



Assessment of maternal knowledge of infant movement and nutrition guidelines in Canada: The PREVENT survey study (Physical activity, Rest, Exercise and nutrition Values for Education of New moms with Type 2 diabetes/gestational diabetes)

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ABSTRACT

Infants born to mothers with type 2 diabetes (T2D) and gestational diabetes (GDM) are at an increased risk of being overweight/obese. Modifiable lifestyle factors play a role in prevention of overweight and obesity. In 2017, the Canadian 24 h Movement Guidelines for the Early Years (CMG) were released. Alongside physical activity recommendations, sweetened beverage consumption (SBC) recommendations were also released by the American Academy of Pediatrics in 2017. The objective of this study was to determine the knowledge pregnant women with T2D and GDM have on the CMG and SBC recommendations, and to determine what factors affect this. A survey with questions regarding demographics, socioeconomic variables and the CMG and SBC recommendations was administered to pregnant women at Diabetes in Pregnancy clinics in Calgary, Alberta from July 2019 to January 2020. Surveys were analyzed utilizing the non-parametric Kruskal-Wallis Rank-Sum test, chi-square test and linear regression. A total of 79 respondents with T2D and GDM were collected. Respondents had the highest knowledge of SBC recommendations and the lowest knowledge of CMG recommendations. A bachelor's or higher degree was associated with significantly higher knowledge scores than a high-school education or less. In conclusion, pregnant women with T2D and GDM in this study had overall poor knowledge of the CMG and SBC recommendations, with less knowledge regarding the CMG. Level of education was found to be associated with knowledge regarding these recommendations. Future programs to improve education around infant and toddler physical activity and SBC recommendations may be beneficial for this patient population.

1. Introduction

The prevalence of paediatric obesity has been significantly rising globally (Shentow-Bewsh and Zuberi, 2018; Spinelli et al., 2021; Pujalte et al., 2017). In 2016, an estimated 124 million children and adolescents aged 5–19 years were affected by obesity and 213 million were affected by overweight (Spinelli et al., 2021). In parallel with the rise of

paediatric obesity, type 2 diabetes (T2D) is being increasingly diagnosed in children and youth (McPhee et al., 2020; Valaiyapathi et al., 2020). Infants born to mothers with gestational diabetes (GDM) and T2D are at an increased risk of being overweight or obese and developing prediabetes and/or T2D later in life (Perng et al., 2019; Berry et al., 2016; Halipchuk et al., 2018). In a survey-based analysis of >14,000 US youth in the Growing Up Today Study, maternal GDM correlated with 40%

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higher odds of being overweight during adolescence (Perng et al., 2019). In 461 participants of the Exploring Perinatal Outcomes in Children cohort, GDM exposure correlated with higher BMI, waist circumference, and visceral and subcutaneous tissue in offspring at age 6–13 years (Perng et al., 2019). It is believed that exposure to persistent hyperglycemia in utero causes epigenetic reprogramming in the fetus, which increases the risk for obesity and T2D later in life (Perng et al., 2019; Berry et al., 2016; Halipchuk et al., 2018).

Genetic and environmental risk factors for paediatric obesity are difficult to control, however behavioural factors such as nutrition and physical activity levels are modifiable. Active lifestyles help prevent childhood obesity and the development of T2D (Shentow-Bewsh and Zuberi, 2018; Pujalte et al., 2017; McPhee et al., 2020). In 2017, in response to undesirable trends in childhood physical activity, sedentary behaviour and sleep, the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years): An Integration of Physical Activity, Sedentary Behaviour and Sleep* were released by the Canadian Society for Exercise Physiology. These guidelines were developed with the hope to provide guidance on the quality and quantity of physical activity, sedentary behaviour and sleep needed by young infants and children in a 24 h period to achieve the greatest health benefits (Tremblay et al., 2017). Emerging research shows that the composition of movement behaviours throughout the day, rather than isolated single movement behaviours, is related to indicators of health (Tremblay, 2020).

Alongside physical activity and reduced sedentary behaviour, proper nutrition and a healthy diet are equally as important for preventing childhood obesity and T2D (Shentow-Bewsh and Zuberi, 2018; Pujalte et al., 2017; McPhee et al., 2020; Heyman and Abrams, 2017; Breda et al., 2019). Previously, fruit drinks were recommended as a source of vitamin C, however today it is seen as a drink high in sugar and low in nutrients that can be a contributory factor to children being overweight when consumed in high amounts (Heyman and Abrams, 2017; Breda et al., 2019). The American Academy of Pediatrics (AAP) in 2017 released *Sweetened Beverage Consumption Recommendations* that infants under 1 year of age completely avoid fruit drinks (Heyman and Abrams, 2017). For children 1 to 3 years old, no more than 4 oz/day of 100% fruit juice are recommended, and for children 4 to 6 years of age, no more than 4 to 6 oz/day are recommended. Whole fruit is recommended over 100% fruit juice due to increased nutrient density and fiber content (Heyman and Abrams, 2017). In the most recent edition of Canada's food guide released in January 2019, water is recommended as the beverage of choice for all ages (Healthy Food Choices. Canada's Food Guide, 2019).

The aim of this study is to describe the knowledge of pregnant women with GDM and T2D on the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years)* and on the *AAP Sweetened Beverage Consumption Recommendations*. The secondary aims were to determine the knowledge these women have in the specific domains (move, sleep, sit) of the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years)*, and to determine if there is an association between socioeconomic status and knowledge of the guidelines.

2. Methods

2.1. Study design

This was an observational study that utilized a cross-sectional survey administered to pregnant women at Diabetes in Pregnancy (DIP) clinics throughout Calgary, Alberta, Canada from July 2019 to January 2020.

2.2. Ethical considerations

This study met the University of Calgary's guidelines for protection of human subjects concerning safety and privacy. Ethical approval was obtained from the Conjoint Health Research Ethics Board (CHREB) at the University of Calgary.

2.3. Survey tool and measures

Pregnant women at DIP clinics were asked to complete the paper survey while waiting to see a DIP health care provider at their appointment. The survey (Appendix) collected information on whether they were diagnosed with diabetes prior to pregnancy, the type of diabetes, parity, current gestational age, and socioeconomic variables such as highest level of education achieved, yearly household income, and postal code. 15 questions on the 3 different domains (move, sleep and sit) of the *Canadian 24 h Movement Guidelines for the Early Years* were asked in a multiple choice fashion, to assess their awareness and knowledge of the guidelines. There were also 6 questions assessing knowledge on the *AAP Sweetened Beverage Consumption* recommendations. The AAP recommendations were used as part of the survey since the Canadian Pediatric Society recommends limiting fruit juice intake but does not have direct measurement recommendations (Critch, 2014). Questions contained one correct answer based on the guidelines. A consent form explaining the purpose and aim of the study was attached to the front of the survey. The women provided implied consent by completing and returning the survey. A paper slip at the end of the survey containing links to the *Canadian 24 h Movement Guidelines for the Early Years* and the *AAP Sweetened Beverage Consumption* recommendations was provided to the participants if they wanted to review the information after the survey was completed.

2.4. Statistical analysis

Surveys from respondents with type 1 diabetes (T1D) were excluded from statistical analysis as the focus of this study was on maternal GDM and T2D due to the known risk for future overweight and obesity in their children (Perng et al., 2019; Berry et al., 2016; Halipchuk et al., 2018). Descriptive statistics of patient characteristics are presented as means and standard deviations (SD) for continuous variables, and as counts and proportions for categorical variables. The correct values were summed for each participant to determine a total score on the survey and a score for each category of interest (play, screen time, sit, sleep, nutrition). A higher score indicates the participant had a higher level of knowledge of the recommendations for that category. Due to the nature of the scoring system, the non-parametric Kruskal-Wallis Rank Sum Test was used to indicate if at least one category of interest is different from the others. Data was also divided into age and category subsets and then the chi-square test was used to determine if the response type was independent of the age group (infant, toddler, preschool) they were being asked for recommendations about. Finally, data was analyzed using linear regression of transformed score with a mean of zero and unit variance to analyze the sample based on the deviance from the sample mean. Factors were analyzed in a stepwise fashion using partial F-tests to determine significance.

3. Results

A total of 93 responses were received. Data for incomplete responses and those with T1D in pregnancy were removed, leading to exclusion of 14 participant responses. 79 responses were included in the analysis (Table 1). Majority of the respondents had GDM (n = 68, 86%) and this was their second or greater pregnancy (n = 48, 61%). In addition, 57% of respondents were diagnosed with diabetes <1 month prior to time of survey completion. The respondents who answered "not diabetic" (n = 16) on their survey were classified to be in the GDM category as respondents were likely to be informed of their diagnosis on the date of survey administration, once they saw the diabetes care provider. 67% of respondents had a University education at the bachelor level or higher.

Respondents overall had limited knowledge on the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years)* and the *AAP Sweetened Beverage Consumption* recommendations with a mean score of 50% on the survey, with a SD of 13%. They had the highest knowledge of

Table 1
Demographic summary and distribution of characteristics of survey respondents at Diabetes in Pregnancy Clinics (N = 79) in Calgary, Alberta between July 2019 to January 2020.

Demographic	Subcategory	N	(%)
Pregnancy Order	T2D	11	(14)
	GDM*	68	(86)
	First Pregnancy	31	(39)
	≥1 Previous Pregnancy	48	(61)
Education	Less than high school diploma	3	(4)
	High school diploma	6	(8)
	Apprenticeship or trade school	5	(6)
	Non-university certificate or diploma	12	(15)
	University at bachelor level	37	(47)
Annual Household Income (n = 78, missing = 1)	University above bachelor level	16	(20)
	<\$24,999	11	(14)
	\$25,000 to \$49,999	10	(13)
	\$50,000 to \$99,999	30	(39)
	\$100,000 to \$149,999	15	(19)
Time Since Diabetes Diagnosis* (n = 61, missing = 18)	> \$150,000	12	(15)
	<1 Month	35	(57)
	1–6 Months	12	(20)
	6–12 Months	3	(5)
Gestational Age (Weeks) (n = 78, missing = 1)	>12 Months	11	(18)
	Mean (SD)Median (IQR)	29.128	(9.38)
			(6.82)

*Those respondents who answered “not diabetic” are classified to be in the gestational diabetes diagnosis category (n = 16) as respondents were likely to be diagnosed on the date of survey administration.

nutrition recommendations (mean score = 62%, SD = 30%) from the AAP Sweetened Beverage Consumption recommendations. They had the lowest knowledge of physical activity recommendations (mean score = 36%, SD = 21%) for their children as part of the Canadian 24 h Movement Guidelines for the Early Years (Fig. 1). 56 out of 79 (71%) of respondents believed that the recommended amount of screen time for a toddler < 2 years was higher than the actual recommended amount. In addition, more than half of respondents believed that the recommended amount

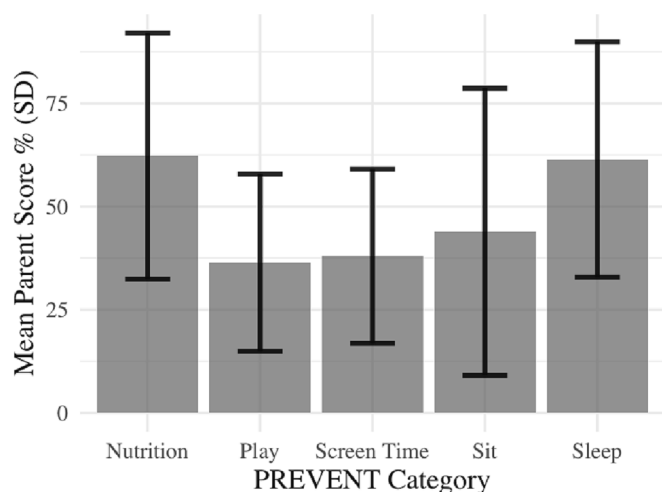


Fig. 1. Mean Score on PREVENT Survey by pregnant women at Diabetes in Pregnancy Clinics in Calgary, Alberta between July 2019 to January 2020. The score that is achieved by the mother is different for at least one PREVENT knowledge category ($\chi^2_{KW} = 59.704, p < 0.001$). Respondents generally had the highest knowledge of nutrition recommendations (mean score = 62%, SD = 30%), and the lowest knowledge of physical activity recommendations (mean = 36%, SD = 21%) for their children.

of physical activity is less than what is actually recommended for toddlers (66%) and infants (52%).

In terms of the respondents’ scores based on age group, they had the highest knowledge of infant recommendations (mean score = 58%, SD = 19%) and the lowest knowledge of preschooler recommendations (mean score = 46%, SD = 18%). However, close to half of respondents (46%) believed that the recommended amount of sleep for an infant was more than the actual recommended amount. In addition, in terms of the AAP Sweetened Beverage Consumption recommendations, 49% of respondents believed that the amount of juice or soda a preschooler could have is more than the recommended amount.

The highest attained education by the mother (high school or less, non-degree post-secondary or bachelor’s degree/higher) significantly explained some variation in the overall scores (p = 0.049) when compared to the sample mean score. There was no significant effect on the final score when considering household income (p = 0.16), pregnancy order (p = 0.86) or diabetes type (p = 0.22). Those with a bachelors or higher degree averaged 0.57 SDs above the mean overall score (95% CI [-0.134, 1.27]), whereas those with a high school or less education averaged 0.38 SDs below the mean (95% CI [-1.02, 0.270]). While all 95% confidence intervals overlap zero, the partial F-test indicates a significant difference between level of education that significantly affects the overall score (Fig. 2).

4. Discussion

This is the first study, to our awareness, that explores the knowledge of pregnant women with GDM and T2D on the Canadian 24 h Movement Guidelines for the Early Years (0–4 years) and the AAP Sweetened Beverage Consumption recommendations. In this study, respondents generally had overall limited knowledge of these guidelines with a mean score of 50% on the survey. However, respondents had the highest level of knowledge that was consistent with the AAP Sweetened Beverage Consumption recommendations, with a mean score of 62%, and the lowest knowledge on the physical activity recommendations from the Canadian 24 h Movement Guidelines for the Early Years (0–4 years), with a mean score of 36%. This suggests there is increased awareness and maternal knowledge about the lack of benefits from juice and soda consumption, however, more education to expectant mothers is needed on physical activity recommendations.

This study also shows that generally respondents have less knowledge of the Canadian 24 h Movement Guidelines for the Early Years (0–4 years) and on the AAP Sweetened Beverage Consumption recommendations for children greater than 1 year-old. Respondents scored higher on survey questions pertaining to infants than on questions pertaining to toddlers and preschoolers. Similarly, in Australia, a qualitative study explored knowledge of physical activity and screen time guidelines for preschoolers in parents and preschool staff and found that they were unfamiliar with national guidelines and the recommendations for these behaviours. (Dwyer et al., 2008) In our study, 61% of participants had already had one or more pregnancies. Therefore, one reason why parental knowledge of recommendations for toddlers and preschoolers may be less than for infants is that there are multiple opportunities for physician-patient interaction and education in the first year of life through well baby visits, compared to when a child passes age 1 year.

Overall, respondents tended to overestimate the recommended amount of screen time infants and toddlers could have, but underestimated the recommended amount of physical activity. Respondents also believed that the amount of sleep an infant needs was higher than the recommended amount. Tremblay et al, in 2017, found that only a total of 12.7% of preschool-aged children met the overall Canadian 24 h Movement Guidelines for the Early Years (0–4 years) and 3.3% met none of the three recommendations for physical activity, screen time and/or sleep (Chaput et al., 2017).

Research has shown that prenatal education may be an effective way to improve parental knowledge. The Grow2Gether study, randomized

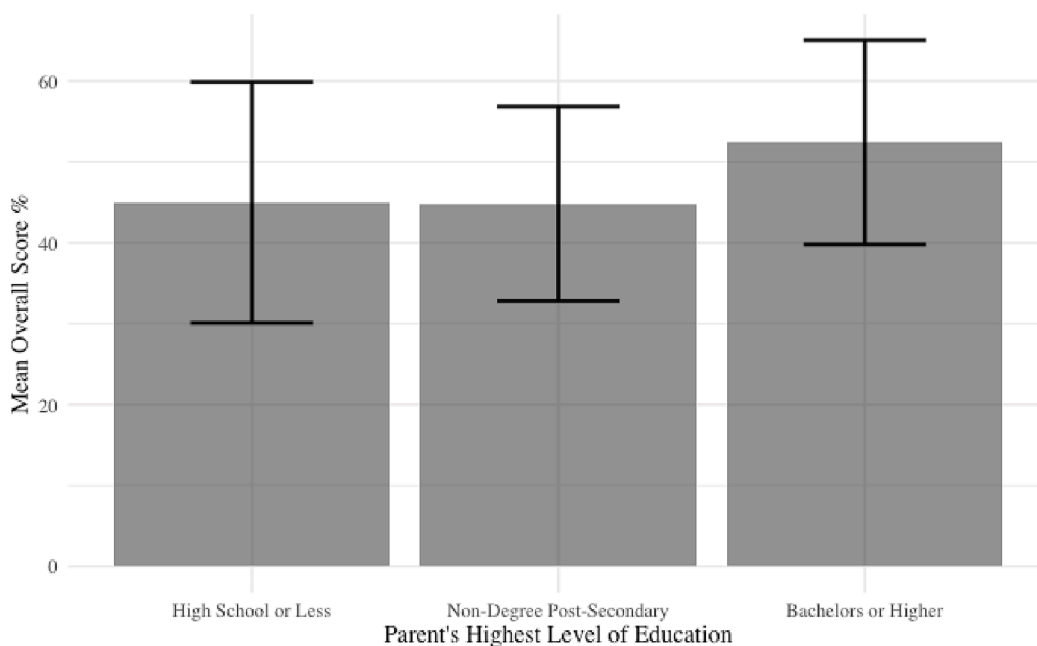


Fig. 2. Mean Score on PREVENT survey by pregnant women at Diabetes in Pregnancy Clinics in Calgary, Alberta between July 2019 to January 2020 based on highest level of education. Those with a bachelor's or higher degree had significantly higher scores than those with a high-school or less education and a non-degree post-secondary education. Those with a bachelors or higher degree averaged 0.566 standard deviations above the mean score (95% CI [-0.134, 1.27]), whereas those with a non-degree post-secondary education averaged 0.0119 standard deviations below the mean (95% CI [-0.812, 0.789]). Those with a high school or less education averaged 0.377 standard deviations below the mean (95% CI [-1.02, 0.270]). While all 95% confidence intervals overlap zero, the partial F-test indicates a significant difference between levels that significantly affect the overall score.

overweight pregnant women to a control group or an intervention group consisting of a private social media group focused on healthy parenting and infant growth (Shentow-Bewsh and Zuberi, 2018). Mothers participated from 2 months before delivery until the infant was 9 months of age. The study found that participants in the intervention group had significant improvement in infant feeding behaviours compared to the control group; and those in the intervention group were significantly less likely to pressure infants to finish food. (Fiks et al., 2017) A 2019 randomized controlled trial explored whether prenatal education of women who were overweight or obese on infant and maternal nutrition would decrease post-natal excessive weight gain (Parat et al., 2019). While they did not find a significant change in post-natal excessive weight gain of infants or the ability to prevent overweight in mothers and children 2 years after delivery; they did find that normalization of maternal BMI was more frequent in the intervention group. Furthermore; at 2 years of age, those children whose mother was in the intervention group were less likely to have a BMI greater than the 97th percentile (Parat et al., 2019). These studies showcase that early intervention and education of high risk mothers may have positive effects on themselves and their children in terms of preventing childhood obesity.

The highest level of attained education by the mother was found to significantly explain some variation in the overall scores. Those with a bachelor's degree or higher education scored higher in terms of mean score than those with a high school or less education. Having a higher level of education may allow for improved understanding and interpretation of guidelines which could lead to increased adherence to recommendations. In a study on the relationship between physical activity levels and maternal education, girls with University educated mothers compared to non-University educated mothers were more likely to participate in vigorous physical activity on the weekend and in moderate-to-vigorous physical activity during the morning commute to school (Sherar et al., 2009).

Our study had several limitations. First, due to the COVID pandemic and transition to virtual appointments, our recruitment ended early and resulted in a smaller sample size. Secondly, the women who choose to complete the survey may be those who had more awareness and knowledge on the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years)* and on the *AAP Sweetened Beverage Consumption* recommendations. In addition, 67% of respondents had a University education at the bachelor level or higher, which could suggest a potentially biased

population. It is possible that this may mean that knowledge in the general population is even lower than noted in our study.

5. Conclusion

We found that pregnant women with GDM or T2D had low knowledge on the *Canadian 24 h Movement Guidelines for the Early Years (0–4 years)* and the *AAP Sweetened Beverage Consumption* recommendations. Knowledge was lower for physical activity versus sugar sweetened beverages recommendations, and for preschoolers versus infants. Higher maternal education level was associated with higher knowledge of these recommendations. Our study shows potential targets for prenatal and postnatal education that are important for all those interacting with parents of young children and pregnant mothers (primary care providers, obstetrical providers, pediatricians, public health, day care) to provide anticipatory guidance on at each health encounter. Future studies should examine long term outcomes in children whose mothers and families receive an intervention to improve knowledge on these behavioural habits, to determine the impact of early educational programs during a child's life.

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Authors contributions

JM, PL, MR, JY, LD, CH, JH, JHo designed the research; JM, JY, LD, JHo collected data; JM, PL, MR, JY, LD, CH, JH, JHo discussed investigation methodology and contributed to result interpretation; MR performed data analysis; JHo supervised the study conduction; JM, JHo wrote the original draft; all authors revised the paper and agreed with the final version of the manuscript.

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.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2023.102268>.

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