

Food Literacy of Young Canadian Adults Living with Type 1 Diabetes

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ABSTRACT

Introduction: Food literacy is defined as an individual's ability to prepare meals that align with dietary guidelines, while having the skills and confidence to do so. People living with type 1 diabetes (PWT1D) are regarded as a high-risk group for developing cardiovascular disease (CVD). Having a greater understanding of how these individuals make their food choices may play a role in improving their health. Young adulthood is an important transition period, during which individuals are becoming independent, including of their dietary choices.

Objective: The first objective is to assess the differences in food literacy scores among young Canadian adults (18-29 years old) living with type 1 diabetes (T1D) and without diabetes (controls). The second objective is to compare the proportion of participants in both groups' with adequate food literacy.

Methods: This cross-sectional study collected responses from June 2018 to January 2020 from young Canadian adults living with and without T1D through an online survey using the software Survey Monkey. The survey included questions on socioeconomic status, basic nutrition knowledge and attitudes, as well as the Short Food Literacy questionnaire. Inclusion criteria to participate in the study was being 18-29 years old, self-reported living with T1D or living without diabetes and living in Canada. Those living without diabetes were the control group. Recruitment was done through social media. Statistical analysis included descriptive data presented as means and standard deviations (SD). The two-sample t-test was used to compare the proportion of participants having adequate food literacy between those living with diabetes and those living without diabetes. Chi square tests were performed to compare the categorical variables between both groups.

Results: There were 236 PWT1D (84.3% female) and 191 controls (78.6% female) who responded to the questionnaire and were included in the analysis. The mean age of PWT1D was 24 ± 3 years with an average duration of living with diabetes being 10.2 ± 7.8 years. The control group was slightly younger (mean age was 22 ± 3 ; $p < 0.001$). Of both groups 11% reported living alone, while majority of controls (47.0%) reported living with their parents compared to PWT1D (29.6%). There was a significant difference ($p < 0.05$) in the proportion of participants reporting adequate food literacy of PWT1D (88.0%; 95% CI, 84.2%-91.7%) vs. Controls (68.0%; 95% CI, 66.1%-71.0%). Majority of PWT1D prepared their own meals (74.5%), while for the controls, a greater proportion of parents were involved (47.6% themselves, 42.9% parents). There were significant differences in food literacy domains (knowledge, skills, confidence and dietary intake) between both groups. A greater proportion of PWT1D reported a high confidence in preparing well balanced and tasty meals compared to the controls (54.5%; 95% CI, 48.0-61.1% vs. 49.2%; 95% CI, 41.9-56.5%) and more participants living with T1D reported being a competent cook compared to the controls (86.4%; 95% CI, 83.0-91.5% vs. 75.9%; 95% CI, 69.9-82.0% $p < 0.05$).

Conclusion: A larger proportion of young Canadian adults living with T1D demonstrated adequate food literacy compared to those living without diabetes. This is concordant with majority of PWT1D who reported preparing meals on their own, who reported a higher confidence in meal preparation and a higher skill level in cooking. Nutritional interventions for individuals living with and without diabetes should encompass a global method in nutrition education, including food literacy and understanding barriers in making healthy dietary choices

and, should not solely focus on the intake of macronutrients. Policy makers and health care professionals will be key players in determining appropriate educational tools to enable individuals. Future studies should investigate the reasons for the difference in the food literacy level between both groups and barriers in making good dietary choices.

RÉSUMÉ

Introduction: La littératie alimentaire est la capacité d'un individu à préparer des repas conformes aux recommandations nutritionnelles, tout en ayant les compétences et la confiance nécessaires pour le faire. Les personnes vivant avec le diabète de type 1 (DT1) sont considérées comme un groupe à risque de développer une maladie cardiovasculaire (MCV). Une meilleure compréhension de la façon dont ces personnes font leurs choix alimentaires peut jouer un rôle dans l'amélioration de leur santé. L'âge adulte est une période de transition importante, au cours de laquelle les individus deviennent indépendants, y compris dans leurs choix alimentaires.

Objectif: Le premier objectif est d'évaluer les différences dans les scores de littératie alimentaire chez les jeunes adultes canadiens (18-29 ans) vivant avec le diabète de type 1 (DT1) et sans diabète (témoins). Le deuxième objectif est de comparer la proportion de participants dans les deux groupes ayant une littératie alimentaire adéquate.

Méthodes: Cette étude transversale a été menée de juin 2018 à janvier 2020 chez des jeunes adultes Canadiens vivant avec ou sans DT1 qui ont répondu à un sondage en ligne utilisant le logiciel Survey Monkey. L'enquête inclut des questions sur le statut socio-économique, les connaissances et attitudes en matière de nutrition, ainsi que le questionnaire *Short Food Literacy*. Les critères d'inclusion pour participer à l'étude étaient d'être âgés de 18 à 29 ans, de vivre avec ou sans le DT1 et de vivre au Canada. Les personnes vivant sans diabète constituaient le groupe témoin. Le recrutement s'est fait via les réseaux sociaux. L'analyse statistique comprenait des données descriptives présentées sous forme de moyennes et d'écart types (SD). Le test t à deux échantillons a été utilisé pour comparer la proportion de participants ayant des connaissances alimentaires adéquates entre les personnes vivant avec le DT1 et celles vivant sans diabète. Des

tests du Chi carré ont été effectués pour comparer les variables catégorielles entre les deux groupes.

Résultats : Il y avait 236 personnes vivant avec le DT1 (84.3 % de femmes) et 191 témoins (78.6 % de femmes) qui ont répondu au questionnaire et ont été inclus dans l'analyse. L'âge moyen des personnes vivant avec le DT1 était de 24 ± 3 ans avec une durée moyenne de vie avec le diabète de 10.2 ± 7.8 ans. Le groupe témoin était plus jeune (l'âge moyen était de 22 ± 3 ; $p < 0.001$). Parmi les deux groupes, 11 % ont déclaré vivre seuls, tandis que la majorité des témoins (47.0 %) ont déclaré vivre avec leurs parents comparativement aux personnes vivant avec le DT1 (29.6 %). Il y avait une différence significative ($p < 0.05$) dans la proportion de participants rapportant une littératie alimentaire adéquate de personnes vivant avec le DT1 (88.0 % ; IC à 95 %, 84.2 % à 91.7 %) par rapport aux témoins (68.0 % ; IC à 95 %, 66.1%-71.0%). La majorité des personnes vivant avec le DT1 préparaient leurs propres repas (74.5 %), tandis que pour les témoins, une plus grande proportion de parents étaient impliqués (47.6 % eux-mêmes, 42.9 % les parents). Il y avait des différences significatives dans les domaines de la littératie alimentaire (connaissances, compétences, confiance et apport alimentaire) entre les deux groupes. Une plus grande proportion de personnes vivant avec le DT1 a une confiance élevée dans la préparation de repas équilibrés et savoureux par rapport aux témoins (54.5 %; IC à 95 %, 48.0-61.1 % contre 49.2 %; IC à 95 %, 41.9 à 56.5 %) et plus de participants vivant avec le DT1 ont déclaré être un cuisinier compétent par rapport aux témoins (86.4 % ; IC à 95 %, 83.0 à 91.5 % contre 75.9 %; IC à 95 %, 69.9 à 82.0 % $p < 0.05$).

Conclusion: Une plus grande proportion de jeunes adultes Canadiens vivant avec le DT1 ont démontré une littératie alimentaire adéquate par rapport à ceux vivant sans diabète. Ceci est

concordant puisque la majorité des personnes vivant avec le DT1 qui ont déclaré préparer leurs repas eux-mêmes, ont déclaré une plus grande confiance dans la préparation des repas et un niveau de compétence plus élevé en cuisine. Ainsi, les interventions nutritionnelles pour les personnes vivant avec et sans diabète devraient englober une méthode globale d'éducation nutritionnelle, y compris la littératie alimentaire et la compréhension des obstacles à des choix alimentaires sains et, ne devraient pas se concentrer uniquement sur l'apport de macronutriments. Les décideurs et les professionnels de la santé seront des acteurs clés dans la détermination des outils éducatifs appropriés pour permettre aux individus. Les études futures devraient examiner les raisons de la différence de niveau de littératie alimentaire entre les deux groupes et les obstacles à faire de bons choix alimentaires.

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CONTRIBUTION OF AUTHORS

Alexandra Itzkovitz conducted recruitment and collected data, organized and coded data, performed statistical analysis and is the primary writer of the thesis and manuscript.

Vanessa Maggio worked on the research protocol with the support of Dr. Brazeau, set up the 67-item survey in SurveyMonkey and helped recruit participants.

Amelie Roy-Fleming helped with recruitment methods and provided translation from English to French for necessary documents and applications.

Dr. Anne-Sophie Brazeau was the primary supervisor of Alexandra Itzkovitz and oversaw the research project, while providing guidance throughout.

Dr. Laurent Legault was the co-supervisor to Alexandra Itzkovitz and attended bi-annual committee meetings to ensure the project was progressing appropriately and provided timely and constructive feedback.

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LIST OF ABBREVEIATIONS

CVD Cardiovascular disease

CEGEP Collège d'enseignement général et professionnel

DNKS Diabetes nutrition knowledge survey

FL Food literacy

PWT1D People living with type 1 diabetes

SFLQ Short food literacy questionnaire

T1D Type 1 diabetes

CHAPTER 1 INTRODUCTION

1.1 Research Rational

Type 1 diabetes (T1D) is a chronic autoimmune disease impacting over 100,000 Canadians (1). This clinical population is regarded as a high cardiovascular risk group with up to a tenfold increased risk of cardiovascular disease (CVD) mortality (2). Additionally, overweight and obesity are on the rise in people living with type 1 diabetes (PWT1D), increasing their risk of developing comorbidities such as CVD (3). Poor diet is a leading risk factor of overweight, obesity and related chronic diseases in Canada (4). Previous research has shown that PWT1D tend to consume an atherogenic diet containing high levels of saturated fat and sodium and low levels of fiber (5). Education provided to PWT1D has mostly focused on carbohydrate counting to match insulin dosing and does not always evaluate the full scope of nutrition (5, 6).

Dietary intake is complex and depends on many factors. An additional level of complexity is the drastic transition in the food system from basic food preparation to reliance on ultra-processed foods that require minimal planning or preparation. In 2015 Vaitkeviciute et al. investigated the association between food literacy and adolescent's dietary intake. This systematic review demonstrated that adolescents and young adults are the most frequent consumers of ultra-processed foods, increasing their risk of becoming overweight and obese (7). Young adulthood is a fundamental period in an individual's life as they are developing their independence and becoming responsible for their food choices. Health related behaviours developed during this time often continue into adulthood (7).

An emerging concept that is key in making dietary choices is *Food Literacy* and is defined as an individual's ability to plan, select and prepare meals in a healthful manner that aligns with nutrition guidelines, while having the skills and confidence to do so (8). This term is

also based on an individual's food and nutrition related knowledge, while encompassing their cultural, social and environmental influences (9). The Diabetes Canada 2018 Clinical Practice Guidelines recognized the role that food skills, a component of food literacy, may have in managing diabetes in PWT1D (10).

Food literacy has seldomly been assessed among this clinical population and the need for basic cooking skills is undervalued (10). Understanding how young adults living with T1D are making their food choices and how their food choices impact their overall health would be useful to educate them appropriately. Nutritional education needs are broad and require a global approach of both therapeutic and preventative interventions. Food literacy may be one missing piece to improving health behaviours and to help in the prevention of comorbidities in this clinical population.

1.2 Research Objectives

The main objective of this study is to understand the food literacy level of young Canadian adults living with T1D. More specifically, the aims of this study are:

- 1) To assess the differences in food literacy scores among young Canadian adults (18-29 years old) living with type 1 diabetes (T1D) and without diabetes (controls).
- 2) To compare the proportion of participants living with T1D and without diabetes that have adequate food literacy.

1.3 Research Hypothesis

- 1) We hypothesize that at least 50% of young Canadian adults living with T1D have adequate food literacy.
- 2) We hypothesize that there is a greater proportion of adequate food literacy among young Canadian adults living with T1D compared to those living without diabetes.

CHAPTER 2 REVIEW OF THE LITERATURE

2.1 Type 1 Diabetes

2.1.1 Definition

Diabetes is characterized by hyperglycemia (blood glucose level $\geq 11\text{mmol/L}$) (1), which may be controlled through pharmacological measures, as well as nutritional interventions. T1D is an autoimmune disease and is a consequence of the destruction of the pancreatic islet beta cells, resulting in little to no insulin production. T1D was primarily known as juvenile diabetes and individuals were diagnosed under the age of 20 years old. Over 1 million American adults (20 years and older) were diagnosed with type 1 diabetes in 2020 (11).

PWT1D require multiple daily insulin injections, must check their blood glucose regularly and count carbohydrates at meals and snacks for glycemic control. Chronic hyperglycemia is known to cause macrovascular and microvascular complications, which includes CVD, cerebrovascular disease, nephropathy, neuropathy and retinopathy (12). If excessive insulin is administered, if there is inadequate carbohydrate intake or if there is suboptimal macronutrient distribution throughout the day, patients can experience hypoglycemic episodes. Hypoglycemia (blood glucose levels $< 3.9\text{ mmol/L}$) can cause serious health conditions, as severe as coma and death (13).

2.1.2 Risk of comorbidities for PWT1D

There are risks of macrovascular and microvascular complications associated with poorly managed glycemia among PWT1D. Adults living with T1D had a higher prevalence of CVD and related death outcomes compared to the general population, where there was shown to be a tenfold elevated risk of cardiovascular mortality amongst this clinical population (2). In a recent

longitudinal study including 12,678 adults living with T1D, it was identified that the most common cardiometabolic risk factors among this population were hypercholesterolemia, hyperlipidemia, hypertension, and obesity (14). Results from the study indicated that approximately 40% of the individuals from the study sample presented with at least one of these cardiometabolic risk factors (14). A cross-sectional study that examined 115 adults living with T1D (mean age: 44 ± 12.5 years old; 51% female) explored the association between a healthy lifestyle and a cardiometabolic risk profile. PWT1D were consuming on average, a diet high in saturated fat (greater than 7% of daily intake) and sodium (greater than 2300 mg/day), and low in fiber (less than 25 g/day) (5). It was suggested that a healthy lifestyle including, a balanced diet, regular physical activity, smoking cessation and weight management, among adults living with T1D was associated with a reduced cardiometabolic risk profile including, dyslipidemia, hypertension and insulin resistance ($p < 0.05$) (5). This finding correlates with a review that looked at the increasing overweight and obesity rates of PWT1D and how to manage this issue (15). The 2017 review indicated that approximately 50% of PWT1D are overweight or obese and the rate of weight gain in this population has increased in the last decade at a higher rate compared to the general population (15). These findings indicate the importance of targeting and reducing cardiometabolic risk factors among PWT1D.

2.2 The food environment and nutrition

2.2.1 Nutritional management of T1D

Nutrition therapy is an essential part of the overall treatment for PWT1D; therefore, it should be an essential part of the intervention plan (10). A position statement from the American Diabetes Association on nutrition therapy for the management of diabetes in adults, discussed the focus on nutritional education offered to PWT1D, emphasized recognizing source of

carbohydrates, and estimating their quantity in order to match insulin doses accordingly (16). It was suggested that PWT1D needed to focus on carbohydrates and insulin, while those living with type 2 diabetes, non-insulin dependent, should focus on healthful eating habits (16). A cross-sectional study done on 110 young adults (18-45 years old) living with T1D, was conducted to understand the barriers to good nutrition in this clinical population. The study demonstrated that PWT1D reported a lack of proper awareness about the importance of diabetes nutritional principles (17). It is important to understand why PWT1D feel this way and to properly address it.

2.2.2 Dietary recommendations for PWT1D and the general population

According to the 2019 Canadian Food Guide, people should consume a variety of vegetables and fruits, choose whole grains and eat lean protein sources, majority being plant-based (18). The recommendations proposed in the new food guide align with elements of the Mediterranean Diet. A systematic review that included epidemiological studies and clinical trials, looked at the protective effects of the Mediterranean diet and proposed that following a Mediterranean diet was inversely associated with the risk of diabetes, metabolic syndrome and improved blood lipid levels, which is a factor impacting cardiovascular health (19). In accordance with Canada's new food guide and the Mediterranean diet, the 2018 Clinical Diabetes Guidelines suggested consuming legumes, whole grains, vegetables and fruits (10). Additionally, the 2018 guidelines suggested selecting unsaturated fats, including oils and nuts, and to choose lean proteins with an emphasis on plant-based protein. The guidelines stated: "The style of eating that works well for diabetes may be described as Mediterranean style diet, DASH diet or vegetarian style diet as they have been shown to manage diabetes and cardiovascular

disease” (10). Nutritional interventions are important for preventing CVD, but also diabetes management. Therefore, it can be inferred that dietary recommendations for PWT1D and those living without diabetes are consistent.

2.2.3 Dietary intake in PWT1D

In a cross-sectional study investigating the association between a healthy lifestyle and a cardiometabolic risk profile, PWT1D reported to consume a daily diet that on average consisted of 11% of saturated fat, 2900 mg of sodium and 22 g of fiber (5). These reported intakes did not meet the recommendations outlined in the 2013 Canadian Diabetes Association practice guidelines, which suggested a daily intake containing less than 7% of saturated fat, less than 2300 mg of sodium and greater than 25 g of fiber (5). A cross-sectional study examining young adults living with T1D (18-45 years old) main objective was to understand the major barriers to adequate nutrition in this clinical population. Results from the study showed that 72% of young adults living with T1D had a poor vegetable and fruit intake of less than 4-5 servings daily and an inadequate intake of whole grain products including cereal grains and millets, resulting in suboptimal fiber intake (17). These results suggest that these individuals had a poor nutrient intake that is insufficient in macronutrients and micronutrients. A main reported reason for inadequate vegetable and fruit intake was not wanting to or having the time to prepare these foods (17). Additionally, appropriate meal and snack distribution is important in nutrition therapy for this population, and the study showed that majority of young adults living with T1D skipped snacks, as they were not aware of the importance of proper meal distribution (17). These findings suggest that nutrition education needs are not being fully met for this clinical population.

2.2.4 Barriers to healthy eating

According to a review from the Canadian Journal of Diabetes in trying to understand the barriers to healthy eating, several factors showed to impede on making healthy food choices amongst adults. Some of these factors were: gender, peer and family influences, cost, availability, preferred taste and lack of both time and skills to plan, shop, prepare and cook (20). A dietitian interviewed 100 young adults (18-45 years old) living with T1D to learn what were the barriers to healthy eating. The most commonly reported barriers were time constraints in relation to work and studying, inadequate awareness of importance of nutrition in diabetes management and lack of confidence in being able to follow general healthy dietary guidelines (17).

Another factor that may limit the adoption of healthy dietary behaviour could be the lack of nutrition education in school curriculums and the absence of courses tailored to enable basic food skills (21). A recent 6-week randomized control study that included 131 second-grade level children (89 part of the intervention and 49 part of the control group), evaluated the effect of a nutrition education curriculum on dietary behaviours in school aged children. It was seen that nutrition education and the promotion of healthy eating behaviours in school amongst youth improved their dietary intake, which could have significant impacts on their health (21).

2.2.5 Changes in the food system

There has been a drastic shift in the food environment regarding where, what, how and with whom we eat our meals, as well as a large transition from basic food preparation to ultra-processed foods that require minimal planning or preparation. These concepts were explored in chapter 3 of Colatruglio's book of *Food Literacy: Bridging the Gap between Food, Nutrition and*

Well-being (22). Ultra-processed foods include take-away, fast food, ready-to-eat meals/ snacks and sugar-sweetened beverages, which have low nutritional value. Nardocci et. al, conducted a cross-sectional study on 19,363 Canadian adults, to assess the association between consumption of ultra-processed foods and obesity (23). Results showed that 45% of calories consumed amongst Canadians come from ultra-processed foods. In a systematic review investigating the relationship between food literacy and dietary intake, it was seen that adolescents and young adults (10-19 years old) were the most frequent consumers of packaged snacks and consuming meals away from home (7). It has been argued that these frequently consumed foods have resulted in less time developing skills and confidence in the kitchen, as it has become unnecessary to prepare foods and easier to rely on pre-prepared items (22). Studies have shown that involving individuals in home food experiences have a positive correlation with food skills. Furthermore, the evidence indicated an association between improved diet quality and increased involvement in food preparation and cooking (22).

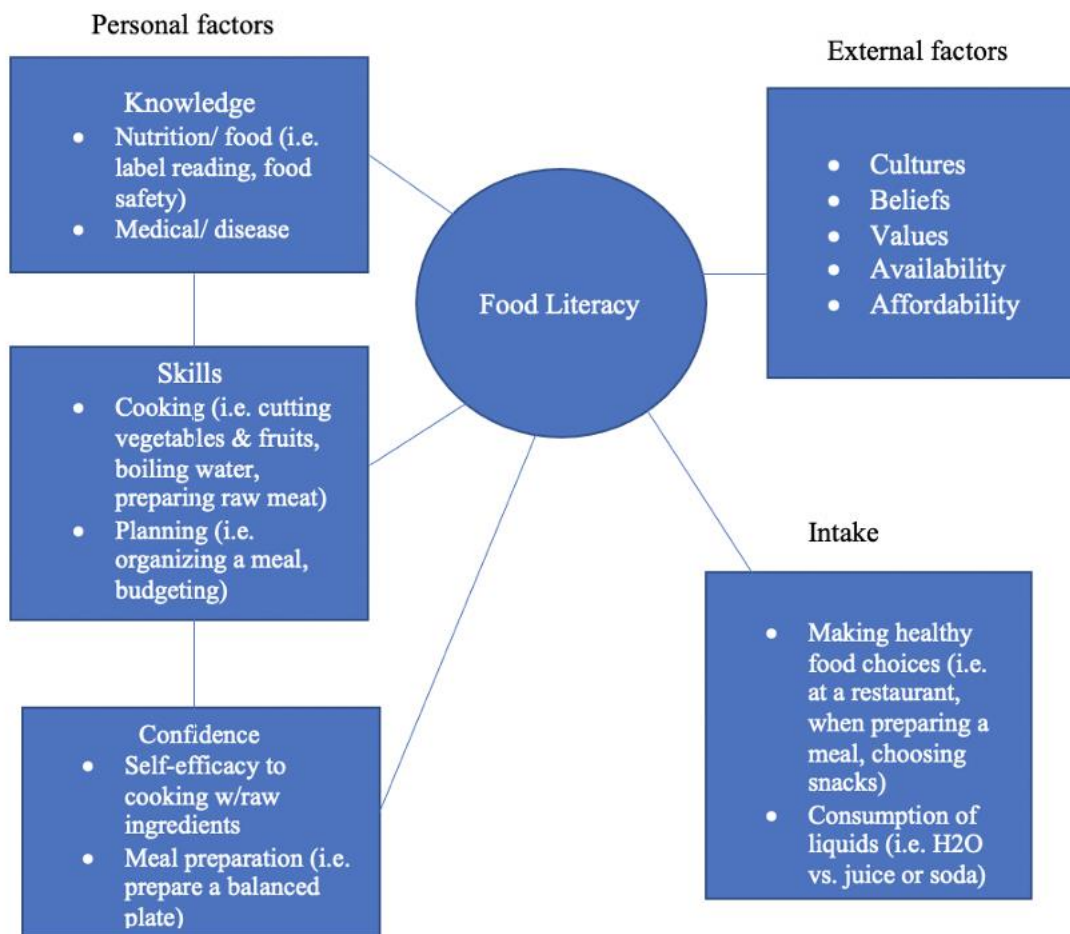
2.3 Food Literacy

2.3.1 Definition

Food literacy is an emerging topic for which there is no one specific definition for the term. In 2014, Vidgen and Gallegos conducted a study to understand and define food literacy. This was done through looking at the perspectives of both food experts, who understand food policy, and of food consumers, who are considered experts on practicality. The components of food literacy that were identified are: planning and management, selection, preparation and eating (8). Self-efficacy can play a role in food literacy as participants with greater ability to perform food related tasks, were more likely to make the effort to obtain the desired outcome

(24). In other literature, food literacy components were noted as food skills, food security and health literacy, while enabling people to make food decisions that supported their health (9). It was noted that food literacy is linked to the environment and the social context of individuals, therefore, personal and external factors are to be considered (9). From the combined literature, food literacy seems to encompass an individual's ability to plan, select and prepare meals in a healthful manner, while having the confidence and skills to do so, and considering personal and external factors, see *figure 1-1*.

Figure 1-1 Components of Food Literacy



2.3.2 Food literacy and type 1 diabetes

A cross-sectional study including 1399 Danish people 18 years and older living with T1D, looked at the association between health literacy domains and glycated hemoglobin (HbA1c) levels. Results suggested that higher health literacy levels are associated with lower HbA1c levels, signifying improved glycemic control (25). Better glycemic control (HbA1c $\leq$ 7.7) in adults living with T1D involved adequate self-management of the disease, which included the ability to access, understand and use health related information on a daily basis (25). Another study investigated alcohol consumption and knowledge regarding alcohol and carbohydrate counting amongst 547 PWT1D between the ages of 18-30 years old, through a multiple-choice web-based survey. This is an important topic in this clinical population, as the consumption of alcohol is common amongst young adults living with T1D (greater than one third of women and one fifth of men), and the impact that alcohol can have on the management of their disease should be understood. Results indicated that there was a lack of knowledge regarding alcohol and carbohydrate content as less than 10% of the participants were able to identify the carbohydrate content in alcoholic beverages. The study demonstrated that greater alcohol related health literacy was associated with reduced risk of poor disease management (26). Diabetes Canada recognized the importance of food literacy in diabetes management, as the 2018 Clinical Practice Guidelines stated that food skills, a component of food literacy can play a major role in managing diabetes in PWT1D (27).

2.3.3. Food literacy in the general population of young adults

A cross-sectional descriptive study included 276 University students and investigated the association between nutrition literacy level and dietary habits. This study was conducted as young adults are known as one of the nutritionally vulnerable groups due to their unhealthy

eating habits, resulting in inadequate macronutrient and micronutrient intake. Dietary habits are complex and are influenced by the food environment and personal factors. Nutrition literacy was measured using the validated Adolescent Nutrition Literacy Scale and food habits were evaluated using the validated Adolescent Food Habit Checklist. Results from the study demonstrated that food habits are influenced by nutrition literacy and females showed to have better food habits compared to the male participants (28). In Chapter 3 of the book *Food Literacy: Bridging the Gap between Food, Nutrition and Well-Being*, Colatruglio stated that young Canadian adults transitioning from adolescents' face barriers in becoming food literate which directly influences their food choices (22). Many young adults were not involved as younger children and adolescents in hands-on meal planning, grocery shopping or food preparation, which was in part due to poor cooking skills and negative attitudes around cooking in their homes. These findings were directly correlated with the consumption of poor nutritional quality food (22). These findings indicate the importance of nutritional knowledge and food literacy.

2.3.4 Food Literacy and dietary intake

Since 2007 there has been a reduction in food and nutrition knowledge and food related skills, which is linked to overweight, obesity and chronic diseases (22). In a systematic review investigating the association between food literacy and adolescents (10-19 years old) dietary intake, it was concluded that food literacy was shown to have a positive association with shaping dietary intake (7). A cross-sectional study evaluating the association between grocery shopping and dinner preparation, included 2008 participants between the ages of 16-24 years old. An online survey was used and measured self-reported grocery shopping and dinner preparation behaviours along with the participants eating habits. Results showed that greater meal

preparation and participation in grocery shopping was associated with healthier eating patterns (29). For individuals to make healthy food choices it is important they have food knowledge, such as basic nutrition education and food skills. A study conducted at the University of Guelph on 47 students enrolled in the “Understanding Foods” course, investigated the impact of a food course on food skills through a survey provided before and after completion of the course. The results indicated that nutrition related education showed to increase an individual’s confidence and knowledge of food skills (30). In an educational flyer discussing the evidence supporting food literacy education, it was mentioned that food literacy was recognized by the Conference Board of Canada as an important influence due to its role on health and disease prevention (31). The literature suggested that eating behaviours are affected by nutrition literacy and that having this type of literacy is more than just healthy eating knowledge (28).

2.3.5 Tools to assess food literacy

There are few existing validated tools to assess food literacy (See *Figure 2-1*). The short food literacy questionnaire (SFLQ), one of the first developed (published in 2018), includes 12 items and was first validated amongst a Swiss adult population. Areas covered in the SFLQ are: knowledge regarding sodium intake, general understanding of general nutrition , confidence in evaluating healthy foods and the ability to make healthy dietary choices (32). Another tool is the food literacy behaviors tool, published in 2018, that includes 14 items and was validated for Australian adults. This tool includes basic healthy eating, label reading and food selection, meal planning and budgeting, food preparation skills, and cooking (33). Lastly, there is the self-perceived food literacy tool which includes 29 items and was validated for Dutch adults in 2018.

This tool includes items on planning, managing, selecting, preparing and eating practicalities (34). Each one of these tools uses a Likert scale as the grading system (See *Table 2-1*).

Table 2-1 Tools to assess food literacy

Tool	Length	Population/ Validation	Areas Covered	Scoring System
SFLQ (Short food literacy questionnaire) (Krause, 2018)	12-item	Swiss Adults (n=350)	-Health knowledge on salt -Functional, interactive and critical elements highlighting FL -Using nutrition and food related knowledge -Confidence in evaluating healthy foods and making decisions	-Likert scale -Score was summed. Total scores were put into categories of inadequate, problematic, sufficient & excellent
Food Literacy Behaviors Tools (Begley, 2018)	14-item	Australian Adults (n= 882)	-Basic Healthy Eating -Label reading & Food Selection -Meal planning & Budget -Food safety, preparation and cooking	-Factor loadings for each domain to create a planning, selection and preparation score
SPFL (Self Perceived Food Literacy) (Poelman, 2018)	29-item	Dutch Adults (n=755)	-Planning, managing, selecting, preparing & eating practicalities (ie.can you cook vegetables in a variety of ways? Do you eat fruit as snacks?)	-Likert Scale -Scores were summed. For negative items the scores were reversed -Higher scores indicated higher food literacy

2.3.6 Validation of the Short Food Literacy Questionnaire (SFLQ)

The Short Food Literacy Questionnaire (SFLQ) was developed to measure food literacy and was validated for Swiss adults. When this questionnaire was developed there was no existing instrument to measure food literacy. The questionnaire items are directly related to health literacy based on the Nutbeams model including measures of functional, interactive and critical health (35). This model's main outcome measure was self-efficacy, which was defined as the perceived ability to carry out a recommended action. To measure this desired outcome, perceived threat was measured, by evaluating the perceived susceptibility to a problem and the perceived seriousness of consequences to a problem. Another important outcome that was evaluated was the outcome of expectations, by assessing the perceived benefits of a specified action and perceived barriers of taking that action.

As this was the first tool to measure food literacy it was done by adapting items from various existing instruments that assessed health and nutrition literacy. Items focused on understanding nutrition information and being able to prepare a balanced menu, having the ability to share nutrition information with others and the ability to use critical skills in judging nutritional information and dietary choices on health. Each item was self-rated on a scale of four or five with a total threshold score including four categories of: inadequate, problematic, sufficient and excellent, based on the recommendations of the European Health Literacy Project. To eliminate ambiguity items were scored 0 for "I don't know". To ensure reliability and validity of the questionnaire, it underwent a face validity test and a cognitive and standard pretest. To assess the internal consistency, a Cronbach's Alpha score was used with a significance level set

at 0.05 and came out to be 0.82 on the entire scale, indicating adequate internal consistency. Exploratory factor analysis was done to identify the relationships between each measured variable. Using Spearman's rank correlation coefficients, it was identified that each of the 12 items were consistently and positively associated with one another. A weakness of this tool is that it does not capture all aspects of food literacy as this term is complex, as it includes environmental and societal aspects as well. Overall, this instrument can be beneficial in helping to evaluate and plan health interventions focusing on food literacy.

CHAPTER 3 MANUSCRIPT

Manuscript prepared for submission to the Diabetes Research and Clinical Practice Journal

Title: Food Literacy of Young Canadian Adults Living with Type 1 Diabetes

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3.1 Abstract

Aims: Food literacy (FL) encompasses knowledge, skills and confidence to prepare healthy meals. This project aimed to assess and compare the proportion of young Canadian adults (18-29 years old) living with type 1 diabetes (PWT1D) and without diabetes (controls) demonstrating adequate FL.

Methods: This cross-sectional study included 236 PWT1D and 191 controls. Participants completed an online survey that included questions on socioeconomic status, nutrition knowledge, confidence in meal preparation, cooking skills and the validated Short Food Literacy Questionnaire. The two-sample t-test was used to compare the proportion of adequate FL between the groups.

Results: Among the 423 participants (81.5% women), mean age of PWT1D was 24 ± 3 years old and the control group was slightly younger (22 ± 3 ; $p < 0.001$). The majority of PWT1D prepared their own meals compared to the controls (74.5% vs. 47.6%; $p < 0.001$). More PWT1D reported adequate FL compared to those without diabetes (PWT1D 88.0% vs. Controls 68.0%; $p < 0.001$). Enhanced FL was associated with higher cooking skills ($p = 0.02$) and confidence ($p < 0.01$) in preparing healthy meals.

Conclusion: Living with T1D was associated with greater food literacy among young Canadian adults. Having the independence, the confidence and the skills in meal preparation are important contributing factors to having adequate food literacy.

3.2 INTRODUCTION

Type 1 diabetes (T1D) is a chronic autoimmune disease impacting over 100,000 Canadians (1). Insulin therapy and nutrition are essential for T1D management to prevent short- and long-term complications. Nutritional education offered to people living with type 1 diabetes (PWT1D) is often focused on enhancing their knowledge of sources and type of carbohydrates and on learning how to estimate portion sizes in order to match insulin doses accordingly (5, 6).

Currently, guidelines for diabetes management are shifting away from macronutrient-based recommendations to focusing on dietary patterns, such as the Mediterranean diet, not only to help with blood glucose management, but also to promote cardiovascular health (36, 37). The Mediterranean diet has similar principles to the most recent 2019 Canadian Food Guide and the balanced plate (18). Each focuses on consuming vegetables, fruits, whole grains, lean proteins and limiting saturated fats. A cross-sectional study investigating 115 Canadian adults living with T1D (mean age 44 SD 12.5) found that greater than 50% of the participants were not following the recommendations outlined in the previous 2007 Canadian Food Guide, as they reported consuming an atherogenic diet, that contained high levels of saturated fat and sodium and low levels of fiber (5). It is important to acknowledge, as the literature indicated, that this clinical population is regarded as a high cardiovascular disease (CVD) risk group, with a tenfold elevated risk of developing CVD compared to those living without diabetes (2). This demonstrates the importance of educating on the full scope of nutrition and that a global approach is required, focusing on both preventative and therapeutic interventions.

Individual food choices are complex and are dependent on many factors such as, socioeconomic status, personal preferences, education, nutrition knowledge and cooking skills (4). An additional level of complexity is the drastic shift in the food environment over the years with regards to where, what, how and with whom we eat our meals. This is in part due to the transition in the food environment from basic food needing preparation to omnipresent ultra-processed foods, that require minimal planning and preparation (38). Research suggested that adolescents and young adults were the most frequent consumers of packaged snacks and consuming meals away from home, increasing their risk of becoming overweight and obese (7). It has been argued that these frequently consumed foods have resulted in less time developing skills and confidence in the kitchen, as it has become unnecessary to prepare meals and easier to rely on pre-prepared foods (22). Moreover, young adulthood represents a period when individuals are developing their independence and are becoming responsible for their dietary choices, and in the case of PWT1D, are now responsible for their disease management. Health-related behaviours developed in childhood and adolescence often continue into adulthood, therefore it is important to educate and enable individuals early on, especially when living with a chronic condition such as T1D (7).

An emerging concept that is key in making dietary choices is called *Food Literacy*. This term defines an individual's ability to plan, select and prepare meals in a healthful manner that aligns with nutrition guidelines, while having the skills and confidence to do so (8, 9). This term is also based on an individual's food and nutrition related knowledge, while encompassing their cultural, social, and environmental influences. Overall, food literacy encompasses an individual's knowledge, skills, confidence, and dietary choices. The Diabetes Canada 2018 Clinical Practice

Guidelines recognized the role that food skills, a component of food literacy, could have in managing glycemic control for PWT1D (10).

The aim of this study was to understand the current level of food literacy among young Canadian adults living with T1D and to compare it to those living without diabetes.

3.3 METHODS

3.3.1 Study design

This cross-sectional study included 236 PWT1D and 191 participants living without diabetes (i.e., control group). Inclusion criteria included: self-reported living with T1D or living without diabetes, ages between 18-29 years old and living in Canada. Participants answered an online questionnaire through the cloud-based software *Survey Monkey* from June 2018 to January 2020. Participants with incomplete answers to mandatory questions (i.e., the Short Food Literacy Questionnaire (SFLQ)) were excluded from the analysis. Recruitment was done through social media (Twitter, Facebook, LinkedIn) with help from diabetes organizations and medical clinics (websites and flyers) across Canada.

3.3.2 Questionnaire

The questionnaire was developed by a team of dietitians, physicians and patient partners living with T1D. The 67-item survey included questions concerning socioeconomic status, general health (i.e, living with any medical conditions), usual dietary intake (i.e, following specific diets, consumptions of various food groups), nutrition knowledge, food environment, self-efficacy in

cooking and preparing meals, and the validated 12-item SFLQ (32) adapted to the 2007 Canadian Food Guide (39) .

Each question of the SFLQ was scored on a Likert scale from 0 to 4 or 0 to 5 depending on the item, with a maximum total score of 52; a higher score indicating a greater food literacy. A score less than 25 was considered insufficient, a score of 25-33 was considered problematic, a score of 34-42 was considered sufficient and a score of 43-52 was considered excellent (32). For the purpose of our binary analysis, a score lower than 33 was considered inadequate and a score above 34 was considered adequate FL. To assess cooking skills there was a question regarding ability to cook (40) and there were six items to choose from. For the purpose of our analysis, we had two categories of being a basic cook and a competent cook. A basic cook included: ‘I don’t know where to start when cooking’, ‘I can do things such as boil an egg or cook a grilled cheese’ and ‘I can prepare simple meals but nothing too complicated’. A competent cook included: ‘I can prepare most dishes’, ‘I can cook most dishes if I have a recipe to follow’ and ‘I frequently prepare sophisticated dishes’. Knowledge of chronic diseases associated with food intake was assessed using one multiple choice question. For each correct answer on the 7 choices, one point was attributed, with a maximum of seven points.

Additional questions for PWT1D included diabetes duration, self-reported glycated hemoglobin (HbA1c), method of insulin administration, whether they have met with a dietitian and topics that were discussed and the Diabetes Nutrition Knowledge Survey (DNKS). The DNKS questionnaire contained a total of fifteen multiple choice questions, each with four options to choose from. Each question had one correct answer and the total score was a percentage (41).

3.3.3 Statistical analysis

Statistical analysis was performed using R Studio 1.1.456. Descriptive data are presented as mean values and standard deviations (SD) for continuous data that follows a normal distribution and as percentages for categorical variables. Quantitative data was compared between groups using the t-test and categorical data using the chi square test. To compare the proportion of adequate food literacy between PWT1D and the control group, the two-sample t-test was used. To determine variables associated with the FL score, linear regression model was used (adjusted for age, gender, education, knowledge related to chronic diseases, confidence in preparing well balanced and tasty meals, ability to cook from basic ingredients and the consumption of vegetables and fruits). Association between the FL total score and the DNKS score (adjusted for age, age of diagnosis, education and who prepares meals) was measured using a linear regression model.

3.4 RESULTS

A total of 745 young adults provided written consent to participate in the study. After excluding the participants who did not complete the SFLQ questionnaire, a total of 236 PWT1D and 191 controls were included in the analysis. Descriptive characteristics of participants are presented in *Table 3-1*. Overall, PWT1D were slightly older than the controls (24.3 SD 3.3 vs. 22.5 SD 3.4 years old) and more reported being Caucasian (95.7% vs. 56.7%). Majority of the total participants were female (82.0%). The average duration of participants reported living with T1D was 10.2 (SD 7.8) years, with most using an insulin pump for insulin administration (60.5%) and using carbohydrate counting for mealtime insulin adjustments (63.7%). About two-thirds of PWT1D reported meeting with a dietitian in the past. The most frequent topic covered with the

dietitian was carbohydrate counting (63.7%), but portions sizes, meal planning and label reading were also discussed (see Appendix 1 for the full list). The most commonly reported followed diet amongst PWT1D was a low carbohydrate diet (defined as a diet containing less than 100 grams of carbohydrates per day; 16.5%) (*see Appendix 1*).

According to participants' score on the SFLQ, the proportion of young Canadian adults living with T1D reporting adequate food literacy was greater than amongst controls (PWT1D: 88.0% 95% CI 84.2-91.7%) vs controls 68.0% (95% CI 66.1-71.0%) ($p < 0.001$). Results for dietary knowledge, skills, confidence and intake, four areas related to food literacy, are presented in *Table 3-2*. Nutrition and chronic disease knowledge was similar between the two groups.

Websites were one of the primary sources of nutritional information for both groups, however the majority of PWT1D (72.0%) used food labels, but not the controls (49.2%). In terms of cooking and food preparation skills, PWT1D were more likely to prepare their own meals compared to the control group (74.5% vs. 47.6%) and to report being a competent cook (86.4% vs. 75.9%). More PWT1D reported having a high confidence in preparing well balanced and tasty meals compared to the control group. Despite a similar proportion of participants following the balanced plate, a greater proportion of young adults without diabetes reported eating out or consuming take-out food (47.4%) compared to PWT1D (31.3%). Those living without diabetes consumed more fruits and vegetables (88.7%) compared to PWT1D (69.4%). Juice and soda were more frequently being consumed amongst those living with T1D ($p < 0.001$).

Living with T1D correlated with greater food literacy as presented in *Table 3-3*. Having a high/very high confidence in preparing well balanced tasty meals was positively associated with

a higher food literacy score. As for the chronic disease and knowledge score (*Table 3-3*), there was no association between the SFLQ score and the DNKS ($p = 0.543$) (*Table 3-4*.) The high DNKS score is consistent with the majority of PWT1D reporting having met with a dietitian, with the main topic discussed being carbohydrate counting.

3.5 DISCUSSION

The majority of young Canadian adults who participated in this study reported having adequate food literacy as assessed by the SFLQ. This proportion was even greater among young adults living with T1D, with nearly 9 out of 10 participants who were considered as food literate. Our study was the first to examine the concept of food literacy among PWT1D. Living with diabetes, having a higher education and reporting high confidence and skills in preparing meals were associated with a greater food literacy score. The high proportion of food literate young adults may be related to the education level of the current study sample. Indeed, another study showed that in a large sample of adults ($n=1626$; average age between 26-45 years old), lower confidence was associated with lower education and overall was identified with poorer food literacy outcomes (42).

PWT1D may have enhanced food literacy compared to those living without diabetes possibly because nutrition is such an important part of managing diabetes. From our study, even after adjustment of certain variables (age, gender, level of education and cooking skills), living with T1D was still associated with a greater SFLQ score. From the time of diagnosis, PWT1D are possibly more likely to have met with a dietitian and learn how food impacts glycemia. In fact, the nutrition therapy chapter of the Canadian Diabetes Clinical Practice Guidelines states that those living with diabetes should meet with a dietitian for counselling and management (10).

Interestingly, the majority of participants reported having met with a dietitian. Participants reported the most frequent discussed topic with a dietitian was carbohydrate counting and a significant proportion also reported having discussed meal planning. Those living with T1D reported that their main source of nutritional information were food labels. This could indicate that these individuals consume pre-packaged foods which have food labels. This is in accordance with a cross-sectional study done on individuals living with T1D (8-21 years old, n=35), evaluating their perception as well as their parents' perception, of healthful eating and dietary behaviours. The study found that nutrition labels influenced individuals living with T1D and their parents to choose pre-packaged food more often (43). Those living without T1D reported their main source of nutritional information being websites. In accordance to this finding, previous research has stated that 92% of young adults (18-25 years old, n=192) reported obtaining nutrition information from online resources (44). In light of these findings, healthcare professionals should consider including websites in their approach, in addition to food labels, to educate young adults with and without T1D, making sure the information is valid, reliable, current and patient friendly.

The four domains of food literacy included in this study were health and nutrition-related knowledge, confidence and skills in preparing well balanced and tasty meals and, general dietary intake. Our results showed that having the skills and confidence to prepare meals are key components to having a higher food literacy score among young Canadian adults living with and without diabetes. Confidence is a term that is related to self-efficacy. Bandura defined confidence as the perception that one is competent and able to meet particular expectations, including knowing how to do something and having the ability to complete a task (45); while

self-efficacy is defined as people's beliefs in their abilities to perform a specific behavior (46). Self-efficacy is an essential predictor of behaviour change (46). Therefore, having confidence and perceived self-efficacy is important for the adoption of healthy dietary behaviours. For individuals to develop skills and acquire confidence in cooking, it is important for them to participate in meal preparation. It was shown that adolescents who helped prepare dinner were more likely to engage in food preparation as young adults between the ages of 19-23 years old (7). These individuals were shown to purchase vegetables and fruits and prepare dinner with a protein source, which are healthful concepts that align with nutrition guidelines (7). These findings are in accordance with our results showing that a higher food literacy score was associated with having the skills to cook and prepare dishes from basic ingredients. In addition, our results also indicate that majority of PWT1D prepare most meals on their own. These are important factors to consider when developing programs and methods of how to have individuals engage in meal preparation and build their confidence and skills in doing so.

Vegetable and fruit consumption are an important part of a healthy diet and the literature suggested that higher food literacy is associated with increased consumption of vegetables and fruits (34). However, our results indicated that vegetable and fruit consumption are not associated with improved food literacy in this clinical population. Our results also showed that PWT1D consumed less vegetables and fruits at meals compared to the controls. This may be related to the fact that PWT1D consume more pre-packaged foods with food labels compared to more wholesome foods lacking food labels (43). Additionally, PWT1D reported greater daily juice consumption compared to the controls, however it was not specified if this was a result of treating hypoglycemic episodes. These findings indicate the importance in addressing potential

barriers faced in consuming a healthy diet. Additionally, it was seen that there is an increased prevalence of individuals eating out of the home and this is may be related to the limited opportunities for food skill development both in school and home settings (38). These findings should be considered when planning school curriculums and when health care providers are educating their patients. Some interventions can include community programs with cooking classes, having a school course on food skills, understanding how to use tools in the kitchen and encouraging parents to involve children in meal preparation, all while addressing barriers faced by the individual (4, 22, 47).

The overrepresentation of females and Caucasians was a limitation of our study and may be due to the recruitment means or study design. A recent study examined factors impacting response rates of university students of online surveys. Results indicated that males were more likely to complete the survey if they received a reminder and if the survey was short and concise (48). Given that we were unable to send reminder emails due to confidentiality and that our survey was 67-items long, that could have deterred male participants completion. Additionally, the SFLQ is an interesting short tool to assess general food literacy, however it does not allow to understand specific areas that may need improvement. The SFLQ scoring involved cut-offs which poses a limitation in that a one-point difference can place a participant in different categories of food literacy. We opted to create a binary variable with only one cutoff which was a further limitation. Future studies could include questions on how and where participants learnt food related skills, to inform on what is working and where improvements are required. Our cross-sectional design cannot inform on the development and maintenance of healthy eating habits during adulthood. However, the high proportion of food literate young adults may be

indicative that health professionals are taking a more global approach in educating young adults living with T1D with regards to food intake and dietary behaviours, which may be reflecting a change in clinical practice.

3.6 Conclusion

In conclusion, a high proportion of young Canadian adults living with T1D have adequate food literacy. Enhanced food literacy is associated with higher skills and confidence in preparing meals from basic ingredients. Although PWT1D showed to have adequate food literacy, our results indicate that these individuals have a poorer diet quality. There are other factors to consider when understanding this clinical populations dietary choices. Our findings may contribute to helping health professionals intervene appropriately with PWT1D. Interventions should include a global method in nutrition and food skills education, and not solely focus on the intake of macronutrients, such as carbohydrate counting. Policy makers and health care professionals will be key players in determining appropriate educational tools to enable individuals. Future studies should investigate why PWT1D have high food literacy and determine methods in tackling individual barriers in consuming a well-balanced diet amongst this clinical population.

3.7 Tables

Table 3-1 Description of the participants

	PWT1D (n=236)	CONTROLS (n = 191)	P Value^a
Age in years; Mean (SD)	24.3 (3.3)	22.5 (3.4)	< 0.001
Gender (Female); n (%)	199 (84.3%)	151 (78.6%)	0.214
Ethnicity (Caucasian); n (%)	226 (95.7%)	109 (56.7%)	< 0.001
Residence; n (%)			
Quebec	100 (42.3%)	161 (84.2%)	< 0.001
Ontario	53 (22.4%)	21 (10.9%)	0.002
British Columbia	37 (15.6%)	2 (1.0%)	< 0.001
The Prairies	30 (12.7%)	4 (2.0%)	< 0.001
Others ^b	13 (5.5%)	3 (1.2%)	0.033
Education; n (%)			0.174
Higher level education (Uni/Grad)	123 (52.1%)	90 (46.8%)	
College/ CEGEP	69 (29.2%)	51 (26.5%)	
≤ Grade 12	44 (18.6%)	50 (26.0%)	
Living with whom; n (%)			
Alone	27 (11.4%)	23 (11.9%)	0.849
One or both parents	70 (29.6%)	91 (47.3%)	0.001
Roommate	47 (19.9%)	24 (12.5%)	0.042
Significant other	71 (30%)	37 (19.2%)	0.011
Others ^c	36 (15.2%)	53 (35.0%)	0.001
Following a specific diet; n (%)	124 (52.4%)	67 (35.0%)	< 0.001
Glycated Haemoglobin (HbA1c); n (%) ^d			
< 6%	24 (12.1%)	NA	
6-7.5%	103 (52.2%)	NA	
7.5-9%	59 (29.9%)	NA	
>9%	11 (5.5%)	NA	
Hypoglycemic episodes in a week; mean (SD)	2.2 (1.1)	NA	
Met with a dietitian; n (%)	136 (61.5%)	NA	
DNKS ^e score; mean (SD)	84.1 (11.4)	NA	

^a=comparison between both groups; ^b= Newfoundland, The Maritimes and Northwest Territories; ^c=brothers/sisters, grandparents, children, other; ^d= n= 197; ^e= diabetes nutrition knowledge survey, maximal score on 100 points

Table 3-2 Food literacy score and related domains

	PWT1D (n=236)	CONTROLS (n=191)	P Value^a
KNOWLEDGE			
SFLQ score ^b ; Mean score (SD)	39.1 (5.4)	36.0 (6.3)	< 0.001
Nutrition & Disease; Mean score (SD)	2.7 (1.26)	2.9 (0.99)	0.249
Main sources of nutritional information; n (%) ^c			
Websites	164 (69.4%)	133 (69.6%)	0.976
Food label	170 (72.0%)	94 (49.2%)	< 0.001
Books	89 (27.7%)	46 (24.0%)	0.002
Scientific articles	40 (16.9%)	64 (33.5%)	< 0.001
Others ^d	230 (97.4%)	138 (72.2%)	< 0.001
SKILLS			
Who prepares most meals; n (%)			< 0.001
Myself	176 (74.5%)	91 (47.6%)	
Parents	41 (17.3%)	82 (42.9%)	
Significant other	16 (6.7%)	10 (5.2%)	
Other (friend, sibling, eat out)	3 (1.2%)	8 (4.1%)	
Ability to cook from basic ingredients; mean (SD)			0.020
Basic cook ^e	32 (14.8%)	46 (24.0%)	
Competent cook ^e	204 (86.4%)	145 (75.9%)	
CONFIDENCE			
Confidence in preparing well balanced & tasty meals; n (%)			0.035
Very Low/Low	18 (7.6%)	26 (13.6%)	
Moderate	89 (37.7%)	71 (37.1%)	
High/ Very High	129 (54.6%)	94 (49.2%)	
Confidence in looking up recipes; n (%)			0.270
Very Low/Low	20 (8.4%)	25 (13.0%)	
Moderate	64 (27.1%)	53 (27.7%)	
High/ Very High	152 (64.4%)	113 (59.1%)	
DIETARY INTAKE			
Fruits & Vegetables at each meal; n (%)	159 (69.4%)	165 (88.7%)	< 0.001
Protein source at each meal n; (%)	174 (75.9%)	145 (78.3%)	0.564
Starch at each meal; n (%)	164 (71.6%)	139 (75.1%)	0.421
Restaurant/ take-out; n (%)	72 (31.3%)	73 (47.4%)	0.001
Following balanced plate ^f ; n (%)	165 (72.3%)	149 (80.9%)	0.250
How often juice is consumed; n ^g (%)			< 0.001
Never/ Rarely	48 (22.1%)	88 (47.5%)	
Monthly	43 (19.8%)	18 (9.7%)	
Once-Few times/ week	53 (24.4%)	51 (27.5%)	

	Once -Multiple times/ day	73 (33.6%)	28 (15.1%)	
How often soda is consumed; n ^h (%)				< 0.001
	Never/ Rarely	64 (29.6%)	105 (56.7%)	
	Monthly	10 (4.6%)	31(16.7%)	
	Once-Few times/ week	141 (65.2%)	31 (16.7%)	
	Once-Multiple times/ day	1 (0.4%)	18 (9.7%)	

^a= comparison between groups; ^b=Short food literacy questionnaire; ^c= participants able to select more than one options; ^d= newspaper, TV, school, family member, social network, cell phone apps, others (clinics, youtube, dietitian); ^e=basic cook included: 'I don't know where to start when cooking', 'I can do things such as boil an egg or cook a grilled cheese' and 'I can prepare simple meals but nothing too complicated' and Competent cook included: 'I can prepare most dishes', 'I can cook most dishes if I have a recipe to follow' and 'I frequently prepare sophisticated dishes'; ^f=1/2 vegetables & fruits, ¼ protein & ¼ starch; ^g = n =217 responses of PWT1D and n = 185 responses of controls; ^h = n= 216 responses of PWT1D and n = 185 responses of controls

Table 3-3 Association between SFLQ score and living with diabetes

Variables	β [95% CI]	P value
Living with diabetes	2.07 [1.47 - 3.81]	< 0.001
Age	-0.05 [-0.23 - 0.12]	0.531
Gender	0.46 [-5.80 - 6.74]	
	Female 0.46 [-5.80 - 6.74]	0.863
	Male -0.63 [-6.97 - 5.69]	0.852
Education		
	College/CEGEP 2.12 [1.24 - 4.30]	0.002
	Uni/Grad 2.45 [0.92 - 3.99]	0.007
Nutrition & Diseases knowledge	0.12 [-0.26 - 0.51]	0.520
Confidence prep. well balanced tasty meals		
	Moderate 1.89 [-0.19 - 3.98]	0.051
	High/Very High 5.13 [3.02 - 7.25]	< 0.001
Ability to cook from basic ingredients		
	Basic Cook 0.13 [0.09 - 0.18]	0.125
	Competent Cook 0.86 [0.81 - 0.90]	0.109
Consuming fruits & vegetables at each meal	1.26 [0.01-2.50]	0.042

Multivariable linear regression model adjusted for age, gender, education, nutrition & disease knowledge, confidence in preparing well balanced & tasty meals, ability to cook from basic ingredients and consuming fruits and vegetables at meals

Table 3-4 Association between food literacy and diabetes nutrition related knowledge

Variables	β [CI 95%]	P value
DNKS	0.226 [-0.24-0.69]	0.347
Age	-0.104 [-0.36-0.15]	0.431
Education	0.429 [-0.42-1.28]	0.322
Who prepares meals	-0.304 [-1.49-0.88]	0.614
Age of diagnosis	-0.009 [-0.12-0.10]	0.875

Multiple linear regression model adjusted for age, age of diagnosis, education and who prepares meals

Appendix 1 - Topics covered with dietitian PWT1D & diets followed by both groups

Topics covered with dietitian; n (%)		
	Carbohydrate counting	150 (63.7%)
	Snacks	97 (41.5%)
	General nutrition	86 (36.6%)
	Insulin adjustment	82 (34.8%)
	Physical activity	77 (32.2%)
	Meal planning	75 (31.8%)
	Recipes	31 (13.1%)
	Food Labels	59 (25.0%)
	Hypoglycemia	57 (24.4%)
	Portion sizes	51 (21.7%)
	Blood glucose self monitoring	49 (20.8%)
	Concerns re: living with T1D	43 (18.5%)
	Cell phone applications	43 (18.5%)
	Weight management	42 (17.8%)
	Alcohol	35 (14.9%)
	Insulin pumps	33 (14.0%)
	Weight management	32 (13.5%)
	Portion sizes	31 (13.1%)
	Sleep	17 (7.2%)
Diets followed; n (%)		
	PWT1D	Controls
Low carbohydrate (< 100g carbohydrates)	38 (16.5%)	7 (3.6%)
Vegetarian	23 (10.1%)	13 (6.8%)
Gluten free	20 (8.8%)	7 (3.6%)
Ketogenic	4 (2.1%)	3 (1.5%)
Raw foods	2 (0.8%)	1 (0.5%)
Intermittent fasting	2 (0.8%)	12 (6.2%)
Paleo	1 (0.4%)	2 (1.0%)
Whole 30	1 (0.4%)	1 (0.5%)

Vegan	7 (3.3%)	7 (3.6%)
Mediterranean	3 (1.2%)	3 (1.5%)
Other ^b	9 (4.2%)	12 (6.2%)
None	136 (58.0%)	141 (74.3)

^b= Fodmap (fermentable oligosaccharides, disaccharides, monosaccharides and polyols), pescatarian, meal plan, low sodium, no refined sugar

CHAPTER 4 GENERAL DISCUSSION

4.1 Main outcomes

The objective of this study was to assess the proportion of participants with adequate food literacy in young Canadian adults living with T1D and compare the proportion of participants with adequate food literacy to the participants living without diabetes. Our hypothesis was confirmed in that at least 50% of our sample of young Canadian adults living with T1D have adequate food literacy (88%) and that a greater proportion of these individuals have adequate food literacy compared to those living without diabetes (88% vs. 68%). This is interesting to note as our study demonstrates that living with T1D is associated with a higher food literacy score, but a greater food literacy score does not translate to better dietary choices.

From this thesis, we learnt that food literacy is a concept that goes beyond nutrition knowledge and encompasses skills and confidence in food preparation and cooking. Additionally, food literacy is associated with having a higher education and preparing meals on your own.

This study was conducted as there was limited existing research on food literacy in PWT1D. Our study provides the basis of information of food literacy on this clinical population and demonstrates the need for further investigations on this topic and to understand impeding factors on adequate food literacy and dietary choices.

4.2 Strengths and Limitations

Compared to other studies investigating food literacy, this is the first study to explore this concept with regards to PWT1D. This is important as the Diabetes Clinical Practice Guidelines

of 2018 recognizes the role of food skills, a component food literacy, can have on diabetes management (10). Using the validated SFLQ and the DNKS allowed us to see if there was an association between food literacy and nutrition knowledge, which provided a novelty finding. Other strengths of this study were the large sample size that allowed us to have adequate power to detect a significant difference between the study groups. There were many variables collected and studied, which allowed us to have a greater understanding of food literacy amongst our study population. This large number of variables collected allowed us to run many statistical tests to interpret our data. Overall, we were able to get a snapshot of the food literacy level in this clinical population and of the comparator group and understand what food literacy entails. Lastly, the software *Survey Monkey* that was used for our online questionnaire and had excellent features to ensure participants met the eligibility criteria.

Limitations of the study were the following. When obtaining responses through an online survey there is the risk of false responses as there is no way to accurately know if the participants responding are being truthful. Our study did not adequately represent all young Canadian adults, as there was an overrepresentation of female participants and majority of participants were living in Quebec or Ontario. It would have been interesting to assess the relationship between food literacy and living alone, as those living alone would likely be more autonomous in meal preparation. However, we were unable to appropriately run any statistical tests to assess this association, as the participants were able to select more than one option for the variable 'living with whom'. Also, participants were not able to contribute if they did not have access to a computer or the internet, therefore limiting low socioeconomic groups from participating in the study. Although the sample size was large enough to have sufficient power, the majority of

participants reported adequate food literacy and there was few that reported inadequate food literacy, which did not allow for sufficient variance and created some very large odd ratios. These large odd ratios presented challenges in analyzing the results in some areas.

4.3 Future directions

My thesis provides a basis for understanding what food literacy entails and gives a general idea of the level of food literacy among young Canadian adults living with and without diabetes. Our study shows that PWT1D have a high level of skills and confidence in meal preparation and cooking, however we do not know how they developed these skills. Future studies could look at how these individuals developed food preparation and cooking skills, which could help create interventions in improving food literacy amongst individuals. We could also study how and when cooking skills were learnt, and barriers faced in preparing and consuming well balanced meals. Although our study indicates that there is no association between food literacy and the consumption of fruit and vegetables among PWT1D, the literature suggested otherwise. Therefore, it would be interesting to understand why young Canadian adults living with T1D have a lower intake of fruits and vegetables and to investigate if this is truly related to the lack of food labels on these food items and to then properly address it.

The literature suggested that overweight and obesity are increasing in PWT1D, which can be associated with poor health outcomes (4). Our study shows that PWT1D have good diabetes nutrition related knowledge, through the DNKS. However, research showed despite having nutrition related knowledge, interventions at addressing overweight and obesity have been unsuccessful. It was believed that the interventions did not produce the desired outcome because

there was no connection made between nutrition knowledge, skills and dietary choices (7).

Nutrition related knowledge is insufficient in addressing poor health outcomes; therefore, food literacy can be essential in helping to improve overweight, obesity and related comorbidities (7).

It would be interesting to investigate the relationship between food literacy, the risk of CVD and other comorbidities.

The information obtained in this study is pertinent in being able to create appropriate interventions in helping in T1D management. Moving forward, research of randomized trials involving interventions including food literacy could be of importance to evaluate its impact on diabetes management. If results are significant, these findings could be included in future diabetes clinical guidelines.

4.4 Conclusion

In summary, our findings indicate that there is a higher proportion of young Canadian adults living with T1D that have adequate food literacy compared to those living without diabetes. Our research was the first to study food literacy in this clinical population and determine key components of food literacy through statistical analysis. Food literacy among patients may be one missing piece to improve health behaviours and to help in the prevention of comorbidities and complications in T1D. The novel information discovered can help guide future research using food literacy as the basis for interventions in addressing diabetes management, overweight and obesity and health outcomes.

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APPENDIX

English consent form

Thank you for agreeing to receive information about our research study. Before agreeing to participate, please read the information below to help you understand the study and what will happen if you agree to participate. If you have any questions or comments that you would like us to answer before you proceed with participating in the study, please contact us by phone or email (contact information are at the end of the document).

Purpose: The purpose of this research study is to understand how young adults make their food choices.

Procedures: If you agree to participate: you will click “agree” at the end of this form.

You can then begin the questionnaire. It will take you up to 25 minutes to complete the questions. You can start and stop and your answers will be saved. When you are done, you will ‘submit’ the answers. Some questions ask about you (e.g., age, gender), and your health, and some ask about your eating habits and food choices. For many questions, you will have a choice of answers and we ask that you choose the answer that best corresponds to what you are living.

Potential Benefits: Although you will not benefit directly from the study results, will help the research team better understand how “young adults” make their food choices.

Risk and Discomforts: One inconvenience will be the time that it takes to complete the questionnaires. There are also risks associated with sending personal information over the internet. We are using a secure website to protect your personal information.

Compensation: Upon completion of the survey you will receive instructions regarding how to have your name entered into a lottery for a chance to win an Ipad Mini.

Voluntary Participation and/or Withdrawal: Your participation in this study is strictly voluntary. You may refuse to participate or you may discontinue your participation at any time without explanation.

Confidentiality:

All information obtained during the study will be kept confidential as required or permitted by law. Your identity will not be associated with your responses.

In order to ensure your protection and quality control of the research project, the following organizations could consult your research records:

The sponsor(s) of this project;

Research ethics committees or a person mandated by one of them;

These organizations all adhere to a confidentiality policy.

If information from this study is published or presented at scientific meetings, your name and

other personal information will not be used.

The principal investigator, Anne-Sophie Brazeau, will be responsible for securely storing all the research data for 7 years.

If you have any questions or concerns about your rights or welfare as a participant in this research study, please contact the Manager, Research Ethics at 514-398-6831 or Lynda.mcneil@mcgill.ca.

Contact information:

Investigators:

Anne-Sophie Brazeau, RD, PhD, McGill University
Meranda Nakhla, MD, Montreal Children Hospital
Sarah Blunden, RD, CDE, LMC Clinic
Maude Lafontaine Hébert, RD, Montreal Children Hospital

Should you have any questions concerning this study, you may call the study center at 514-398-7848 to speak with the principal investigator, Anne-Sophie Brazeau, or the study coordinator, Vanessa Maggio (student researcher). You may also email us at foodchoices.study@gmail.com.

I have read through this page and understand it. I do not waive my legal rights by consenting to participate.

[French consent form](#)

Merci d'avoir accepté de recevoir de l'information par rapport à notre projet de recherche. Avant d'accepter de participer au projet, lis l'information qui suit. Ceci va t'aider à mieux comprendre le projet et ce que tu devras faire si tu acceptes de participer. Si tu as des questions ou des commentaires dont tu voudrais discuter avant de participer au projet, svp contacte-nous par téléphone ou par courriel (les coordonnées sont à la fin de ce document).

Objectif: Nous faisons cette recherche afin de mieux comprendre comment les « jeunes adultes » font leurs choix alimentaires.

Procédures:

Si tu acceptes de participer, tu devras appuyer sur « J'accepte » à la fin de ce formulaire.

Tu pourras ensuite commencer le questionnaire en ligne. Nous estimons qu'il te prendra environ 25 minutes pour répondre à toutes les questions. Tu pourras débiter et arrêter de répondre aux questions à tout moment et tes réponses seront sauvegardées.

Lorsque tu auras complété le questionnaire, clique sur « soumettre ». Certaines questions concernent des informations démographiques (ex. genre, âge) et ta santé, d'autres concernent tes

habitudes and tes choix alimentaires. Pour plusieurs questions, tu auras un choix de réponses et nous te demanderons de choisir celles qui correspondent le mieux à ce que tu vis. Tu n'as pas à répondre à toutes les questions si certaines te rendent inconfortable.

Bénéfices potentielles: Tu n'obtiendras pas de bénéfices directes en participant à cette étude mais tu vas aider l'équipe de recherche à mieux comprendre comment « les jeunes adultes » font leurs choix alimentaires.

Risques et inconvénients: Un inconvénient du projet est le temps que ça prend pour répondre au questionnaire. Il y a des risques liés à la transmission d'informations personnelles par internet. Nous utiliserons un site web sécurisé pour protéger les informations personnelles.

Compensation: Afin de te remercier pour ta participation, ton nom sera inscrit à une loterie pour une chance de gagner un Ipad Mini. Tu devras envoyer un courriel à la coordonnatrice de l'étude lorsque tu auras terminé le questionnaire pour que ton nom soit entré dans le tirage.

Participation volontaire et/ou retrait de ton consentement: Ta participation à cette étude est strictement volontaire. Tu peux refuser de participer ou cesser de participer à tout moment sans fournir d'explication.

Confidentialité: Toutes les données collectées seront conservées de façon confidentielle tel que prescrits ou permis par la loi. Votre identité ne sera pas associée à vos réponses. Afin d'assurer ta sécurité ainsi que pour faire un contrôle de la qualité du projet de recherche, les organismes suivants pourraient consulter les dossiers de recherche :

Les commanditaires du projet;

Les comités d'éthiques ou une personne mandatée par eux;

Ces organismes adhèrent tous à une politique de confidentialité. Si des données de ce projet de recherche sont publiées ou présentées lors de congrès scientifiques, ni ton nom, ni tes informations personnelles ne seront utilisés. Le chercheur principal, Dr. Anne-Sophie Brazeau est responsable de conserver de façon sécuritaire les données de recherche durant 7 ans.

Si vous avez des questions ou des préoccupations concernant vos droits ou votre bien-être en tant que participant à cette étude de recherche, veuillez communiquer avec le gestionnaire, Éthique de la recherche au 514-398-6831 ou Lynda.mcneil@mcgill.ca.

Information pour nous joindre : Si tu as des questions, tu peux nous contacter au 514-398-7848 ou par courriel au foodchoices.study@gmail.com

Si j'ai des questions concernant l'étude, je peux téléphoner au centre de recherche, au 514-398-7848, pour parler à la coordonnatrice Vanessa Maggio (chercheuse étudiante) ou à la chercheuse principale, Dr. Anne-Sophie Brazeau

J'ai lu ce document et je le comprends. Je ne renonce à aucun des droits qui me sont reconnus par la loi en acceptant de participer à ce projet.

List of organizations

Calgary Insulin Pumpers (Alberta)
Canadian Celiac Association
Canadian Obesity Network
Celiac association NL & Labrador chapter
Celiac Association of Canada Calgary
Connected In Motion
Crohn's and Colitis Canada
Diabète Québec
Diabetes Canada
Dskate Canada
Live Well! Bien Vivre!
National Aboriginal Diabetes Association
Southern Ontario Aboriginal Diabetes Initiative
The Canadian Addison Society
Vancouver Island Addison support group
Waltzing the dragon
Waterloo Wellington Diabetes
Young & T1
Athletes+causes
Beyondtype1.org
Diabetes Care Community
Diabetic connect
T1dactiveliving
TheCeliacScene
Type 1 Diabetes Think Tank Network
type1diabetesproject
Type1strong
Uwalk
Abbott Freestyle
Accu-Chek Canada
Banting House
Canadian Diabetes Care Guide
Centre for Studies in Primary Care (CSPC)
Champlain Diabetes Services
Diabetes Care Program of Nova Scotia
Dietitians of Canada
Guelph General Hospital
Health Prince-Edouard-Island
Horizon Health network for the Maritimes
Hotel Dieu Hospital
Huron Perth Diabetes Education Program
IWK Health Centre

Joseph Brant Hospital
Markham Stouffville Hosp
Medavie Blue Cross
Medtronics Canada
MYSUGR
Niagara Health System
Norfolk General Hospital
Provincial Council for Maternal and child health
Rouge Valley Health System
St. Joe's Youth Wellness Centre
Stollery Children's Hospital
Trillium Health Partners
Fondation Du Diabete Juvenile
Huron Perth Diabetes Education Program
Diabetes Care Program of NS
Diabetes Nurse Educator
Hotel Dieu Hospital
Champlain Diabetes Services
Social Worker
http://www.diabetestalk.ca/
Diabetes Comprehensive Care Program St. Michaels Hospital Toronto
Center for Integrated Diabetes Care Women's College Hospital
LMC Diabetes
MDCM Clinic Montreal
Charles H. Best Diabetes Center, Ontario
Diabetes Education Center - Niagara Health
Cleveland Clinic Canada - Endocrinology
Dawson College
Marionopolis College
John Abbot College
Family Medicine Clinic on Cote Des Neige
Wagar (high school for adults)
YMCA language school
Carlton Ottawa high school for adult
Diabetes Camps
McGill Uni facebook group to sell items
I challenge diabetes
VPN Type 1 Diabetes group
Youth in action Diabetes Canada
Ottawa Diabetes Support group (Diabetes Canada)
Alberta diabetes foundation (they have 2 chapters)
Connected in Motion diabetes education group
Diabetes at school
Ottawa Public Health
Diabetes Advocacy group (education&awareness)

Beyond type 1
Health Link BC
Preventing and living with type 1 diabetes Canada
Diabetes Center in Ontario
UBC small steps big change re: Diabetes
CBC Website
T1 International
My health alberta
Toronto Diabetes Care Connect
BC diabetes
T1D thinktank network
Diabetes Heart and Stroke Foundation
Type 1 Together
Diabetes Canada Manitoba Facebook page
Diabetes Action Canada Network
Alberta's Diabetes Institute (associated with U Alberta)
HAPI la sante des adultes
Carb counting mama
I challenge diabetes
Ottawa public health
Diabetes care community
University of Manitoba Diabetes Clinic
Half your plate (initiative to increase fruits and vegetable intake)
Sanofi Canada (educational programs for pts)
Insulet Corporation
Ascensia diabetes care Canada
Womens college hospital
Bcdiabetes
Diabetes Depot
Diabetes Community
CDN chapter at U of T