Preventive Medicine Reports 35 (2023) 102328

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Intention to adopt a healthy diet among women with and without a history of gestational diabetes: Constructs and beliefs from the theory of planned behavior

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ARTICLE INFO

Keywords:
Theory of planned behavior
Beliefs
Diet
Postpartum lifestyle
Diabetes
Gestational

ABSTRACT

Women with a history of gestational diabetes (GDM) have difficulty maintaining a healthy diet after delivery. The theory of planned behavior (TPB) is effective in identifying the determinants of adopting a healthy diet. The objectives were to identify the determinants of the intention to adopt a healthy diet among the TPB constructs in women with (GDM+) and without (GDM−) a history of GDM, and to identify the beliefs associated with these constructs. The study was conducted in Québec (Canada) between 2009 and 2017. Data from 213 GDM+ and 91 GDM− women were analyzed. Women completed a questionnaire on the determinants of intention to adopt a healthy diet, defined as adherence to 2007 Canada's Food Guide. The subjective norm and perceived behavioral control (PBC) constructs were associated with the intention to adopt a healthy diet among GDM+ women ($\beta = 2.21$ and $\beta = 4.37$, respectively, $p < 0.0001$), whereas among GDM− women, PBC was the only construct associated with intention ($\beta = 0.78$; $p < 0.0001$). More specifically among GDM+ women, the disapproval of a family member other than the partner ($\beta = 1.49$; $p = 0.0005$), not feeling capable of adopting a healthy diet with access to food treats ($\beta = 1.58$; $p < 0.0001$), lack of free time ($\beta = 1.31$; $p = 0.002$), lack of information about healthy eating ($\beta = 1.02$; $p = 0.015$) or lack of easy recipes to prepare ($\beta = 0.84$; $p = 0.042$) was associated with a lower intention to adopt a healthy diet. Overall, among GDM+ women, different beliefs related to the subjective norm and PBC could be targeted to improve the eating habits of this specific population.

1. Introduction

Gestational diabetes mellitus (GDM), defined as hyperglycemia with onset or first recognition during pregnancy (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018), is one of the most common pregnancy complications (McIntyre et al., 2019). GDM prevalence has increased rapidly during recent decades in many countries, resulting in an "emerging worldwide epidemic" (Zhu and Zhang, 2016). In Canada, the prevalence of GDM has increased by more than 30% in less than one decade (PHA, 2014). GDM has short- and long-term health implications for both the children exposed *in utero* and the mother (Metzger, 2007). Women with a history of GDM (GDM+) are at increased risk to develop chronic diseases during the years following delivery, such as type 2 diabetes (T2D) (seven-fold risk) and cardiovascular diseases (CVD) (two-fold risk), compared to women without this history (GDM−) (Xu et al., 2014; Bellamy et al., 2009; Kramer et al., 2019).

In order to prevent or delay the progression of GDM to chronic diseases among these women, the adoption of a healthy diet during the

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https://doi.org/10.1016/j.pmedr.2023.102328
Received 12 January 2023; Received in revised form 26 June 2023; Accepted 12 July 2023
Available online 16 July 2023

postpartum period is important (Diabetes Canada Clinical Practice Guidelines Expert Committee, 2018; McIntyre et al., 2019). However, GDM+ women have difficulty maintaining a healthy diet after delivery (Stage et al., 2004; Fehler et al., 2007; Evans et al., 2010; Hoedjes et al., 2012). Although suboptimal eating habits have been demonstrated in many previous studies (Jones et al., 2009; Aluş Tokat et al., 2016; Persson et al., 2015; Koning et al., 2016; Ferranti et al., 2014; Gingras et al., 2012), little is known about what might influence the adoption of a healthy diet among GDM+ women (Ferranti et al., 2014). GDM+ women represent a unique population at risk for chronic diseases due to their age and family context; they may face barriers to adopt healthy eating habits related to lack of time, tiredness, and childcare demands, among others (Nicklas et al., 2011; Lie et al., 2013; Ørtenblad et al., 2021). To our knowledge, no prior studies have examined determinants of the adoption of a healthy diet among GDM+ women in Canada. Moreover, the absence of a theoretical framework represents a methodological issue among previous qualitative studies (Lie et al., 2013; Ørtenblad et al., 2021; Zulfiqar et al., 2017; Sundarapperuma et al., 2018; Svensson et al., 2018; Zehle et al., 2008; Dennison et al., 2022).

It is recognized that the development of an effective intervention requires an understanding of the determinants of the given behavior (Michie et al., 2008). Indeed, using theories to identify these determinants can increase the potential effectiveness of an intervention (Michie et al., 2008). Ajzen's Theory of Planned Behavior (TPB) is one of the most widely used health behavior models (Ajzen, 1991; Godin and Kok, 1996; McDermott et al., 2015). The TPB is a reliable predictor of a variety of health behaviors, but it is particularly effective at predicting dietary behaviors (Godin and Kok, 1996; McDermott et al., 2015; McEachan et al., 2011). Moreover, Ajzen's theory is suitable for interventions targeting individuals with a high risk of T2D (Blue, 2007; Akbar et al., 2015), such as GDM+ women. According to this theory, the intention to adopt a behavior is explained by three constructs: attitude, subjective norm, and perceived behavioral control (PBC) (Ajzen, 1991). This theory states that the stronger the intention, the more likely individuals are to perform the given behavior (Ajzen, 1991). The TPB also postulates that the intention to adopt a behavior is a function of three kinds of salient beliefs that are specific to the population and the studied behavior: behavioral beliefs (related to attitude), normative beliefs (related to the subjective norm), and control beliefs (related to PBC) (Ajzen, 1991).

The objectives of this study were: 1) to identify the determinants of the intention to adopt a healthy diet among the three constructs of the TPB in GDM+ and GDM− women, and 2) to identify the salient beliefs associated with these constructs.

2. Methods

2.1. Study population

The recruitment of this cohort was performed between 2009 and 2017 at a research center, the Institute of Nutrition and Functional Foods (INAF) in Quebec City, Canada. The first phase, between 2009 and 2012, aimed to evaluate the impact of GDM on the mother's health. The second phase, between 2012 and 2017, aimed to evaluate the impact of GDM on mothers and offspring health. Details on the study design have been previously described (Gingras et al., 2012; Dugas et al., 2018). Briefly, GDM+ and GDM− women were recruited through data from the provincial health plan registry (*Régie de l'assurance maladie du Québec*), medical records of the two major hospitals with a neonatal care unit in Quebec City (*Hôpital Saint-François d'Assise* and *Centre Hospitalier de l'Université Laval*), emails sent to Laval University community, and posts on healthcare websites and social networks. Women from the Quebec City metropolitan area aged ≥18 years who had a pregnancy between 2003 and 2013 were invited to participate. Data was collected at the time of recruitment, between 2009 and 2017. Exclusion criteria included pregnancy at the time of the study or pre-existing diabetes (type 1 or type 2). Women were invited to INAF for a single visit. A total of 287 GDM+ women and 120 GDM− women have been taking part in this study. Women with missing TPB data were excluded from analyses (n = 74 GDM+ and n = 29 GDM−). Therefore, 213 GDM+ women and 91 GDM− women were included in the present study. The analyses presented in this manuscript were performed using cross-sectional data of mothers only. Written consents were obtained from all participants and ethical approval was obtained from the *Université Laval* Ethics Committee (2011-196-A-4 R-3) and the *Centre Hospitalier Universitaire de Québec* Ethics Committee (2015–2031, B14-07-2031-21). This cohort study was registered in the Clinical Trials.gov registry (NCT01340924).

2.2. Exposure

GDM was diagnosed between 24 and 28 weeks of gestation according to the 2008 Diabetes Canada criteria using the two-step approach, which consists of a 50 g glucose challenge test followed by a 75 g oral glucose tolerance test (Canadian Diabetes Association Clinical Practice Guidelines Expert Committee, 2008). Diabetes Canada's criteria for the diagnosis of GDM remained the same between 2003 and 2013 (Canadian Diabetes Association Clinical Practice Guidelines Expert Committee, 2003). Among a subsample of our cohort, the diagnosis of GDM was confirmed by medical records for most women (97%) and self-reported for the remaining 3%. On average, women were recruited 4.7 ± 2.7 years following their last pregnancy complicated by GDM.

2.3. Outcomes

2.3.1. Theory of planned behavior

To elicit salient beliefs, a pilot questionnaire was administered to a subgroup of 15 women representative of our research population. A registered dietitian met these women one by one and collected behavioral, normative, and control beliefs with an open-ended questionnaire. Salient beliefs were identified for each construct after content analysis by two investigators and the most frequent items were used in the final TPB questionnaire. A total of four behavioral, three normative, and four control beliefs were assessed.

The construction of the final TPB questionnaire was based on the methods suggested by Godin (Godin and Kok, 1996; Godin and Gagné, 1999). The questionnaire was written in French, the native language of the majority of participants. The studied behavior was clearly defined: "to adopt a healthy diet as recommended by 2007 Canada's Food Guide (CFG) (Health Canada, 2007) during the next month". To assess the major variables of the TPB, three questions for each construct (attitude, subjective norm, and PBC) and intention were formulated. A Likert-type scale was used, except for attitude (semantic differential scale). All scales ranged from 1 to 5 points and had a positive pole, a negative pole, and a neutral position. Women completed the final TPB questionnaire during their visit to the research center, along with an original version of the 2007 CFG used as a tool to well understand the behavior "healthy diet" (McDermott et al., 2015).

The internal consistency of the constructs was measured using the Cronbach alpha coefficient and the temporal stability using the intra-class correlation coefficient (Ajzen, 2006). A subsample of 75 women was recruited from a group session on the management of GDM during their pregnancy to complete a 2-week reliability test–retest. Women were asked to complete the questionnaire at 4 weeks postpartum (test) and 6 weeks postpartum (retest). A total of 37 women completed the test questionnaire and 32 women completed the retest questionnaire. Valid data were available for 31 women (test and retest data). Cronbach alpha values ranged between 0.75 and 0.95. More specifically, the internal consistency was considered high for subjective norm (test: $\alpha = 0.93$; retest: $\alpha = 0.95$) and PBC (test: $\alpha = 0.86$; retest: $\alpha = 0.88$), and substantial for attitude (test: $\alpha = 0.75$; retest: $\alpha = 0.90$). The Intra-Class coefficients varied between 0.41 and 0.79, indicating that items were moderately stable over time.

2.3.2. Past behavior

To assess past behavior, dietary intakes over the last month were obtained using a food frequency questionnaire (FFQ) administered by a registered dietitian (Goulet et al., 2004). This FFQ included 91 items from typical foods eaten in the province of Quebec, Canada, has been validated in a sample of this population, and is reproducible (Goulet et al., 2004). Nutrient analyses were performed using the Nutrition Data System for Research (NDS-R) (Nutrition Coordinating Center, 2000; Schakel, 2001). Data collected with the FFQ allowed the calculation of a diet quality score derived from the Alternate Healthy Eating Index (A-HEI) (McCullough et al., 2002), which included 7 components adapted from the 2007 CFG (Gingras et al., 2012; Health Canada, 2007). This score, along with two other preventive practices, has previously been associated with a better anthropometric and metabolic profile among GDM+ women in our cohort study (Gingras et al., 2012).

2.3.3. Covariates

Sociodemographic characteristics were obtained from self-administered questionnaires. Women were asked about their age, ethnicity, household annual income, highest education level, and occupation. Characteristics specific to their family context were also obtained: age of their youngest child, classified as preschool (0–5 years) or school-age (6–12 years), and number of children.

2.4. Statistical analyses

Participants' characteristics according to history of GDM were compared using Chi-square tests (or Fisher exact tests) for categorical variables and ANOVA (adjusted for age, age of the youngest children, number of children, household annual income, highest maternal level of education) for past behavior. Multiple linear regression models were computed among all women to investigate the association between the three constructs and the intention to adopt a healthy diet. Interaction with history of GDM was tested in these models to verify whether determinants of intention to adopt a healthy diet vary according to history of GDM. Then, multiple linear regression models were computed among the two groups separately (GDM+ and GDM− women). Postulates of multiple linear regressions were verified, including the absence of collinearity between the constructs. Three models were performed: model 1 with no adjustment, model 2 with adjustment for past behavior, and model 3 with adjustment for past behavior and other potential covariates (age, age of the youngest child, number of children, household annual income, highest maternal level of education). These covariates were selected based on their influence on mothers' dietary habits according to the current literature (Moura and Aschemann-Witzel, 2020; Bassett-Gunter et al., 2013; Blake et al., 2011; Fernandez et al., 2019; McLeod et al., 2011; Reczek et al., 2014; Berge et al., 2011; Haakstad et al., 2019). Constructs that were significant predictors of intention were selected for further analyses (subjective norm and PBC for GDM+ women, PBC for GDM− women). Multiple linear regression models were computed between all beliefs entered simultaneously in the model and the intention to adopt a healthy diet (normative and control beliefs for GDM+ women, control beliefs for GDM− women). Variables non-normally distributed were transformed according to the Box-Cox procedure when needed. The statistical software SAS OnDemand for Academics was used for analyses. Results of the present study were not pre-registered and are considered exploratory.

3. Results

A total of 304 women (213 GDM+ and 91 GDM−) were included. Characteristics of women excluded from this study (n = 103) due to missing TPB data did not differ compared with those of women included (data not shown). Participants' characteristics according to history of GDM are presented in Table 1. Characteristics were not different between GDM+ and GDM− women. Most women were between 30 and 39

Table 1
Women's characteristics according to history of gestational diabetes, Québec (Canada), 2009–2017.

	All women (n = 304)	GDM+(n = 213)	GDM− (n = 91)	*p*
Age (years)				
20–29	19 (6.3)	9 (4.2)	10 (11.0)	0.056
30–39	200 (65.8)	140 (65.7)	60 (65.9)	
≥40	85 (28.0)	64 (30.1)	21 (23.1)	
Ethnicity				
Caucasian	192 (95.5)	132 (94.3)	60 (98.4)	1.000
African and Afro-American	2 (1.0)	2 (1.4)	0 (0.0)	
Native Americans	2 (1.0)	2 (1.4)	0 (0.0)	
Asians	1 (0.5)	1 (0.7)	0 (0.0)	
Hispanics	4 (2.0)	3 (2.1)	1 (1.6)	
Age of the youngest child				
Preschool (0–5 years)	241 (79.3)	173 (81.2)	68 (74.7)	0.201
School-age (6–12 years)	63 (20.7)	40 (18.8)	23 (25.3)	
Number of children				
1 child	56 (18.4)	39 (18.3)	17 (18.7)	0.957
2 children	169 (55.6)	120 (56.3)	49 (53.9)	
3 children	58 (19.1)	39 (18.3)	19 (20.9)	
4 children or more	21 (6.9)	15 (7.0)	6 (6.6)	
Household annual income ($CAN/year)				
0–39,999	40 (14.7)	28 (14.8)	12 (14.3)	0.402
40,000–79,999	90 (33.0)	65 (34.4)	25 (29.8)	
80,000–99,999	58 (21.3)	43 (22.8)	15 (17.9)	
≥100,000	85 (31.1)	53 (28.0)	32 (38.1)	
Highest maternal level of education				
High school of less	51 (17.4)	40 (19.2)	11 (12.8)	0.119
CEGEP[a]	82 (27.9)	62 (29.8)	20 (23.3)	
University	161 (54.8)	106 (51.0)	55 (64.0)	
Occupation				
Full-time occupation	218 (73.4)	157 (75.9)	61 (67.8)	0.409
Part-time occupation	41 (13.8)	24 (11.6)	17 (18.9)	
Stay-at-home parent	24 (8.1)	17 (8.2)	7 (7.8)	
No job	2 (0.7)	1 (0.5)	1 (1.1)	
Other (seasonal work or self-employed)	12 (4.0)	8 (3.9)	4 (4.4)	
Past behavior[b]				
Modified A-HEI score (/70 points)	51.7 ± 8.6	50.9 ± 8.6	53.5 ± 8.3	0.027*

Results are expressed as mean ± SD or n (%).
GDM+: women with a history of gestational diabetes; GDM−: women with no history of gestational diabetes.
[a]In the Quebec education system, CEGEP refers to "Collège d'enseignement général et professionnel" and includes preuniversity programs and technical programs.
[b]Past behavior refers to dietary intakes over the last month, assessed with a food frequency questionnaire and calculated with a modified Alternate Healthy Eating Index.
*ANOVA adjusted for age, age of the youngest children, number of children, household annual income and highest maternal level of education.

years old, were Caucasian, had at least one child aged 5 years or less (preschool child), had two children, had a household annual income of $80,000 or more, held a university degree, and had a full-time occupation. Intention to adopt a healthy diet among GDM+ and GDM− women was 3.7 ± 0.8 and 3.6 ± 0.9 on a scale of 5 points, respectively (p = 0.429; data not shown). The mean of each TPB construct was also similar between GDM+ and GDM− women: 3.9 ± 0.8 vs. 4.0 ± 0.9 for attitude (p = 0.231), 3.9 ± 0.8 vs. 3.9 ± 0.7 for subjective norm (p = 0.694), and 3.8 ± 0.7 vs. 3.8 ± 0.8 for PBC (p = 0.938), respectively (data not shown).

The association between each construct and the intention to adopt a healthy diet is presented separately among GDM+ and GDM− women, given that the association between the construct of subjective norm and the intention to adopt a healthy diet was different according to history of GDM (p for interaction = 0.027; data not shown). In Table 2, associations between each construct and the intention to adopt a healthy diet among GDM+ women are presented. The three constructs explained 55% of the variance in intention to adopt a healthy diet (model 1). After adjustment for past behavior (model 2) and other covariates (model 3), the attitude was no longer a significant predictor of intention to adopt a healthy diet, leaving subjective norm and PBC as main predictors (β = 2.21; p < 0.0001 and β = 4.367; p < 0.0001, respectively). Further analyses on normative and control beliefs are presented in Table 3. Among normative beliefs, only the disapproval of a family member other than the partner (β = 1.49; p = 0.0005) was associated with a lower intention to adopt a healthy diet. Moreover, all control beliefs were associated with the intention to adopt a healthy diet. Thus, not feeling capable of adopting a healthy diet with access to food treats (β = 1.58; p < 0.0001), lack of free time, (β = 1.31; p = 0.002), lack of information about healthy eating (β = 1.02; p = 0.015) or lack of easy recipes to prepare (β = 0.84; p = 0.042) was associated with a lower intention to adopt a healthy diet.

In Table 4, associations between each construct and intention to adopt a healthy diet among GDM− women are presented. The three constructs explained 66% of the variance in intention to adopt a healthy diet (model 1). Further adjustment for past behavior (model 2) and other covariates (model 3) did not bring significant changes to the model. PBC was the main predictor of intention to adopt a healthy diet (β = 0.78; p < 0.0001). The highest maternal level of education was also a predictor of intention to adopt a healthy diet (β = 0.224; p = 0.006). Further analyses on control beliefs are presented in Table 5. Not feeling capable of adopting a healthy diet with a lack of free time (β = 2.73; p < 0.0001) or access to food treats (β = 1.37; p = 0.012) was associated with a lower intention to adopt a healthy diet.

Table 2
Associations between constructs and intention to adopt a healthy diet among women with a history of gestational diabetes, Québec (Canada), 2009–2017.

	Model 1		Model 2		Model 3	
	β	*p*	β	*p*	β	*p*
Attitude	0.72	0.044	0.65	0.070	0.53	0.164
Subjective norm	2.02	<0.0001	2.05	<0.0001	2.21	<0.0001
Perceived behavioral control	4.42	<0.0001	4.18	<0.0001	4.37	<0.0001
Past behavior [a]			0.07	0.017	0.05	0.112
Covariates:						
Age					−0.26	0.640
Age of the youngest child					−0.18	0.814
Number of children					0.16	0.644
Highest maternal level of education					−0.21	0.596
Household annual income					0.04	0.881
Adjusted R^2	0.55		0.56		0.58	

Model 1: no adjustment; Model 2: with adjustment for past behavior; Model 3: with adjustment for past behavior and other covariates (age, age of the youngest children, number of children, household annual income and highest maternal level of education).
[a]Past behavior refers to dietary intakes over the last month, assessed with a food frequency questionnaire and calculated with a modified Alternate Healthy Eating Index.

Table 3
Associations between beliefs and intention to adopt a healthy diet among women with a history of gestational diabetes, Québec (Canada), 2009–2017.

		β	*p*
Normative beliefs	**Intention to adopt a healthy diet with support of:**		
	Partner	0.21	0.608
	Family member (other than the partner)	1.49	0.0005
	Health professional	0.21	0.634
Control beliefs	**Intention to adopt a healthy diet despite:**		
	Access to food treats	1.58	<0.0001
	Lack of information on healthy eating	1.02	0.015
	Any easy recipes to prepare	0.84	0.042
	Lack of free time	1.31	0.002

Table 4
Associations between constructs and intention to adopt a healthy diet among women with no history of gestational diabetes, Québec (Canada), 2009–2017.

	Model 1		Model 2		Model 3	
	β	*p*	β	*p*	β	*p*
Attitude	0.09	0.196	0.09	0.160	0.13	0.106
Subjective norm	0.15	0.065	0.14	0.086	0.05	0.572
Perceived behavioral control	0.76	<0.0001	0.75	<0.0001	0.78	<0.0001
Past behavior[a]			0.01	0.155	0.01	0.244
Covariates:						
Age					−0.01	0.921
Age of the youngest child					0.04	0.772
Number of children					0.01	0.946
Highest maternal level of education					0.24	0.006
Household annual income					−0.04	0.523
Adjusted R^2	0.66		0.66		0.69	

Model 1: no adjustment; Model 2: with adjustment for past behavior; Model 3: with adjustment for past behavior and other covariates (age, age of the youngest children, number of children, household annual income and highest maternal level of education).
[a]Past behavior refers to dietary intakes over the last month, assessed with a food frequency questionnaire and calculated with a modified Alternate Healthy Eating Index.

Table 5
Associations between beliefs and intention to adopt a healthy diet among women with no history of gestational diabetes, Québec (Canada), 2009–2017.

		β	***p***
Control beliefs	**Intention to adopt a healthy diet despite:**		
	Access to food treats	1.37	0.012
	Lack of information on healthy eating	−0.19	0.716
	Any easy recipes to prepare	1.07	0.097
	Lack of free time	2.73	<0.0001

4. Discussion

Results of this study showed that subjective norm and PBC were the main predictors of intention to adopt a healthy diet among GDM+ women, whereas among GDM− women, PBC was the only main construct associated with intention. More specifically among GDM+ women, the disapproval of a family member other than the partner was a normative belief associated with a lower intention to adopt a healthy diet. Moreover, not feeling capable of adopting a healthy diet with access to food treats, lack of free time, lack of information about healthy eating and lack of easy recipes to prepare were control beliefs associated with a lower intention to adopt a healthy diet among these women.

4.1. Constructs

We showed that PBC and the subjective norm were the main predictors of intention to adopt a healthy diet among GDM+ women. To our knowledge, this is the first quantitative study assessing the association between the TPB constructs and the intention to adopt a healthy diet among GDM+ women, which limits comparisons with the current literature. However, this is consistent with findings from other similar populations, such as postpartum mothers and adults at risk of chronic diseases (Blue, 2007; Bassett-Gunter et al., 2013; Lakerveld et al., 2011). In a previous study, the subjective norm was a predictor of intentions to eat healthy among mothers, who might be more affected by the perceived beliefs of their relatives, which is well documented for other health behaviors like breastfeeding (Bassett-Gunter et al., 2013). Moreover, among adults at high risk of T2D or CVD, PBC and subjective norm were significant predictors of the intention to eat healthier (Blue, 2007; Lakerveld et al., 2011). Specifically, social influence seems to be an important determinant in diet among individuals at risk for diabetes (Blue, 2007). As proposed by Ajzen, people's beliefs about a behavior and the relative importance given to each construct can greatly differ across specific populations (Ajzen, 1991). Indeed, among the general population, the subjective norm was often demonstrated as the weakest predictor of intention related to eating behaviors among the three main constructs (McEachan et al., 2011; Conner et al., 2002; Blanchard et al., 2009). According to previous meta-analyses, the attitude was the strongest predictor of adults' dietary intentions, followed by PBC and subjective norm (McDermott et al., 2015; McEachan et al., 2011). Generally, the approval or disapproval of important others does not predict intentions to eat healthy among adults (Bassett-Gunter et al., 2013). Of note, the subjective norm was not a predictor of intention to adopt a healthy diet among GDM− women, which suggested that this construct is specific to GDM+ women and might require further investigation.

4.2. Beliefs

4.2.1. Normative beliefs

We further found that among GDM+ women, the disapproval of a family member other than the partner was associated with a lower intention to adopt a healthy diet. Since most women in our cohort study lived with their partner and children, we can assume that "a family member other than the partner" refers indirectly to children. Thus, the degree of children's approval of adopting a healthy diet seems to have an impact on the intention to adopt a healthy diet among GDM+ women. These results are consistent with the current literature. In an Australian study investigating psychosocial factors related to diet among GDM+ women, more than one-third stated that "dislike of healthy foods by others in the household" was a barrier to healthy eating (Zehle et al., 2008). Similarly, results from qualitative studies showed that food preferences of family members including children were an important barrier to adopting a healthy diet among GDM+ women (Evans et al., 2010; Jones et al., 2009; Nicklas et al., 2011). Furthermore, in a study conducted among GDM+ women, only those who lived with children were less likely to meet fruit and vegetable intake recommendations than GDM− women (Kieffer et al., 2006). Thus, GDM+ women are influenced by the disapproval of their important ones regarding the adoption of a healthy diet and may face additional barriers when it comes to planning and preparing meals that appeal to all family members.

4.2.2. Control beliefs

We also found that intention to adopt a healthy diet was negatively affected in GDM+ women with a reduced perceived control in adopting a healthy diet, when they have access to food treats in their environment. Similarly, in a study of GDM+ Danish women, most of them identified the difficulty to continue their healthy diet during the postpartum period, talking about cravings and having the will to resist food treats like sweets and chocolate among other barriers (Svensson et al., 2018). Lack of time is also a major barrier to healthy eating frequently mentioned by GDM+ women, often related to competing work and family demands including childcare (Evans et al., 2010; Hoedjes et al., 2012; Jones et al., 2009; Nicklas et al., 2011; Ørtenblad et al., 2021; Zulfiqar et al., 2017; Sundarapperuma et al., 2018). In our cohort study, more than 75% of GDM+ women had a full-time occupation and more than 80% of them had two children or more, possibly reducing available time to plan and prepare healthy meals and to "worry" about their eating habits (Bassett-Gunter et al., 2013). Similarly, lack of time for meal preparation has been previously reported by GDM+ women (Evans et al., 2010), hence the importance to have easy and healthy recipes to prepare to facilitate the adoption of a healthy diet. Lack of information about healthy eating represents another important barrier to adopt a healthy diet during the postpartum period for GDM+ women (Evans et al., 2010; Aluş Tokat et al., 2016; Zulfiqar et al., 2017; Sundarapperuma et al., 2018; Dennison et al., 2022). In absence of specific long-term nutritional guidelines, some women might continue their GDM diet in an attempt to eat healthy (Dennison et al., 2022). Other women might remain confused about what constitutes a "normal" healthy diet without specific restrictions related to glycemic control (Dennison et al., 2022). According to the current literature, GDM+ women would appreciate a postnatal diet follow-up to know how to adopt a healthy diet supported with concrete advice, like how to balance a healthy diet with family context and how to plan and prepare healthy food recipes (Zulfiqar et al., 2017; Dennison et al., 2022).

4.3. Study limitations and strengths

The present study has some limitations. As mentioned above, the annual family income and the maternal education level were relatively high, despite efforts have been made to recruit in a less advantaged area of the city, which may limit the generalizability of the results. In addition, the limited number of subjects could lead to low statistical power and increase the risk for false negative results, particularly among GDM− women. Therefore, these findings should be interpreted with caution and confirmed in further larger studies. Moreover, in our study, it was not possible to examine the relationship between the intention and the adoption of the behavior, which was "to adopt a healthy diet during the next month", given the transversal study design. Although the intention to adopt a dietary behavior is usually a key predictor of the given behavior, as demonstrated in many previous reports (McDermott et al., 2015; Akbar et al., 2015), some studies have put forward an intention-behavior gap among health behaviors (Bassett-Gunter et al., 2013; Rhodes and Dickau, 2012; Sheeran, 2002). Finally, the modified A-HEI score used to assess past behavior has not been validated in a subsample of our study population (Gingras et al., 2012) although this score reflected the 2007 CFG guidelines.

Strengths of this study include the investigation of GDM only, excluding other types of diabetes or pregnancy complications associated with various outcomes for mothers. The presence of a control group also allowed for comparing TPB constructs and beliefs between GDM+ and

GDM− women. Dietary intakes that were obtained using an objective and valid measure (FFQ) administered by a registered dietitian to assess past behavior represent another strength of this study (McDermott et al., 2015). Finally, the consistency and the reproducibility of our construct items in the TPB questionnaire were verified.

5. Conclusion

Overall, among GDM+ women, different beliefs related to the subjective norm and PBC could be targeted to improve the eating habits of this specific population. Results of the current study highlight the relevance for GDM+ women of implementing a systematic postnatal follow-up provided by a multidisciplinary team including a registered dietician. Within this follow-up, it would be pertinent to help GDM+ women increase their ability to overcome identified barriers limiting their intention to adopt a healthy diet. Since more than 40% of GDM+ women had an intention to adopt a healthy diet during the next month below 4 on the 5-point scale, our results indicate a clear opportunity for improvement (Bassett-Gunter et al., 2015).

CRediT authorship contribution statement

Mélissa Bélanger: Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **Camille Dugas:** Investigation, Writing – review & editing. **Julie Perron:** Investigation, Writing – review & editing. **Annie St-Yves:** Investigation, Writing – review & editing. **Maryka Rancourt-Bouchard:** Writing – review & editing. **S. John Weisnagel:** Conceptualization, Methodology, Writing – review & editing. **Julie Robitaille:** Conceptualization, Methodology, Supervision, Writing – review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgments

Mélissa Bélanger received a scholarship from the Canadian Institutes of Health Research and the *Fonds de recherche du Québec – Santé*. Camille Dugas received a scholarship from the *Fonds de recherche du Québec – Santé*. Julie Robitaille is Chair of Nutrition at Université Laval, which is supported by private endowments from Pfizer, *La Banque Royale du Canada*, and Provigo-Loblaws. The authors would like to sincerely thank Pierre Gagnon, statistician (Centre NUTRISS, INAF, Laval University), for his help with statistical analyses, and all women who participated in the study for their devoted time.

Funding

This work was supported by the Canadian Institutes of Health Research [OOP-98026, 2009-2010], *Fonds de recherche du Québec – Santé* [2009-2012], Diabetes Canada [OG-3-14-4543-JR, 2014-2017] and the Danone Institute of Canada [2012-2014]. The funders had no role in the design of the study; collection, analysis, and interpretation of data; the writing of the manuscript, or the decision to submit the manuscript for publication.

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