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Correlates of pregnant women's gestational weight gain knowledge

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Abstract

Objective: To investigate correlates of pregnant women's gestational weight gain (GWG) knowledge commensurate with GWG guidelines.

Design: Cross sectional quantitative study.

Setting: An Australian tertiary level maternity hospital.

Participants: Pregnant women (n=1032) following their first antenatal visit.

Measurements: Survey to assess GWG knowledge and a range of potential correlates of knowledge including socio-economic characteristics, pregnancy characteristics (parity, gestation, pre-pregnancy BMI) and GWG information procurement and GWG attitudinal variables.

Findings: Participants (n=366; 35.4% response) averaged 32.5 years of age with 33% speaking a language other than English. One third of women reported GWG knowledge consistent with guidelines. Women overweight prior to pregnancy were less likely to underestimate appropriate GWG (RRR 0.23, 95% CI=0.09-0.59). Conversely, women in the overweight (RRR 8.80, 95% CI=4.02-19.25) and obese (RRR 19.62, 95% CI=8.03-48.00) categories were more likely to overestimate GWG recommendations, while tertiary educated women were less likely to overestimate GWG (RRR 0.28, 95% CI= 0.10-0.79). No associations were found between GWG knowledge and pregnancy, GWG information source or attitudinal variables.

Conclusions and implications for practice: The findings highlight women's lack of GWG knowledge and the role of pre-pregnancy body mass index and women's education as correlates of GWG knowledge. Women susceptible to poor GWG knowledge should be a priority target for individual and community-based education.

Keywords: Pregnancy, gestational weight gain, knowledge, IOM guidelines; obesity

Introduction

Gestational weight gained outside recommended guidelines is recognised as having a negative influence on maternal and child health (Kieffer et al., 2006, Mamun et al., 2014).

The short and long term consequences of excess gestational weight gain (GWG) include an increased risk of hypertensive disorders (Kiel et al., 2007), glucose intolerance (Kieffer et al., 2006), negative delivery outcomes (McDonald et al., 2011), infant morbidity and mortality (Chen et al., 2009) and short and long term weight retention for mother and child (Mannan et al., 2013, Mamun et al., 2014).

While a variety of GWG guidelines exist, many countries have adopted the Institute of Medicine (IOM) guidelines (Alavi et al., 2013, IOM et al., 2009), including Australia, where these guidelines have recently been included in the Australian Dietary Guidelines (National Health and Medical Research Council, 2013). Despite incorporation of the IOM recommendations into national guidelines, evidence suggests that both health professionals and women lack knowledge and acceptance of these guidelines in pregnancy, and that women are not aware of the health consequences of insufficient or excess GWG (Groth and Kearney, 2009, Wilkinson and Stapleton, 2012, Willcox et al., 2012, Whitaker et al., 2016).

Knowledge of GWG concordant with guidelines, henceforth referred to as GWG knowledge, is a potentially modifiable risk factor for excess GWG, and may be a prerequisite for behaviour changes to promote healthy weight in pregnancy. Behaviour change models promote the importance of knowledge and information as one construct informing, supporting and modifying behaviour change (Michie et al., 2013). A small number of studies

suggest that knowledge regarding appropriate GWG among pregnant women is poor, and that poor knowledge predicts failure to meet GWG guidelines (Tovar et al., 2011, McPhie et al., 2015). For example, a recent study of 166 Australian women reported that around 65% overestimated the maximum weight to gain during pregnancy (McPhie et al., 2015). Further, those who gained excess gestational weight were more likely to overestimate the minimum amount of GWG for their pre-pregnancy body mass index (ppBMI) compared with women with a healthy GWG. These findings highlight the likely importance of women identifying and understanding their GWG targets.

It is important to understand correlates of women's knowledge of appropriate GWG to enable the refinement and targeting of educational efforts and messages in interventions seeking to improve GWG. A small number of studies have examined associations of GWG with ppBMI (McPhie et al., 2015, Tovar et al., 2011, de Jersey et al., 2012), socio-economic characteristics (Stotland et al., 2005), provider advice (Stotland et al., 2005, Tovar et al., 2011) and GWG attitudinal variables (Tovar et al., 2011). For example, one US study of 292 women analysed selected attitudes from the Pregnancy and Weight Gain Attitude Scale (Palmer et al., 1985) as predictors of setting a concordant GWG goal versus no goal. They found that women were more likely to have a guideline concordant goal rather than no GWG goal if they agreed that "I tried to keep my weight down not to look pregnant" (OR=14.3, 95%CI: 1.4, 140.5). Moreover, this study emphasised the importance of provider advice, finding that receipt of health provider IOM weight gain recommendations increased the likelihood of women setting a concordant GWG goal (versus no goal) (OR = 5.3, 95% CI: 1.5, 18.6), which in turn was predictive of actual weight gains that fell within IOM guidelines (Tovar et al., 2011).

Few studies have examined psychosocial factors that influence GWG knowledge.

Psychosocial influences, including self-efficacy and attitudes related to weight, are

increasingly recognised as important factors in related health behaviours (Bandura, 2004, Palmeira et al., 2007). These potential predisposing factors may provide the motivation or rationale for knowledge or behaviour to acquire the knowledge. Self-efficacy, that is a person's beliefs in their capabilities to undertake a course of action to satisfy situational demands (Bandura, 1986), has not previously been examined as a correlate of GWG knowledge.

Research suggests that being active in information-seeking may improve knowledge (Gustafson et al., 2005). The existing studies of GWG information procurement and GWG knowledge have restricted their focus to information provided by health professionals only (Willcox et al., 2015). Investigating women's GWG information seeking behaviours that are associated with GWG knowledge, therefore, is important.

In summary, GWG knowledge is a potentially modifiable predictor of GWG. Associations of GWG knowledge with selected socio-economic and pregnancy-related variables have been investigated in a small number of studies, but little is known about how attitudinal factors or GWG information procurement are associated with GWG knowledge. This study aimed to investigate potential demographic, GWG attitudinal and information procurement correlates of pregnant women's GWG knowledge commensurate with GWG guidelines.

Methods

A cross sectional study, Pregnancy, Health, Information and You (PHIY), utilising a mailed self-administered survey was conducted at a major Australian maternity tertiary training hospital with eligibility screening between October 2012 and January 2013. The study was designed to explore GWG attitudes and knowledge in pregnant women at the time of their first hospital visit. The hospital had no protocols for regular weighing or GWG counselling at

that time. The data utilised in this study were derived from the PHIY. Ethics approval was obtained from Deakin University (2012-183) and Mercy Hospital for Women (R12/29) Human Research Ethics Committees.

Participants and recruitment

Consecutive eligible pregnant women were mailed the questionnaire following their first hospital antenatal visit. Inclusion criteria included sufficient English to complete the survey, being aged more than 18 years and continuing pregnancy care at the hospital.

Survey design

The survey design was informed by the literature (Kowal et al., 2012, Brawarsky et al., 2005, Tovar et al., 2011) and discussion with a wide range of health professionals working with pregnant women. Table 1 outlines the newly derived survey questions and reliability testing. Survey question test-retest reliability was established via repeated administration of the survey two weeks apart in a separate subsample of 38 pregnant women.

Measures

GWG guideline knowledge

Women's knowledge of the appropriate GWG for their ppBMI, was assessed by asking participants "What do you think is the best amount of weight (or range) to gain in pregnancy for someone of your weight and height? (If unsure, please give your best guess)" with kilograms or stone/pounds as options for answers. Based on the response and self-reported ppBMI the values were coded into IOM GWG guideline groups 1) within guidelines 2) below guidelines 3) above guidelines.

Sociodemographic and pregnancy characteristics

Socio-demographic variables assessed included: maternal date of birth; highest level of maternal education; maternal main daily activity; relationship status; household income; country of birth; and primary language. Pregnancy characteristics assessed were parity and weeks gestation. Self-reported pre-pregnancy height and weight were used to calculate ppBMI. BMI categories were defined using the on the World Health Organization guidelines (World Health Organization, 2012).

GWG information procurement

GWG information seeking behaviour was assessed utilising a question about whether the participant had looked for information about how much weight they should gain in pregnancy (yes/no response). Questions assessing women's GWG information seeking behaviours and attitudes were adapted from the Health Information Competence Scale, developed by Gustafson et al (Gustafson et al., 2005). The two questions asked women (yes/no responses) about their need for more information about GWG and if help was required to make decisions about GWG.

Recalled GWG guideline provision by a doctor or midwife was elicited, along with the amount of GWG suggested by the health professional.

GWG attitudinal variables

A variety of attitudinal factors were selected on the basis of theoretical models and prior evidence of their importance as correlates for GWG or weight management in the general

population. Measures of self-efficacy for GWG management (Kendall et al., 2001) and feelings about weight gain in pregnancy (Palmer et al., 1985) were based on existing scales.

Data analyses

Descriptive statistics (mean, standard deviation, percent and range) were used to describe characteristics and potential associations of GWG knowledge of the sample. The distributions of continuous variables were inspected for normality. Likert scales were condensed, for analysis, from a five point scale to a three point scale.

Bivariate multinomial logistic regression models were conducted to investigate the associations of the three-level GWG knowledge guideline groupings (1. within guidelines; 2. below guidelines; 3. above guidelines) with potential individual correlates (socio-demographic, pregnancy, GWG attitudinal, GWG information procurement). In the regression analysis, 'within guidelines' was the reference category for knowledge related to guidelines. Statistical significance was set at $p < 0.05$ (two tailed) for all analyses. Those variables significantly associated with the outcome were adjusted for in multivariable multinomial logistic regression analysis. Analysis was conducted using Stata 12 (Stata Corp, College Station, Texas, USA).

Findings

Participant characteristics

A total of 1032 consecutive eligible women received a mailed questionnaire after their first antenatal visit. Thirty five percent of participants that were eligible for inclusion in this study completed surveys ($n=366$) (Figure 1).

The demographic, socioeconomic and pregnancy characteristics are presented in Table 2.

The mean age of participants was 32.5 years with a mean gestation of 20.8 weeks at time of survey completion. More than one third of women were born overseas and more than half of women (61.2%) had some tertiary education. Almost one in two women (53.5%) was primigravida. One fifth (20.5%) of the women had a ppBMI in the overweight range and 15.6% were obese.

GWG information procurement

More than half the women (54.6%) had actively sought GWG information (Table 3). Thirty five women (9.5%) recalled receiving GWG guidelines from doctors or midwives (Willcox et al., 2015). Of these 35 women, half had received information consistent with IOM GWG guidelines. Given the small numbers of women receiving GWG advice from health professionals, this construct was precluded from inclusion in further analysis. While a quarter of women (24.6%) did not feel they needed more GWG information at this time in their pregnancy, more than half (56.0%) indicated that further information was required. When asked if they needed help making decisions about GWG, one third (33.6%) agreed while 44.8% disagreed.

Attitudes to GWG

The majority of women (86.4%) expressed a degree of confidence in gaining a healthy amount of weight in pregnancy and being able to take the weight off after pregnancy (77.0%) (Table 3). Nearly half of women (47.2%) agreed that they did not care how much weight they gained as long as their diet was well-balanced but a similar proportion (48.1%) also agreed that they worried that they may “get fat” during this pregnancy. More than half of women (57.9%) agreed that they would lose excess weight gained after the baby was born. A similar

proportion (55.7%) disagreed with the proposition that they could fully control the amount of weight they gained during the pregnancy.

GWG knowledge

Analysis of women's GWG knowledge revealed 136 (37.2%) estimated appropriate GWG below, 125 (34.2%) within and 105 (28.6%) above IOM guidelines (Table 3). The characteristics of the 366 participants for three GWG guideline groups (below, within and above GWG guidelines) are presented in Table 3 along with the results from the bivariate multinomial regression.

Six variables were associated with GWG knowledge category at a bivariate level (Tables 2 and 3). In the multivariable multinomial logistic regression, three variables remained significant correlates of GWG knowledge (Table 4). Women in the ppBMI overweight range were significantly less likely to underestimate appropriate GWG. Conversely, women with a ppBMI in the overweight and obese ranges were at significantly higher risk of overestimating appropriate GWG, but caution is warranted given the small cell sizes. Tertiary educated women were less likely to overestimate GWG compared with secondary educated or trade or diploma graduates.

Discussion

This study examined whether pregnant women's socio-economic characteristics, pregnancy characteristics and GWG information procurement indicators and GWG attitudes were associated with their GWG knowledge. This study found that one third of women could identify the correct GWG for their ppBMI. Further, the findings suggest that women in the pre-pregnancy overweight and obese BMI categories, in comparison to those in the underweight or healthy weight categories, were substantially more likely to overestimate

appropriate GWG parameters. Additionally, women in the overweight category were less likely to underestimate appropriate GWG in comparison to the other weight categories.

Women with a tertiary education were also less likely than those with secondary or trade qualification to overestimate the GWG parameters. No associations were found between GWG knowledge and pregnancy, GWG information procurement or attitudinal variables. Given that GWG knowledge is potentially a modifiable factor among the numerous factors influencing GWG, these results signal opportunities to provide interventions to promote healthier GWG knowledge in more vulnerable groups.

The finding that women with a ppBMI in the overweight and obese ranges were most vulnerable to overestimation of GWG is not surprising considering previous research (McPhie et al., 2015, Phelan et al., 2011, Tovar et al., 2011) but remains concerning. The major change to GWG guidelines in the past few decades has been to include separate guidelines for different ppBMIs, in part, given the multiplication of risk of women entering pregnancy overweight or obese with subsequent large GWG (IOM et al., 2009). Research indicates that women remain unaware of the risks of excess GWG and that many health professionals infrequently discuss GWG with women and tend to be more likely to advise overweight and obese women to gain weight in excess of recommendations (Willcox et al., 2012, van der Pligt et al., 2011, Brown and Avery, 2012, Whitaker et al., 2016)

The overestimation of GWG in our sample is consistent with results of Groth and Kearney's qualitative study with 49 women which found that women were concerned about the effects of insufficient pregnancy weight gain on the infant but were unaware of the infant risks of excessive gain (Groth and Kearney, 2009). Knowledge of GWG at different ppBMIs may be a reflection of the extensive time it takes for research findings or guidelines to be translated into practice or consumer information sources (Grimshaw and Russell, 1993, Grol, 2001). At the time of this study, formal GWG guidelines were recently incorporated into the Australian

Dietary Guidelines. Further research is required to understand how GWG education may be built into health professionals' engagement with women.

Of interest is the lack of observed associations in the present study between attitudinal variables and GWG knowledge. Tovar and colleagues (Tovar et al., 2011), in their study with 292 US women, found that selected attitudes related to weight gain were associated with women's weight gain goals. In that study, women reporting negative attitudes were more likely to have a GWG goal discordant with recommendations, which may reflect a lack of GWG knowledge. Further, the women in the Tovar study reported higher levels of tertiary education (91% versus 61%) and income (47% versus 30% in the highest income bracket of \$100,000). Research suggests that these two socio-economic variables are strong predictors of weight related behaviours and weight outcomes (Ball et al., 2012). Potentially in our study, the attitudinal measures used may not be adequately sensitive to detect weight related attitudes important for GWG knowledge in this more socioeconomically diverse group of women. Further research is required to understand GWG attitudinal correlates of GWG knowledge in lower socio-economic groups of women.

Education level was correlated with knowledge of appropriate GWG, with tertiary educated women less likely to overestimate appropriate GWG. This is consistent with research in nutrition knowledge studies (McLeod et al., 2011) and obesity studies (Ball et al., 2012) showing more highly educated women to have higher nutrition knowledge, and to manage to avoid becoming obese. In one example McLeod and colleagues' research with Australian first time mothers (n=527) suggested that maternal nutrition knowledge was found to partly mediate the association between socioeconomic position and maternal diet quality. This may be the case with GWG and further investigation of mediators is warranted to learn more about knowledge and how to impart it.

This was the first study, to the authors' knowledge that investigated the association between GWG information seeking and knowledge. Notable is the lack of association between the two. It may be hypothesised, for example from the health belief model (Glanz et al., 2002), that greater confidence to actively seek information would increase the likelihood of improved knowledge and positive health behaviours. Our previous research suggests that many women are more likely to consult non-clinical than clinical sources such as health professionals for GWG information (Willcox et al., 2015). The validity of GWG information in popular health information sources, such as the internet, applications, books and magazines, is unknown and research is required to examine the quality of GWG information and its influence on women's GWG knowledge.

It is informative that there was a negligible association in the estimation of appropriate GWG with parity. This is concerning given the evidence that excess GWG over subsequent pregnancies significantly increases the prevalence of midlife obesity (Cohen et al., 2014). Research suggests that women gather most of their pregnancy information in their first pregnancy and may refine their information and knowledge over subsequent pregnancies (Szwajcer et al., 2005). Our study illustrates that it is important for women to be targeted at each individual pregnancy, regardless of parity, for health professional interactions and future GWG interventions.

As discussed in a previous study (Willcox et al., 2015), the small numbers provided with GWG guidelines and with evidence based guidelines is cause for concern. Unfortunately these small numbers precluded further correlation analysis. The few women provided with guidelines is troubling given previous research suggesting that provision of guidelines increases the likelihood of women setting a concordant GWG goal and gaining weight consistent with the guidelines (Tovar et al., 2011). Further research is required to ascertain the best way to embed GWG evidence-based practice within antenatal care.

Our findings need to be interpreted in the context of the study design. This study was cross-sectional in nature and thus causality cannot be inferred. Further, this study was conducted approximately half way through pregnancy, and it is plausible that women's knowledge of GWG guidelines may change over the course of their pregnancy as their GWG increases or their frequency of health professional interaction increases. In addition, knowledge does not necessarily translate to behaviour change. Additional longitudinal studies examining women's GWG knowledge, correlates of knowledge and GWG outcomes are required.

A potential limitation of this study is the self-reported ppBMI with the potential for recall or other reporting bias. This is a common concern for GWG research seeking pre-pregnancy anthropometry. The recruitment from one site may limit generalisability. While there was an unrepresentatively high proportion of a tertiary educated woman, the study had a reasonable spread of education and household incomes. On the other hand, the study has a number of strengths. These include the inclusion of a broad range of women including those born in countries other than Australia, a span of household incomes and a relatively large sample size.

Conclusion and implications

This study has highlighted the lack of women's GWG knowledge and the importance of a woman's ppBMI and education as correlates of GWG knowledge. These results add to other research in suggesting that pregnant women susceptible to poor GWG knowledge should be an important target for both individually-targeted and community-based education. To improve the number of women meeting GWG guidelines, individual and public health interventions must align with programs to embed evidence-based GWG medicine into antenatal services. Moreover, both individual and public health engagements need to acknowledge that overweight and obese women, along with lower educated women, should

be targets for focussed advice regarding GWG targets. Further investigation of the information provided to women by commonly used information sources is required to understand its quality and how it translates to GWG knowledge.

Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

JW designed the study, project managed the research and prepared the manuscript. JW and KB conducted the statistical analysis. KJC, KB, DC and SAW participated in the research design and interpretation of the data. All authors read and approved the final manuscript.

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References

Alavi, N., Haley, S., Chow, K. & McDonald, S. D., 2013. Comparison of national gestational weight gain guidelines and energy intake recommendations. *Obes Rev* 14, 68-85.

- Ball, K., Abbott, G., Cleland, V., Timperio, A., Thornton, L., Mishra, G., Jeffery, R. W., Brug, J., King, A. & Crawford, D., 2012. Resilience to obesity among socioeconomically disadvantaged women: the READI study. *International Journal Of Obesity* 36, 855-865.
- Bandara, A. 1986., *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, Prentice-Hall, Inc.
- Bandura, A., 2004. Health promotion by social cognitive means. *Health Educ Behav* 31, 143-164.
- Brawarsky, P., Stotland, N. E., Jackson, R. A., Fuentes-Afflick, E., Escobar, G. J., Rubashkin, N. & Haas, J. S., 2005. Pre-pregnancy and pregnancy-related factors and the risk of excessive or inadequate gestational weight gain. *Int J Gynecol Obstet* 91, 125-131.
- Brown, A., Avery, A., 2012. Healthy weight management during pregnancy: what advice and information is being provided. *J Hum Nutr Diet* 25, 378-387.
- Campbell, K. J., Lioret, S., McNaughton, S. A., et al., 2013. A parent-focused intervention to reduce infant obesity risk behaviors: a randomized trial. *Pediatrics*, 131, 652-660.
- Chen, A., Feresu, S. A., Fernandez, C. & Rogan, W. J. 2009. Maternal obesity and the risk of infant death in the United States. *Epidemiology* 20, 74-81.
- Cohen, A. K., Chaffee, B. W., Rehkopf, D. H., Coyle, J. R. & Abrams, B. 2014. Excessive gestational weight gain over multiple pregnancies and the prevalence of obesity at age 40. *Int J Obesity* 38, 714-718.
- De Jersey, S. J., Nicholson, J. M., Callaway, L. K. & Daniels, L. A., 2012. A prospective study of pregnancy weight gain in Australian women. *Aust N Z J Obstet Gynaecol* 52, 545-551.
- Glanz, K., Lewis, F. M. 2002. *Health Behavior and Health Education. Theory, Research and Practice*. San Francisco, Wiley & Sons.
- Grimshaw, J. M., Russell, I. T., 1993. Effect of clinical guidelines on medical practice: a systematic review of rigorous evaluations. *Lancet* 342, 1317-1322.
- Grol, R., 2001. Successes and failures in the implementation of evidence-based guidelines for clinical practice. *Medical Care*, 39, II-46-II-54.
- Groth, S. W., Kearney, M. H., 2009. Diverse women's beliefs about weight gain in pregnancy. *J Midwifery Wom Heal* 54, 452-457.
- Gustafson, D., Mctavish, F., Stengle, W., et al., 2005. Use and impact of ehealth system by low-income women with breast cancer. *J Hlth Commun* 10, 195-218.

- Institute of Medicine, Rasmussen, K, Yaktine, A., 2009. Weight gain during pregnancy: reexamining the guidelines. Washington, The National Academies Press.
- Kendall, A., Olson, C. M., Frongillo, E. A., Jr. 2001. Evaluation of psychosocial measures for understanding weight-related behaviors in pregnant women. *Ann Behav Med*, 23, 50-58.
- Kieffer, E. C., Tabaei, B. P., Carman, W. J., et al., 2006. The influence of maternal weight and glucose tolerance on infant birthweight in Latino mother-infant pairs. *Am J Pub Health* 96, 2201-2208.
- Kiel, D. W., Dodson, E. A., Artal, R., et al., 2007. Gestational weight gain and pregnancy outcomes in obese women: how much is enough? *Obstet Gynecol* 110, 752-758.
- Kowal, C., Kuk, J., Tamim, H., 2012. Characteristics of weight gain in pregnancy among Canadian women. *Matern Child Health J* 16, 668-676.
- Mamun, A. A., Mannan, M., Doi, S. A. R., 2014. Gestational weight gain in relation to offspring obesity over the life course: a systematic review and bias-adjusted meta-analysis. *Obes Rev* 15, 338-347.
- Mannan, M., Doi, S. A., Mamun, A. A., 2013. Association between weight gain during pregnancy and postpartum weight retention and obesity: a bias-adjusted meta-analysis. *Nutr Rev* 71, 343-52.
- McDonald, S. D., Han, Z., Mulla, S., Lutsiv, O., Lee, T., Beyene, J., 2011. High gestational weight gain and the risk of preterm birth and low birth weight: a systematic review and meta-analysis. *J Obstet Gynaecol Can* 33, 1223-1233.
- McLeod, E., Campbell, K., Hesketh, K., 2011. Nutrition knowledge: A mediator between socioeconomic position and diet quality in Australian first-time mothers. *J Am Diet Assoc* 111, 696-704.
- Mcphie, S., Skouteris, H., Hill, B., Hayden, M., 2015. Understanding gestational weight gain: the role of weight-related expectations and knowledge. *Aust N Z J Obstet Gynaecol* 55, 21-6.
- Michie, S., Richardson, M., Johnston, M., et al. 2013. The behavior change technique Taxonomy of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 46, 81-95.
- National Health and Medical Research Council 2013. Australian Dietary Guidelines. Canberra.

- Palmeira, A. L., Teixeira, P. J., Branco, T. L., et al. 2007. Predicting short-term weight loss using four leading health behavior change theories. *Int J Behav Nutr Phy* 4, 14-14.
- Palmer, J. L., Jennings, G. E., Massey, L. 1985. Development of an assessment form: attitude toward weight gain during pregnancy. *J Am Diet Assoc* 85, 946-949.
- Phelan, S., Phipps, M. G., Abrams, B., Darroch, F., Schaffner, A., Wing, R. R. 2011. Practitioner advice and gestational weight gain. *J Womens Health* 20, 585-591.
- Stotland, N. E., Haas, J. S., Brawarsky, P., et al., 2005. Body mass index, provider advice, and target gestational weight gain. *Obstet Gynecol* 105, 633-638.
- Szwajcer, E. M., Hiddink, G. J., Koelen, M. A. & Woerkum, C. M., 2005. Nutrition-related information-seeking behaviours before and throughout the course of pregnancy: consequences for nutrition communication. *Eur J Clin Nutr* 59, 57-65.
- Tovar, A., Guthrie, L. B., Platek, D., et al., 2011. Modifiable predictors associated with having a gestational weight gain goal. *Matern Child Hlth J* 15, 1119-1126.
- Van Der Pligt, P., Campbell, K., Willcox, J., Opie, J. & Denney-Wilson, E., 2011. Opportunities for primary and secondary prevention of excess gestational weight gain: General practitioners' perspectives. *BMC Fam Pract* 12, 124.
- Whitaker, K. M., Wilcox, S., Liu, J., Blair, S. N., Pate, R. R. 2016. African American and White women's perceptions of weight gain, physical activity, and nutrition during pregnancy. *Midwifery* 34, 211-220.
- Wilkinson, S. A., Stapleton, H., 2012. Overweight and obesity in pregnancy: the evidence-practice gap in staff knowledge, attitudes and practices. *Aust N Z J Obstet Gynaecol* 52, 588-92.
- Willcox, J. C., Campbell, K. J., McCarthy, E. A., et al., 2015. Testing the feasibility of a mobile technology intervention promoting healthy gestational weight gain in pregnant women (txt4two) - study protocol for a randomised controlled trial. *Trials* 16, 209-209.
- Willcox, J. C., Campbell, K. J., Van Der Pligt, et al., 2012. Excess gestational weight gain: an exploration of midwives' views and practice. *BMC Pregnancy Childbirth*, 12, 102-113.
- World Health Organization. 2012. BMI Classification. Available: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html (Accessed 30/05/2012)

Table 1: GWG knowledge and newly derived correlate measures

	Measure	Question type	Response	Reliability*	Source
GWG guideline knowledge	What do you think is the best amount of weight (or range) to gain in pregnancy for someone of your weight and height? (If unsure, please give your best guess)	Open	Numerical	n/a [†]	Original
GWG information procurement	Has your doctor or midwife given you a specific weight gain suggestion or target for this pregnancy?	Dichotomous	Yes/No	$\kappa = 0.77^{\S}$	Adapted from (Campbell et al., 2013)
	What weight or weight range did the doctor or midwife advise you to reach?	Open	Open	n/a [†]	Adapted from (Campbell et al., 2013)
	During this pregnancy have you looked for information (including on the internet) or asked anyone about how much weight you should gain during pregnancy?	Dichotomous	Yes/No	$\kappa = 0.68^{\S}$	Original
	I need more information about gaining a healthy amount of weight during pregnancy.	Likert	6 point Strongly disagree to strongly agree ^{**}	$\kappa = 0.54^{\S}$	Adapted from the Health Information Competence Scale (Gustafson et al., 2005)
	I need help making decisions about healthy weight gain in pregnancy.	Likert	6 point Strongly disagree to strongly agree ^{**}	$\kappa = 0.38^{\S}$	Adapted from the Health Information Competence Scale

* Survey question test-retest reliability was established via repeated administration of the survey two weeks apart in a separate subsample of 38 pregnant women.

† Not applicable for reliability testing

§ Kappa coefficient

** Recoded to three categories for reliability analysis; agree, neutral, disagree

Table 2: Bivariate multinomial logistic regression correlating GWG knowledge concordant with guidelines according to socio-economic and pregnancy characteristics.

Characteristics of women	Whole sample (n=366)	GWG knowledge estimation category		
		Within guidelines (n=136)	Below guidelines (n=125)	Above guidelines (n=105)
	Mean (SD)	n (p-value)	n (p-value)	n (p-value)
Pregnancy characteristics				
Gestation (weeks) at survey	20.8 (5.5)	21.3 (ref)	20.1 (0.14)	21.2 (0.98)
	n (%)	n (p-value)	n (p-value)	n (p-value)
Socio-demographic characteristics				
Maternal age (mean 32.5 years, SD 4.5)				
<30 years	161 (44.0)	65 (ref)	54 -	43 -
31-35 years	118 (32.2)	42 -	43 (0.49)	34 (0.51)
> 36 years	87 (23.8)	35 -	25 (0.52)	27 (0.60)
Country of birth				
Australia	230 (62.8)	85 (ref)	75 -	70 -
Overseas	136 (37.2)	51 -	50 (0.68)	35 (0.50)
Language				
English	245 (66.9)	93 (ref)	81 -	71 -
LOTE	121 (33.1)	43 -	44 (0.54)	34 (0.90)
Relationship status †				
Married/defacto	358 (97.8)	133	123	102
Separated				
/widowed/never married	8 (2.2)	3	2	3
Education				
Secondary or less	40 (10.9)	11 (ref)	11 -	18 -
Trade/Certificate or	102 (27.9)	30 -	31 (0.95)	41 (0.69)
Diploma				
Tertiary	224 (61.2)	95 -	83 (0.77)	46 (<0.01)
Main daily activity				
Working full time	138 (37.7)	57 (ref)	39 -	42 -

Working part time	119 (32.5)	36 -	47 (0.03)	36 (0.33)
Raising children	90 (24.6)	37 -	29 (0.68)	24 (0.70)
Unemployed/studying	19 (5.2)	6 -	10 (0.11)	3 (0.60)
Household income				
<\$51,999	70 (19.1)	27 (ref)	30 -	13 -
\$52-77,999	64 (17.5)	18 -	22 (0.82)	24 (0.03)
\$78-99,999	72 (19.7)	26 -	25 (0.71)	21 (0.25)
>\$99,999	110 (30.0)	50 -	33 (0.13)	27 (0.78)
Did not answer	51 (13.7)	15 -	15 (0.82)	20 (0.03)
Pregnancy characteristics				
Single/multiple pregnancy†				
Single	360 (97.5)	138	119	103
Multiple	9 (2.5)	4	3	1
Parity				
0	170 (46.5)	64 (ref)	59 -	47 -
> 1	196 (53.5)	72 -	66 (0.98)	58 (0.72)
ppBMI kg/m² (mean 24.7, SD 5.6)				
Underweight (<18.5kg/m ²)	18 (4.9)	4 -	13 (0.73)	1 (0.82)
Healthy weight (18.5-24.9 kg/m ²)	216 (59.0)	93 (ref)	105 -	18 -
Overweight (25-29.9 kg/m ²)	75 (20.5)	26 -	7 (< 0.01)	42 (< 0.01)
Obese (30-34.9 kg/m ²)	57 (15.6)	13 -	0*	44 (< 0.01)

Abbreviations: BMI, body mass index; LOTE, language other than English; mod, moderately; ref, reference category; SD, standard deviation

* The occurrence of small cell counts prevents computation.

Table 3: Bivariate multinomial logistic regression correlating GWG knowledge concordant with guidelines according to GWG information procurement and GWG attitudinal variables.

Characteristics of women	Whole sample (n=366)	GWG knowledge estimation category		
		Within guidelines (n=136)	Below guidelines (n=125)	Above guidelines (n=105)
	n (%)	n (p-value)	n (p-value)	n (p-value)
GWG knowledge procurement				
Received GWG advice				
Yes	35 (9.5)	14 (ref)	8 -	10 -
No	333 (90.5)	122 -	117 (0.26)	95 (0.84)

Received IOM consistent				
GWG advice				
Yes	18 (4.6)	10 (ref)	5 -	3 -
No	348 (95.4)	130 -	117 (0.55)	101 (0.12)
Sought GWG information				
Yes	200 (54.6)	75 (ref)	63 -	62 -
No	166 (45.4)	61 -	62 (0.44)	43 (0.54)
Need more GWG information				
Agree/strongly agree	205 (56.0)	73 -	73 (0.12)	59 (0.49)
Neither agree nor disagree	71 (19.4)	26 (ref)	29 -	16 -
Disagree/strongly disagree	90 (24.6)	37 -	23 (0.73)	30 (0.45)
Need help making decisions about GWG				
Agree/strongly agree	123 (33.6)	42 -	41 (0.76)	40 (0.51)
Neither agree nor disagree	79 (21.6)	30 (ref)	25 -	24 -
Disagree/strongly disagree	164 (44.8)	64 -	59 (0.65)	41 (0.62)
GWG attitudes				
a. Self-efficacy for GWG				
Gain a health amount of weight in this pregnancy				
Not at all confident	56 (15.3)	19 -	14 (0.97)	23 (0.16)
Slightly/mod confident	138 (37.8)	56 (ref)	42 -	40 -
Very/extremely confident	171 (46.8)	61 -	68 (0.14)	42 (0.90)
Take off extra weight you gain after the pregnancy				
Not at all confident	84 (23.0)	35 -	17 (0.05)	32 (0.38)
Slightly/mod confident	125 (34.3)	47 (ref)	46 -	32 -
Very/extremely confident	156 (42.7)	54 -	61 (0.61)	41 (0.72)
b. Weight gain in pregnancy				
I like being able to gain weight for a change				
Agree/strongly agree	54 (14.8)	16 -	18 (0.50)	20(0.35)
Neither agree nor disagree	84 (23.0)	33 (ref)	30 -	21 -
Disagree/strongly disagree	228 (62.3)	87 -	77 (0.97)	64 (0.27)
As long as I am eating a well-balance diet, I don't care how much I gain during this pregnancy				
Agree/strongly agree	173 (47.2)	68 -	52 (0.11)	53 (0.65)
Neither agree nor disagree	74 (20.2)	23 (ref)	30 -	21 -
Disagree/strongly disagree	119 (32.5)	45 -	43 (0.37)	31 (0.46)
I will feel badly if I gain more than the recommended weight during pregnancy				
Agree/strongly agree	222 (60.7)	82 -	79 (0.69)	61 (0.72)

Neither agree nor disagree	65 (17.8)	26 (ref)	22 -	17 -
Disagree/strongly disagree	79 (21.6)	28 -	24 (0.97)	27 (0.35)
I worry I may get fat during this pregnancy				
Agree/strongly agree	176 (48.1)	68 -	5 (0.51)	51 (0.63)
Neither agree nor disagree	76 (20.8)	26 (ref)	27 -	23 -
Disagree/strongly disagree	114 (31.2)	42 -	41 (0.86)	31 (0.63)
If I gain too much weight one month, I will try to keep from gaining the next month				
Agree/strongly agree	72 (19.7)	25 -	27 (0.79)	20 (0.52)
Neither agree nor disagree	70 (19.1)	25 (ref)	30 -	15 -
Disagree/strongly disagree	224 (61.2)	86 -	68 (0.19)	70 (0.40)
If I gain too much weight during pregnancy I will lose it after the baby is born				
Agree/strongly agree	212 (57.9)	80 -	84 (0.45)	48 (0.03)
Neither agree nor disagree	85 (23.2)	28 (ref)	23 -	34 -
Disagree/strongly disagree	69 (18.9)	28 -	18 (0.55)	23 (0.30)
I am sure that I will be able to fully control the amount of weight I will gain this pregnancy				
Agree/strongly agree	64 (17.5)	22 -	26 (0.50)	16 (0.80)
Neither agree nor disagree	98 (26.8)	36 (ref)	33 -	29 -
Disagree/strongly disagree	204 (55.7)	78 -	66 (0.79)	60 (0.88)

Abbreviations: ref, reference category;

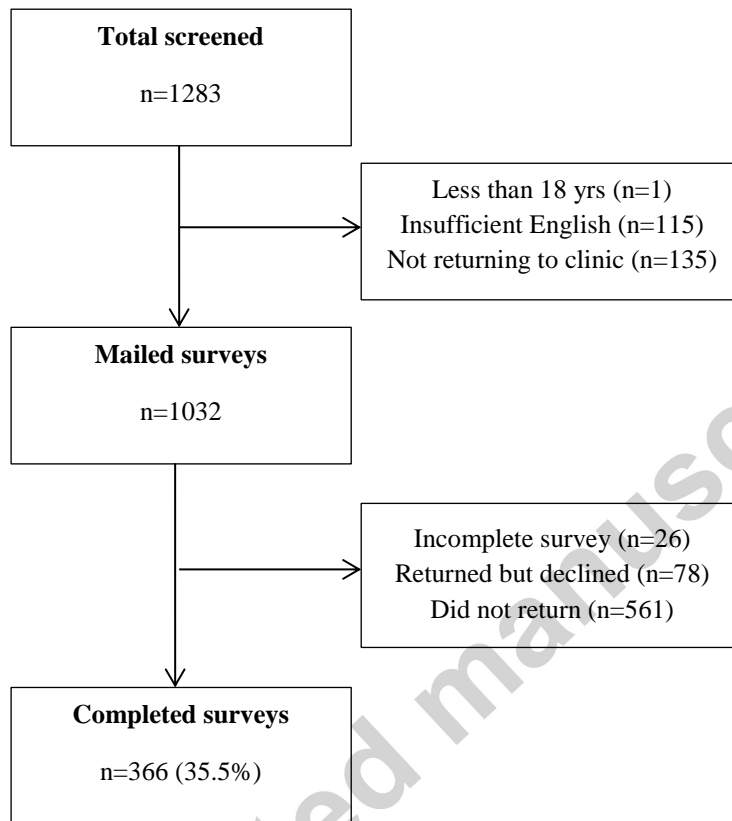
Table 4: Multivariable multinomial logistic regression analyses correlating GWG knowledge concordant with guidelines according to socio-economic characteristics, pregnancy and GWG attitudinal variables.

Characteristics	Estimation of GWG					
	Below guidelines			Above guidelines		
	RRR	(95%CI)	p	RRR	(95%CI)	p
Socio-demographic						
Education						
Secondary or less	Ref			Ref		
Trade/Certificate/Diploma	1.24	0.43, 3.56	0.69	0.53	0.18, 1.57	0.26
Tertiary	0.96	0.37, 2.49	0.93	0.28	0.10, 0.79	0.02
Main daily activity						
Working full time	Ref			Ref		
Working part time	1.71	0.90, 3.25	0.10	1.25	0.59, 2.69	0.56

Raising children	0.84	0.40, 1.71	0.61	0.67	0.28, 1.58	0.36
Unemployed/studying	2.32	0.68, 7.89	0.78	0.87	0.15, 4.90	0.87
Household income						
<\$51,999	Ref			Ref		
\$52-77,999	1.44	0.58, 3.58	0.43	1.82	0.60, 5.50	0.29
\$78-99,999	1.07	0.46, 2.47	0.88	1.90	0.64, 5.66	0.25
>\$99,999	0.67	0.31, 1.46	0.31	1.48	0.52, 4.21	0.46
Did not answer	0.74	0.29, 1.94	0.54	4.08	1.27, 13.10	0.02
Pregnancy						
ppBMI kg/m ²						
Underweight (<18.5kg/m ²)	3.04	0.91, 10.12	0.07	1.27	0.13, 12.67	0.84
Healthy weight (18.5-24.9 kg/m ²)	Ref			Ref		
Overweight (25-29.9 kg/m ²)	0.23	0.09, 0.59	<0.01	8.80	4.02, 19.25	<0.01
Obese (30-34.9 kg/m ²)	-*	-	-	19.62	8.03, 48.00	<0.01
GWG self-efficacy/ weight attitudes						
Take off extra weight you gain after the pregnancy						
Not at all confident	0.50	0.23, 1.09	0.08	0.89	0.39, 2.02	0.77
Slightly/mod confident	Ref			Ref		
Very/extremely confident	0.95	0.52, 1.72	0.87	1.71	0.77, 3.80	0.19
If I gain too much weight during pregnancy I will lose it after the baby is born						
Agree/strongly agree	0.78	0.37, 1.64	0.52	0.91	0.35, 2.41	0.86
Neither agree nor disagree	Ref			Ref		
Disagree/strongly	0.64	0.26, 1.55	0.32	0.95	0.39, 2.35	0.91

Abbreviations: Ref., reference category; RRR relative risk ratio

* The occurrence of small cell counts prevents computation.

Fig 1: Flow diagram of study recruitment**Highlights**

- One third of women reported gestational weight gain knowledge consistent with guidelines.
- Women overweight prior to pregnancy were less likely to underestimate but more likely to overestimate appropriate gestational weight gain.
- Tertiary educated women were less likely to overestimate gestational weight gain.
- No associations were found between gestational weight gain knowledge and pregnancy, gestational weight gain information procurement or attitudinal variables.