canada, 2001 – 2007
[f] For white women only – authors recommend <2.2 kg for black women

Multiple pregnancies

Provisional guidelines for total GWG in women pregnant with twins are also provided in the 2009 IOM guidelines (Table 3), although insufficient evidence was available to inform recommendations for underweight women with a twin pregnancy or for women pregnant with more than two foetuses [3].

Table 2 Provisional guidelines for total weight gain (twin pregnancies), Institute of Medicine, 2009

Pre-pregnancy BMI		Total Weight Gain
Healthy weight	*18.5 – 24.9kg/m^2*	17 – 25 kg
Overweight	*25 – 29.9kg/m^2*	14 – 23 kg
Obese	*≥ 30kg/m^2*	11 – 19 kg

AUSTRALIAN GUIDELINES – NATIONAL

Currently, there are no Australian guidelines on appropriate weight gain during pregnancy, nor is there consensus within Australia or its states or territories regarding which guidelines should be adopted in practice. National evidence-based antenatal care guidelines are currently being developed by the Australian Government in collaboration with state and territory governments. These guidelines, due for release in 2013 [7], begin with module one, which provides guidance on antenatal care during the first trimester of pregnancy.

In accordance with antenatal care practice guidelines from the US, UK and Canada [4-6, 14, 15], the draft Australian national antenatal care guidelines recommend measuring women's weight and height at the first antenatal visit to calculate BMI [7]. Given that many women do not attend their first antenatal visit until late in the first trimester, the draft guidelines suggest self-reported pre-pregnancy weight may be used to calculate BMI, assuming a 0.5 to 2.0 kg total GWG for the first trimester (which is based on the 2009 IOM recommendations [3]). Similar to guidelines from the US and Canada [4, 15], the draft Australian guidelines recommend providing verbal and written advice to women about weight gain during pregnancy that is appropriate to their pre-pregnant BMI, although no specific guidance is provided on the amount of GWG to recommend [7].

Australian guidelines on pre-pregnancy counselling, published by the Royal Australian College of General Practitioners [20] and the Royal Australian and New Zealand College of Obstetricians and Gynaecologists [21], uniformly recommend: (1) promoting a healthy body weight outside of pregnancy (counselling against being over- or under-weight and correcting obesity), (2) recommending regular moderate-intensity exercise, and (3) assessing for risk of nutritional deficiencies [20, 21]. Further, the Australian College of Midwives recommends referral to a medical or health care provider if maternal weight is > 100kg or BMI is <17 kg/m^2 or >35 kg/m^2 at the initial antenatal care visit [22].

Current Australian clinical practice guidelines for the management of overweight and obesity in adults make little reference to appropriate weight gain during pregnancy, and instead, identify pregnancy as a life-stage that increases the risk of weight gain (due to post-partum weight retention), as well as focusing on pregnancy as a contraindication to the clinical treatment of overweight and obesity (pharmacological or surgical) [23].

The current *Australian National Physical Activity Guidelines* (Table 4) stipulate they are appropriate for pregnant women, with the exception of vigorous intensity PA which should only be undertaken with medical supervision [24].

Table 3 Australian Physical Activity Guidelines [24]

1.   Think of movement as an opportunity, not an inconvenience. Where any form of movement of the body is seen as an opportunity for improving health, not as a time-wasting inconvenience.
2.   Be active every day in as many ways as you can. Make a habit of cycling or walking instead of using the car, or do things yourself instead of using labour-saving machines.
3.   Put together at least 30 minutes of moderate-intensity physical activity on most, preferably all, days. Moderate-intensity activity includes things such as brisk walking or cycling. Combine short sessions of different activities of around 10-15 minutes each to a total of 30 minutes or more. The 30 minutes total need not be continuous.
4.   If you can, also enjoy some regular, vigorous exercise for extra health and fitness. Vigorous exercise makes you 'huff and puff'. For best results, this should be added to the above Guidelines on 3-4 days a week for 20 minutes or more each time.

The NSW Department of Sport and Recreation provides a consumer education resource aimed at pregnant mothers [25]. The resource encourages pregnant women to *"exercise at levels appropriate to previous fitness then taper off, at least in the last three months"*, referring to the national physical activity guidelines for Australians and the Sport Medicine Australia guidelines for pregnant athletes. Consistent with the Royal College of Obstetrics and Gynaecologists (RCOG) guidelines, the resource advocates the goal for activity during pregnancy as 'maintaining physical fitness' [25]. Sports Medicine Australia guidelines on exercise in pregnancy recommends that pregnant women without complications may continue their previous exercise program under doctor's supervision, that it is safe to start an exercise program during pregnancy and that moderate intensity exercise can be performed throughout the duration of pregnancy [26].

In terms of nutrition, pregnant women experience increased nutritional requirements due to gains in maternal and foetal tissues. While there is no additional requirement for dietary energy (kilojoules) during the first trimester, an additional 1.4 MJ per day is required in the second trimester and 1.9 MJ per day in the third trimester [27]. During pregnancy, requirements also increase for essential nutrients protein, water, calcium, iron and folate, while requirements for other nutrients increase relative to increases in energy requirements [27]. The increased nutritional requirements of pregnancy are translated into recommendations for pregnant women in the Australian Guide to Healthy Eating (AGHE). Compared with a healthy adult female, the updated draft AGHE recommends an additional one serving of meat, fish, poultry, eggs, nuts or legumes each day (equivalent to 100g

cooked fish) and two-and-a-half servings of grain (cereal) foods each day (equivalent to 2 ½ slices of bread) for pregnant women aged 19 – 50 years [28].

AUSTRALIAN GUIDELINES – STATE OR TERRITORY

The New South Wales (NSW) Ministry of Health publishes the consumer education resource '*Having a baby*', which is available in English, Arabic, Chinese, Khmer, Korean, and Vietnamese [29]. The resource is targeted at women who are currently pregnant, as well as those planning a pregnancy, and includes the following recommendations:

➢ Weight loss for overweight or obese women who are planning pregnancy
➢ Moderate exercise for 30 minutes on most days of the week, after consultation with an appropriate health care provider concerning suitability to this level of exercise
➢ Gentle exercise, for women who were not active before pregnancy
➢ Discuss current exercise routine with doctor or midwife, for women who were active before pregnancy
➢ AGHE (1998) number of servings from each core food group that pregnant women should aim to eat daily
➢ Eat foods high in fat, sugar and salt in small amounts (if eaten at all), as *"...they can also cause weight problems"*.

In terms of the recommended amount of weight gain, the '*Having a baby*' resource states: "*It is important for all women to eat healthily and stay active during pregnancy to minimise the risk of gaining too much weight*" [29]. The resource also encourages women to 'get back into shape' with healthy eating and exercise. The 2009 IOM guidelines are included and cited as being sourced from the Queensland Health '*Statewide Maternity and Neonatal Clinical Guideline: Obesity*', the clinical practice guidelines published by Queensland Health. These guidelines specify that, at the first antenatal visit (including by primary care providers), height and pre-pregnancy weight should be measured and recorded in the health record and in the Perinatal Data Collection Form to facilitate the collection of state-wide data on BMI in pregnancy [30]. Further, weight gains during pregnancy should be documented and monitored at each antenatal consultation, and interpreted in accordance with IOM 2009 recommendations for GWG, as well as plotting (graphing) GWG to assist with the identification of trends [30].

Queensland Health has also produced a consumer education resource '*Healthy Weight Gain during pregnancy*' outlining the 2009 IOM guidelines for appropriate GWG [31]. The resource advises frequent meals and snacks for women who are not gaining enough weight and, for women who are gaining too much weight, it recommends limiting high fat and sugar foods, limiting portion sizes and listening to hunger cues. PA recommendations provided in the resource are in line with the Australian National Physical Activity Guidelines and the Sports Medicine Australia statement on exercise in pregnancy [31].

In contrast to Queensland Health, guidelines published by the Victorian state government recommend weight is measured at the antenatal booking visit, with subsequent weight measurements *"...confined to circumstances where clinical management is likely to be influenced"* [32], which is more consistent with UK-based guidelines. Specific guidelines for

appropriate GWG are not stated, although the Victorian guidelines are only intended for women of a healthy pre-pregnancy BMI with their first singleton pregnancy.

CONCLUSIONS

Evidence from Australian studies indicates a lack of awareness and implementation of guidelines for appropriate gestational weight gain in antenatal care and General Practice [33-35]. Such findings are unsurprising, given the inconsistencies in antenatal clinical practice guidelines internationally and across Australia regarding how much GWG is appropriate for health, and the information provided to pregnant women in antenatal care (if any) across different Australian states and territories. The most comprehensive and recent evidence-based guidelines on appropriate weight gain during pregnancy are those published by the IOM, which categorise GWG recommendations according to pre-pregnancy BMI for singleton and twin pregnancies [3]. These have been adopted in the US and Canada, and are referred to in a number of documents in Australia. Further research is needed to inform specific GWG ranges for women with a pre-pregnancy BMI ≥35.0 kg/m^2 and ≥40.0 kg/m^2 and women of different cultural backgrounds. The imminent release of Australian national antenatal care guidelines will hopefully provide a starting point for promoting a more consistent national approach to addressing the prevention of EGWG in antenatal care.

3 CONSEQUENCES OF EXCESSIVE GESTATIONAL WEIGHT GAIN

HEALTH OUTCOMES

Existing evidence on the health effects of EGWG is derived almost entirely from observational cohort or longitudinal studies in pregnant populations. The maternal and offspring health outcomes assessed in these studies have primarily included infant birth weight and foetal growth (LGA or SGA), pre-term birth, delivery complications such as caesarean section, and post-partum weight retention. This chapter summarises the adverse health outcomes (maternal, birthing, foetal, neonatal and childhood) associated with both *excessive* and *inadequate* GWG. Where findings from Australian populations were available, they have been indicated in the summary below.

Gaining weight in excess of the IOM guidelines (EGWG) has been associated with an increased risk for the following health outcomes:

Maternal outcomes

➢ **Overweight or obesity** among Australian women [36]. Australian women with EGWG are at an increased risk for becoming overweight (OR 2.15; 95% CI: 1.64, 2.82) or obese (OR: 4.49; 95% CI: 3.42, 5.89) 21 years post-pregnancy [36], and experience a larger increase in post-pregnancy BMI (3.72 on average) compared with women with adequate GWG [36]. Weight gain and being overweight or obese in mid-life place women at a higher risk for cardiovascular disease, metabolic syndrome, type II Diabetes and early mortality [37].

➢ **Higher post-partum weight retention** in the short term (<12 weeks), medium term (3-36 months), and some evidence of retaining more weight in the long-term (8.5-16 years) [38-41]. The amount of weight retained is approximately 3kg after three years and almost 5kg after ≥15 years [42]. For Australian women, approximately 20% gain >5 kg by 6-18 months post-partum [43].

➢ **Gestational Diabetes Mellitus (GDM)**, among Australian women [44], and among women of a healthy pre-pregnancy BMI with EGWG in the first 15-18 weeks of pregnancy [45].

➢ **Gestational hypertension** in women of a healthy, overweight and obese pre-pregnancy BMI [19, 46].

➢ **Higher blood pressure** 16 years post-partum [40].

Birth process outcomes

➢ **Augmentation of labour** (stimulation of contractions to assist movement of the neonate down the birth canal) among women of a healthy pre-pregnancy BMI [19].

➢ **Caesarean section**, particularly among women classified as overweight or obese pre-pregnancy [19, 39], even if birth weight is not excessive [47]. Others have shown an increased risk of caesarean delivery with excessive second and third trimester weight gain among women of all pre-pregnancy BMI categories, except underweight and obese class III women [48]. Australian women with EGWG have a greater risk of experiencing caesarean delivery [49], estimated at a 9% greater risk for each 0.1 kg/week increase in GWG [44].

- ➢ **More anaesthesia-related complications** [50].
- ➢ **Hypertensive disorders** of pregnancy among Australian women [44].

Foetal and neonatal outcomes

- ➢ **Higher birth weight** (73-300g higher) [38], or an average 206g higher birth weight among Australian women [44], and there appears to be a greater risk among women of an underweight or healthy weight pre-pregnancy BMI [39], and among women who experience a higher rate of weight gain in their second trimester [41].
- ➢ **Macrosomia** (birth weight >4000g or >4500g) [19, 38, 39]. Risk of birth weight (>4000g) has also been demonstrated among healthy weight women with EGWG in the first 15-18 weeks of pregnancy [45].

There is some evidence that higher birth weight neonates have increased lean muscle rather than fat mass [51], while other studies have shown fat mass is increased [52, 53]. Regardless, evidence supporting associations between a higher fat mass at birth and adiposity in later life is conflicting [52].

- ➢ **Large-for-gestational age (LGA)** (>90th percentile of birth weight for gestational age), regardless of which standards are used to define percentiles [8, 38, 39]. An increased risk of LGA has been demonstrated among Australian women [49], among women of a healthy or overweight pre-pregnancy BMI with EGWG in the first 15-18 weeks of pregnancy [45], and among women with excessive second and third trimester weight gain [48]. Delivery of larger neonate can result in obstetric complications, and large birth size has been identified as a risk factor for offspring obesity in childhood [54].
- ➢ **Pre-term birth** among women who experience a higher weekly rate of EGWG [39, 55].
- ➢ **Gastroschisis** (type of congenital defect) among babies of women with higher total weight gain, adjusted for pre-pregnancy BMI [56].

Childhood outcomes

- ➢ **Higher BMI z-score:**
  - – in 4-6 year old children, among women of a healthy or overweight pre-pregnancy BMI [57, 58]
  - – in 5-year old children, among women of an underweight or healthy weight pre-pregnancy BMI with high first trimester GWG [59].

Despite this, it has been argued that the risk of higher BMI in children may be explained by family characteristics (e.g. genetic, behavioural, and environmental) rather than in utero programming [60].

- ➢ **Overweight, obesity and abdominal adiposity** in childhood [59]. Interestingly, there is no increased or decreased risk among women with inadequate GWG [61].
- ➢ **Overweight, obesity and abdominal obesity** at 16 years of age, among women with high GWG in the first 20 weeks of pregnancy, independent of pre-pregnancy BMI. However, maternal pre-conception obesity has also been shown to place offspring at a greater risk of overweight, obesity and abdominal obesity [62].
- ➢ **Onset of Type 1 Diabetes Mellitus** in susceptible children, among women with GWG ≥15kg, independent of pre-pregnancy BMI [61].
- ➢ **Asthma** diagnosis in first seven years of life, among women with >20kg GWG, independent of pre-pregnancy BMI [63].

Pre-conception obesity

It is important to acknowledge that while EGWG carries increased risks for many adverse maternal and offspring health outcomes, a plethora of adverse outcomes has been demonstrated for women who are obese pre-conception. There are risks to **offspring** (*macrosomia, foetal death, miscarriage, still birth, early neonatal death, metabolic and congenital abnormalities, including an increased risk of neural tube defects independent of folate supplementation, and an increased risk for obesity, poor cardio-metabolic health and possibly attention deficit hyperactivity disorder in childhood*) and to the **mother** (*hypertensive disorders of pregnancy, GDM, higher post-partum weight gain and retention, maternal infection, thrombo-embolic disorders, delivery complications, including augmentation or induction of labour, instrument assisted delivery and caesarean section*) [19, 64-67]. There is also a greater burden placed on the health care system due to longer hospital stays [68-70], and a greater likelihood for admission to neonatal intensive care units (NICU) [69, 70]. Further, a larger waist circumference and BMI pre-pregnancy, has been associated with an increased risk of GDM among Aboriginal women, translating to a 4% and 6% increased risk for developing GDM for each 1 cm increase in waist circumference and 1 unit increase in BMI, respectively [71].

Hence, antenatal care should not only focus on preventing EGWG in women, but also promoting a healthy weight prior to conception.

Inadequate gestational weight gain

Gaining less than the IOM recommendations for appropriate GWG has been found to increase the risk for the following outcomes:

➢ **Less post-partum weight retention** in the short-term (immediately after birth) and medium-term (6-18 months) [38, 41]. Approximately 3kg less weight is retained after <6 months, although after ≥15 years there appears to be no difference in post-partum weight retention between women with adequate or inadequate GWG [42].
➢ **Lower birth weight** [38, 39], and threefold greater risk for birth weight <2500g [55]. Australian women, on average, deliver a 191g lighter baby [44]. A U-shaped relationship has also been reported between birth weight and fat mass in adulthood such that both low and high birth weight infants are at increased risk of having a higher fat mass in adulthood [72].
➢ **Small-for-gestational age (SGA)** [8, 38, 39], which has been demonstrated among Australian women [49], and among women with inadequate second and third trimester weight gain from all pre-pregnancy BMI categories except obese classes II and III [48].
➢ **Low birth weight (<2500g)**, although this association may not exist for overweight or obese women [38].
➢ **Less likely to initiate breastfeeding** [39].
➢ **Less likely to require epidural analgesia**, among women classified as morbidly obese pre-pregnancy [19]
➢ **Pre-term birth** in singleton pregnancies [39, 55]; also demonstrated among Australian women [44], and women with twin pregnancies [73].
➢ **Anencephaly and *spina bifida*** (the latter only for deliveries <37 weeks gestation), among women with lower GWG, independent of pre-pregnancy BMI [56].

ECONOMIC OUTCOMES

There is little evidence to inform the impact of maternal EGWG on health care costs, although one Australian study reported that women with EGWG stay 20% longer in hospital compared with women with appropriate GWG [44]. This translates to an extra day in hospital for every 1kg increase in GWG. Importantly, this estimate is independent of maternal factors, pregnancy complications, birth weight and mode of delivery [44].

CONCLUSIONS

Women who gain excess weight during pregnancy, i.e. gain in excess of the IOM recommended guidelines, have a greater risk of multiple obstetric and longer-term health outcomes. They are more likely to be overweight or obese and have a higher weight post-pregnancy, are at an increased risk of chronic disease, and are more likely to give birth to larger neonates with a higher risk for obesity in childhood.

Adverse health outcomes have also been associated with pre-conception obesity, such as higher post-pregnancy weight retention. Thus, optimising pregnancy-related health outcomes requires a whole of pregnancy approach aimed at entering pregnancy at a healthy BMI, gaining an appropriate amount of weight during pregnancy, and returning to a healthy weight post-partum.

There is currently very limited evidence regarding the costs of EGWG to the community.

4 PREVALENCE OF EXCESSIVE GESTATIONAL WEIGHT GAIN

PREVALENCE OF OBESITY PRIOR TO/DURING PREGNANCY IN AUSTRALIA

Data show that the prevalence of obesity among women bearing children in Australia is rising, and this has important implications for obstetric care [64, 69].

The clinical practice guidelines for the management of overweight and obesity in adults identify pregnancy as a critical period for weight gain in women (revision of the guidelines due for release mid-2013). Data from 1999-2000 indicate that approximately 47% of Australian women aged 25-34 years were overweight or obese [28]. Mean body weight was found to have increased by 3.5 kg in 2004-2005 [74].

➢ In the most recently published study in Australia [75], a retrospective cohort of 6138 pregnancies, managed in a rural Victorian maternity service from 2005-2010, showed that 65.6% of all women were overweight or obese. Only 32.7% of the women were of normal/healthy weight, 1.6% were underweight, 33.0% were overweight, 18.6% were obese class I, 8.3% obese class II and 5.7% were obese class III. Analysed separately, 60.5% of first-time mothers were overweight or obese. Other data reported indicated that 56.8% of women aged 25-44 were overweight or obese among a non-obstetric rural population in south-western Victoria [76].

➢ Based on self-reported pre-pregnancy weight, 34% of 502 pregnant women in Brisbane were overweight prior to pregnancy [34].

➢ Over 30% of pregnant women attending a public tertiary maternity hospital (about 5000 births per annum) in SE Queensland were determined to be overweight or obese [77].

➢ From 1998 to 2009, among 75,432 women attending this same hospital in Brisbane, Queensland, the proportion of women with a normal or overweight pre-pregnancy BMI remained stable at around 60% and 20%, respectively [78]. However, class II obesity increased from 2.5% to 3.2% and class III obesity from 1.2% to 2.0%, and the proportion of underweight decreased from 7.9% to 7.4%. McIntyre et al (2012) indicated that around 8-9 women with class II or III obesity give birth each week in the Brisbane hospital [78].

➢ Among a convenience sample of 149 women attending antenatal services in the Canberra Hospital in 2010, 39% were overweight/obese (63.6% of their partners were overweight/obese) [79].

➢ Of 1661 women enrolled in the Australia Collaborative Trial of Supplements to pregnant women for the prevention of pre-eclampsia, 43% of nulliparae were overweight or obese [64].

➢ In a cross-sectional study of 14,230 women attending the Mater Mother's Hospital in Brisbane, Queensland, between 1998 and 2002, the distribution across pre-pregnancy BMI categories was 21% underweight, 45% normal weight, 20% overweight, 12% obese and 2% morbidly obese [80].

➢ In a study of 2827 women in Perth, pre-pregnancy BMI classified 331 women as underweight (11.7%), 1982 normal (69.9%), 326 overweight (11.5%), and 188 as obese (6.6%) [81].

PREVALENCE OF EGWG IN AUSTRALIA

There are limited epidemiological data reporting the weight gains that occur during pregnancy in Australian women. Much of the available evidence comes from single cohort studies conducted at various locations within Australia. In each study, EGWG was considered to be weight gain exceeding that recommended within the IOM guidelines (2009) according to pre-pregnancy BMI.

➢ The most recent data on weight gain during pregnancy in Australia is in the study by de Jersey et al (2012)[34]. This was the first prospective study of measured weight gain in pregnancy in Australia. Among 664 women recruited at 20 weeks gestation in a tertiary teaching hospital in Brisbane between August 2010 and July 2011, 36% gained weight according to the guidelines, 26% gained IGW and 38% gained EGW. Ten per cent of women in the study had gained their recommended weight by 16 weeks gestation.

➢ In a prospective longitudinal cohort study of 179 women (data available for 165) with singleton pregnancies in Newcastle, NSW, 54% of the cohort experienced EGWG [51]. Median weight gain exceeded the IOM guidelines in overweight and underweight women, but not normal weight or obese women.

➢ Chung et al found a prevalence of EGWG from the second and third trimesters of gestation to be 74% among N=1950 women from Ireland, New Zealand and Australia [82]. 17.2% achieved adequate GWG, 8.6% inadequate GWG and 74.3% high GWG. High GWG was observed in 67% (n = 724) of normal weight women, 84% (n = 476) of overweight women and 80% (n = 248) of obese women. Among the data for Australia (Adelaide) only, prevalence of EGWG was 66.7%.

➢ Among a small sample of 50 overweight and obese pregnant women in Brisbane (pre-pregnancy weight 34.4 ± 6.6 kg/m^2), 52% gained EGW (GWG varied widely between -4.1 kg to 23.0 kg with a mean of 10.6 ± 6 kg) [34]. Although not an intervention study *per se*, the women were informed of the IOM recommendations regarding pregnancy weight gain at a group education session at between 12-15 weeks gestation.

PREVALENCE OF EGWG INTERNATIONALLY

There is evidence that prevalence of insufficient and excessive GWG varies between countries, e.g. EGWG appears to be much higher in the US compared to the Netherlands.

➢ In Florida in the US, among 570,672 women aged 18-40 years with a singleton full-term live-birth between 2004-2007, 41.6% of women began pregnancy as overweight and obese and 51.2% had EGWG, [8].

➢ Among a sample of 1449 women in The Netherlands, 60% of the pregnant women did not meet the IOM recommendations: 33.4% had IGWG and 26.7% had EGWG [83].

➢ A smaller study in the US showed that, among 1537 women with either healthy or overweight/obese pre-pregnancy weight, 54% had EGWG [84]. Similarly, in a prospective cohort study of 1100 women, IGWG was 14% and EGWG was 53% [85].

➢ For prenatal and birth data for 2760 women aged 18 to 40 years with term singleton births from 2004 to 2007, among African-American and white American women, excessive weight gain began by the second trimester [86]. Similarly, Chmitorz et al (2012) present data from 7962 pregnant women in Germany showing that it is possible

to identify women at risk of gaining weight outside the guidelines as early as the second trimester [87].

DETERMINANTS OF EGWG

Provision of weight gain advice during pregnancy

➢ In the recent prospective study of 94 prenatal care patients in the US, clinician advice discordant with IOM guidelines was associated with EGWG (OR 5.88, 95% CI 1.04-33.32 for discordant versus concordant advice) [88].

➢ In another recent US study among 1,454 pregnant women, there was a weak effect of provider advice on inadequate or excessive gain (Relative Risk (RR) 0.96, 95% CI 0.74-1.26 for inadequate gain and RR 1.01, 95% CI 0.97-1.06 for excessive gain) [89].

➢ The giving of erroneous advice among 2237 predominantly white, middle class women in the earlier study by Cogswell et al (1999) was associated with a three-fold increased risk of EGWG, while receiving no advice about recommended GWG at all was also associated with gains outside of the recommendations [90]. EGWG was observed in 44.8% of women who received no weight gain advice, in 18.1% of women who had advice to gain less weight than the guidelines, 35.7% among women who received weight gain advice consistent with the guidelines, and 67.3% among those who received advice to gain more than the IOM guidelines.

➢ In the study by Stotland et al (2005), women who received physician advice to gain below the IOM recommendations were most likely to have inadequate weight gain, while those with physician advice for gain above the recommendations were most likely to gain an excessive amount [91].

➢ In the US study (n=1100, prospective cohort study) by Brawarski et al (2005), receiving no physician advice versus receiving advice about GWG did not affect GWG [85].

Pre-pregnancy BMI

Mean total weight gain during pregnancy tends to be less for those women who enter pregnancy overweight or obese. For example, in an Australian study by de Jersey et al (2012), weight gains were 11.6±8.1 kg for overweight women versus 14.2±5.3 kg for healthy weight women [34]. Also, in Althuizen et al (2009), obese women gained almost 4 kg less than healthy weight women [92]. However, women who enter pregnancy overweight or obese are more likely to exceed IOM recommended weight gain.

➢ In a recent study among 775 women in an infant-feeding trial in the US, although overweight/obesity was associated with EGWG, this risk was not modified by inaccurate reporting/perception of weight status [93].

➢ In Victoria, Harrison et al (2012) found that, for an observational sub-study of 97 pregnant women at risk of developing GDM, actual weekly weight gain in the second trimester was significantly higher than IOM recommended weekly weight gain in the second trimester among those women at risk of GDM who were overweight or obese pre-pregnancy [94].

➢ Among 664 pregnant women in Brisbane (n=502 with sufficient data), 56% of overweight women gained EGW compared with 30% of those who started with a healthy weight (p < 0.001) [34]. Study participants who were obese pre-pregnancy had the highest prevalence of EGWG (62%) and the lowest prevalence of IGWG (11%).

- Among 1950 nulliparous pregnant women in Ireland, New Zealand and Australia, overweight and obese women were the most likely to have high GWG, with mean estimated GWGs of 13.77±5.2 kg for overweight and 11.92±8.1 kg for obese women, compared with the recommended IOM optimum GWGs of 7–11 kg and 5–9 kg respectively. EGWG was observed in 67% of normal weight women, 84% of overweight women and 80% of obese women [82].
- In a sample of 1449 women in the Netherlands, BMI at 12 weeks was significantly positively correlated with total GWG. The relative risk of EGWG for overweight women compared to healthy weight women was 2.90, and for class 1 obese women this risk increased to 4.38; but then reduced to 2.18 for class II and class III obese women [83]. Obese women in classes II and III were at risk of both over- and under-gaining.
- Among 1420 women in a population-based cohort study in the US, preconception overweight increased the odds of EGWG nearly three-fold (AOR 2.84, 95% CI 1.11-7.29) [95]. The AOR was the same for pre-pregnancy obesity; however, this finding wasn't statistically significant (AOR 2.84, 95% CI 0.81-9.96).
- Among 144 women in an observational study in the US, being overweight was associated with increased odds of EGWG (OR 6.33, 95% CI 2.01-19.32) [92].
- Stotland et al (2005) showed that individual covariates associated with EGWG included overweight compared to healthy pre-pregnancy weight (OR 2.26, CI 1.43-3.56) [91]. Similarly, Brawarsky et al (2005) indicated that pre-pregnancy factors (such as obesity) contributed 74% to EGWG, substantially more than pregnancy-related health conditions (15%) and modifiable pregnancy factors (11%); although these three groups of 'actors' contributed fairly equally to IGWG [85].
- In Canada, Strychar et al (2000) provided evidence that women with a high pre-pregnancy BMI who experienced EGWG are less knowledgeable about the importance of not gaining excess weight and have a less favourable attitude towards their weight gain during pregnancy [96].

Weight gain in different trimesters of pregnancy

- In a prospective study of 94 prenatal care patients in the US, significant predictors of EGWG included high early pregnancy body mass index (OR 4.20; 95% CI 1.43-12.34 for overweight/ obese vs. normal weight) [41].

Previous pregnancy weight gain

- Gestational weight gain is highly concordant between consecutive pregnancies such that women who gained excessively during their first pregnancy are much more likely to do so in their second and third pregnancies (Waring et al 2012; US; n=1325) [97]. Similarly, those who gained within the range and those who gained inadequate weight followed the same patterns of weight gain in subsequent pregnancies. EGWG during the first pregnancy was strongly associated with EGWG in second pregnancy AOR 5.4 (95% CI: 1.7-16.4) for underweight pre-pregnancy; 3.7 (2.4-5.5) for normal weight, 3.0 (1.2-7.6); and 5.3 (2.4-11.7) for obese women.

Self-assessed pre-pregnancy weight status

➢ In the study by Herring et al (2008) in the US, compared with normal weight accurate assessors, the adjusted odds of EGWG was 2.0 (95% CI 1.3, 3.0) in normal weight over-assessors, 2.9 (95% CI: 2.2, 3.9) in overweight/obese accurate assessors, and 7.6 (95% CI: 3.4, 17.0) in overweight/obese under-assessors [84].

Diet

➢ Data on 47,003 women in the Danish National Birth Cohort Study (1996-2002) indicated that, among normal-weight and overweight women, higher GWG rates were detected in the highest glycaemic load quintile (26 g/week (95 % CI 19, 34) and 30 g/week (95 % CI 13, 46), respectively [98].

➢ Data from 1231 women with singleton pregnancies who participated in the Pregnancy, Infection, and Nutrition Cohort Study (US) showed that dietary energy density, but not glycaemic load, was associated with total GWG or weight gain ratio [99]. After adjustment for covariates, compared with women in the first quartile consuming a mean dietary energy density of 0.71 kcal/g (reference), women in the third quartile consuming a mean energy density of 0.98 kcal/g gained an excess of 1.13 kg (95% CI: 0.24, 2.01), and women in the fourth quartile consuming a mean energy density of 1.21 kcal/g gained an excess of 1.08 kg (95% CI: 0.20, 1.97) and had an increase of 0.13 (95% CI: 0.006, 0.24) units in the weight gain ratio.

➢ Data from 1231 women with singleton pregnancies in the US showed that restrained eating behaviours were associated with weight gains above the IOM's recommendations for normal, overweight, and obese women, and weight gains below the IOM recommendations for underweight women [100].

➢ Among 144 women in an observational study in the US, the odds of EGWG were increased among pregnant women who perceived elevated food intake during pregnancy (OR 3.14, 95% CI 1.18-8.36) [92].

➢ One study showed that odds for EGWG were higher for low dairy consumption during pregnancy (OR 1.74, 95% CI 1.06, 2.87), although there were methodological limitations to this study [85].

Physical activity levels

A general consensus exists that PA levels decrease over pregnancy; however, whether this is a metabolic alteration to offset the energy cost of pregnancy to ensure adequate fuel to support the foetus, or is a behavioural alteration due to discomfort or increased fatigue of moving when pregnant, is unclear. Two recent studies indicated behavioural and biological compensation in the energy cost of walking in obese women during gestation [101], [102]. DiNallo et al (2008) indicate that encouraging pregnant women to walk for 30-40 min per day at a self-selected walking pace may be an appropriate public health recommendation [103].

➢ In an observational sub-study of 97 pregnant women at risk of developing GDM in Victoria, increased GWG was not found to be significantly associated with reduced PA levels (which occurred in those women who developed GDM) [94].

➢ In Canada, walking and pedometer steps were found to be the only PA factors out of 32 PPAQ questions associated with GWG among pregnant women [104].

- Among 1420 women in a population-based cohort study in the US, preconception PA levels meeting activity guidelines reduced the odds of EGWG but the effect was marginally statistically significant (>30 minutes PA on most days of the week versus <30 minutes PA on most days of the week; AOR 0.34; 95% CI 0.11-1.07; p=0.07) [95].
- Among 144 women in an observational study in the US, pregnant women who judged themselves to be less physically active than others were significantly at increased odds of EGWG (OR 3.96, 95% CI 1.55-10.15) [92].
- High BMI and low pre-pregnancy PA level were associated with EGWG among 223 healthy Swedish women. However, together with smoking, parity, education and age, pre-pregnancy PA level and BMI explained only 4% of the variation in GWG [105].

Gestational Diabetes Mellitus (GDM)

- A prospective clinical audit of 212 women (115 with GDM and 97 non-GDM) in Victoria showed that, for each BMI category, GDM women gained less weight than non-GDM women: normal weight 0.21 kg/week versus 0.47 kg/week, P < 0.0001; overweight 0.12 kg/week versus 0.58 kg/week, P < 0.001; obese 0.05 kg/week versus 0.55 kg/week, P < 0.0001. GDM status was the only independent predictor of post-recruitment weight gain. Of note, women with GDM were more likely to have been born outside of Australia or New Zealand, relative to non-GDM women. Relative to the non-GDM women, those with GDM had a lower rate of weight gain in the 8 weeks following recruitment (calculated as mean rate over the 8 weeks) (P < 0.0001). This was only for weeks 1-4 not weeks 5-8 post-recruitment. The reduced weight gain was attributed to either the lifestyle advice (received only by those with GDM; did not include specific advice for weight gain) or to the diagnosis of GDM – the effects of the two could not be distinguished in the study [106].
- In the US, individual covariates associated with increased risk of inadequate weight gain included chronic or gestational diabetes versus no diabetes (OR 2.70, CI 1.18–2.19) [85].

Race

- A prospective clinical audit of 212 women (115 with GDM and 97 non-GDM) in Victoria showed that within the GDM group, percentage weight gains differed significantly across ethnic groups (P = 0.03). On *post hoc* analysis, women born in Australia or New Zealand had lower percentage gains relative to women born in South-east Asia [106].
- Among a population-based cohort of 6632 women who gave birth in Brisbane between 1981 and 1983, those of Aboriginal-Islander origin were more likely than other women to gain EGW during pregnancy. Unadjusted data indicated that 35.6% of white women, 21.5% of Asian women, and 41.9% of Aboriginal women experienced EGWG [44].
- In the US, white women have been found to be at increased risk of EGWG compared to black women (e.g. [86, 107]). Latina women were more likely to experience low GWG compared to white women [85].
- Among 311 predominantly low-income patients in the US, white women were significantly less likely to be counselled about nutrition than non-white women (p=0.02; despite having higher rates of EGWG nationally); former smokers were more likely to receive counselling about nutrition and exercise than never smokers (p<0.05). More advanced gestational age was associated with high rate of counselling on weight gain (p=0.01) [108].

Maternal age

➢ According to Bergmann et al (2007), women between 22 yrs and 26 yrs were more likely than other women to gain excessively [109].

➢ Gunderson et al (2000) found that women aged 24-30 years were likely to gain more weight during pregnancy than women older than 30 years [110]. However, this difference may be related to the socioeconomic status (SES) of the women involved, which affects the timing of employment and career paths, and which in turn, creates differences in the timing of pregnancy among women with different levels of SES.

➢ There is evidence to suggest that GWG is increased for women in their twenties but the data are inconclusive, with some studies finding no relationship whatsoever. In particular, the relationship between age and SES and parity is not well understood, so further research into the relationship between age and GWG is warranted.

Parity

Findings are not consistent between studies examining parity and gestational weight gain.

➢ Among 94 low-income, urban women in the US, nulliparity was significantly associated with increased odds of EGWG (OR 3.35, 95% CI 1.17-9.62) [41].

➢ Similarly, in another American study, nulliparity versus one or more previous births was associated with an increased risk of EGWG (AOR 1.49; 95% CI 1.08-2.04) [85].

➢ However, Stotland et al (2005) indicated that the AOR for EGWG was 0.38 (95% CI 0.23-0.65) for nulliparous versus multiparous pregnant women [91].

Psychosocial factors

➢ A conceptual model of psychosocial risk and protective factors for EGWG has been proposed by Hill et al (2012), in Australia [111]. They cite literature showing that increased depressive symptoms, anxiety, lower self-esteem and body image dissatisfaction are associated with EGWG.

➢ Similarly, in a prospective study of 1605 women in the US, higher depressive symptoms reported throughout pregnancy were significantly associated with higher adequacy ratios (ratio of observed/expected weight gain) [112]; and in another study, women who experienced high stress during pregnancy were more likely to have IGWG than women with no stress [85].

➢ Body image is associated with GWG but the relationship is complex [113].

➢ Olson et al (2003) developed a biophysical model to predict EGWG but found that no psychosocial variables remained significant in a model that included household income and diet and PA behaviours [114].

➢ Recently, the review to support the IOM 2009 guidelines (review of potential socio-ecological and psychosocial risk factors) found that few of the potential risk factors could conclusively be deemed determinants of GWG [115].

Miscellaneous

➢ Among 810 pregnant women in the US, 76% were from fully food secure, 14% were from marginally food secure, and 10% were from food insecure households [116]. Living in a food insecure household was significantly associated with severe pre-gravid obesity (AOR 2.97, 95% CI 1.44 to 6.14), higher GWG (adjusted beta coefficient 1.87, 95% CI 0.13 to 3.62), and with a higher adequacy of weight gain ratio (adjusted beta

0.27, 95% CI 0.07 to 0.50). Marginal food security was significantly associated with GDM (adjusted OR 2.76, 95% CI 1.00 to 7.66). Therefore, living in a food insecure household during pregnancy may increase the risk of EGWG and pregnancy complications.

➢ In the US, Gallagher et al (2013) found that rural women were more likely to have an unhealthy pre-pregnancy weight than urban women; however, rural residence was found to be protective against unhealthy GWG in overweight/obese women [117].

➢ In Belgium, data from 54 022 singleton pregnancies showed that, in 2009, those with high and the highest educational level had lower odds for EGWG (OR 0.76, 95% CI 0.72-0.80) and insufficient GWG (OR 0.93, 95% CI 0.89-0.98) [118].

➢ In the US, several studies have found that low income women are at a higher risk for both IGWG and EGWG [119], [120], [114].

➢ Also in the US, Althuizen et al (2009) indicated that among 144 women the odds of EGWG were significantly reduced among those who received more mean hours of sleep (OR 0.35, 95% CI 0.57-0.93) [92].

➢ In the US, 1605 pregnant women followed prospectively showed that women who tend to believe that external factors primarily determine foetal health appear to be more vulnerable to non-adherence to GWG guidelines [112].

➢ Among a population-based cohort of 6632 women who gave birth in Brisbane between 1981 and 1983, those mothers who gained excessive weight were more likely to have experienced previous pregnancy complications, have had their infant delivered by caesarean section, and to have had higher birth weight infants. Also, mothers with lower educational attainment and those who never smoked and abstained from alcohol prior to pregnancy were more likely than other women to experience EGWG [44].

➢ Frequent versus some or no acid reflux during pregnancy has been associated with EGWG (OR 1.57, 1.10-2.24) [91].

➢ The majority of research regarding smoking and pregnancy deals with the effects smoking has on the infant and not GWG for the mother.

Risk factors for IGWG

➢ In a study in Sri Lanka, the risk factors for IGWG were low per-capita monthly income (OR 1.63, 95% CI 1.03, 2.58), multiparity (OR 1.96, 95% CI 1.34, 2.87), sleeping <8 h/day during the second, third, or both second and third trimesters (OR 1.60, 95% CI 1.05, 2.46), standing and walking 5 h/day during the second trimester (OR 1.50, 95% CI 1.04, 2.15), and the newborn being of the male sex (OR 1.50, 95% CI 1.04, 2.16), controlling for the effect of body mass index and gestational age [121].

CONCLUSIONS

There is a lack of distinction among researchers and maternity health care providers regarding the management of obesity in pregnant mothers and the prevention of EGWG across all pre-pregnancy BMIs. Consequently, some of the levels of prevalence of EGWG and the risk factors, or determinants, for EGWG cannot be distinguished between those for all pregnant mothers and those for women who enter pregnancy already overweight or, particularly, obese.

Many of the data regarding levels of overweight and obesity pre-pregnancy and levels of EGWG are from small cohort studies. Reported rates of overweight among women entering

pregnancy in Australia vary from 20% to 43%; although many of these data are based on self-reported data and actual rates are therefore likely to be higher. Levels of pre-pregnancy overweight are much higher in some rural areas (e.g. rural Victoria). Levels of class II and class III obesity among pregnant women have increased.

Prevalence of EGWG in Australia has been reported in various studies to be between 38% and 67%. Internationally rates vary, ranging for example between 26.7% in The Netherlands and 51.2% in the US, the latter from population-level data. Other studies in the US indicate prevalence levels of around 50-54%.

Socioeconomic factors associated with EGWG include race/ethnicity: Australian women born in Australia/New Zealand compared to those born in South-East Asia, Aboriginal women compared to non-Indigenous Australian women, and American white women compared to American black women and Latinas, are more likely to gain EGW. There is no information on the rates of EGWG among other Australian ethnic groups. Women with a higher education are less likely to experience EGWG. There is a lack of clarity around the evidence for the effect of age on EGWG, although younger women may be at increased risk. Evidence for the effect of parity on GWG is inconsistent.

A large number of other factors have been found to be associated with EGWG. The receipt of erroneous advice on weight gain – particularly advice to gain more than the guidelines – appears to be more strongly correlated with EGWG than a complete lack of advice on weight gain. Other weight factors positively associated with EGWG include: pre-pregnancy overweight and obesity, high early pregnancy BMI, previous EGWG, and poor self-assessment of pre-pregnancy weight status.

Possible aspects of diet positively associated with EGWG include: high glycaemic load, an energy dense diet, restrained eating behaviours, perceived elevated food intake, and low dairy consumption. Aspects of PA have been less conclusively linked to GWG, although there is some evidence to suggest that low levels of PA pre-pregnancy, even self-perceived, may impact on EGWG. GDM is probably associated with lower prevalence of EGWG. Food insecurity may be associated with higher EGWG.

Several psychosocial factors are considered to be associated with GWG, e.g. depression, anxiety, low self-esteem, body image dissatisfaction. However, models using psychosocial factors to predict GWG indicate that these factors are not conclusively determinants of GWG.

5 PREVENTION OF EXCESSIVE GESTATIONAL WEIGHT GAIN

This chapter presents a summary of recent evidence to inform effective strategies for intervention to prevent EGWG in healthy pregnant populations.

SCOPE OF THE EVIDENCE

Since 2010, at least 14 systematic reviews of lifestyle interventions aimed at reducing GWG and preventing EGWG have been published (cf. Appendix 1 for a summary of these reviews). Among these, two reviewed dietary interventions [122, 123], a further three reviewed PA interventions [89, 124, 125], while the remainder reviewed a combination of diet only, PA only and combined dietary and PA 'lifestyle' interventions [1, 126-133]. Ten of the 14 reviews included in this summary were systematic reviews (with or without meta-analyses) of randomized controlled trials (RCTs), which provide the highest level of evidence available on this topic [1, 122, 126, 127, 129-134]. Where available, the findings of recent Australian trials are reported. Nine trials are currently underway across South Australia, Victoria, Western Australia and New South Wales (these are listed at the end of this chapter).

The primary outcome reported in all reviews was total GWG during pregnancy, although the period of gestation over which GWG was reported varied across trials (e.g. from 12 weeks gestation to two weeks post-partum versus 25 weeks gestation to post-delivery). There were also differences in how GWG was measured, e.g. some trials used self-reported as opposed to measured pre-pregnancy weight, and some but not all trials calculated GWG by subtracting foetal and placental weight. Exceeding the IOM guidelines for appropriate GWG was only reported in five reviews [123, 129, 131, 133, 134], and weekly rate of GWG was reported as an outcome in one [123].

REDUCING GWG IN PREGNANT WOMEN

Lifestyle programs – aimed at diet and PA, diet only or PA only – have been shown to result in 1.2 – 1.4kg less GWG on average among women of all pre-pregnancy BMI categories [128, 132, 133], and 2.1 – 3.0kg less GWG among overweight and obese women [128, 130, 132, 133], compared with usual pre-natal care.

Effective programs have encouraged daily monitoring of intake and have provided women with _structured meal plans based on individualised energy requirements_, _structured exercise sessions or advice_, _weekly contact with a care provider_, and _regular weight monitoring according to IOM guidelines_ (inadequate evidence to suggest whether this should be by the care provider or the women themselves) [131, 132]. In a recent RCT conducted in the Netherlands among pregnant women of all pre-pregnancy BMI categories, no difference was found in total GWG between women who received four counselling sessions around controlling their GWG and controls receiving 'usual care' [135]. However, overweight and obese women who received this intervention were found to gain less gestational weight than those receiving usual care (10.6 kg vs. 12.1 kg, non-significant). This contrasts with findings from a recent systematic review of RCTs that found individualised behavioural counselling involving _monitoring GWG at antenatal clinic visits_ (with personalised graphs in two studies) and _providing advice on diet, PA and appropriate GWG tailored to current GWG_,

resulted in 1.4kg less GWG on average, compared with usual pre-natal care, among women of all pre-pregnancy BMI categories [129]. There was a lack of description in studies about whether the women were educated on the health outcomes associated with appropriate GWG; hence, it is not possible to say whether this is an effective counselling strategy [128].

Initiating programs *at or before a mean of 12 weeks gestation* resulted in 1.7kg less GWG, compared with after 12 weeks (-0.9 kg GWG) [128], thus *setting goals for appropriate GWG as well as their diet and PA* during pregnancy may be an effective strategy for all women regardless of pre-pregnancy BMI [126].

de Jersey et al delivered an antenatal care program to obese pregnant women at a Queensland hospital which involved a group education session and written information on PA, diet and IOM recommendations for appropriate GWG during pregnancy [136]. By the end of their pregnancy, only 16% of obese women who recieved the intervention recalled being spoken to about GWG. Most (68%) of the women who recieved the intervention reported GWG goals of 5 – 18 kg (5 – 9 kg recommended for obese women), while the remainder were unsure how much weight they should gain [136]. The authors also reported little change in the total energy and macronutrient profile of the diet, suggesting a *one off group counselling with written information on dietary recommendations is not sufficient to prevent EGWG* [136]. In contrast, obese women in Belgium were found to have significantly less total GWG with an informational healthy lifestyle brochure (9.5 kg), and with the same brochure plus four small group motivational counselling sessions (10.6 kg), compared with normal care (13.5 kg) [137].

In a separate Queensland hospital antenatal program called the *'Healthy Start to Pregnancy'* workshop [138], a one-off booklet was found to be less effective for increasing women's fruit and vegetable intake, diet quality and PA during pregnancy. The booklet contained information on key behaviours that influence maternal and infant health outcomes (fruit and vegetable intake, PA and healthy weight gain), as well as screening tools, goal setting and self-monitoring activities for these key behaviours. The 60-minute one-off workshop provided *screening tools to assess the key behaviours, explanation of and assistance during the session with goal setting and self-monitoring based on screening outcomes, followed by links to more specialised services to support behaviour change where required* [138].

Dietary programs, with or without PA counselling, result in 1.9 – 3.8 kg less GWG on average, among all women regardless of pre-pregnancy BMI, and tend to reduce the risk of EGWG (findings non-significant), compared with usual pre-natal care [123, 133]. Dietary programs that only provide a brochure and group counselling sessions may not be sufficient [122], but rather, should include *individualised energy controlled diets in line with national dietary recommendations*, with *monitoring of intake (i.e. with food diaries)*. This aligns with the findings from cohort studies among pregnant populations which show a positive association between energy intake and GWG, suggesting limiting energy intake based on individualised requirement is a prudent strategy to limit GWG [139]. Energy restrictions have ranged from 36kcal/kg per day for healthy weight women, 18-25kcal/kg per day for overweight or obese women and 15kcal/kg per day for morbidly obese women [131],

although dietary instruction should take into account the additional 1.4 MJ per day during the second trimester and 1.9 MJ per day during the third trimester recommended for all pregnant women [27]. _Monitoring dietary intake with food diaries_ may assist with informing dietary recommendations, raising women's awareness to their intake, and assisting care providers in monitoring women's adherence to dietary instruction, although there is insufficient evidence to conclude whether monitoring should be by care providers or the women themselves [133].

Dietary interventions (with or without PA counselling) appear to have a greater effect among overweight and obese women, resulting in 6.5 – 7.7kg less GWG compared with usual care in this pre-pregnancy BMI group [122, 133]. Programs for overweight and obese women appear to require more _intensive dietary counselling aimed at restricting energy intake and possibly with regular weight monitoring_ against appropriate GWG targets [122, 123, 129]. The provision of dietary counselling in antenatal care settings may also benefit women at risk of inadequate GWG, as women receiving _nutrition education counselling_ have been shown to have a 0.5kg higher GWG on average [140].

Findings are conflicting for the benefit of a _low glycaemic index (GI) or glycaemic load diets_ for limiting GWG in overweight and obese pregnant women [98, 141]. Among women in Ireland, a low GI diet was shown to result in significantly less GWG, compared with controls who received no dietary intervention (12.2 _v_ 13.7 kg; mean difference −1.3, 95% confidence interval −2.4 to −0.2; P=0.01) [141]. However, a recent Australian trial found a low GI diet to have no effect on total GWG, compared with a high GI diet [142].

Three recent systematic reviews concluded that PA during pregnancy is effective for reducing total GWG [124, 125, 134]. Among overweight and obese women, supervised PA programs result in 0.4 kg less GWG on average, and 0.9 kg on average among obese women [125]. Similarly, PA programs that are supervised or monitored (e.g. using pedometers or activity diaries) have been shown to result in 0.6 – 2.0 kg less GWG in women of all pre-pregnancy BMI categories [124, 129]. The PA programs included in these reviews have instructed women to perform _resistance training or aerobic exercises such as stationary cycling or walking, 3-5 times per week, in supervised exercise sessions_ [124, 125]. This type of PA intervention may be more effective than counselling for home-based exercise, although more evidence is needed to confirm this [134]. In a recent Canadian trial, healthy weight women participating in either a low intensity (LI) or moderate intensity (MI) exercise program were found to experience less total GWG compared with controls (C) (LI: 15.3kg, MI: 14.9kg, C: 18.3kg), with EGWG prevented in 70% of cases with the LI program and 77% of cases in the MI program [143]. The exercise program involved walking three to four times per week, increasing from 25 to 40 minutes per session, performed at 30% (LI) or 70% (MI) of heart rate reserve [143]. Further, among inactive pregnant women _persuasive messages about exercise during pregnancy_ have been shown to increase scheduling self-efficacy, task self-efficacy, intention to exercise, and stronger action plans to exercise [144]. Different tailored messages however may be required for those who are already active prior to pregnancy to maintain PA levels during pregnancy [144].

FEASIBILITY OF INTERVENTION DURING PREGNANCY

Chapter 6 of this report summarises the barriers experienced by health professionals and women in addressing appropriate GWG; however, a brief summary of feasibility issues highlighted in the interventions evidence is presented in this section.

Due to the paucity of descriptive information presented in interventions on patient compliance, satisfaction and program implementation, there is limited evidence available to inform factors influencing the feasibility of interventions for preventing EGWG [123, 133]. There is some evidence that Australian women feel it is important for hospitals to offer a weight management program [145], and that individual appointments are preferred (due to less shame or embarrassment and perception of an individualised approach as being more appropriate), as well as regular weighing and regular time with the dietitian [145].

Antenatal programs however, may be perceived as too time consuming by women (e.g. ten one hour one-on-one dietary counselling sessions during the second and third trimesters) leading to non-attendance [126]. A pilot study conducted with pregnant women in Victoria found poor uptake and high attrition rates with a program consisting of four individual dietary education sessions (three antenatal, one post-natal) and three antenatal group exercise classes [145]. Reasons for non-attendance in Australian trials have included only wanting post-pregnancy weight reduction information, work commitments, access (location, travel distance, lack of transport, time of day, childcare), expensive parking, pregnancy complications, too tired, bad timing, or diet not culturally relevant [145, 146]. Australian midwives may also find it challenging to discuss weight management with pregnant women due to concern about losing rapport with the pregnant woman and their own weight status being an issue / embarrassment [146]. Other implementation issues have included midwives' time, defensiveness of overweight or obese pregnant women about weight, and the need for attractive and informative advertising of programs.

While the available evidence suggests programs should provide regular contact with care providers and be initiated at or before a mean of 12 weeks gestation, women tend to attend antenatal care infrequently early in pregnancy, increasing frequency of contact later in pregnancy, thus the ability to provide such programs during antenatal care visits is questionable [127, 131]. Further, many interventions have used nutrition and PA professionals to deliver education and counselling to the women; so it is unclear whether training professionals already involved in antenatal care would have the same effect on reducing GWG [1]. While regular weighing to monitor GWG may be an effective strategy to prevent EGWG, there is a lack of evidence on the emotional effects of this practice in pregnant women [131]. Finally, while health care provider advice about appropriate GWG may be effective, evidence suggests providers may be uncomfortable or feel under-skilled to offer advice [146].

DECREASING RISK FOR EGWG IN PREGNANT WOMEN

The primary outcome measured in interventions aimed at preventing EGWG has been total GWG during pregnancy. Few studies have reported on the effect of antenatal interventions on the risk of exceeding GWG guidelines, i.e. risk of EGWG, and of those that have, the findings have been mixed. Two systematic reviews reported no significant effect of dietary

or lifestyle interventions on risk of EGWG or on adherance to IOM guidelines for appropriate GWG [123, 133]. Another review reported that, on average, behavioural counselling for diet and PA behaviour change for the purpose of achieving appropriate GWG reduces the risk of EGWG [129]. Furthermore, women who report having recieved such counselling have been shown to have a slightly reduced risk of excessive GWG (Relative Risk 0.96 [95% CI 0.74, 1.26]) [89].

EFFECTS OF INTERVENTIONS ON HEALTH OUTCOMES

Few intervention studies aimed at achieving appropriate GWG have reported on changes in maternal and offspring health outcomes. However, among those studies that have included these outcomes, lifestyle intervention has been shown to reduce post-partum weight retention, incidence of caesarean section and pre-eclampsia in accordance with a reduction in EGWG [123, 133]. Nutrition education counselling to increase maternal weight has also been shown to increase the birth weight of offspring and reduce the risk of pre-term delivery [140]. Finally, lifestyle intervention in obese pregnant women has been shown to not only reduce EGWG but also levels of anxiety, which may assist with reducing post-partum weight retention and later obesity in these women [137].

CURRENT AUSTRALIAN TRIALS

➢ Limiting weight gain in overweight and obese women during pregnancy to improve health outcomes: a randomised trial. *Dodd, J. University of Adelaide, South Australia* (ACTRN12607000161426)

➢ Weighing pregnant women to achieve ideal weight gains in pregnancy. *Shub, A. Mercy Hospital for Women, Victoria. (ACTRN12607000272493)*

➢ The effect of regular weighing and dietary advice on maternal health and complications of pregnancy in overweight pregnant women. *Shub, A. Mercy Hospital for Women, Victoria. (ACTRN12611000881932)*

➢ In antenatal women, does weighing at each visit compared with routine antenatal care reduce the incidence of excessive weight gain during pregnancy? *Brownfoot, F. The Royal Women's Hospital, Victoria. (ACTRN12610000331033)*

➢ In obese pregnant women, does continuity of care compared to usual care prevent excessive gestational weight gain? *Nagle, C. Deakin University, Victoria. (ACTRN12610001078044)*

➢ A Randomised Controlled Trial of a Specialised Health Coaching Intervention to Prevent Excessive Gestational Weight Gain and Postpartum Weight Retention. *Skouteris, H. Deakin University, Victoria. (ACTRN12611000331932)*

➢ The Diary trial. Does a diary help pregnant women achieve ideal weight gain in pregnancy and reduce gestational diabetes? *Quinlivan, J. Joondalup Health Campus, Western Australia. (ACTRN12611001156976)*

➢ A project funded by Western Australia Health is underway to develop a novel antenatal education programme for first-time obese mothers-to-be to assist with managing GWG and adopting a healthy lifestyle [147].

➢ A group-based antenatal care program involving sessions in community health settings has been trialled in South East Sydney and the Central Coast [146]. Facilitated by two midwives, the program provides women with education on healthy eating and PA in

pregnancy, setting of weight management goals, peer support, encouragement and motivational techniques including the WELL diary (Weekly Eating and Lifestyle Log). Additional funding (Nursing and Midwifery Office of NSW Health) was provided in 2011 to train midwives in motivational interviewing.

GENERALISABILITY

Pregnant populations studied in the trials summarised in this chapter are largely healthy adult women with singleton pregnancies from developed or 'Western' countries, particularly the US. Only five studies specifically excluded women aged <18 years of age [1, 123, 126, 128, 131].

Women were also of varying pre-pregnancy BMI, although studies acknowledged this by either limiting their review to overweight and obese pregnant populations [122, 125, 127, 130], or reporting findings separately according to pre-pregnancy BMI [1, 123, 126, 128, 129, 132, 133]. Three reviews examined heterogeneity by undertaking sub-group analyses according to pre-pregnancy BMI, with all authors concluding no moderating effect of pre-pregnancy BMI on GWG outcomes [1, 123, 128].

Hence, the findings presented in this summary may not be generalised to adolescents and women of other ethnic or racial backgrounds. Differences in the effects of interventions according to pre-pregnancy BMI suggest programs for women should be tailored according to their pre-pregnancy BMI, with more intensive strategies provided to overweight and obese women. In addition, most trials did not specifically exclude women with GDM, which complicates the recommendations that may be made to women with and without GDM as these groups are often managed separately in clinical antenatal settings. Further, this current review focuses on healthy pregnant populations and excludes findings from trials specifically among women at risk of GDM.

CONCLUSIONS

Programs delivered in antenatal care aimed at modifying dietary and PA behaviours to promote appropriate GWG are, on average, effective in reducing total GWG by a clinically important amount for all women regardless of pre-pregnancy BMI. Effective strategies include providing women with structured meal plans based on individualised energy requirements, structured exercise sessions or advice, weekly contact with a care provider, goal setting for health behaviour change and regular weight monitoring according to IOM guidelines. A one-off group counselling or information handout/brochure may not be sufficient for limiting GWG, and combined lifestyle programs may be more effective if administered prior to 12 weeks gestation.

There is some evidence to suggest that women classified as overweight or obese on the basis of pre-pregnancy BMI may require more intensive dietary counselling aimed at reducing total energy intake, which should be achieved by limiting energy-dense nutrient poor foods in the diet, and increasing fruit and vegetable intakes, rather than restricting food intake, to avoid preoccupations with dieting during pregnancy. The intensity of dietary counselling required however remains unclear. Regular PA during pregnancy also reduces

GWG, although more evidence is needed to assess whether GWG can be reduced by a clinically important amount. Most studies prescribed exercise 3-5 times per week, which is consistent with recommended PA guidelines of moderate exercise on most days of the week. Further research is needed to determine the optimal type, intensity and duration of exercise required to prevent EGWG.

The delivery of antenatal care interventions is likely to be complicated by the lack of time experienced by health professionals and that perceived by pregnant women, considering regular contact is more likely to reduce GWG. There may be a need for different systems for the provision of care to pregnant women with GDM compared with non-GDM pregnant women.

Regular weighing of women in antenatal care and monitoring women's GWG according to recommended guidelines may also be important, and a number of trials assessing the effectiveness of this approach are currently underway in Australia. For practitioners, communication with pregnant women should be around appropriate GWG, rather than the avoidance of EGWG *per se*.

6   BARRIERS TO THE PREVENTION OF EXCESSIVE GESTATIONAL WEIGHT GAIN

HEALTH PROFESSIONALS

Knowledge, skills and confidence

de Jersey et al (2012), in a study conducted in a Brisbane hospital where routine weighing was not standard practice, only 20.2% of the 84 maternity staff sampled had received training in the care of overweight/obese pregnant women (3/20 obstetricians, 7/35 midwives, 0/10 physiotherapy staff, 3/3 dietitians), and 50% correctly identified WHO BMI categories [34]. In a Victorian study of obstetrics and midwives, 79% of staff considered their training in GWG was inadequate [33]. This lack of training leads to a lack of confidence in dealing with weight during pregnancy.

Awareness of adverse consequences of overweight/obesity in pregnancy (although EGWG was not specifically mentioned) among health professionals in Australia is high [34, 35, 77], although it is likely that knowledge of the full range of negative health outcomes is limited. For example, in one of these studies GDM was consistently identified as one of the most important implications of EGWG, whereas few GPs identified childhood overweight and obesity in the long term as being among the most important identifiable problems [35]. Health professional concerns about their own expertise and knowledge were expressed in a number of these studies.

In Brisbane, only 32.1% of 68 maternity care providers (20 obstetricians, 35 midwives, 13 allied health) were aware of the Queensland state-wide guidelines for the management of pregnancy-related obesity (which provide advice regarding recommended weight gain based on pre-pregnancy BMI, referral practices for multidisciplinary care, including specialist support, and postpartum advice, all with clear links to improved maternal and neonatal outcomes) [77]. Guideline adherence was self-rated most highly among dietitians (score 10.3/15) and least among physiotherapists (3.8/15). Obstetricians and midwives scored themselves as 6.3/15.

Obesity in pregnancy has become a 'creeping normality' according to midwives in NSW and there is also the feeling that they are 'not waving but drowning' in dealing with this issue [148]. The findings from this qualitative study of 34 midwives and 3 other health professionals highlighted a number of tensions or contradictions experienced by health professionals when caring for childbearing women who are obese. There were particular concerns about how to communicate with obese women without altering the relationship. Another study in NSW indicated that health professionals were not sure how to raise the issue of weight without offending overweight or obese women [149].

Perceptions that weight gain was beyond the control of the woman and that discussion would create a sense of failure, plus concerns that weight was a sensitive and emotional topic, were reported as significant barriers to communicating about GWG by the health providers in Brisbane [34]. In practice, providers reported waiting for the patient to raise the topic of their weight, with many not providing a recommended GWG range or weighing patients to avoid anxiety. de Jersey et al (2012) cite evidence indicating that historically

there has been reluctance among some healthcare providers to weigh women in the belief this causes unnecessary anxiety during pregnancy [34].

A recent Australian study showed that weight stigma is present in maternity care settings in Australia [150]. Pre-service maternity care providers perceived overweight and obese women as having poorer self-management behaviours, and reported less positive attitudes towards caring for overweight or obese pregnant women than normal-weight pregnant women.

In the UK, midwives' uncertainty about effective obesity communication and management, and concerns of a negative impact on the midwife-woman relationship were identified as key barriers to their practice [151]. In the US, Stotland et al (2010) showed that insufficient training, concern over sensitivity of topic, and perception that counselling is ineffective were indicated as barriers by health professionals [152].

Provider knowledge, confidence and own body satisfaction has been found to increase guideline (management of obesity in pregnancy) adherence scores in the US [153]. Similarly, knowledge deficits may be compounded by the practitioners' own weight, because self-identified "overweight" physicians had almost 4 times as much difficulty counselling about weight as average weight physicians (AOR 3.8, 95% CI 1.1–13.3)[154].

In the UK study by Furness et al (2011) there were echoes of other studies where midwives expressed difficulties raising the issue of weight (obesity) with their clients, and awkwardness and anxiety around the use of obesity-related language, thus indicating that the stigma was still very much alive [155]. Some pregnant women had encountered practitioners whose critical and offensive approach had caused considerable distress.

Prevalence of provision of advice on GWG and routine weighing

Australia

➢ Only 8% of the 68 maternity care staff who responded to a survey in Brisbane provided appropriate GWG goals for each BMI category, and 25% indicated they did not provide patients with any advice on this issue [34].

➢ Among 14 GPs in Sydney and 14 GPs in Geelong, advice regarding GWG was not consistent and GPs rarely took account of BMI when offering advice at the start of pregnancy [35]. A small proportion of GPs offered no weight gain advice or offered advice only when asked by the woman. GPs considered healthy eating advice among the most important of topics that should be covered in an initial consultation, exercise advice was rarely proffered, and few GPs reported that GW would be among the most important issues to be discussed at a first appointment.

Most GPs weighed women only occasionally throughout their pregnancies. Only a small proportion weighed women at every visit, and few weighed only at the first visit or never. Over a third of GPs did not weigh at all or only when the woman asked. Attitudes towards weighing varied and there was a clear division in comments provided by the GPs for and against weighing. There was a distinct division among GPs surrounding the usefulness and appropriateness of weighing. The majority of GPs

reported being more likely to assess, advise and/or refer for weight management to other health practitioners if the woman was overweight at first presentation.

➤ Among 103 obstetric healthcare providers (obstetricians and midwives) in a large tertiary hospital in Victoria, only 19% of respondents weighed women regularly or beyond the booking visit with overt inconsistency of practice in those surveyed [33]. Specific weight gain targets were set by 22%, and the majority reported inadequate education about gestational weight gain. 77% reported advising women about weight gain in pregnancy under some circumstances.

➤ Among a convenience sample of 149 women attending antenatal services in the Canberra Hospital in 2010, 69.2% had not received advice from their caregiver on their weight [156].

Internationally

➤ In a study of 78 midwives in the UK (low response rate), 79% reported always calculating BMI at booking, with 73% routinely explaining the BMI category [157]. However, only 15% offered personalised advice regarding weight management based on a woman's diet and PA levels.

➤ In the UK, Brown & Avery (2012) indicated that, in a study of 60 women with singleton pregnancies, 84.1% of the women were weighed at least once during pregnancy, although overweight/obese women were weighed significantly more times than women in other weight categories (p=0.014) [158]. A quarter of the women received weight gain advice and 64.3% of the women received diet/exercise advice from a healthcare source. Advice was brief and generally not related to weight management. A lack of advice from HPs led women to seek information for themselves from potentially un-regulated sources, and in some cases feelings of anxiety were expressed.

➤ In a Canadian study, there were widely discordant reports of provision of advice according to health providers as opposed to pregnant women. Among 42 health providers 95% reported counselling women to gain a specific amount of weight, and 81% reported that they were in accordance with the guidelines [159]. In the same research study, among 310 pregnant women (95% response rate), only 28.5% reported that their health care provider had made a recommendation about how much weight they should gain. One quarter of the women reported being told that there were risks with inappropriate gain and 51.3% did not receive any advice. Further, only 12.0% of the women reported having achieved the IOM recommended weight gain [160]. Among midwives, family physicians, obstetricians, or other types of care providers, respectively, 16.3%, 10.3%, 9.2%, and 5.7% of patients reported being counselled correctly about how much weight to gain during pregnancy. In contrast, 96.8% of patients reported that their health care provider had recommended that they take a vitamin. In addition, 17.7% reported that their health care provider recommended that they eat a specific range of additional calories each day, and one-third of them could not recall the amount that had been recommended.

➤ In a larger study in Canada, 27% of 2237 pregnant women received no advice about pregnancy weight gain [90]. Among those who received advice, 14% were advised to gain less than the recommendations and 22% were advised to gain more than the

recommendations. Black women were five times more likely to be advised to gain less than white women.

➢ Among 58 maternity care providers in the US, 37% did not correctly report the minimum BMI for reporting obesity, and most reported advising weight gains that were discordant with the IOM guidelines, especially for obese women. The majority of respondents almost always recommended a range of weight gain (74%), advised regular PA (74%), or discussed diet (64%) with obese mothers but few (14%) referred patients to a nutritionist.

➢ In the US, studies indicate that over one third [85], 41% [131, 161], and 49% [89]of pregnant women receive no advice regarding GWG. Factors associated with not receiving advice on GWG in the US included lower income, younger age, and multiparity [161]. Phelan et al (2012) indicated that overweight-obese women were more likely to be advised to over-gain compared with normal weight women (OR 4.7, 95% CI 2.6-8.4) [161].

➢ In the US, Stengel et al (2012) identified 3 themes on GWG and PA advice during pregnancy. In terms of GWG: (1) women were advised to gain too much weight or given no recommendation for GWG at all; (2) providers were perceived as being unconcerned with EGWG; (3) women desire and value GWG advice from their providers. Regarding provider advice on exercise: (1) women received limited or no advice on appropriate PA during pregnancy; (2) women were advised to be cautious and limit exercise during pregnancy; and (3) women perceived that provider knowledge on appropriate exercise intensity and frequency was limited [74].

HEALTH SYSTEM STRUCTURAL BARRIERS

In Sydney and Geelong, GP-reported barriers to the provision of support to provide healthy lifestyle advice and manage GWG included: cost to patient and medical system, lack of physical capacity within GP practices, and lack of organisational structure for additional consulting [35]. Few GPs reported that support provided to women via the internet or written resources to reiterate their own advice would be preferred support. Most preferred multidisciplinary support and input from other practitioners – dietitian support (referral for healthy lifestyle advice and weight management) was the most preferred, others indicated exercise physiologists, diabetes educators, endocrinologists or midwives. Lack of time was cited as a barrier in the UK study by Olander et al (2011) [162].

Also in the UK, Smith et al (2011) reported that community-service providers, although they considered the prevention and management of maternal obesity to be part of their role, identified numerous barriers including: overlap between generic 'health' targets and maternal obesity services; a lack of targeted programs in the community; a lack of partnership working between community services, healthcare practitioners and maternity services; and a lack of structured postnatal support [163].

BARRIERS AMONG PREGNANT WOMEN

Maternal knowledge

➤ In Brisbane, Australia, over 75% of respondents identified that, compared with normal weight women, obese women have an increased risk of overall maternal complications, including GDM and hypertensive disorders of pregnancy, and caesarean section [164]. Less than half identified an increased risk of neonatal outcomes. Women with BMI<25.0 were less likely to know that obesity was associated with an increased rate of c-section than those with higher BMI (16.8% vs. 4.5%, p<0.001). Higher educational status was associated with more knowledge of risks of overweight/obesity in pregnancy.

➤ Australian women are more likely to be aware of the maternal complications of EGWG, while awareness of neonatal complications is more limited [165].

➤ In Brisbane, barriers included lack of knowledge of appropriate maternal weight gain, high intakes of saturated fat, and failure to achieve recommended intakes of core food groups [104].

➤ In a meta-analysis of qualitative studies among obese women in the UK and Sweden, women were generally knowledgeable at some level about the beneficial role of a healthy lifestyle [166]. The benefits reported included engaging in PA was personal (e.g. *"the fitter you are throughout your pregnancy, the more supple you are"*, and *"you're supposed to have an easier time giving birth"*), whereas the benefits in eating healthily were centred on their unborn baby (e.g. *"it's just as important that you give the baby good nutrients and good food"*).

➤ Knowledge of neonatal outcomes associated with obesity in pregnancy and GWG is less well known than maternal health outcomes [126]. While agreeing that healthy eating and PA might improve maternal and neonatal health, the majority of women in this study in the UK were unable to identify these benefits in detail, with fewer women identifying PA during pregnancy as beneficial for baby's health. Underweight/normal weight women tended to underestimate and overweight/obese women overestimated recommended GWG.

➤ Women report a lack of confidence about what foods to eat, how much, and what types of exercise are safe and how much weight gain is acceptable [155].

Maternal intentions, attitudes, beliefs and self-efficacy (to diet, PA and GWG)

➤ In the British study by Olander et al (2012), it was clear that women lacked concern regarding their GWG, at least partly due to not receiving appropriate information from midwives and other health professionals [162]. They also believed that they would lose the weight postnatally.

➤ Weight gain during pregnancy is often viewed as transient and okay, as well as 'beyond control' by women; it gives larger women, and others, the chance to 'let go'. Similarly, assumptions exist about weight gain during pregnancy, such as feeling able to eat with fewer limitations, and overweight being more socially acceptable during this period [1].

➤ A study by Sui et al (2012) in Australia indicated that, although women believed they did not receive enough information from their health providers, only one-quarter reported that they would respond to such advice [165]. Similarly, although many women planned

to make healthy changes during pregnancy, approximately half were confident in their ability to do so. In addition:

- 43% (n=464) knew that the baby may have weight problem in the future
- 43% perceived that healthy eating would lead to fewer pregnancy compications
- 24% indicated that healthy eating would relieve pressure from others
- 23% perceived that PA would relieve pressure from others
- Most (81%) knew how to eat healthily
- 44% disagreed with the statement that they had no time for healthy eating
- 56% disagreed with the statement that they had no time for PA
- Many considered that expense was not a barrier to healthy eating and PA
- At least half of the women indicated that they were able to eat healthily and exercise, even on busy days
- Most (74-5%) planned to eat healthily and be physically active.

➢ A study among 50 obese women in Australia indicated that those pregnant women who were more likely to exercise in early pregnancy were those with a history of miscarriage, who had children living at home, had a lower pre-pregnancy weight, reported no nausea and vomiting, had no lower back pain and were tertiary educated [167].

➢ Among 14 obese pregnant women in Sydney, most reported their weight to be an issue, but they also felt that health professionals should address their individual needs and expectations [168].

➢ In the meta-analysis of qualitative studies in the UK and Sweden, there was a view that it is socially-acceptable for a woman to have a large body size when pregnant – an opportunity for those who are obese to become 'socially-acceptable' – although these women still experienced stigma and mistreatment from health professionals due to their obese status [166]. Other findings from these qualitative studies include:

- A lack of information from health professionals about the increased risks associated with maternal obesity led the women to think that maternal obesity was acceptable, and that they were not at an increased risk.
- Women reported making a conscious decision to focus on weight loss in the postnatal period, because they felt that weight gain was unavoidable in pregnancy.
- They also felt there was a contradiction between eating the right foods to ensure that their baby received the necessary nutrients, and not gaining excessive weight in pregnancy. For example, at the clinic midwives said "*are you getting enough protein? You should have plenty of milk and cheese*".
- Internal barriers to PA included feelings of low confidence and motivation, and ill health (e.g. "you just get heavier and you are bigger and it is harder to move and everything is more uncomfortable"). External barriers to PA included a lack of information and advice, as well as a lack of PA classes.

➢ In the UK, among 14 overweight/obese pregnant women, healthy eating was often viewed as being of greater importance for the health of mother and baby than participation in PA [169]. A commonly cited motivator for maintaining PA during pregnancy was an aid to reducing pregnancy-related weight gain. However, participants often described how they would wait until the postnatal period to try to lose weight. A wide range of barriers to PA during pregnancy was highlighted, including both internal (physical and psychological) and external (work, family, time and environmental). The

study participants also lacked access to consistent information, advice and support on the benefits of PA during pregnancy.

➢ Concern about maternal and child health was a much stronger motivator compared with the advice of health professionals [158].

➢ Women consider that if the issue of weight was not raised by their health professional then it was not important [149].

➢ In the US, low income pregnant women had lifestyles that were more likely to promote weight gain than those of high income women [170]. In this study:

– Low income women reported that: fruit and vegetables taste bad; eating makes you feel better; energy dense foods are preferable; partners and friends support poor diets; weight is not equal to health; PA is activity associated with daily living (e.g. walking up the stairs) not exercise; and the extended family was responsible for cooking. Also, during pregnancy women reported that: it is okay to indulge in cravings and eat for two, fruit and vegetables cause heartburn, substance cessation is the most important health priority; women can't be active because they are tired and physically uncomfortable. Beliefs about health in general de-emphasised weight in this low income population where smoking and substance abuse were the highest priority. The disconnect between weight and health relates to long-term perceptions of body image among African American women as well as association of thinner body types to long-term drug abuse. Income-related factors were rarely related to weight-promoting beliefs among low income women. Food insecurity was not mentioned. Cost of healthy food was only mentioned by high income women. Emotional eating was high.

– High income women reported that they: soothed cravings and nausea with healthy foods, chose less EDNP foods to satisfy increasing appetite, ate small frequent meals to prevent hunger, brought lunch from home to avoid overeating at work, and maintained exercise frequency. They also believed that eating too much food leads to GWG and that PA helped slow weight gain; and were confident they could maintain exercise despite pregnancy discomfort by modifying routines.

➢ In the Canadian study by McDonald et al (2011), few of the women (37%) were planning to gain weight within the guidelines [160]. Overall, 39.2% of women were inadvertently planning to gain weight above the guidelines (31.6%, 15.6%, 75.0%, and 73.8% of underweight women, normal weight women, overweight women, and obese women, respectively) and 23.9% were inadvertently planning on gaining less than the guidelines (42.1%, 29.9%, 10.0% and 14.3%, respectively). 84% of patients reported that they were either "comfortable" or "very comfortable" discussing weight-related issues with their health care provider [171].

➢ A survey of 1535 pregnant US women found that barriers to exercise were most commonly intrapersonal, particularly motivation, procrastination and a lack of time. A lack of social support (informational, emotional and tangible) was important [172].

➢ In a recently published study in the UK, 39% pregnant women were unconcerned about weight gain during their pregnancy, including 34 women (19%) who reported having retained weight gained in earlier pregnancies and despite the fact that 81% were dissatisfied with their current weight [173]. Amongst those concerned about weight

gain, advice on PA (41%) and access to sports/leisure facilities were favoured resources (36%). Fewer women (12%) felt that group sessions on healthy eating or attending a clinic for individualised advice (14%) would be helpful. "Getting time off work" was the most frequently cited barrier (48%) to uptake of resources other than leaflets.

➢ In the UK, explanations for obesity in pregnancy included a lack of knowledge about weight, diet and exercise during pregnancy; self-talk messages which excused overeating; difficulties maintaining motivation for a healthy lifestyle; and the importance of social support [155]. The women felt that they did not always receive clear guidance and that social messages especially about eating, placed extra pressure on them. There was a strong social pressure, reinforced by media images, to remain thin during pregnancy. There is a widely held belief that breastfeeding will aid postpartum weight loss, which is not supported by the literature.

➢ Potential barriers to addressing overweight and obesity in pregnancy, which have been identified in Australia, include poor uptake of routine pre-pregnancy health activities, inaccurate self-categorisation of weight, unsuccessful weight loss attempts, and inadequate advice regarding pregnancy weight loss [79]. Inaccurate self-categorisation of weight has also been identified as an issue in the Healthy Beginnings Trial [174].

➢ Inaccurate self-categorisation of weight was also identified as an issue in the Australian study by Callaway et al (2009). Only 35% of pregnant women in the overweight category and 16% of women in the obese category correctly categorised themselves.

ENABLERS TO THE PREVENTION OF EGWG

➢ Furness et al (2011) indicated that 'best care' suggested that weight management required care which was consistent and continuous, supportive and non-judgemental, and which created opportunities for interaction and mutual support between obese pregnant women. Pregnant women in the UK were shown to enjoy existing services (e.g. 'Aquanatal') but also identified organised walks, regular support days, and dedicated websites and chat rooms as desirable [155].

➢ Focus groups conducted by Olander et al (2012) in the UK indicated that there was a preference for early information, leading to routine formation of healthier eating habits; a desire for practical information sessions; and support and signposting to services from health professionals [162]. Sessions should be in a convenient location, preferably led by women who had been pregnant themselves. Suggested delivery modes were through midwives and the internet.

➢ Women in Australia and Canada have reported being very comfortable discussing weight during pregnancy with their health care provider and express a desire for appropriate weight gain advice and support [160, 175].

➢ Similarly, Brown & Avery (2012; UK) indicated that pregnant women wanted weight gain advice, diet and PA advice, particularly to reduce anxiety around those issues [158]. Clearer, more personalised advice was indicated as desirable.

➢ A study in Australia reflected that women were willing to be weighed more in pregnancy [165].

➢ In the Canadian study by McDonald et al (2011) approximately one-half of the patients (52.7%) thought that an aid or tool that would calculate how much weight should be

gained each week and in total would either "probably" or "definitely" be helpful; 69.6% of the patients ranked as first either a chart from their health care provider that would show appropriate weight gain or a website [160].

INTERVENTION CONSIDERATIONS IDENTIFIED IN BARRIERS/ENABLERS LITERATURE

Australia

➢ Communication of neonatal complications due to EGWG may provide an important opportunity to influence healthy behaviours, given the most frequently reported cue to action was concern about their baby's health [165]. It is also important to incorporate individualised strategies for enhancing self-efficacy in terms of weight management. Additionally, there is a need to investigate the role of health professionals in information provision and the potential for education in overweight and obese women prior to conception.

➢ Mulherin et al (2013) suggested a need for further research into the nature and consequences of weight stigma in maternity care, and for the inclusion of strategies to recognise and combat weight stigma in maternity care professionals' training [150].

➢ Thompson et al (2011) indicate that pregnant women require targeted advice on their weight, ideal weight gain and impact of these on pregnancy [156].

➢ From their survey of obstetric health care providers in a large tertiary hospital in Victoria, Allan et al (2011) recommend the development of hospital-based protocols or implementation of published guidelines to assist staff and pregnant women in GWG education and management [33, 106].

➢ Van der Pligt et al (2011) suggest that an alternative approach may be through an allied health Enhance Primary Care (EPC) plan, offered through Medicare to pregnant women. EPC plans currently allow for a limited number of GP referred visits per year to allied health practitioners; but only for those diagnosed with a chronic disease such as obesity, alongside comorbidities. Pregnancy, excess weight gain and pregnancy-induced comorbidities could be included in this scheme [35].

United States

➢ Strategies to address health professionals' personal factors, such as confidence and body satisfaction, may be important predictors of adherence to recommendations for managing obese pregnant women [153].

➢ It is necessary for health professionals to understand women's prepregnancy BMI and PA levels in order to give individualised and accurate advice [74]. Automated BMI calculators are suggested as being helpful. It is common for women to be seen for their first prenatal visit when they are well into their first trimester and already on their GWG trajectory. Common misconceptions, such as the need to 'eat for two', need to be debunked.

➢ The format and manner in which information is presented to maternity patients is known to affect uptake, including whether it is assimilated and acted on, discarded or simply forgotten; information intended to assist decision-making should not be bundled with advertising materials nor should it be offered when women may be distracted by clinical procedures [176].

United Kingdom

➢ A community development model to allow service users to be more actively involved in service development has been suggested in the UK [163].

➢ From a large study in the UK, Heslehurst et al (2011) indicate the following considerations for practice: the provision of a systematic approach to training and education that is endorsed by midwives, and would provide the required level of knowledge and skills to deliver the recommended standard of care appropriate to their practice. It is clear that midwives require both training and education, although there are challenges to midwives' engagement, with effective continuous professional development largely outside their control [151].

➢ It has been recommended that strategies to improve midwife confidence and weight management services should include training, ongoing support, and definition of the midwife's role within the multidisciplinary team to support practice in the future [157].

➢ More could be done to raise awareness among student and practising midwives of the importance of obesity among women as a physical and psychological health issue, and to enhance their communication skills and confidence in discussing it effectively with service users [155]. A simple, straightforward, non-judgemental approach, with the same midwife to establish rapport, is necessary. Women need unambiguous advice regarding healthy lifestyles, diet and exercise in pregnancy to address a lack of knowledge and a tendency towards unhelpful self-talk messages.

These authors emphasise the importance of taking an holistic approach to midwifery care, considering the woman's support network and influences, and including family members in consultations where appropriate. Evidence suggests that interventions should focus on motivational strategies and social support facilitation.

➢ Interventions to promote healthy GWG may benefit from targeting women's beliefs about ideal and expected gestational weight gain [161].

➢ Interventions to encourage recommended levels of PA in pregnancy should be accompanied by accessible and consistent information about the positive effects for mother and baby. Midwives should be encouraged to do more to promote activity in pregnancy [169].

CONCLUSIONS

Much of the literature regarding barriers to excessive gestational weight gain relates to the management of obese pregnant women rather than EGWG according to the range of pre-pregnancy BMIs.

Although many staff are aware of the adverse consequences of overweight/obesity in pregnancy, it is not clear whether this knowledge extends to EGWG or is only related to those women who enter pregnancy overweight or obese. Few relevant health professionals appear to be aware of the full range of negative health outcomes associated with EGWG, particularly the risk of overweight among children. Awareness of guidelines for the management of obesity in pregnancy is low. Few staff are trained in the management of obesity in pregnancy and/or in how to discuss weight gain during pregnancy. There are

particular concerns among relevant health professionals with regard to how to communicate weight issues with obese pregnant women. There are perceptions that weight gain is beyond the control of the woman, that discussion may create a sense of failure. Particularly, there is a sense that weight is a sensitive and emotional topic and that discussion of weight may impact negatively on the relationship between the pregnant woman and the health professional. Many professionals appear to wait for the woman to raise the issue of weight for fear of causing anxiety around weight. Knowledge, confidence, and body satisfaction/weight status of the health professional is also related to adherence to guidelines regarding the provision of weight gain advice and management of obesity in pregnancy.

In Australia, and internationally, provider advice regarding GWG is inconsistent; few weigh women regularly, many do not weigh at all or only at the first visit and are only likely to weigh, provide advice and refer women who present at first visit as overweight or obese; few set GWG targets. Many pregnant women receive no weight gain advice from their provider. Internationally, more health professionals indicate that they have provided weight gain advice than pregnant women report receiving weight gain advice, suggesting bias in the self-reported health provider data. Advice to gain above the recommendations, particularly among obese pregnant women, is common. Few health professionals provide healthy eating and exercise advice to pregnant women. There are practical limitations within the GP setting in Australia regarding the provision of support for GWG, and most GPs would prefer support and input from allied practitioners.

Maternal knowledge of the maternal risks of obesity in pregnancy is good, but knowledge of neonatal complications is more limited. There is a lack of knowledge of appropriate weight gain and many pregnant women lack concern over GWG, considering that if it is not mentioned by their health provider then it is not important. Weight gain during pregnancy is seen as transient and okay, and there is confidence that the weight will be lost postnatally. Pregnancy is seen as an opportunity for larger women, and others, as a chance to 'let go' and gain weight. Barriers to PA during pregnancy include nausea and vomiting, and lower back pain. The perceived benefits of engaging in PA appear to be mainly personal whereas the perceived benefits of eating healthily are centred more on the baby's health. Several studies indicate that pregnant women are very comfortable discussing weight with their health care provider. Inaccurate self-categorisation of weight by pregnant women is an issue.

7   RECOMMENDATIONS FOR POLICY, PRACTICE AND RESEARCH

POLICY

➢ Review the current IOM gestational weight guidelines to evaluate their potential for implementation into routine antenatal care (with ongoing monitoring of clinical outcomes) as a necessary first step.

➢ Develop protocols for appropriate maternity care providers to guide the consistent and accurate management of weight gain in pregnancy and incorporate specific 'GWG management' as part of routine antenatal care. The protocols should indicate the information, and the manner in which the information, regarding appropriate GWG should be communicated to pregnant women, across the range of pre-pregnancy BMIs. Referral pathways should be indicated.

➢ Ensure adequate dissemination of the protocols and guidelines and monitor usage.

➢ Design and implement appropriate training and professional development for maternity care providers (obstetricians, midwives, GPs) to increase the skills and confidence of health professionals in communicating sensitively and effectively regarding appropriate GWG. There is a need for increased awareness among maternity care providers concerning the need to counsel all pregnant women, regardless of pre-pregnancy BMI, concerning appropriate GWG. Include training to reduce stigma.

➢ Implement routine surveillance of pre-pregnancy BMI and GWG from booking visit to pre-delivery as part of the New South Wales Perinatal Data Collection program (SAPHaRI), Centre for Epidemiology and Evidence, NSW Ministry of Health.

➢ Appropriate federal, state, and local agencies, as well as health care providers, should inform women of the importance of conceiving at a normal BMI and all those who provide health care or related services to women of childbearing age in their care should include pre-conception counselling [as per the US Committee recommendations].

➢ To assist women to gain pregnancy weight within the guidelines, those who provide prenatal care to women should offer them counselling, such as guidance on dietary intake and PA, that is tailored to their life circumstances [as per the US Committee recommendations].

➢ Update dietary recommendations in the NSW Ministry of Health resource '*Having a baby*' to align with revised national dietary guidelines and the new Australian Guide to Healthy Eating (when officially released).

PRACTICE

➢ The above policy recommendations should be universally applied; however, there is a number of groups of pregnant women that warrant particular attention – namely, those pregnant women who are obese, Aboriginal, low income, those who have experienced

EGWG in previous pregnancies, those who gain excessively during the first trimester, and those who report persistent nausea/vomiting or lower back pain early in pregnancy.

➢ Antenatal programs to prevent EGWG should provide: (1) behavioural counselling and goal setting on diet, PA and appropriate GWG tailored to the woman's current GWG (ideally by antenatal care providers on a regular basis); (2) structured meal plans based on individualised energy requirements and national dietary recommendations, with support for monitoring intake; (3) structured exercise sessions involving resistance training or aerobic exercise 3-5 times per week; and (4) be initiated before 12 weeks gestation.

➢ Conduct intensive lifestyle interventions, informed by recent studies, among pregnant women who enter pregnancy very overweight or obese. Programs need to find ways to maximise attendance, and should focus on motivational strategies and social support facilitation. Interventions may benefit from targeting women's beliefs about ideal and expected GWG. A separate module for pregnant women could be considered for the NSW Get Healthy Coaching and Information Service.

➢ Examine midwives and other health professional roles within multidisciplinary teams to ensure optimal support of GWG in practice.

➢ Dietary counselling should be aimed at limiting energy-dense, nutrient-poor foods (including soft drinks) in the diet, and increased fruit and vegetables intake, rather than restricting food intake. Culturally-relevant dietary advice should be incorporated.

➢ Trial community-based strategies which seek to educate and inform the wider family and social network surrounding weight, diet and PA among pregnant women. Group-based approaches involving peer/social support may be effective.

Communication should concentrate on 'appropriate weight gain during pregnancy' rather than focusing on 'obesity in pregnancy' or '*excessive* gestational weight gain'. Target women's beliefs about ideal and expected weight gain such as 'eating for two', 'a chance to let go', and post-pregnancy weight loss. Communication of neonatal complications of EGWG regardless of pre-pregnancy weight status may be particularly relevant.

➢ Advertise group-based PA activities in the community (e.g. walking groups, antenatal yoga) to increase exercise in pregnant women. Encourage midwives to promote PA in pregnancy.

➢ Be mindful that smoking cessation during pregnancy does not result in EGWG.

RESEARCH

➢ Investigate tools or aids to support maternal care providers and pregnant women to monitor weight gain, diet and PA. Investigate the applicability of a recently-developed web-based applet in the US – a clinical tool for setting precise goals during early pregnancy and continuous objective feedback throughout pregnancy.

- Investigate the optimal format, content and type of printed information that would be acceptable and useful to pregnant women regarding appropriate GWG and associated lifestyle factors.

- The large number of current trials in Australia will inform the evidence base regarding the optimal means of support concerning GWG. Meanwhile, the feasibility and acceptability of programs should be investigated, as there have been limitations in intervention programs, particularly intensive ones, to date. Some of the barriers women have described in achieving healthy weight gain have not been addressed in the studies included in systematic reviews to date.

- There is currently insufficient evidence to recommend whether behavioural counselling and dietary planning need to be face-to-face or if telephone/online delivery is equally effective. Current trials being conducted around Australia are exploring whether regular weighing or continuity of care provider are important program components, and whether individual health coaching with follow-up brief telephone coaching is effective for preventing EGWG/ensuring appropriate GWG.

- While regular weighing during pregnancy is generally recommended as necessary to identify those progressing at risk of gaining weight excessively during pregnancy, and qualitative research indicates acceptability of this practice to women, there is no evidence on the emotional effects of this practice, nor of potential inadvertent effects regarding inappropriate dieting, excessive PA and inadequate GWG.

- Further research is required into the nature and consequences of weight stigma in maternity care, and how to reduce that stigma.

- More research is required to examine how to overcome barriers to PA and to understand which interventions could be most effective for overweight/obese pregnant women. Evidence is also required to assess whether GWG can be reduced by a clinically-significant amount by PA in pregnancy; and to determine the optimal type, intensity and duration of exercise required to prevent EGWG. Community-level initiatives to increase participation in appropriate physical activities could be investigated.

- Monitoring of implementation and effectiveness of guidelines for appropriate GWG. This includes assessment of the extent to which women are provided with the NSW Ministry of Health '*Having a baby*' consumer education resource through antenatal health services, or access to the resource online.

- Obesity in pregnancy is a common problem, urging the need for more clinical research to understand appropriate weight gains for obesity classes II and III women, and to support practitioners in recommending appropriate amounts of GWG to these women.

- Future intervention studies should include as outcomes the relative risk of EGWG according to the 2009 IOM guidelines, as well as priority maternal and infant health outcomes; so that clear conclusions can be drawn around both the efficacy of lifestyle interventions for preventing EGWG and the appropriateness of the IOM guidelines for application in healthy Australian pregnant populations.

- Cost-benefit analyses are uncommon in the intervention trials to date and would add valuable information to balance efficacy with health care costs.

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9 APPENDIX

Table 5 **Recent systematic reviews of lifestyle interventions aimed at reducing EGWG during pregnancy, their focus (physical activity and diet, diet only or physical activity only), inclusion criteria, key findings, limitations and implications for practice**

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Physical activity and Dietary interventions				
Brown et al., 2012 [126]	• **Populations:** Healthy, pregnant women, aged ≥18 years, pre-pregnancy BMI (21.0-34.7kg/m^2), excludes adolescent mothers. • **Study designs:** RCTs. • **Interventions:** Goal setting alongside modification of diet and/or physical activity, compared with standard antenatal care. • **No. Studies:** 5. • **Languages:** not reported. • **Date range**: inception – Apr 2011.	• All studies set goals for GWG according to IOM guidelines or a range of 10-14kg or 6-7kg (for obese women). • Two studies reported significantly lower GWG among intervention women compared with controls only among those with a normal pre-pregnancy BMI. • Other three studies reported significantly lower GWG among all intervention women (not defined by pre-pregnancy BMI), compared with controls.	While goal setting was common to all included studies, provision on one-to-one diet and/or PA counselling was also provided in all studies and regular monitoring/ tracking of GWG was used in four of the five studies.	Goal setting for appropriate GWG, as well as diet and PA during pregnancy may be a useful strategy for reduce GWG.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Muktabhant et al., 2012 [129]	• **Populations:** Pregnant women from US, Australia, Belgium, Canada, Denmark, Finland, Spain, Brazil and Taiwan. • **Study designs:** RCTs and quasi-RCTs. • **Interventions:** Any aimed at preventing EGWG, compared with routine care or other intervention for preventing EGWG. • **No. Studies:** 27 (total), 26 (measured GWG). • **Languages:** no restrictions. • **Date range**: inception – Oct 2011.	• Behavioural counselling reduces relative risk of EGWG, compared with standard care (0.72 [95% CI 0.54kg, 0.95kg], 2 RCTs), and results in 1.39kg less GWG ([95% CI -2.48kg, -0.30kg], 3 RCTs). • Supervised exercise sessions result in 2kg less GWG ([95% CI -3.26kg, -0.74kg], 1 RCT). • Among women at risk/diagnosed GDM or overweight/obese, no interventions were associated with a reduced risk of EGWG, although two RCTs resulted in less GWG on average. These interventions involved energy restriction counselling (-6.70 [-10.31, -3.09], 1 RCT) or regular weight monitoring with counselling and continuity of care provider (-6.80 [-8.63, -4.97], 1 RCT).	Heterogeneity in interventions limits the number of studies that may be combined in meta-regression analyses, although this is only meta-analysis (other than Thangaratinam et al.) to conduct subgroup analyses by intervention type.	Interventions based on individual behavioural counselling for diet, PA and appropriate weight gain are effective in reducing the risk of EGWG and lowering GWG in women of a normal pre-pregnancy weight. Overweight and obese women may benefit from interventions based on energy restriction with regular weight monitoring against goals for appropriate GWG.
Oteng-Ntim et al., 2012 [130]	• **Populations:** Overweight and obese pregnant women (excluded GDM). Predominantly Caucasian from US, Canada, Australia, Finland, Denmark, the Netherlands, Sweden, Spain, Brazil and Belgium. • **Study designs:** RCTs and non-RCTs. Excluded systematic reviews and observational studies. • **Interventions:** Dietary and activity (lifestyle). • **No. Studies:** 19 (total), 16 (measured GWG; 10 RCTs, 6 non-RCTs). • **Languages:** no restrictions. • **Date range**: inception – Jan 2012.	• Meta-analysis of RCTs showed GWG among intervention participants was, on average, 2.21kg lower than control participants [95% CI -2.86, -1.57].	Significant heterogeneity across trials - authors conclude *'...no obvious patterns between intervention type and study outcomes'*.	Lifestyle interventions for overweight and obese pregnant women are effective for reducing total GWG. Insufficient evidence for what intervention programs reduce GWG.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Thangaratinam et al., 2012 [133]	• **Populations:** Pregnant women (excluded underweight <18.5kg/m^2). • **Study designs:** RCTs. • **Interventions:** Dietary or lifestyle interventions with potential to influence outcomes related to maternal weight. • **No. Studies:** 44 (total), 34 (measured GWG) • **Languages:** no restrictions. • **Date range**: inception – Jan 2012.	• Lifestyle intervention resulted in lower GWG compared with controls (-1.42kg difference [95% CI -1.89kg, -0.95kg]). When women with GDM were excluded the effect was similar (-1.40kg [95% CI -2.09kg, -0.71kg]), although when only overweight and obese women were included the effect on GWG was greater (-2.1kg [95% CI -3.46kg, -0.75kg]). • Dietary interventions had a greater effect on GWG (-3.84kg [95% CI -5.22kg, -2.45kg]). Dietary therapies included individualised energy requirements, balanced intake of 30% fat, 15-20% protein and 50-55% carbohydrates, and use of a food diary. When women with GDM were excluded the effect of diet therapies was greater (-5.53kg [95% CI -8.54kg, -2.53kg]), although the greatest effect was seen in overweight and obese women without GDM (-7.73kg [95% CI -9.40kg, -6.05kg]). • No significant difference between groups in adherence to IOM GWG guidelines.	Variability in GWG remained in sub-group analyses by intervention type, BMI and without GDM, although this is only meta-analysis (other than Muktabhart et al.) to conduct subgroup analyses by intervention type.	Lifestyle (diet and physical activity) intervention is effective for reducing GWG, particularly among overweight and obese women, although this might be attributable to these women requiring less weight gain for a healthy pregnancy. Dietary interventions appear to have the greatest effects on GWG, particularly among overweight and obese women. Interventions should include individualised energy controlled diets in line with national dietary recommendations, with self-monitoring of intake (i.e. with food diaries).
Campbell et al., 2011 [1]	• **Populations:** Healthy women aged ≥18 years, currently pregnant or planning pregnancy, from US, Canada and Europe. Underweight women and non-OECD countries were excluded. • **Study designs:** RCTs. • **Interventions:** Dietary, with or without PA counselling. • **No. Studies:** 5. • **Languages:** English. • **Date range**: 1990-2010.	• No significant effect of intervention on GWG (-0.28kg [-0.64kg, 0.09kg]). • Sensitivity analyses did not demonstrate any differential effects of different intervention components. • Sub-group analysis by baseline BMI also did not show significant differences between intervention and control groups.	Small number of trials included in sub-group and sensitivity analyses limited the findings of these analyses.	This review found dietary intervention, with or without PA counselling, may not have a clinically important effect on reducing GWG, although there was a trend toward interventions reducing GWG which with a greater number of studies might have shown an effect.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Gardner et al., 2011 [128]	• **Populations:** Pregnant women aged ≥18 years, from US, Canada and Europe. • **Study designs:** RCTs, quasi-RCTs, historical control and time series. • **Interventions:** Improving diet or increasing PA to prevent EGWG. Excluded information only and psychological interventions. • **No. Studies:** 12. • **Languages:** English. • **Date range**: 1990-2010.	• Lifestyle interventions, resulted in lower GWG, compared with controls (-1.19kg [95%CI -1.74kg, -0.65kg]). • No moderating effect of pre-pregnancy BMI, although a greater difference in GWG was observed among overweight women (-2.26kg [95% CI -3.28kg, -1.24kg]), compared with those of mixed BMI (-0.77kg [-1.42kg, -0.13kg]). • Common intervention techniques were self-monitoring behaviour, provision of feedback on performance and setting goals for behaviour, although techniques were present in both effective and non-effective interventions.	Varied study designs included in meta-analyses providing lower levels of evidence.	Lifestyle intervention appears to result in a greater reduction in GWG among overweight women, although this might be attributable to these women requiring less weight gain for a healthy pregnancy. It was unclear as to what specific strategies or techniques may be effective for preventing GWG.
Phelan et al., 2011 [131]	• **Populations:** Healthy pregnant women aged ≥18 years, from US, Australia, Denmark, Belgium and Canada. • **Study designs:** RCTs. • **Interventions:** Dietary, physical activity or combined (diet and PA) interventions. • **No. Studies:** 12 • **Languages:** English. • **Date range**: 1985 – 2011.	• Interventions with daily diet monitoring that provided calorie goals with structured meal plans to women reduced GWG/ improved adherence to IOM guidelines. Calorie restrictions ranged from 36kcal/kg/day for healthy weight women, 18-25kcal/kg/day for overweight or obese women and 15kcal/kg/day for morbidly obese women. • Interventions providing weight monitoring (usually at regular antenatal clinic visits) reduced GWG. • Interventions with weekly careprovider contact (whether face-to-face or over the telephone) reported reductions in GWG.	Studies are summarised subjectively rather than by statistical pooling of outcomes, although the findings provide some insight into the nature of interventions that might be more effective.	Programs should provide structured meal plans based on specific calorie goals during pregnancy, encourage women to monitor their diet daily, provide weekly contact with a care provider and regular weight monitoring according to IOM guidelines (inadequate evidence to suggest whether this should be by the care provider or women).

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Dodd et al., 2010 [127]	• **Populations:** Healthy, pregnant, overweight or obese women. • **Study designs:** RCTs • **Interventions:** Dietary and/or lifestyle advice. • **No. Studies:** 9 (total), (4 measured GWG). • **Languages:** no restriction. • **Date range**: inception – Jan 2010	NB: Findings are based on 4 RCTs with GWG outcome data. • Dietary advice resulted in a non-significant lower GWG, on average, among overweight and obese women (-3.10kg [95% CI -8.32kg, 2.13kg]). • Three trials in obese women found dietary intervention resulted in a reduction in GWG, on average (ranging from -0.8kg to -7.9kg), while one trial in overweight women (BMI >26.0kg/m^2) found standard care resulted in 3.5kg less weight gain compared with intervention. • Intensity of dietetic sessions required to obtain benefit was unclear.	Meta-analysis of GWG outcomes only based on four trials available at the time.	Dietary interventions resulted in less GWG among obese women.
Streuling et al., 2010 [132]	• **Populations:** Healthy pregnant women from US, Canada, Sweden, Finland and Belgium. • **Study designs:** RCTs, CT and cohort studies. • **Interventions:** Modify diet and activity. • **No. Studies:** 9 (4 RCTs) • **Languages:** English or German. • **Date range**: inception – 2009.	• Interventions resulted in an average 1.2kg lower GWG, compared with controls, although when limited to the four RCTs the difference between intervention and control groups in GWG was nonsignificant. • Significant differences in GWG were found when analyses were limited to overweight and obese women (SMD -3.0kg), and where studies with potential bias were removed (SMD -0.37kg).	Non-randomised controlled trials which provide a lower level of evidence were included to increase sample size for meta-analyses.	Programs comprising dietary counselling or advice, structured physical exercise sessions or advice, and regular weight monitoring (usually by an antenatal care provider) reduced total GWG by a clinically meaningful average of 1.2kg.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Dietary interventions				
Quinlivan et al., 2011 [122]	• **Populations:** Overweight or obese pregnant women from US, Australia, Denmark and Belgium. • **Study designs:** RCTs. • **Interventions:** Antenatal dietary interventions. • **No. Studies:** 4 • **Languages:** no restriction. • **Date range**: inception – Mar 2011.	• Dietary intervention resulted in 6.5 kg less GWG among overweight and obese pregnant women (95% CI -7.6kg, -5.4kg). In three of the four included RCTs, dietary intervention resulted in an average GWG that was in line with the IOM recommendation of 5 – 9 kg for obese women (hence the intervention prevented EGWG). • No significant effect of dietary intervention on neonate birth weight (8.5g [95% CI -84.9g, 101.9g]).	Only one pregnancy related complication assessed, although the IOM recommendations of 5 – 9 kg for obese women are based on multiple health outcomes.	Dietary intervention is effective for preventing EGWG in overweight and obese women. Interventions were limited energy intake or reduced energy density. Interventions with individualised dietary counselling and monitoring had a greater effect than group counselling.
Tanentsapf et al., 2011 [123]	• **Populations:** Healthy, pregnant women aged ≥18 years, from mostly Western countries. Excluded underweight women. • **Study designs:** RCTs and quasi-RCTs. • **Interventions:** Dietary – aimed at preventing EGWG, with or without PA counselling. • **No. Studies:** 13 • **Languages:** no restriction. • **Date range**: inception – Mar 2011.	• Intervention resulted in lower GWG, compared with controls (-1.92kg [95% CI -3.65kg, -0.19kg]). • On average, relative risk of EGWG among women receiveing dietary or lifestyle interventions was lower but non-signifiant (0.90 [95% CI 0.77, 1.05]). • Energy restriction in obese women or women with high weight gain significantly reduced weekly GWG (-0.26 [95% CI -0.42 kg, -0.09 kg]). • Interventions demonstrating the lowest GWG among obese women were based on individualised one-on-one dietary instruction aimed at energy (kilojoule) restriction and self-monitoring intake with food records. • Intervention also reduced incidence of caesaerean section and post-partum weight retention.	Sub-group analyses according to pre-pregnancy BMI category or type of intervention did not explain the heterogeneity across trials.	Dietary counselling, with or without PA counselling, appears beneficial to reduce GWG, although women of obese pre-pregnancy BMI are likely to require more intensive dietary instruction.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Physical activity interventions				

Nascimento et al., 2012 [134]	• **Populations:** Healthy pregnant women from US, UK, Denmark and Brazil.
	• **Study designs:** RCTs
	• **Interventions:** Any physical exercise program, of the four RCTs measuring weight gain two provided dietary advice in addition to exercise intervention.
	• **No. Studies:** 19 (4 measured GWG).
	• **Languages:** English.
	• **Date range:** July 2010 – July 2012.
		• Compared with non-pregnant adult women, pregnant women are less likely to be active and to exercise at a lower duration, frequency and intensity, such that their activity is insufficient to assure health benefits.
		• Among the four RCTs that measured EGWG:
		  o Supervised exercise programs were more effective than home exercise counselling.
		  o Women with a higher pre-pregnancy BMI are resistant to achieving IOM GWG guidelines.
		  o Combining exercise and dietary intervention is the best way to control weight gain.
		  o Interventions also reduced post-partum weight retention after 2-6 months.
			Only four trials assessed GWG, of which the nature of the interventions ranged from lifestyle behavioural counselling with feedback on GWG (n=1), group exercise with dietary advice (n=1) and weekly supervised exercise sessions (n=2).	Overall, studies with larger sample sizes consistently showed exercise programs reduced EGWG. The nature of the interventions varied and hence the effective strategies for intervention are unclear from this review, although combining a supervised regular exercise program with dietary intervention might be more effective.

Sui et al., 2012 [125]	• **Populations:** Overweight or obese pregnant women from Australia, Brazil, Canada, Spain or Sweden. • **Study designs:** RCTs and quasi-RCTs. • **Interventions:** Monitored PA (supervised). Controls received no PA intervention. Excluded counselling or education based interventions. • **No. Studies:** 7 (5 measured GWG). • **Languages:** no restriction. • **Date range:** no restriction.	• Supervised PA intervention resulted in less GWG among overweight and obese women, compared with controls (-0.36kg [95% CI -0.64kg, -0.09kg]). • Among overweight women only, there was no significant effect on GWG (-0.12kg [95% CI -0.51kg, 0.26kg]). • Among obese women, the intervention resulted in -0.91kg less GWG (95% CI -1.66kg, -0.16kg).	Included RCTs varied in the nature of the PA intervention provided, limiting inferences about effective strategies for intervention.	Supervised physical activity sessions are effective for reducing GWG, particularly for obese, rather than overweight, women.

Review	Inclusion criteria	Key findings	Limitations	Implications for practice
Streuling et al., 2011 [124]	• **Populations:** Healthy pregnant women from US, Brazil, Iran, Australia, New Zealand and Spain. • **Study designs:** RCTs. • **Interventions:** Monitored PA **only** (supervised or home based). Controls received no intervention promoting PA. • **No. Studies:** 12. • **Languages:** not reported. • **Date range**: inception – Oct 2010.	• Physical activity intervention reduces total GWG by -0.61kg [95% CI -1.17kg, -0.06kg], compared with controls. • After removing three trials with a high risk of bias, mean difference in GWG was -0.93kg [95% CI -1.35kg, -0.50kg]. • All interventions were based on a minimum of 3-5 sessions per week.	Findings inconsistent across trials: 7/12 reported less GWG in the intervention group (1/7 significant), 5/12 reported less GWG in control group (none significant).	Physical activity may reduce GWG during pregnancy, although preventing ~1kg GWG may not be of clinical importance, and the findings were mixed across trials Insufficient evidence available to recommend specific types of activity, although a minimum of 3 times per week is prudent.

Abbreviations: BMI = Body Mass Index, CI = Confidence Interval, CT = Controlled Trials, EGWG = Excessive Gestational Weight Gain, GDM = Gestational Diabetes Mellitus, GWG = Gestational Weight Gain, IOM = Institution of Medicine, NEC = Nutrition Education Counselling, OECD = Organisation for Economic Co-operation and Development (Member Countries),PA = Physical Activity, RCT = Randomized Controlled Trial, UK = United Kingdom, US = United States, SMD = Standardised Mean Difference.