A path model of psychosocial and health behaviour change predictors of excessive gestational weight gain

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Conflict of Interest

The authors declare that they have no conflict of interest.

Keywords

Gestational weight gain, psychosocial factors, health behaviour change, pregnancy, path analysis

Objective: This study aimed to evaluate a conceptual model of psychosocial, behaviour change, and behavioural predictors of excessive gestational weight gain (GWG).

Background: Excessive GWG can place women and their babies at risk of poor health outcomes including obesity. Models of psychosocial and behaviour change predictors of excessive GWG have not been extensively explored; understanding the mechanisms leading to excess GWG will provide crucial evidence towards the development of effective interventions..

Method: Two hundred and eighty-eight pregnant women (≤18 weeks gestation) were recruited to a prospective study . Demographic, psychosocial, health behaviour change, and behavioural factors were assessed at 17 (Time 1, T1) and 33 weeks (Time 2, T2) gestation. Pre-pregnancy and final pregnancy weight were obtained and women were classified with/without excessive GWG. Logistic regressions refined the list of predictors of excessive GWG; variables with $p<.1$ were included in a path analysis.

Results: Age, family income, T2 depression, T2 pregnancy-specific coping, T1 buttocks dissatisfaction, T2 GWG-specific self-efficacy, T1 dietary readiness, T1 dietary importance, and T1 vegetable intake predicted excessive GWG in the logistic regressions and were included in the path model. The baseline path model demonstrated poor fit. Once statistically and theoretically plausible paths were added, adequate model fit was achieved ($\chi^2 = 21.61(9)$, $p<.05$; RMSEA=.07; CFI =.93); this revised model explained 19.5% of the variance in excessive GWG. Women with high T1 buttocks dissatisfaction were more likely to exhibit low levels of dietary readiness. Women with low dietary readiness were more likely to have a lower vegetable intake, which predicted excessive GWG. Women with higher T2 depressive symptoms were more likely to report lower GWG self-efficacy and gain excessively.

Conclusion: Future behavioural GWG trials should consider combining psychosocial and health behaviour change factors to optimise GWG.

Introduction

Fifty percent of women gain weight during pregnancy that exceeds the recommended range for pre-pregnancy body mass index (BMI) defined by the United States (US) Institute of Medicine (IOM 2007; Rasmussen & Yaktine, 2013). Exceeding these weight gain recommendations can place women and their babies at risk of poor health outcomes including obesity (Phillips, King, & Skouteris, 2014; Rasmussen & Yaktine, 2013; Schack-Nielsen, Michaelsen, Gamborg, Mortensen, & Sorensen, 2010).

In 2013, the IOM recommended that funding agencies provide support for the conduct of research to understand how diet and physical activity, and the social, cultural and environmental context affect GWG (Rasmussen & Yaktine, 2013). Additionally, the IOM recognised that the relationship between mental health and GWG is grossly understudied. Behavioural change is necessary for modifying the weight-gain trajectory of a large proportion of childbearing women (Campbell, Johnson, Messina, Guillaume, & Goyder, 2011), yet most behavioural interventions designed to reduce excessive GWG have had little success (Hill, Skouteris, & Fuller-Tyszkiewicz, 2013; Skouteris et al., 2010; Thangaratinam et al., 2012). Identifying specific paths leading to the development of excessive GWG will provide crucial evidence towards the development of effective interventions.

In light of the recommendations proposed by the IOM, several researchers have begun to explore the aetiology of excessive GWG in a psychological and socio-cultural context. However, this has been limited to testing a series of biological, psychosocial, or demographic factors (McDonald et al., 2013; Olson & Strawderman, 2003; Webb, Siega-Riz, & Dole, 2009), with only one of these including a behaviour change construct – self-efficacy (McDonald et al., 2013). Additionally, Hill, Skouteris, McCabe, Milgrom, et al. (2013) built a model on the basis of existing empirical evidence that identified a range of demographic, psychological, socio-contextual, and behavioural factors that may influence the development

of excessive GWG (Figure 1). This model includes health behaviour change constructs such as self-efficacy and motivation and identifies paths by which these factors affect GWG. The model suggests that maternal psychological factors, knowledge and understanding of GWG, and familial and socio-contextual factors influence the development of positive or negative body image and coping skills. These in turn may shape one's self-efficacy and motivation to initiate or maintain weight management behaviours during pregnancy, directly influencing their behavioural choices that lead to unhealthy or healthy GWG. This model may be useful for understanding the mechanisms by which interventions impact on weight management during pregnancy. At present, work using this model has been purely conceptual and the model has not been tested empirically. Furthermore, existing models have only been able to identify factors directly affecting GWG. Empirical tests of the model will improve our understanding of how determinants of GWG may interact with each other and subsequently directly or indirectly influence GWG.

The aim of this study was to evaluate the suitability of Hill et al.'s (2013) conceptual model of predictors of excessive GWG. Given the detail and complexity of the model, this was done in two parts: (1) the large list of potential predictors outlined in the conceptual model was refined using a series of logistic regression analyses; and (2) the refined list of predictors was incorporated into a path model to test the ability of the model to predict excessive GWG.

[Figure 1 near here. *Note: Publication permissions for Figure 1 are current pending. This figure is available in Hill, Skouteris, McCabe, Milgrom et al., 2013.*]

Method

Participants

Eligible women were pregnant, less than 18 weeks gestation, and over 18 years of age. Participants were recruited via advertising on online pregnancy forums, parenting

magazines (*n*=303) from February 2010 to July 2012 and through the maternity clinic at a large tertiary hospital Melbourne, Australia (*n*=128) from December 2011 to January 2013. Four hundred and thirty-one women were recruited, however only women who provided both pre-pregnancy weight and final weight at ≥36 weeks gestation (allowing GWG to be calculated) were included in the analyses (*n*=288, 66.8% of sample). Women included in the final sample were more likely to be married/de facto (*p*=.045), have a higher annual family income (*p*<.001), and less likely to smoke (*p*<.001) than women who were not included.

Procedure

Women completed questionnaires at 16-18 weeks gestation (Time 1, T1; *M* weeks gestation=16.9, *SD*=1.47) and again at 33 weeks (Time 2, T2; *M*=32.6, *SD*=0.87). Recruitment for Time 1 occurred between 10-16 weeks, to minimise the risk that women who would go on to miscarry would be recruited to the study, while allowing for collection of data from women in the early- to mid-stages of pregnancy. The 33 week gestation timepoint was selected to ensure that data was collected in the third trimester while minimising participant burden throughout the late stages of pregnancy with the goal to increase participant retention. Gift cards worth AUD$30 were offered to women at study completion. Ethics approval was provided by the Human Research Ethics Committees of Deakin University (36-2009) and Melbourne Health (2011.133). All participants gave voluntary informed consent.

Outcome measure – GWG

Women reported their height and pre-pregnancy weight at T1 to calculate pre-pregnancy BMI. Women who were recruited through the hospital (*n*=67) had their height measured at their first antenatal appointment and their final weight prior to delivery recorded by their midwife (*M*=39.4 weeks, *SD*=1.46). Participants recruited through online pregnancy forums and parenting magazines (*n*=221) self-reported their height and pre-pregnancy weight on their T1 questionnaire and were asked to indicate their weight at 36 weeks gestation in an

additional brief questionnaire (*M*=36.4 weeks, *SD*=0.71). Additionally, women were asked to indicate whether they had weighed themselves (coded as self-reported) or had been weighed by a health professional such as a nurse or obstetrician (coded as objectively measured). Forty percent of the sample (*n*=115) provided objective measurements. Objective and subjectively measured final pregnancy weight were not significantly different in the current sample (*p*=.198).

Total GWG was calculated as pre-pregnancy weight subtracted from final pregnancy weight (*M*=37.1 weeks, *SD*=1.55). Total GWG and pre-pregnancy BMI were used to classify women as exceeding or not exceeding the 2013 IOM GWG recommendations (Rasmussen & Yaktine, 2013). Women who are underweight prior to pregnancy (BMI <18.5 kg/m^2) are recommended to gain 12.5 to 18 kg, women entering pregnancy at a normal weight (BMI 18.5 to 24.9 kg/m^2) should gain between 11.5 and 16 kg, women who are overweight pre-pregnancy (BMI 25 to 29.9 kg/m^2) are recommended to gain 7 to 11 kg, and women who are obese (BMI ≥30 kg/m^2) should aim to gain 5 to 9 kg throughout the duration of their pregnancy. Our dichotomous outcome variable was grouped as follows: GWG above the IOM recommendations was classified as excessive GWG and gaining within or below these guidelines was classified as not exceeding recommendations.

Predictor variables

Predictor variables were grouped into conceptual blocks that match those identified in Hill et al.'s (2013) conceptual model, outlined by subheadings, below. Conceptual blocks, measurement tools, reliability of tools in pregnant populations, and predictor variables are summarised in Appendix 1.

Maternal psychological factors

Self-esteem was assessed using the Rosenberg Self-Esteem Scale (Rosenberg, 1965), with participants rating how they had felt over the past month on a scale from strongly

disagree to strongly agree. Maternal depressive symptoms during pregnancy were assessed via the Edinburgh Postnatal Depression Scale (EPDS; Murray & Cox, 1990). The EPDS asked how one has felt over the past week. Maternal anxiety and stress were assessed using the anxiety and stress subscales of the Depression, Anxiety, and Stress Scale (Lovibond & Lovibond, 1995). Past psychicatric history was also assessed via a single item.

Knowledge of GWG

Knowledge of GWG was assessed by asking how much weight gain over nine months of pregnancy would be 'normal' for most women. Responses were coded as to whether women reported a GWG within or outside the IOM GWG recommended range for normal weight women. These guidelines recommend that women with a pre-pregnancy BMI of 18.5–24.9 kg/m^2 gain between 11.5 and 16.0 kg (25–35 lbs).

Familial/socio-contextual factors

Social support was measured via the Multidimensional Scale of Perceived Social Support (Zimet, Dahlem, Zimet, & Farley, 1988) which assesses subjective social support available from a significant other, family, or friends. Marital/relationship quality was assessed using the Dyadic Adjustment Scale and the total score used to assess general relationship quality (Spanier, 1976). Educational attainment, annual family income, parity, and age were also assessed.

Coping skills

Two measures of coping were assessed that tap into different aspects of coping during pregnancy. The Revised Prenatal Coping Inventory (PCI) is a pregnancy-specific measure of coping that comprises three distinct and conceptually interpretable coping factors; planning-preparation, avoidance, and spiritual-positive coping (Hamilton & Lobel, 2008). Participants indicated how often they had used 32 different strategies "as a way of managing some of the strains and challenges that are sometimes associated with being pregnant". For each strategy

women were asked to report the frequency with which that strategy on a five-point scale; higher scores indicated more frequent use of that strategy. Example items include *Asked doctors or nurses about the birth* and *Thought about pregnant women who are doing better than you*.

The COPE measure is not specific to pregnancy and provides an indication of coping strategies generally used when experiencing stressful events (Carver, Scheier, & Weintraub, 1989). The present study included six COPE sub-scales that have been shown to be salient for pregnant women (Huizink, de Medina, Mulder, Visser, & Buitelaar, 2002): active coping, seeking instrumental social support, positive reinterpretation and growth, planning, seeking emotional social support, and acceptance. Women were asked to respond to potential coping mechanisms they have usually used over the past month when they have been under a lot of stress on a four-point Likert scale from (1) *I usually don't do this at all* to (4) *I usually do this alot*.

Body image

Measures of body image tapping into women's body attitudes (including both positive and negative aspects of body image overall) and body dissatisfaction with specific body parts were included. The Ben-Tovim Walker Body Attitudes Questionnaire (BAQ; Ben-Tovim & Walker, 1991) assessed body attitudes using four subscales that are, at face value, relevant to pregnant women (Skouteris, Carr, Wertheim, Paxton, & Duncombe, 2005): strength and fitness, salience of weight and shape, feeling fat, and attractiveness. Participants reported how they felt over the past month. This measure has been validated in a sample of pregnant women (Skouteris et al., 2005). The Pregnancy Figure Rating Scale (PFRS) assessed body dissatisfaction through women's perceived current and idealised scores for their busts, pregnant bellies, and buttocks (Skouteris et al., 2005). Each body part was depicted by five drawings of that part, increasing in size from small to very large. Body dissatisfaction for

each body part was calculated by subtracting the ideal from the current rating. Higher scores indicate higher body disstatisfaction. The PFRS has been shown to be a valid and reliable measure of body dissatifiaction during pregnancy (Skouteris et al., 2005).

Self-efficacy and motivation

A readiness to change questionnaire modeled from Mason and Butler (2010) was used to assess confidence (self-efficacy), readiness and importance (motivation) to make diet and physical activity-related lifestyle changes during pregnancy. Six items were phrased as follows, *how: ready are you/confident are you/important is it to you to make healthy lifestyle changes during your pregnancy regarding your eating/physical activity given everything going on in your life right now?* Participants rated each question on a scale of zero to ten, with higher scores indicating greater motivation. Three additional items specifically assessing self-efficacy and motivation towards appropriate GWG (i.e. *It is important for me to/I am trying to/I can adopt and/or maintain healthy lifestyle behaviours during my pregnancy for the purpose of gaining the recommended amount of gestational weight*) were also used and were assessed on a scale from one to five; as with the previous scale higher scores indicated greater motivation and self-efficacy. Self-efficacy was determined as the individual confidence scores for diet, physical activity, and GWG. Motivation was determined as the individual readiness and importance scores for diet, physical activity, and GWG.

Physical activity and eating behaviours

Physical activity was assessed via the Active Australia Questionnaire (Australian Institute of Health and Welfare, 2003). Participants estimated the frequency and minutes they had spent participating in walking or moderate physical activity in the last week. Fruit and vegetable intake served as a proxy for diet quality (Raynor et al., 2011) and were assessed by asking how many serves of vegetables and/or fruit participants usually eat each day (Hodge, Patterson, Brown, Ireland, & Giles, 2000). As per Australian dietary guidelines, a standard

serve of fruit is 150 g and a standard serve of vegetables is 75 g (National Health and Medical Research Council, 2003).

Demographics

Other relevant demographic variables were collected, including marital status, location of birth, ethnicity, employment status, smoking status, and psychological history.

Statistical analyses

A sample size of 199 would provide adequate power based on a small effect size, alpha of .05, and 80% power to detect a relationship between a predictor and excessive GWG in logistic regression analyses. This sample size also meets the minimum sample of n=200 for structural equation modelling suggested by Kline (2011). Expectation Maximisation dealt with missing data (except when presenting demographic variables). Univariate outliers were replaced with a value one unit higher or lower than the next highest or lowest value, respectively. Variables for the path analysis were assessed for normality and transformed if appropriate. The following variables were transformed (transformation indicated in brackets): T1 dietary and physical activity readiness (reflect square root), T2 depression (square root), and T2 anxiety (logarithm).

Selection of predictor variables for path analysis

Given the large number of potential predictors of GWG proposed by Hill et al. (2013), a series of logistic regressions were conducted to simplify the model to the most salient predictors (criteria stated below) before formally evaluating using path analysis. Each block of predictors identified in the conceptual model was used to predict the dichotomous variable of exceeding/not exceeding GWG recommendations (see Table 1 for conceptual blocks and included predictors). Each regression was conducted as an adjusted model, in which the contribution of a given conceptual block was evaluated at Step 2, after controlling for all remaining predictors at Step 1. This process was repeated for all conceptual blocks, and

ensured that the contribution of potential confounding variables was accounted for in each regression. Variables that predicted excessive GWG at the level $p<.1$ were selected for inclusion in the path model. The eligble predictors are outlined in Table 2.

Table 1. Conceptual blocks and included predictor variables in logistic regressions.

Conceptual block	**Predictor variable**
Maternal psychological factors	Maternal self-esteem
	Antenatal anxiety
	Antenatal depression
	Antenatal stress
	Past psychiatric history
Knowledge of GWG	Knowledge of GWG
Familial/socio-contextual factors	Social support
	Marital/relationship satisfaction/quality
	Education
	Family income
	Parity
	Age
	Pre-pregnancy BMI
Coping skills	General coping – positive reinterpretation and growth
	General coping – seeking instrumental social support
	General coping – active coping
	General coping – seeking emotional social support
	General coping – acceptance
	General coping – planning
	Pregnancy-specific coping – planning and preparation
	Pregnancy-specific coping – avoidance
	Pregnancy-specific coping – spiritual positive
Body image	Body attitudes – attractiveness
	Body attitudes – feeling fat
	Body attitudes – strength and fitness
	Body attitudes – salience of weight and shape
	Pregnancy figure rating – bust
	Pregnancy figure rating – belly
	Pregnancy figure rating – buttocks
Self-efficacy	Dietary self-efficacy
	Physical activity self-efficacy
	GWG self-efficacy
Motivation	Dietary readiness
	Physical activity readiness
	Readiness to gain appropriate GWG
	Dietary importance
	Physical activity importance
	Importance to gain appropriate GWG
Physical activity and eating behaviours	Physical activity frequency
	Physical activity duration
	Diet – usual vegetable intake
	Diet – usual fruit intake

Table 2. T1 and T2 predictors selected for path model.

Conceptual block	Predictors selected for path model	
	Time 1	Time 2
Maternal psychological factors	n/a	Depression
Familial/socio-contextual factors	Family income Age	n/a
Coping skills		Pregnancy-specific coping – planning and preparation
Body image	Buttocks dissatisfaction	
Self-efficacy		Confidence to gain appropriate GWG
Motivation	Readiness to eat a healthy diet Importance of eating a healthy diet	
Physical activity and eating behaviours	Diet – usual vegetable intake	

Path analysis

Mplus version 7.11 (Muthen & Muthen, Los Angeles, California) was used to conduct path analysis to test the ability of the conceptual model to predict the odds of excessive GWG. Model fit was assessed by chi square goodness-of-fit, Comparative Fit Index (CFI; good fit >.95, acceptable fit >.90; Hu & Bentler, 1999), and Root Mean Square Error of Approximation (RMSEA; good fit <.06, acceptable fit <.08; Hu & Bentler, 1999). In the event of poor fit for the model as conceptualised according to Hill et al. (the baseline model), modification indices >10 were reviewed for the addition of theoretically plausible pathways to improve fit (the revised model).

Results

Participants

All 288 participants completed the T1 questionnaire and 277 (96%) completed the T2 questionnaire. Participant characteristics are presented in Table 3. Mean age was 30.9 years (*SD*=4.56). Most participants were married/de facto (97.9%), born in Australia (81.3%), and

exhibited high socioeconomic status (66.4% were university educated and 69.7% had an annual family income over AUD$85,000; the median household income of an Australian couple with dependent children under five years of age was $87,152 in 2011-2012 (Australian Bureau of Statistics, 2013)).

Table 3. Participant Characteristics

Characteristic		*n*	Value
Age, mean (*SD*), y		288	30.92 (4.56)
Weeks gestation at T1, mean (*SD*)		280	16.86 (1.47)
Weeks gestation at T2, mean (*SD*)		270	32.63 (0.87)
Current marital status, *n* (%)		287	
	Married/De Facto		281 (97.9)
	Never Married/Single		6 (2.1)
Location of birth, *n* (%)		288	
	Australia		234 (81.3)
	New Zealand		10 (3.5)
	UK		11 (3.8)
	Europe		7 (2.4)
	North America		6 (2.1)
	Asia		17 (5.9)
	Other		3 (1.0)
Educational attainment, *n* (%)		288	
	Year 12 or lower		30 (10.3)
	Certificate/Diploma		67 (23.3)
	Bachelor or postgraduate degree		191 (66.4)
Currently in paid employment, *n* (%)		288	
	Yes		222 (77.1)
	No		66 (22.9)
Annual family income (AUD), *n* (%)		283	
	Under $45,000		18 (6.3)
	$45,001-$85,000		68 (24.0)
	$85,001-$125,000		89 (31.5)
	Over $125,000		108 (38.2)
Parity, *n* (%)		287	
	0 other children		159 (55.4)
	1 other child		91 (31.7)
	2 other children		26 (9.1)
	3 or more other children		11 (3.8)
Smoking status, *n* (%)		283	
	Yes		3 (1.1)
	No		280 (98.9)
Pre-Pregnancy BMI, mean (*SD*), kg/m^2		279	25.50 (5.87)
Pre-pregnancy BMI category[a], *n* (%)		279	
	Underweight		9 (3.2)
	Normal Weight		157 (56.3)
	Overweight		68 (24.4)
	Obese		45 (16.1)
GWG, mean (*SD*), kg		288	13.32 (5.74)
GWG categories[a], *n* (%)		279	
	Below		62 (22.2)
	Adequate		99 (35.8)
	Exceed		117 (41.9)

[a]based on the IOM (2013) GWG recommendations

Logistic regressions

Descriptive statistics for predictors included in the logistic regressions at T1 and T2 are presented in Table 4, along with Cronbach's alphas for subscales. The findings of the logistic regressions are presented in detail in Appendix 2. At least one predictor from each conceptual block predicted excessive GWG at the $p<.1$ level except GWG knowledge. The predictors in the conceptual blocks (entered in Step 2) explained between 0.1% (T1 GWG knowledge) and 8.5% (T2 maternal psychological factors) of the variance in excessive GWG above the variance explained by the predictors entered in Step 1.

All predictors that met the $p<.1$ cut-off were included in the path model (see Table 2). In summary, the following variables predicted excessive GWG in the logistic regressions: T1 buttocks dissatisfaction and T1 importance of eating a healthy diet (positive association; $p<.05$); T1 family income, T1 readiness to eat a healthy diet and T1 vegetable intake (negative association; $p<.05$); T2 pregnancy-specific coping planning (positive association; $p<.05$); T2 age (positive association; $p<.1$); T2 family income (negative association; $p<.05$); T2 depressive symptoms and T2 confidence to gain a healthy amount of gestational weight (negative association; $p<.1$).

Table 4. Descriptive statistics and Cronbach's alphas for predictors included in the logistic regression at Time 1 and Time 2, including proportion (n(%)) for categorical variables, and mean (*M*), standard deviation (*SD*), and 95% confidence intervals (95% CI) for mean, for continuous variables.

Predictor Variable	**Time 1**					**Time 2**					**Possible Range for Scores**
	***n* (%)**	***M* (*SD*)**	**95% CI for mean**		**Cronbach's alpha**	***n* (%)**	***M* (*SD*)**	**95% CI for mean**		**Cronbach's alpha**	
			Lower	**Upper**				**Lower**	**Upper**		
Anxiety		2.03 (2.5)	1.74	2.31	.74		2.09 (2.4)	1.82	2.37	.78	0 to 21
Stress		4.33 (3.4)	3.93	4.73	.85		4.44 (3.3)	4.05	4.83	.83	0 to 21
Depressive symptoms		5.10 (4.3)	4.61	5.60	.85		5.53 (4.6)	5.00	6.06	.88	0 to 30
Self-esteem		23.16 (4.6)	23.69	22.63	.88		23.54 (4.1)	23.07	24.02	.78	0 to 30
Psychiatric history, *yes*	90 (31.3)				n/a	n/a				n/a	n/a
GWG knowledge, *yes*	198 (68.8)				n/a	206 (71.5)				n/a	n/a
Relationship satisfaction		98.55 (8.9)	97.51	99.57	.79		99.49 (8.8)	98.46	100.51	.82	0 to 151
Social support		6.07 (0.9)	5.96	6.17	.92		6.01 (0.8)	5.92	6.09	.90	12 to 84
COPE -Growth		11.08 (2.5)	10.79	11.37	.81		11.02 (2.2)	10.77	11.27	.77	4 to 16
COPE-Instrument		11.04 (2.6)	10.74	11.33	.80		11.25 (2.4)	10.98	11.52	.81	4 to 16
COPE-Active		10.77 (2.4)	10.49	11.05	.76		10.82 (2.1)	10.58	11.07	.80	4 to 16
COPE-Emotional		11.15 (2.9)	10.83	11.49	.85		11.13 (2.6)	10.83	11.44	.85	4 to 16
COPE-Acceptance		10.41 (2.2)	10.16	10.66	.69		10.12 (2.0)	9.89	10.35	.67	4 to 16
COPE-Planning		11.16 (2.6)	10.86	11.46	.82		11.10 (2.3)	10.83	11.37	.83	4 to 16
PCI-Planning		34.08 (8.9)	33.05	35.11	.87		36.85 (7.7)	35.96	37.73	.87	0 to 60
PCI-Avoidance		11.20 (6.0)	10.51	11.90	.79		12.40 (5.5)	11.76	13.04	.79	0 to 44
PCI-Spiritual		7.35 (4.8)	6.80	7.90	.78		7.21 (4.4)	6.71	7.72	.78	0 to 24

BAQ-attractiveness	16.52 (3.2)	16.14	16.89	.69	16.46 (3.0)	16.12	16.81	.67	5 to 25
BAQ-feeling fat	31.80 (10.5)	30.58	33.02	.92	29.83 (10.0)	28.67	30.98	.93	5 to 25
BAQ-strength	19.98 (4.4)	17.47	18.49	.78	17.81 (3.9)	17.35	18.26	.76	6 to 30
BAQ-salience	11.45 (3.8)	11.01	11.90	.79	11.08 (3.3)	10.69	11.46	.80	5 to 25
Bust dissatisfaction	0.47 (1.3)	0.31	0.62	n/a[a]	0.57 (1.3)	0.41	0.72	n/a[a]	-10 to 10
Belly dissatisfaction	1.12 (1.7)	0.92	1.31	n/a[a]	1.43 (2.09)	1.19	1.67	n/a[a]	-10 to 10
Buttocks dissatisfaction	1.02 (1.3)	0.87	1.17	n/a[a]	1.11 (1.3)	0.96	1.26	n/a[a]	-10 to 10
Confidence-diet	6.93 (1.8)	6.72	7.14	n/a[b]	6.84 (1.95)	6.62	7.07	n/a[b]	0 to 30
Confidence-PA	6.32 (2.0)	6.09	6.55	n/a[b]	6.05 (2.18)	5.80	6.30	n/a[b]	0 to 30
Confidence-GWG	4.01 (0.8)	3.92	4.10	n/a[b]	3.64 (1.1)	3.52	3.76	n/a[b]	3 to 15
Readiness-diet	7.37 (1.8)	7.16	7.57	n/a[b]	7.21 (1.8)	7.01	7.42	n/a[b]	0 to 30
Readiness-PA	6.70 (1.9)	6.48	6.93	n/a[b]	6.37 (2.1)	6.12	6.62	n/a[b]	0 to 30
Readiness-GWG	3.98 (1.0)	3.87	4.09	n/a[b]	3.87 (1.1)	3.75	3.99	n/a[b]	3 to 15
Importance-diet	7.63 (1.7)	7.43	7.82	n/a[b]	7.16 (1.9)	6.94	7.39	n/a[b]	0 to 30
Importance-PA	7.08 (2.0)	6.85	7.32	n/a[b]	6.40 (2.3)	6.14	6.66	n/a[b]	0 to 30
Importance-GWG	4.24 (0.8)	4.15	4.33	n/a[b]	3.98 (1.0)	3.87	4.10	n/a[b]	3 to 15
PA frequency	5.34 (3.8)	4.90	5.78	n/a	5.37 (4.0)	4.90	5.84	n/a	n/a
PA duration	133.86 (123.3)	119.56	148.16	n/a	153.80 (132.1)	138.48	169.12	n/a	n/a
Vegetable intake	2.67 (1.0)	2.54	2.79	n/a	2.72 (1.0)	2.61	2.83	n/a	n/a
Fruit intake	2.31 (0.9)	2.20	2.42	n/a	2.38 (0.9)	2.27	2.49	n/a	n/a

Note: Demographic variables are not included as they are presented in Table 3 (Participant Characteristics). Past psychiatric history is only included at T1 as this variable was not measured at T2. n/a = not applicable.

[a]Cronbach's alphas are not applicable for the PFRS as each item represents a difference score.

[b]Cronbach's alphas are not applicable for single items.

Path analysis

Baseline model

The baseline model is illustrated in Figure 2. The baseline model was designed to match Hill et al.'s (2013) model as conceptualised, however for practical reasons, it differed in the following ways: (1) 'knowledge of GWG' is absent since it did not meet model selection criteria, and (2) some paths are absent where T2 variables were required to lead to T1 variables (Hill et al.'s model did not account for prospective associations). The baseline model demonstrated poor fit (χ^2 = 115.51(30), p<.05; RMSEA = .10; CFI = .51).

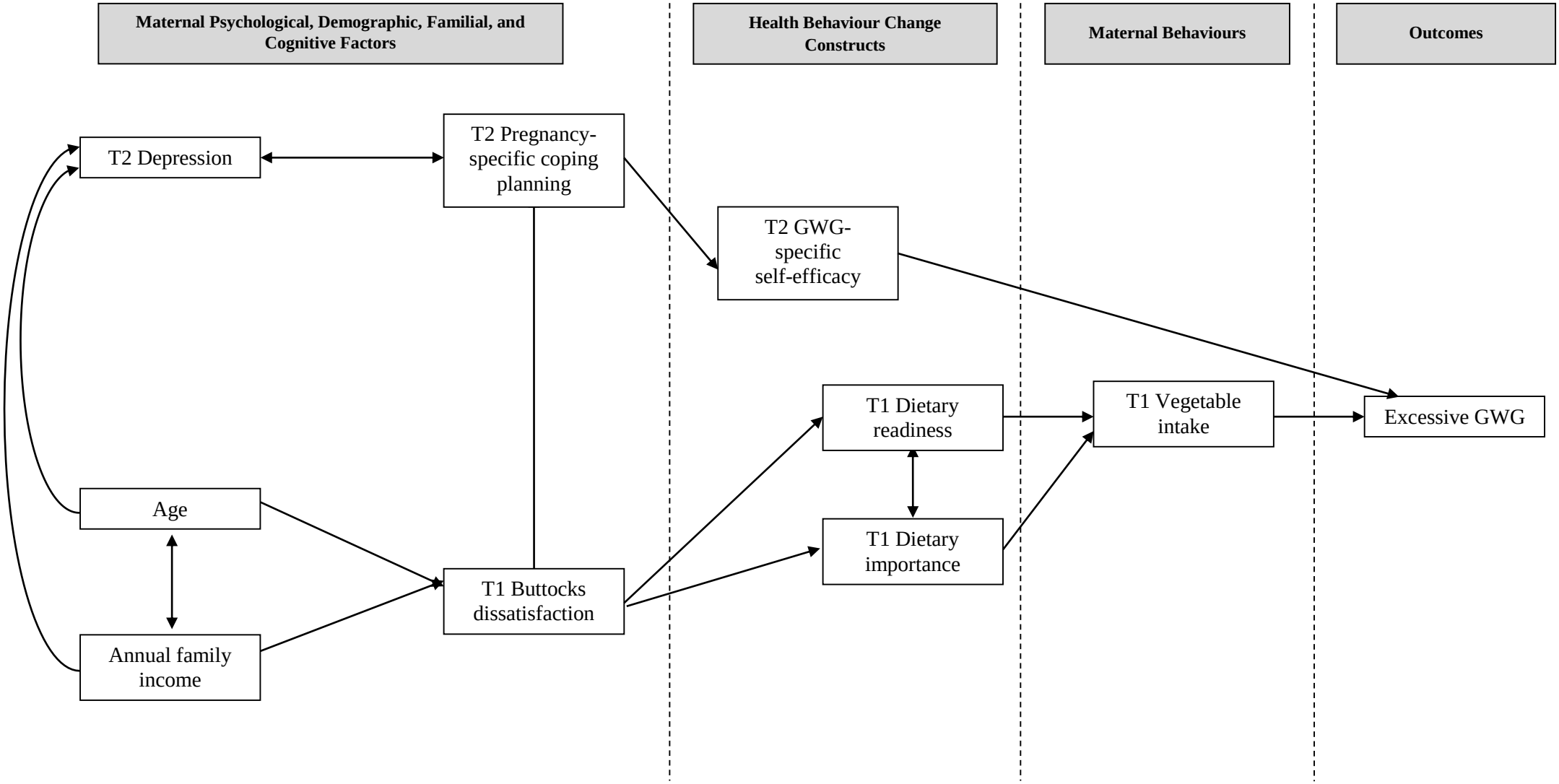

Figure 2. Baseline model

Revised model

Analysis of possible reasons for poor fit in the baseline model (based on modification indices and theoretically plausible paths) identified more complex interactions among variables and a direct effect between depression and self-efficacy as demonstrated in Figure 3. Specifically, in the revised model, direct paths from predictors to GWG were included; paths from T1 dietary importance and T1 dietary readiness to T2 GWG-specific self-efficacy were included; and paths from age and annual family income were added to each other predictor to account for any variance explained by these socio-demographic factors. This revised model demonstrated adequate fit (χ^2 = 21.61(9), p<.05; RMSEA = .07; CFI = .93) and explained 19.5% of the variance in exceeding GWG recommendations (R^2 = .195). Standardised coefficients (Beta weights) and significance values for model parameters in the revised model are presented in Appendix 3, and for clarity, select paths are shown in Figure 3.

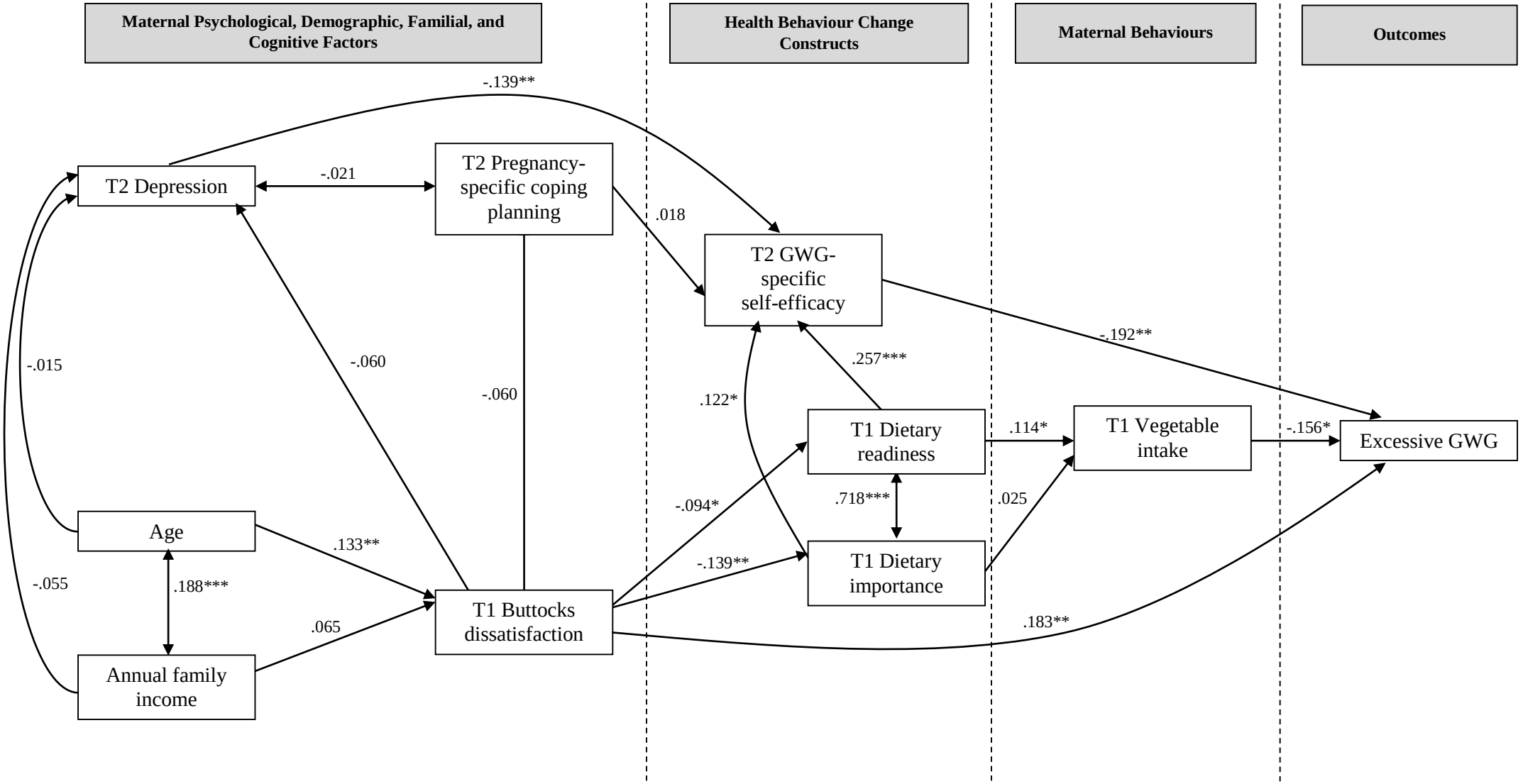

Figure 3. Revised model with standardised Beta weights for regression paths and covariances. To maintain simplicity of the model, the following paths are not shown: paths from all predictors except T1 vegetable intake to Excessive GWG; paths from age and annual family income to all predictors except T1 buttocks dissatisfaction (see Table A3 (Appendix 3) for Beta weights and *p*-values for paths not shown). *p<.05, **p<.01, ***p<.001

Discussion

The aim of this study was to evaluate the suitability of Hill et al.'s (2013) conceptual model for predicting excessive GWG by (1) refining a large list of potential predictor variables using logistic regression, and (2) conducting path analysis to test model fit. This was the first study to empirically test a model that incorporated psychosocial factors, motivation, and self-efficacy as behaviour change predictors of excessive GWG. It is also the first study to use path analysis to explore the interactions and mechanisms by which these modifiable factors, along with depression and body image, may lead to excessive GWG. Ultimately, the revised model demonstrated adequate fit and explained 19.5% of the variance in excessive GWG. This is in accordance with psychosocial and behaviour change models of weight loss in non-pregnant women, which typically account for 10 to 30% of the variance in weight change (Palmeira et al., 2010; Silva et al., 2011; Teixeira et al., 2010).

The revised model demonstrates that excessive GWG is predicted by a range of psychological, demographic, motivational, and behavioural variables in a complex fashion. A key pathway identified in the model was that, in late pregnancy, women with higher depressive symptoms were more likely to report lower self-efficacy for healthy GWG and then more likely to gain excessively, bypassing pregnancy-specific coping planning. In contrast, previous research has suggested that coping is a moderator of the effect of stressors on health in pregnancy, albeit we did not test this association (Guardino & Dunkel Schetter, 2014). Instead, our finding suggests that self-efficacy plays a mediating role between depression and GWG. Whilst the causal relationship between depression and obesity in pregnancy has not yet been determined (Milgrom, Skouteris, Worotniuk, Henwood, & Bruce, 2012), the Theory of Planned Behaviour suggests that emotions and mood are background factors that have an indirect effect on perceived behavioural control (Fishbein & Ajzen, 2010). In late-pregnancy, depression may lead to the formation of negative beliefs about the

personal and environmental factors which facilitate or impede healthy weight gain. In turn, these beliefs may lead to low self-efficacy to gain a healthy amount of gestational weight, which may result in excessive GWG.

A second pathway of interest is that in early-mid pregnancy, women with high dissatisfaction with buttocks size were more likely to exhibit low levels of readiness to consume a healthy diet. Women with low dietary readiness were more likely to have a lower vegetable intake, which in turn predicted excessive GWG. This finding aligns with recent reviews of interventions designed to limit GWG, which identified dietary interventions as more beneficial than other types of interventions (Hill, Skouteris, & Fuller-Tyszkiewicz, 2013; Thangaratinam et al., 2012). Helping women improve body image may hence be an effective strategy to improve dietary outcomes during pregnancy (through increasing motivation). Furthermore, addressing these issues early in pregnancy may help prevent the problems becoming established.

In addition, our path model shows that body image not only directly impacts on GWG, but this relationship is mediated by motivation (at least for buttocks dissatisfaction). Previous research has demonstrated that body image is an important mediator of successful weight change in behaviour change interventions for obese (non-pregnant) women (Annesi, Unruh, Marti, Gorjala, & Tennant, 2011; Palmeira et al., 2010; Teixeira et al., 2010), and is indeed an important determinant of GWG (Hill, Skouteris, McCabe, & Fuller-Tyszkiewicz, 2013; Mehta, Siega-Riz, & Herring, 2010; Sui, Turnbull, & Dodd, 2013), it is crucial that further research begins to examine the relationship between other specific aspects of body image and behaviour change predictors to help promote healthy GWG.

Of note, T1 dietary importance was highly significantly associated with readiness (Figure 3). This aligns with Mason and Butler's (2010) readiness/importance/confidence interpretation of motivation, where individuals will not be ready to make behaviour changes

unless they feel they are important *and* have confidence that they can achieve this change. The association between T1 self-efficacy and readiness/importance was not assessed in this path model because T1 self-efficacy did not meet inclusion criteria. However, T1 readiness and importance for diet were both significantly and positively related to T2 self-efficacy for healthy GWG, providing secondary support for this theory and highlighting the need to increase women's level of motivation and self-efficacy to help achieve healthy GWG.

Limitations and strengths

Firstly, for many of the participants, measurement of GWG and height were limited to self-reported measures. However, objectively and subjectively obtained measurements were not significantly different in this sample. Furthermore, excluding women without objective weight data did not alter the findings and hence all women were retained to preserve sample size.[1] An additional methodological limitation was that the GWG knowledge was tested based on knowledge of the recommended range of GWG for normal weight women (i.e., what would be "normal" for most women). Given that 40% of the sample were overweight or obese pre-pregnancy, it is difficult to ascertain whether most women perceive themselves to be "normal" or accurately perceive their weight status. Explorations of pregnant women's body weight perceptions indicates that there is a proportion of women who do not accurately assess their pre-pregnancy body weight status (Herring et al., 2008).

Secondly, our sample consisted of predominately Australian women of high socio-economic status, limiting the generalisation of our findings to other populations. Research suggests that high and low income women exhibit different risk factors for excessive GWG (Paul, Graham, & Olson, 2013), and thus Hill et al.'s (2013) conceptual model should also be

[1] Path analysis was conducted comparing a baseline model where the two groups (passport vs. no passport) were allowed to be estimated freely and a subsequent model in which the parameters were constrained to be equal across groups (to see whether the model was different across groups). The difference in model fit was non-significant, chi square(df=15) = 18.083, p = .258, which suggests that the groups did not reliably differ in the way the model fits the data.

tested in a low income/low education sample and in women from diverse ethnic backgrounds. Moreover, whilst Hill et al.'s model is comprehensive, it does not include all possible influences on GWG. Factors such as pregnancy physical symptoms may indirectly influence GWG through diet and physical activity levels (Skouteris, 2011).

The strengths of the current study include the broad range of predictor variables, balanced proportions of primiparous and multiparous women, and the longitudinal design. Furthermore, exploring each predictor both in early-mid and late pregnancy allowed us to evaluate Trimester-specific associations with GWG. However, it is important to note that whilst the study was prospective in design, the path analyses do not infer causality.

In addition, there are several limitations to the model as tested that could be addressed in future research. Firstly, the model was limited in the number of predictors that could be included in attempt to preserve power. Retention of predictors in the final model was determined by significance of the path from the predictor to the outcome. As such, variables that may have indirect effects on the outcome via these significant predictors, or other variables that would be significant when considered individually, but whose explanatory worth overlapped heavily with other modelled variables, may have been omitted from the final model. Although we used a relaxed alpha criterion ($p < .1$) for inclusion into the model, the possibility that other important predictors were missed due to sampling fluctuations, random noise, or obfuscation due to overlap with other modelled variables may be overcome by replication of the present models (Kline, 2011). Similarly, there are possible interactions between variables (e.g., self-efficacy may moderate the motivation-behaviour relationship) that were not included in Hill et al.'s (2013) conceptual model and hence were not tested for in the current analyses. Future research should consider the influence of interactions on the aetiology of GWG. It is also imperative to note that this model aims to predict a behavioural outcome, not behaviour in itself and only one behavioural predictor was eligible for inclusion

in the tested model. It is likely that other behavioural factors (not just vegetable intake) also play a role in the development of excessive GWG.

Thirdly, the hypothesised model conceptualised the paths from motivation to GWG to be mediated only by behaviours. Health behaviour change theories suggest that this pathway could be conceptualised differently. The model also does not consider the constructs of behavioural intention, behavioural skills, and habit, factors that may moderate the association between motivation and behaviour (Fishbein & Ajzen, 2010; Fisher & Fisher, 2003).

Conclusion

The findings of this study show that the development of excessive GWG is multifactorial and depends on complex pathways from psychological and demographic identifiers through to health behaviours. The revised model adequately explains the aetiology of excessive GWG from a psychosocial and health behaviour change perspective, however, the model has some limitations that must be addressed in future research. The conceptual model was based on empirical research and identified depression, body image, self-efficacy, and motivation as important modifiable determinants of excessive GWG. The tested model presented here supports these findings and highlights that addressing one or more of these factors in clinical practice could potentially improve GWG-specific self-efficacy and dietary motivation, leading to reduced risk of excessive GWG. Future behavioural GWG trials should consider incorporating psychosocial education and behaviour change strategies into their interventions so that combinations of approaches can be evaluated.

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Appendix 1

Table A1. Conceptual blocks, measurement tools, reliability, and predictor variables included in logistic regressions.

Conceptual block	Measurement tool	Reliable in pregnant sample	Predictor variable
Maternal psychological factors	RSE	Yes[1,2]	Maternal self-esteem
	DASS-21	Yes[3,4]	Antenatal anxiety Antenatal stress
	EPDS	Yes[5,6]	Antenatal depression
	Single item	n/a	Past psychiatric history
Knowledge of GWG	Single item	n/a	Knowledge of GWG
Familial/socio-contextual factors	MSPSS	Yes[7,8]	Social support
	DAS	Yes[9]	Marital/relationship satisfaction/quality
	Single items	n/a	Education Family income Parity Age
	Computed from measures	n/a	Pre-pregnancy BMI
Coping skills	COPE	In non-pregnant sample[10]	General coping – positive reinterpretation and growth General coping – seeking instrumental social support General coping – active coping General coping – seeking emotional social support General coping – acceptance General coping – planning
	PCI	Yes[11]	Pregnancy-specific coping – planning and preparation Pregnancy-specific coping – avoidance Pregnancy-specific coping – spiritual positive
Body image	BAQ	Yes[12]	Body attitudes – attractiveness Body attitudes – feeling fat Body attitudes – strength and fitness Body attitudes – salience of weight and shape
	PFRS	Yes[13]	Pregnancy figure rating – bust Pregnancy figure rating – belly

Conceptual block	Measurement tool	Reliable in pregnant sample	Predictor variable
			Pregnancy figure rating – buttocks
Self-efficacy	Single items	In non-pregnant sample[14]	Dietary self-efficacy Physical activity self-efficacy GWG self-efficacy
Motivation	Single items	In non-pregnant[14] and postpartum samples[15]	Dietary readiness Physical activity readiness Readiness to gain appropriate GWG Dietary importance Physical activity importance Importance to gain appropriate GWG
Physical activity and eating behaviours	Active Australia Survey	In non-pregnant sample[16]	Physical activity frequency Physical activity duration
	FFQ	In non-pregnant sample[17]	Diet – usual vegetable intake Diet – usual fruit intake

Note: BAQ = Body Attitudes Questionnaire; COPE = Coping measure not specific to pregnancy; DAS = Dyadic Adjustment Scale; DASS-21 = Short form Depression, Anxiety, and Stress Scale; EPDS = Edinburgh Postnatal Depression Scale; FFQ = Food Frequency Questionnaire; MSPSS = Multidimensional Scale of Perceived Social Support; PCI = Prenatal Coping Inventory; PFRS = Pregnancy Figure Rating Scale; RSE = Roseburg Self-esteem Scale. n/a = not applicable

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Appendix 2

Table A2-1. Explained variance (R^2), odds ratios (OR) and 95% Confidence Intervals (95% CI) for the unadjusted and adjusted logistic regressions for Time 1 predictors of excessive gestational weight gain.

		Unadjusted model				**Adjusted model**				
				95% CI				**95% CI**		
IV Block	**IV**	**R^2**	**OR**	**Lower**	**Upper**	**R^2 change**	**OR**	**Lower**	**Upper**	***p*-value**
T1 Maternal Psychological Factors	Anxiety	.003	1.050	.922	1.196	.009	.968	.822	1.141	.701
	Stress		.995	.894	1.107		.951	.832	1.086	.456
	Depression		1.008	.9221	1.103		1.009	.895	1.137	.885
	Self-esteem		1.001	.941	1.064		1.051	.962	1.148	.268
	Psychiatric History		.951	.565	1.600		.808	.418	1.560	.525
T1 Knowledge	GWG Knowledge	.004	.727	.440	1.203	.001	1.187	.641	2.195	.586
T1 Familial/socio-contextual Factors	Age	.030	1.013	.955	1.075	.039	1.034	.961	1.113	.374
	Pre-pregnancy BMI		1.020	.971	1.072		1.004	.941	1.071	1.004
	Family Income		.892	.772	1.030		.842	.708	1.001	**.051**
	Education		.928	.797	1.080		.908	.751	1.096	.314
	Parity		1.112	.820	1.501		1.331	.910	1.947	.140
	Relationship satisfaction		.979	.950	1.009		.973	.939	1.009	.143

	Social Support		1.050	.769	1.433		1.154	.783	1.700	.470
T1 Coping Skills	COPE -Growth	.018	1.001	.881	1.138	.015	.980	.843	1.142	.800
	COPE-Instrument		.897	.780	1.031		.922	.773	1.098	.362
	COPE-Active		1.009	.857	1.188		.984	.812	1.192	.871
	COPE-Emotional		1.049	.927	1.186		1.006	.861	1.176	.937
	COPE-Acceptance		1.019	.892	1.165		1.054	.895	1.241	.530
	COPE-Planning		.985	.842	1.152		1.106	.911	1.342	.308
	PCI-Planning		1.011	.982	1.042		1.019	.982	1.057	.323
	PCI-Avoidance		1.038	.995	1.082		1.041	.971	1.117	.258
	PCI-Spiritual		1.009	.957	1.064		.995	.931	1.062	.874
T1 Body Image	BAQ-attractiveness	.031	.942	.871	1.034	.025	.976	.865	1.103	.700
	BAQ-feeling fat		.980	.944	1.0197		.979	.933	1.026	.376
	BAQ-strength		1.001	.944	1.060		1.011	.937	1.090	.787
	BAQ-salience		1.001	.982	1.194		1.074	.953	1.211	.243
	Bust dissatisfaction		.868	.714	1.054		.835	.650	1.073	.158
	Belly dissatisfaction		.971	.825	1.149		.928	.757	1.136	.469
	Buttocks dissatisfaction		1.270	1.038	1.552		1.401	1.088	1.803	**.009**
T1 Self-efficacy	Confidence-diet	.039	.840	.685	1.031	.008	.916	.663	1.267	.598
	Confidence-PA		1.149	.953	1.386		1.107	.808	1.517	.526
	Confidence-GWG		.604	.423	.861		.654	.386	1.112	.117

T1 Motivation	Readiness-diet	.038	.632	.474	.849	.026	.611	.423	.883	**.009**
	Readiness-PA		1.224	.951	1.575		1.165	.833	1.613	.372
	Readiness-GWG		.841	.618	1.146		.846	.575	1.247	.399
	Importance-diet		1.155	.890	1.499		1.421	1.026	1.970	**.035**
	Importance-PA		1.047	.842	1.302		.994	.764	1.294	.964
	Importance-GWG		1.047	.700	1.565		1.176	.713	1.938	.526
T1 PA and Diet	PA frequency	.017	.985	.915	1.060	.011	.998	.910	1.095	.996
	PA duration		1.000	.997	1.002		1.000	.997	1.003	.947
	Vegetable intake		.746	.581	.958		.740	.549	.998	**.049**
	Fruit intake		.957	.741	1.236		1.101	.810	1.499	.539

Bold values indicate $p<.1$ for adjusted model

Abbreviations – IV: independent variable; GWG: gestational weight gain; BMI: body mass index; COPE-growth: general coping – positive reinterpretation and growth; COPE-instrument: general coping – instrumental social support; COPE-active: general coping – active coping; COPE-emotional: general coping – emotional social support; COPE-acceptance: general coping – acceptance; COPE-planning: general coping – planning; PCI-planning: pregnancy-specific coping – planning; PCI-avoidance: pregnancy-specific coping –avoidance; PCI-spiritual: pregnancy-specific coping – spiritual; BAQ: Body Attitudes Questionnaire; PA: physical activity

Table A2-2. Explained variance (R^2), odds ratios (OR) and 95% Confidence Intervals (95% CI) for the unadjusted and adjusted logistic regressions for Time 2 predictors of excessive gestational weight gain.

		Unadjusted model				**Adjusted model**				
				95% CI				**95% CI**		
IV Block	**IV**	**R^2**	**OR**	**Lower**	**Upper**	**R^2 change**	**OR**	**Lower**	**Upper**	***p*-value**
T2 Maternal Psychological Factors	Anxiety	.017	1.109	.981	1.253	.085	1.091	.928	1.282	.294
	Stress		1.059	.955	1.175		1.037	.912	1.178	.580
	Depression		.924	.851	1.004		.910	.824	1.004	**.060**
	Self-esteem		.969	.903	1.039		1.015	.918	1.123	.770
	Psychiatric History		1.022	..605	1.725		.871	.469	1.620	.663
T2 Knowledge	GWG Knowledge	.002	1.243	.742	2.085	.001	1.238	.638	2.406	.528
T2 Familial/socio-contextual Factors	Age	.030	1.017	.959	1.079	.044	1.069	.995	1.148	**.069**
	Pre-pregnancy BMI		1.018	.969	1.069		1.009	.948	1.073	.784
	Family Income		.855	.766	1.024		.794	.660	.955	**.014**
	Education		.928	.805	1.087		.901	.755	1.076	.250
	Parity		1.104	.820	1.487		1.214	.845	1.742	.294
	Relationship satisfaction		.989	.960	1.019		.975	.938	1.013	.195
	Social Support		1.012	.708	1.448		1.068	.606	1.714	.784
T2 Coping	COPE -Growth	.022	1.048	.906	1.211	.026	1.058	.885	1.265	.536

	COPE-Instrument		.968	.816	1.148		.923	.756	1.126	.428
	COPE-Active		1.053	.876	1.265		1.062	.851	1.324	.595
	COPE-Emotional		1.021	.882	1.182		1.108	.923	1.330	.272
	COPE-Acceptance		.933	.806	1.081		.915	.768	1.091	.323
	COPE-Planning		.892	.757	1.051		.914	.751	1.111	.366
	PCI-Planning		1.023	.988	1.059		1.048	1.003	1.096	**.038**
	PCI-Avoidance		1.021	.974	1.069		1.026	.957	1.100	.471
	PCI-Spiritual		1.024	.966	1.085		.998	.925	1.076	.954
T2 Body Image	BAQ-attractiveness	.023	.999	.902	1.106	.019	.940	.822	1.075	.368
	BAQ-feeling fat		1.040	.996	1.087		1.014	.961	1.069	.614
	BAQ-strength		1.040	.971	1.114		1.075	.979	1.180	.128
	BAQ-salience		.942	.840	1.057		.956	.832	1.098	.527
	Bust dissatisfaction		.937	.772	1.136		.893	.708	1.127	.342
	Belly dissatisfaction		1.054	.931	1.193		1.055	.908	1.225	.485
	Buttocks dissatisfaction		1.144	.929	1.409		1.203	.944	1.532	.135
T2 Self-efficacy	Confidence-diet	.027	.831	.684	1.009	.010	.953	.688	1.321	.773
	Confidence-PA		1.151	.960	1.379		1.087	.791	1.494	.606
	Confidence-GWG		.748	.567	.987		.652	.426	.999	**.050**
T2 Motivation	Readiness-diet	.029	.798	.629	1.012	.014	.774	.557	1.076	.128
	Readiness-PA		1.111	.889	1.389		1.126	.836	1.528	.447

	Readiness-GWG		.715	.481	1.064		.760	.457	1.266	.292
	Importance-diet		.913	.730	1.141		.898	.674	1.196	.462
	Importance-PA		1.078	.869	1.337		1.104	.827	1.474	.503
	Importance-GWG		1.318	.861	2.017		1.311	.896	2.547	.121
T2 PA and Diet	PA frequency	.002	1.005	.935	1.081	.009	1.040	.947	1.141	.414
	PA duration		.999	.997	1.002		.999	.996	1.002	.332
	Vegetable intake		.929	.716	1.206		.926	.671	1.278	.640
	Fruit intake		1.044	.804	1.355		1.282	.923	1.780	.138

Bold values indicate $p<.1$ for adjusted model

Abbreviations – IV: independent variable; GWG: gestational weight gain; BMI: body mass index; COPE-growth: general coping – positive reinterpretation and growth; COPE-instrument: general coping – instrumental social support; COPE-active: general coping – active coping; COPE-emotional: general coping – emotional social support; COPE-acceptance: general coping – acceptance; COPE-planning: general coping – planning; PCI-planning: pregnancy-specific coping – planning; PCI-avoidance: pregnancy-specific coping –avoidance; PCI-spiritual: pregnancy-specific coping – spiritual; BAQ: Body Attitudes Questionnaire; PA: physical activity

Appendix 3

Table A3. Standardised Beta weights for regression paths and covariances in the revised model with one-tailed *p*-values.

Path	Beta (β) weight	*p*-value
Regression Paths		
To Excessive GWG		
T1 Vegetable intake	-.156	.021*
T1 Dietary readiness	-.268	.009**
T1 Dietary importance	.193	.051
T2 GWG-specific self-efficacy	-.171	.021*
T2 Pregnancy-specific coping planning	.142	.024*
T1 Buttocks dissatisfaction	.183	.005**
T2 Depression	-.008	.457
Age	.113	.062
Annual family income	-.236	.001**
To T1 vegetable intake		
T1 Dietary readiness	.114	.040*
T1 Dietary importance	.025	.372
T1 Buttocks dissatisfaction	-.014	.407
Age	.045	.217
Annual family income	.035	.282
To T1 Dietary Readiness		
T1 Buttocks dissatisfaction	-.094	.040*
Age	.139	.012*
Annual family income	.066	.122
To T1 Dietary importance		
T1 Buttocks dissatisfaction	-.139	.009**
Age	.038	.260
Annual family income	.047	.208
To T2 GWG-specific self-efficacy		
T1 Pregnancy-specific coping planning	.018	.359
T1 Dietary readiness	.257	.000***
T1 Dietary importance	.122	.032*
T2 Depression	-.139	.005**
Age	-.036	.272
Annual family income	-.129	.006**
To T2 Pregnancy-specific coping planning		
Age	-.187	.001**
Annual family income	.159	.001**
To Buttocks dissatisfaction		
Age	.133	.008**
Annual family income	.065	.141
To T2 Depression		
Age	-.015	.404
Annual family income	-.055	.157
Covariances		

With T1 Dietary readiness		
T1 Dietary importance	.718	.000***
With T2 Pregnancy-specific coping planning		
T1 Buttocks dissatisfaction	-.060	.187
T2 Depression	-.021	.335
With Age		
Annual family income	.188	.000***

*p<.05; **p<.01; ***p<.001