

Development and Evaluation of a Gluten-Free Food Guide for Children and Youth

by

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Abstract

Background: Celiac disease (CD) is an autoimmune disease that results in inflammation and damage to the small intestine when gluten, a protein found in wheat, rye or barley is consumed. The only treatment for CD is lifelong adherence to the gluten-free diet (GFD). However, dietary intake can be high in saturated fat, sugar and lower in micronutrients such as folate. Currently, no comprehensive pediatric guidelines exist that address the nutritional limitations of the GFD. The purpose of this thesis was to describe the development and evaluation of a gluten-free (GF) food guide for children and youth (4-18 years) and to describe potential factors (e.g. home food environment, food literacy) that may influence food guide uptake by children and youth with CD, their parents and health care professionals.

Methods: Guide development included a comprehensive evaluation of dietary intake and patterns in children/youth with CD, the development of GFD simulations (n=1260) and pre-and-post guide stakeholder consultations with 656 members of the CD community (children/youth, parents of children/youth with CD) and 231 health care professionals using focus group and survey methodology. Factors that may influence guide uptake were assessed in 16 households of youth with CD (home food environment, parental food literacy, youth dietary intake and food purchasing patterns) using validated surveys, dietary recalls and food receipt methodology.

Results: The pediatric GF plate model was developed based on diet simulations that met 100% of macronutrient and micronutrient needs for age-sex with the exception of vitamin D. The GF plate model recommends intake of >50% fruits and vegetables (F&V), 25% protein foods and <25% grains. There is an emphasis on plant-based food sources and the recommended beverage of choice is unsweetened fluid milk or a plant-based alternative fortified with calcium and vitamin D. Post-

guide stakeholders (n=353) positively perceived the guide for content, layout, feasibility, ethnicity and usability. It was perceived that the guide can be used in multi-ethnic community and clinical-based settings. Youth with CD (n=16) living in households of higher socioeconomic status with parental food literacy and diverse at-home food availability including F&V, reported dietary intake of F&V below GF plate model recommendations by over 30%. Larger proportions of nutrient-poor foods such as snacks (>35% dietary intake) were consumed taking up >1/3 of the plate.

Conclusions: A GF food guide for children and youth was positively perceived by stakeholders and addresses an important gap in literature. Ongoing work will focus on guideline uptake in children/youth with CD on the GFD. Advocacy efforts for public health policies related to healthy and affordable food environments for diverse children and youth with CD and their families are equally warranted.

Preface

This thesis is an original work by Samantha Cyrkot and Dr. Diana Mager's research group. The research projects, of which this thesis is a part, received ethics approval from the University of Alberta Research Ethics Board and/or the University of Calgary Conjoint Health Research Ethics Board, Project Names: "Quality of life and adherence to the gluten-free diet in children with celiac disease" No. Pro00033867 (05 Sept 2012); "Development of a gluten-free food guide for Canadians" No. Pro00065489 (07 Sept 2016); "A gluten-free food guide: a feasibility analysis" No. Pro00103128 (05 Aug 2020); "The home study" No. Pro00087877 (08 Feb 2019), No. REB19-1110 (05 Aug 2019).

Chapter 3 of this thesis has been published as "Diana R. Mager, Samantha **Cyrkot**, Christine Lirette, Herbert Brill, Jenna Dowhaniuk, Heather Mileski, Carlota Basulado-Hammond, Roseann Nasser, Esther Assor, Margaret Marcon, Justine M. Turner. (2021) Nutritional considerations of a paediatric gluten-free food guide for coeliac disease. *British Journal of Nutrition*, 1-10. doi: 10.1017/S0007114521000994". Samantha **Cyrkot** and Christine Lirette contributed to conceptualization, data curation, formal analysis, methodology, funding acquisition (S.C only, as scholarship funding), project administration (C.L only), resources, software, validation, co-wrote manuscript and approved the final version prior to submission. Diana R. Mager was responsible for all study aspects including design/inception, supervision of data collection, methodology, funding acquisition (operational funding), data analysis, intellectual and scientific interpretation, co-wrote manuscript and approved the final version prior to submission. All other authors contributed to conceptualization, data curation, investigation, validation, writing – review & editing and approved the final manuscript prior to submission.

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List of Abbreviations
in alphabetical order

AI	adequate intake
AMDR	acceptable macronutrient distribution range
ANGCY	Alberta Nutrition Guidelines for Children and Youth
ATTG	anti-transglutaminase
BMI	body mass index
C	child/youth
CCHS	Canadian Community Health Survey
CD	celiac disease
CFG	Canada's Food Guide
CON	controls
COVID-19	Coronavirus Disease 2019
DFE	dietary folate equivalent
DQ	diet quality
DRI	dietary reference intake
Dur	duration
EAR	estimated average requirement
FODMAP	fermentable oligosaccharides, disaccharides, monosaccharides and polyols
F&V	fruits and vegetables
g	grams
GF	gluten free/gluten-free
GFD	gluten-free diet

GI	glycemic index
GL	glycemic load
HC	healthy controls
HEI-C	Canadian Healthy Eating Index
HFI	home food inventory
HLA	human leukocyte antigen
HP	health care professionals
IQR	interquartile range
IU	international units
kcal	kilocalories
kg	kilograms
KIDMED	Mediterranean Diet Quality Index in children and adolescents
Mg	magnesium
mg	milligrams
MUFA	monounsaturated fatty acids
N	no
NEMS-P	Perceived Nutrition Environment Measures Survey
NLit	Nutrition Literacy Assessment Instrument
P	parent
PUFA	polyunsaturated fatty acids
RD	Registered Dietitian
RDA	recommended dietary allowance
RN	Registered Nurse

Sat.	Saturated Fat
Tbsp	tablespoon
tsp	teaspoon
µg	micrograms
UL	tolerable upper intake level
vit.	vitamin
vs.	versus
WCHRI	Women and Children's Health Research Institute
y	years
Y	yes

Publications and Presentations

Publications Related to this Master's Thesis:

1. Mager DR, **Cyrkot S**, Lirette C, Brill H, Dowhaniuk J, Mileski H, Basulado-Hammond C, Nasser R, Assor E, Marcon M, Turner JM. (2021) Nutritional considerations of a paediatric gluten-free food guide for coeliac disease. *Br J Nutr*, 1-10. doi: 10.1017/S0007114521000994.
2. Mager DR, **Cyrkot S**, Lirette C, Brill H, Dowhaniuk J, Mileski H, Basulado-Hammond C, Nasser R, Assor E, Marcon M, Turner JM. (2021) Evaluation of a paediatric gluten-free food guide by children and youth with coeliac disease, their parents and health care professionals. *Br J Nutr*, In press. doi: 10.1017/S0007114521002774.
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5. **Cyrkot S**, Anders S, Kamprath C, Liu A, Mileski H, Dowhaniuk J, Nasser R, Marcon M, Brill H, Turner JM, Mager DR. (2020) Folate content of gluten-free food purchases and dietary intake are low in children with coeliac disease. *Int J Food Sci Nutr* 71:7, 863-874. doi:10.1080/09637486.2020.1734545.

Abstract Presentations

6. **Cyrkot S**, Gidrewicz D, Turner JM, Mager DR. (Nov 2020) The impact of COVID-19 on the food environment, the cost of gluten-free foods and youth diet quality in households with youth with celiac disease in Alberta Women and Children's Health Research Institute Research Day 2020 (Submitted Virtual Abstract).
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8. **Cyrkot S**, Frankish A, Lirette C, Wong E, Ooi PH, Persad R, Carroll MW, Turner JM, Mager DR. (May 2020) Does a high FODMAP diet influence perceptions of gastrointestinal pain, diet quality and health-related quality of life in children with chronic mild gastrointestinal complaints?. (2020) Canadian Nutrition Society: 2020 Scientific Abstracts (Virtual Poster Presentation). *Appl Physiol Nutr Metab* 45, S1-S56.
9. **Cyrkot S**, Turner JM, Haqq A, Mager, DR. (Feb 2020). The effects of the home food environment, food purchasing patterns and food literacy on diet quality and glycemic control in youth with celiac disease and type 1 diabetes consuming the gluten-free diet. Course: AFNS 601, Seminar In Human Nutrition and Metabolism. (Speaker). Edmonton, Alberta, Canada.
10. **Cyrkot S**, Turner JM, Haqq A, Mager DR. (Sept 2019) Food literacy is an important contributor to diet quality in youth. Alberta Diabetes Institute Research Day. Edmonton, Alberta, Canada. (Poster Presentation).

Chapter 1: Literature Review

1.1 INTRODUCTION

Food-based dietary guidelines have been used in a variety of countries (e.g. Canada, United States, Brazil, Australia, United Kingdom) as an education and policy tool to promote healthy eating and prevent chronic disease. Dietary guidelines provide nutritional advice to optimize dietary intake. They are often accompanied by a visual representation such as a plate or pyramid to translate scientific evidence into practical nutritional recommendations for the public. These tools guide the public and allows them to make informed food choices to follow a healthy eating pattern^(1, 2). Health Canada describes the role of a food guide as, “*basic education tools that are designed to help people follow a healthy diet... They translate the science of nutrient requirements into a practical pattern of food choices, incorporating variety and flexibility*”⁽³⁾. The first Canadian food guide was called ‘Canada’s Official Food Rules’ and was introduced in 1942 to the public. The purpose of the guide was to prevent nutritional deficiencies and to improve the health of Canadians in the context of food rationing and poverty due to World War II. Since then, the guide has undergone nine revisions including name changes where ‘Canada’s Official Food Rules’ became ‘Canada’s Food Rules’ (1944, 1949) and in 1961, the first version titled ‘Canada’s Food Guide’ (CFG) was presented to the public. Following this, ongoing updates have been made to the name, design and messaging to reflect the evolving scientific evidence and to consider social and environmental factors that may influence dietary intake. In 1977, a ‘Report of the Committee on Diet and Cardiovascular Disease’ was submitted by an appointed committee of experts to Health Canada who was advised to take action to prevent diet-related chronic diseases (e.g. obesity, cardiovascular disease, type 2 diabetes). This encouraged the release of the 1982 guide where messaging that once focused on addressing nutrient deficiencies was now being joined with

messaging to reduce diet-related chronic diseases⁽³⁾. Although the guide has continued to focus on chronic disease prevention and promote nutritional health among Canadian children/youth, adults and seniors (≥ 2 years), the CFG does not directly address the needs of any clinical populations. The purpose of this literature review is to describe the guiding principles related to the development of the 2019 CFG and factors influencing uptake of food guide recommendations in Canadian children/youth and adults. This review will also highlight the implications that these factors play in the development of a gluten-free (GF) food guide for Canadian children and youth with celiac disease (CD).

1.2 THE 2019 CANADA'S FOOD GUIDE

1.2.1 The Revision Process

The latest version of the CFG was released by Health Canada on 22 January 2019. The target audience is the Canadian population who is two years of age and older⁽⁴⁾. The CFG includes a food guide snapshot with healthy eating recommendations (**Figure 1.1**) and the Canada's Dietary Guidelines for Health Professionals and Policy Makers⁽⁴⁻⁶⁾. The objectives of the dietary guideline are, "*to promote healthy eating and overall nutritional well-being, and support improvements to the Canadian food environment*"⁽⁴⁾. This version of the guide underwent an extensive and transparent revision process where Health Canada used a systematic approach to gather, assess and analyze data from 2013 to 2018. This included reviewing the scientific evidence, existing dietary guidelines and the relevance and applicability within Canadian context. Health Canada also engaged in formal consultations with Canadians and/or stakeholders (e.g. health professionals, policy makers) at four separate timepoints to ensure that the guide would be useful, easy to apply and easy to understand^(7, 8). Health Canada defines a formal consultation as: "*a process where*

Health Canada invites Canadians and stakeholders to comment on new or potential changes to its policies, regulations or guidance and for which there is a defined start and end date for receiving feedback⁽⁸⁾. The first open consultation occurred in fall 2016 with Canadians and stakeholders (e.g. professionals, organizations) where over 19,000 total submissions were received. Perceptions were obtained regarding the needs and expectations for the new CFG^(7, 9).

In spring 2017, Health Canada hosted an online stakeholder discussion forum to obtain perspectives on nutrition topics. Focus groups were also conducted across major cities in Canada with Canadians and stakeholders. There were a total of 12 focus groups conducted with Canadians (n=120 total participants) of which 40 youth (16-19 years) and 80 adults (>19 years) participated. There were a total of 16 focus groups conducted with stakeholders (n=128 total participants) which included registered dietitians, teachers, nurses and physical activity specialists. An additional nine telephone interviews were conducted with a variety of policy makers. The purpose of these consultations were to better understand the healthy eating habits of Canadians and how the public and stakeholders interact with and use healthy eating information^(7, 10).

The second open consultation was conducted in summer 2017. Feedback was obtained regarding the proposed healthy eating recommendations and guiding principles⁽⁴⁾. Responses were obtained from 6,771 Canadians and stakeholders, including 29 participants <18 years^(7, 11). In spring and summer 2018, extensive focus group testing was completed again in major cities across Canada with Canadians and health professionals related to guide messaging (total number of participants is unknown but youth 16-18 years participated). All findings were then summarized and a final version of the CFG was developed and released in 2019 to the public^(7, 12).

1.2.2 The Food Guide Recommendations for Children and Youth

Since 1942, the CFG has provided guidance to Canadians (≥ 2 years) which encompasses children/youth (2–18 years), adults (19–50 years), seniors (>51 years), and women who are pregnant, breastfeeding and those who could become pregnant. Over the years, the guide has also incorporated targeted messaging and supplementary resources for specific population sub-groups and life stages, including children and youth⁽³⁾. Several regions including the United States, Brazil, Australia and the United Kingdom have followed suit⁽²⁾. However, there has never been a food guide targeted solely at Canadian children/youth and their caregivers, especially those with unique dietary restrictions⁽³⁾. This type of guide would be beneficial as early-stages of life are a critical period to focus on the development of life-long healthy eating habits and behaviours which are likely to continue into adulthood^(13, 14).

In June 2008, the Alberta government released the Alberta Nutrition Guidelines for Children and Youth (ANGCY). This guideline complemented the 2007 CFG but focused on providing specific recommendations for children/youth in childcare, school and recreational settings⁽¹⁵⁾. The purpose of this guideline was “*to equip facilities and organizations with the tools they need to provide children and youth with healthful food choices in child-care settings, schools, in recreation centers, at special events, and in the community at large*”⁽¹⁶⁾. Although this is a very important resource for childcare providers outside the home (e.g. school and childcare employees), ANGCY does not specifically target children/youth with a clinical diagnosis like CD who follow a therapeutic diet (e.g. gluten-free diet [GFD]). Targeted information is warranted to ensure that children/youth with CD and their families are provided with the tools to help them consume a healthy diet.

Canada's food guide **Eat well. Live well.**

Eat a variety of healthy foods each day

Have plenty of vegetables and fruits

Eat protein foods

Make water your drink of choice

Choose whole grain foods

Discover your food guide at
Canada.ca/FoodGuide

Canada

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Canada's food guide **Eat well. Live well.**

Healthy eating is more than the foods you eat

Be mindful of your eating habits

Cook more often

Enjoy your food

Eat meals with others

Use food labels

Limit foods high in sodium, sugars or saturated fat

Be aware of food marketing

Discover your food guide at
Canada.ca/FoodGuide

Canada

Figure 1.1 The 2019 Canada's Food Guide. ©All rights reserved. *Canada's Food Guide: Snapshot*. Health Canada, 2019. Adapted and reproduced with permission from the Minister of Health, 2021.

1.2.3 The Food Guide Snapshot and Healthy Eating Recommendations

1.2.3.1 The Food Guide Snapshot

Health Canada designed the food guide to be flexible, to include a variety of tips for healthy eating habits (based on where, when and how you eat) and to recommend a variety of healthy food choices to Canadians at all stages of life⁽⁷⁾. The food guide snapshot (**Figure 1.1**) differs from the previous 2007 guide as it does not specify recommendations based on the size and number of servings^(5, 17). Health Canada heard from Canadians that the previous guide (2007) was overly complex and challenging to incorporate into their daily lifestyle^(7, 9). Therefore, the 2019 food guide snapshot highlights a plate model which is based on relative proportions and is intended to be less prescriptive and cumbersome^(7, 9). The intent is to help Canadians easily plan and build healthy meals and snacks⁽⁵⁾. The plate model has reportedly been used in over 10 different countries due to its perceived effectiveness^(18, 19). The tagline of the 2019 CFG encourages Canadians to “*Eat well. Live well. Eat a variety of healthy foods each day*”. The first page of the food guide snapshot states: 1) have plenty of fruits and vegetables (F&V), 2) eat protein foods, 3) choose whole grain foods, and 4) make water your drink of choice⁽⁵⁾. The plate model from the 2019 CFG depicts three foods groups (F&V, grains, protein) compared to the previous four food groups in the 2007 CFG (F&V, grain products, milk & alternatives, meat & alternatives). The ‘milk & alternatives’ and the ‘meat & alternatives’ food groups have been combined under the ‘protein’ group in the 2019 CFG^(5, 20). The plate model highlights eating 50% F&V, 25% whole grains and 25% protein foods with an emphasis on choosing plant-based sources more often than animal-based (**Table 1.1**)^(4, 5). This pattern of eating has been modeled after the Dietary Approach to Stop Hypertension and the Mediterranean-style diet⁽⁴⁾. Health Canada examined the literature and came to the consensus that increasing the dietary intake of plant-based foods has protective

effects in reducing the risk of cardiovascular disease, including high blood pressure and elevated blood lipids. This dietary pattern can equally help increase fibre intake (associated with a lower risk of cardiovascular disease, colon cancer, type 2 diabetes), F&V intake (associated with a lower risk of cardiovascular disease), and the intake of nuts and soy protein (associated with decreased LDL-cholesterol)⁽⁴⁾.

Table 1.1 Sources of plant and animal-based protein foods.

Plant	Animal
Legumes	Poultry
Nuts	Lean red meat, including wild game
Seeds	Fish
Soy protein (e.g. tofu)	Shellfish
Fortified & unsweetened soy beverage	Eggs
-	Fluid milk
-	Kefir
-	Yogurt
-	Cheese

Examples were obtained from Canada’s Dietary Guidelines for Health Professionals and Policy Makers⁽⁴⁾.

1.2.3.1.1 The Plate Model: Food Selection and Beverage of Choice

The food items visually shown on the plate model of the CFG snapshot are intended to be examples of healthy food choices (**Figure 1.1**). They were chosen by Health Canada based on several factors including the cost, variety, cultural relevance and availability (i.e. fresh, frozen, canned, dried)⁽⁷⁾. Water is shown next to the plate model and is highlighted as the beverage of choice⁽⁵⁾. However, fortified and unsweetened fluid milk or a plant-based beverage is not emphasized nor is a specific recommendation about calcium and vitamin D intake made for children/youth. The previous 2007 CFG encouraged Canadians to “*have 500ml (2 cups) of fluid milk every day for adequate vitamin D. Drink fortified soy beverages if you do not drink milk*”⁽¹⁷⁾. It is estimated that 500ml (2 cups) of fortified and unsweetened cow’s milk provides about 5.2 –

5.6 µg (208 – 224 IU) of vitamin D⁽²¹⁾. To our knowledge, the 2019 CFG does not indicate whether vitamin D requirements can be met by diet alone in children/youth by following the 2019 plate model. However, a study in 2019 has raised concerns that Canadian children/youth and adults are unlikely to meet dietary vitamin D needs by following the 2019 CFG recommendations⁽²²⁾. Data from the Community Health Survey (CCHS) – Nutrition for 2004 and 2015 suggests that over 45% of dietary vitamin D intake in children/youth comes from milk⁽²³⁾. A Canadian study conducted in 2014 found that over 95% of the children (10-11 years) in Alberta and Nova Scotia who consumed <1 glass of white milk per day had vitamin D intake below the estimated average requirement (EAR) of 10 µg/day (400IU/day)⁽²⁴⁾. This is not surprising as there are few other vitamin D-rich dietary sources (e.g. fish, yogurt, egg yolks) and the quantity needed to consume would not be feasible on a routine basis for children/youth⁽²¹⁾. This proportion decreased in children who consumed ≥2 glasses per day (47% in Alberta, 51% in Nova Scotia)⁽²⁴⁾. The northern latitude of Canada also prevents adequate vitamin D synthesis from sun exposure⁽²⁵⁾. The 2019 CFG's de-emphasis of milk is concerning for which vitamin D and calcium intake is key for bone health^(26, 27).

1.2.3.3 Overview of Healthy Eating Recommendations

The second page of the food guide snapshot (**Figure 1.1**) provides seven healthy eating recommendations for Canadians which targets healthy food choices and healthy eating habits. The 2019 guide uniquely encourages Canadians to be mindful of their eating and highlights the importance of food skills as well as the benefits of creating supportive food environments for healthy eating^(5, 6). These were important concepts that arose during the revision process from Canadian and stakeholder consultations⁽⁷⁾. The seven recommendations include: 1) be mindful of

your eating habits, 2) cook more often, 3) enjoy your food, 4) eat meals with others, 5) use food labels, 6) limit foods high in sodium, sugars and saturated fat, and 7) be aware of food marketing⁽⁵⁾. These healthy eating recommendations are further expanded upon and provide more specific guidance (e.g. recipes, tips) for Canadians in a subsequent document made available by Health Canada⁽⁶⁾. This includes general tips for healthy eating at different stages of life (e.g. youth, parents) which is available on a mobile-friendly web application for easier access. The food guide snapshot is available in a variety of languages which is key to ensure that all Canadians can utilize and benefit from these materials.

1.3 DIETARY INTAKE AND QUALITY OF CANADIAN CHILDREN AND YOUTH

In Canada, there is consistent evidence that the majority of Canadian children/youth do not meet their nutritional requirements and have suboptimal diet quality⁽²⁸⁻³⁴⁾. For instance, compared to the 2007 CFG recommendations for age-sex, most did not meet their minimum number of servings for fruits, vegetables and dairy^(17, 28, 31). Magnesium, vitamin A, phosphorus, potassium, calcium, vitamin D and fibre are reported nutrients of concern in the Canadian pediatric population⁽³⁰⁾. Data from CCHS suggests that children/youth (4–18 years) are eating 21–25% of their daily calorie intake from ‘other foods’ such as chips and soft drinks⁽³²⁾. This may be contributing to higher intakes of fat, sugar and sodium⁽³⁵⁾ and possibly displacing nutrient-rich foods.

Average diet quality scores tend to decline as children become older⁽²⁹⁾. This is not unexpected as eating habits change from primary to secondary school. Older children become more independent and take more control of what, where and when they eat⁽³⁶⁾. Patterns of eating in youth have been characterized as increased meal skipping (breakfast and lunch), frequent

snacking, less likely to participate in family mealtime with higher rates of eating meals outside the home⁽³⁶⁻³⁸⁾.

The percentage of children/youth who reported consuming cow's milk decreased from 2004 to 2015 based on CCHS data⁽²³⁾. Intake of plant-based beverages increased in children aged 1-8 years and females aged 14-18 years. Intake did not change in children aged 9-13 years and data was unavailable for males aged 14-18 years. Intake of fruit juice also decreased and water consumptions increased in children/youth between 2004 and 2015⁽²³⁾. This finding is in line with the 2007 CFG recommendations encouraging Canadians to reduce the intake of juice⁽¹⁷⁾. This also aligns with the 2019 CFG where water is the beverage of choice in an effort to reduce the intake of free sugar (e.g. in sweetened beverages). Free sugar has been associated with dental decay which affects about 57% of Canadian children (6-11years)⁽⁴⁾. However, the 2015 data does not suggest that this population has substituted the intake of fruit juice for whole fruits⁽³⁴⁾.

1.4 FACTORS INFLUENCING DIETARY PATTERNS CONSISTENT WITH FOOD GUIDE RECOMMENDATIONS

There are a variety of complex and multi-dimensional factors explored in the literature that can influence dietary intake and diet quality in children/youth (**Table 1.2**)^(36, 39-43). This can subsequently impact guide uptake. Factors can range from individual and social through to environmental. This can play a role in whether children/youth and their parents perceive the guide to be useful and if it translates to eating habits that align with food guide recommendations.

Table 1.2 Factors that may influence guide uptake and/or dietary patterns in children and youth.

Dietary Guideline Factors			
-Awareness	-Layout	-Usage	-Understanding
Child/Youth Factors	Household & Social Factors	Environmental Factors	
<ul style="list-style-type: none"> -Age -Food preferences & aversions -Appearance & texture of food -Time and convenience <ul style="list-style-type: none"> -Schedules & activities -Hunger/satiety -Food literacy -Body image -Emotions 	<ul style="list-style-type: none"> <u>Household</u> <ul style="list-style-type: none"> -Food affordability -Income -Employment -Education -Food availability <ul style="list-style-type: none"> -Home food inventory -Food accessibility -Food visibility <u>Family Network</u> <ul style="list-style-type: none"> -Parental dietary intake -Parental food literacy -Parental role modelling -Time and convenience <ul style="list-style-type: none"> -Employment -Family responsibilities -Family structure -Family meals <ul style="list-style-type: none"> -Frequency -Quality <u>Other</u> <ul style="list-style-type: none"> -Peer influences -Cultural food practices -Social norms 	<ul style="list-style-type: none"> -Food supply -Food price -Food availability -Food outlet proximity -Food outlet density 	

Table developed based on Woodruff et al. (2008); McKinley et al. (2005); Story et al. (2002); Ogden et al. (2020); Gerritsen et al. (2019); Sawyer et al. (2021).

1.4.1. Food Guide Awareness, Layout, Usage and Understanding

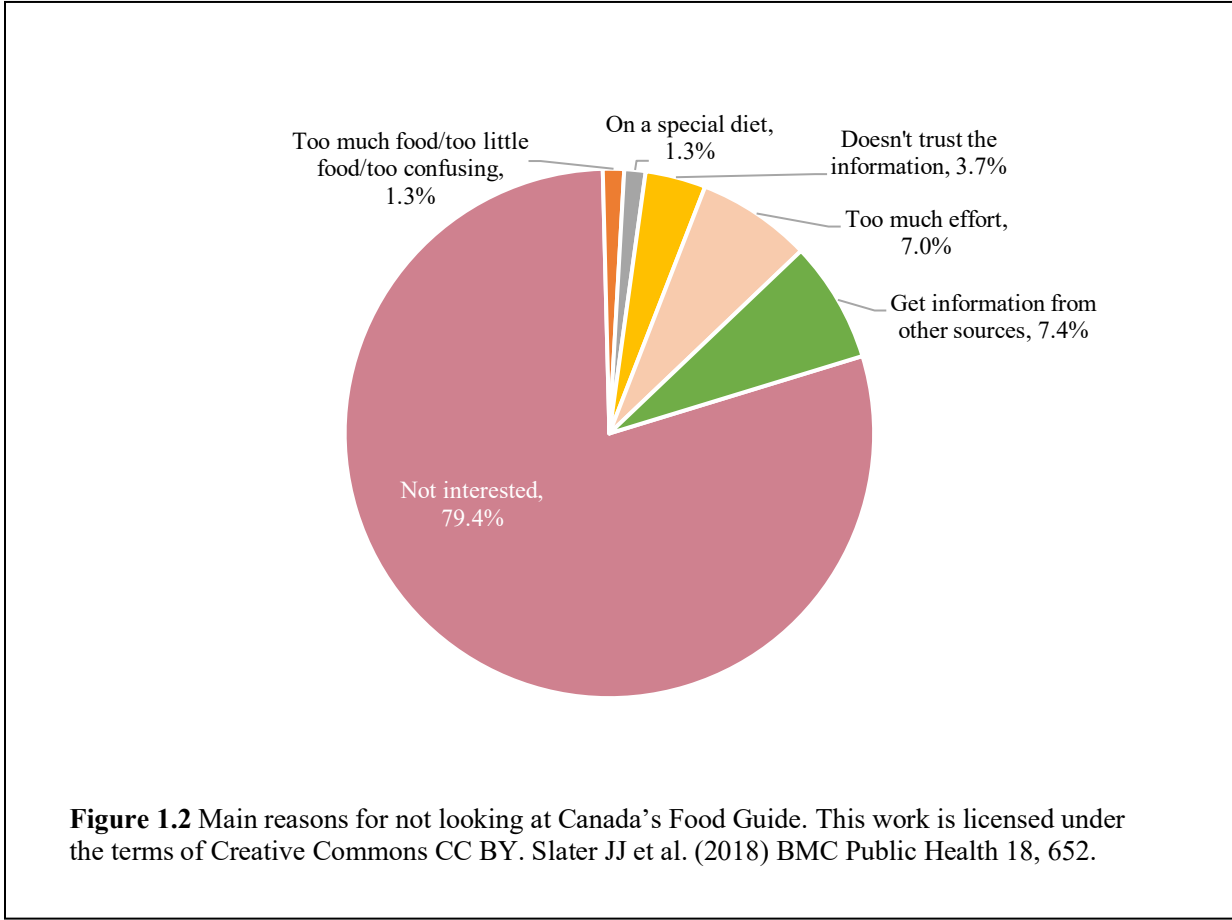
Combined data suggests that approximately 80-91% of surveyed adults in Canada (including parents of children/youth) are aware of the CFG, with more women reporting awareness compared to men^(44, 45). Mathe et al. (2015) found that greater adult awareness was correlated with being female, Caucasian ethnicity, high income and post-secondary education⁽⁴⁶⁾. However, only 8.7% of surveyed Canadian adults with guide awareness consulted it for healthy eating information⁽⁴⁷⁾. This is consistent with other data suggesting that people have a high level of awareness but low understanding and adherence to guide recommendations⁽⁴⁶⁾. Less than 30% of surveyed Canadians reported viewing the CFG (2007 version or earlier) within a 12 month period and another study found that less than 30% reported having a copy in their home^(44, 47). Those who had a copy (2007 version or earlier) reported receiving it from their child's school (20%) or from a health professional or trainer (17%)⁽⁴⁴⁾. The majority who had a copy identified as women⁽⁴⁷⁾.

Recent preliminary data ranks the CFG sixth along the spectrum of where Canadians go for healthy eating information. The guide ranks behind family and friends, general research, social media, cookbooks and magazines, and TV programs/documentaries⁽⁴⁸⁾. Children/youth are also taught about the CFG as part of many Canadian elementary school curriculums (e.g. Alberta). However, limited data is available in children/youth on its impact and long-term effectiveness.

Canadians who used the 2007 guide report that the main reasons were “to choose foods”, “to determine portions”, and to “eat well”⁽⁴⁴⁾. In the United States, the use of MyPyramid or MyPlate has been associated with healthier diets among adults⁽⁴⁹⁾. Conversely, Canadians with guide awareness who do not use it reported six main reasons as outlined in **Figure 1.2**⁽⁴⁴⁾.

The layout of the 2019 plate model is perceived to be simpler to follow for Canadians compared to the previous 2007 serving recommendations which were described as complex and

cumbersome^(7, 9). The new mobile-friendly web application is also meant to help all Canadians including children/youth easily access healthy eating recommendations⁽⁵⁾. The website includes tips, advice, a free monthly e-newsletter subscription and interactive videos to support the learning of all Canadians. Health Canada also has various social media accounts on different media platforms⁽⁵⁾. This appears to be an important stride forward as research suggests that passively distributing information is not enough to increase guide usage and adherence⁽⁴⁴⁾. Slater et al. (2018) suggests that other knowledge mobilization strategies in addition to videos and social media could include lesson plans and self-guided work booklets for different ages, demographics and settings (e.g. school, health care facilities)⁽⁴⁴⁾.



Although most Canadians including parents appear to be aware of the guide, uptake may be hindered if the population is not familiar with its content or has limited food literacy skills preventing them from understanding and applying the recommendations. A cross-sectional study surveyed 1048 Canadian adults and found that less than 45% of respondents correctly identified the four food groups in the 2007 CFG and only 0.8% could express the correct number of daily servings for each group based on their age-sex⁽⁴⁵⁾. The food groups ‘milk and alternatives’ and ‘fruits and vegetables’ were the most commonly recalled groups⁽⁴⁵⁾. Fewer food groups were recalled by adult males compared to females, older age compared to younger age, Caucasian compared to non-Caucasian ethnicities and income <\$40,000 compared to income >\$40,000 recalled⁽⁴⁵⁾. Although the CFG has been translated to many different languages, the 2007 CFG did not appear to be highly adopted by non-Caucasian ethnicities⁽⁴⁵⁾. Therefore, this is an area that also requires further exploration to better understand barriers to guide uptake. This may include evaluating guide awareness or the delivery of guide education targeted at minority populations. Guide formation processes may also benefit from considering and providing examples of different dietary patterns and food items that are beyond the Western diet (e.g. bok choy, roti, legumes, game meat) and are consumed by diverse multi-ethnic populations living in Canada.

1.4.2 Food Affordability, Accessibility and Food Security

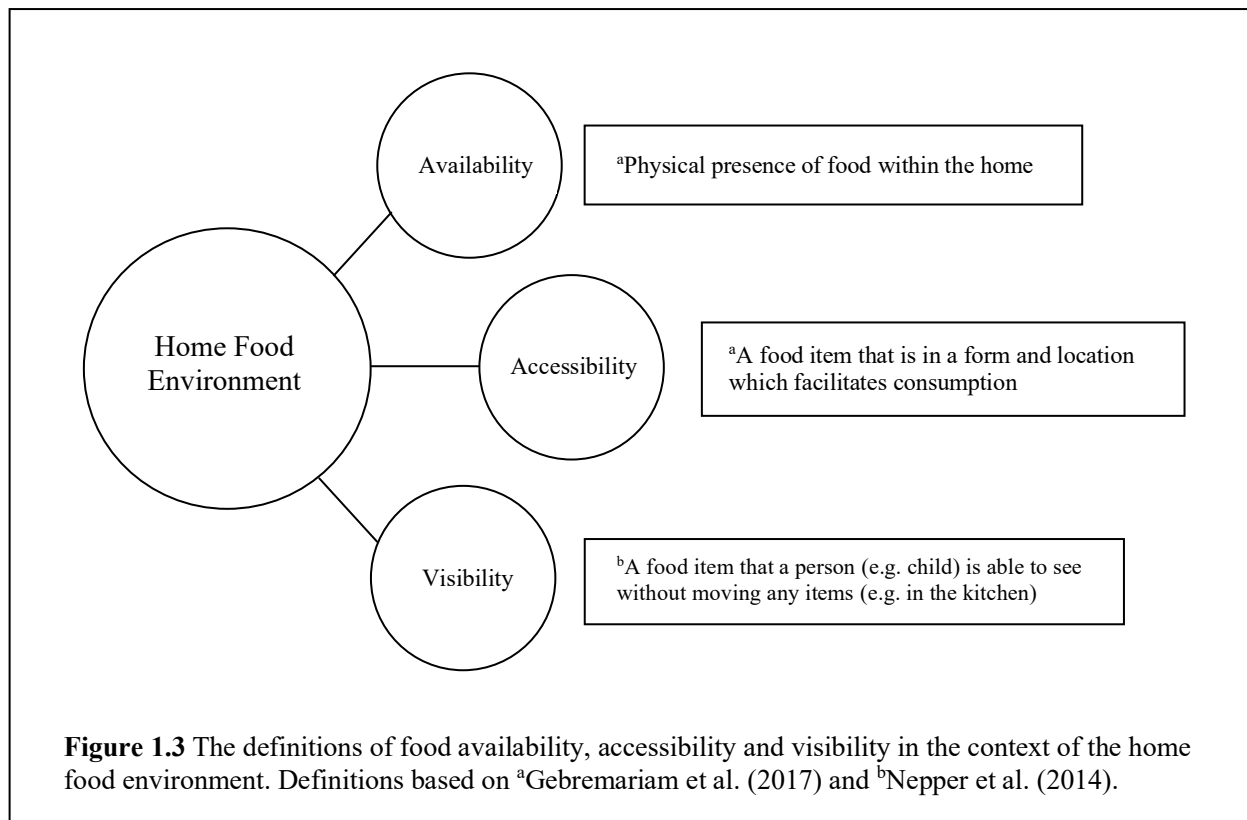
There is a link between the affordability and accessibility of nutritious foods (e.g. vegetables, fruits, milk, grains) and the social determinants of health related to income, education, and employment^(50, 51). Households of lower socioeconomic status may be more vulnerable and less likely to follow dietary patterns that align with the 2019 CFG recommendations. Preliminary data reported by Dalhousie University and the University of Guelph indicates that over 25% of

respondents (n = 254 out of 1017) feel that the 2019 CFG recommendations are not affordable to follow⁽⁴⁸⁾. This perception is anticipated to continue since the Canada's Food Price Report predicts that in 2021, total food prices will increase by 3-5%. Specifically, the cost of fruits are expected to increase by 2-4%, vegetables by 4.5-6.5% and meat by 4.5-6.5%⁽⁵²⁾. Lower food security and income has been associated with a decreased consumption of nutrient-dense foods⁽⁵³⁾. Research shows that lower income households tend to purchase and overconsume energy-dense foods due to higher costs associated with nutrient-dense options (e.g. fruits, vegetables)^(53, 54). Ongoing work needs to be done to support this population in meeting guide recommendations. This potentially includes incorporating affordable and nutritious food options within guide recommendations. Advocating for healthy public policies is also warranted (e.g. food assistance programs, income policies, subsidized housing). This is critical to ensure equitable access to nutritious foods that align with guide recommendations for all Canadians.

Food accessibility is another important consideration that may influence food guide uptake. This is particularly relevant for households living in rural locations where access to larger grocery stores with greater food variety (e.g. fresh produce) may be limited⁽⁵⁵⁾. In the United States, poor uptake of guideline recommendations has been attributed to poor access to larger grocery stores⁽⁵⁶⁾. The 2019 CFG encourages the consumption of fresh, frozen and canned foods, especially when fresh foods are out of season, costly, unavailable, or take too long to prepare⁽⁴⁾. Frozen F&V may be more feasible due to increased accessibility, longer shelf-life and year-round availability⁽⁵⁷⁾. Therefore, considering accessibility appears to be an important factor in developing realistic and useful nutritional guidelines.

1.4.3 The Home Food Environment

The home food environment has been identified as an important factor that can predict the dietary intake of children/youth and thus guide uptake⁽⁵⁸⁻⁶⁰⁾. The home environment is estimated to account for 72-93% of where food consumption occurs^(59, 61). This environment encompasses all areas in the home where food is stored⁽⁶¹⁾. This includes the refrigerator, freezer, cupboards, pantry and other areas of the home (e.g. basement, garage)⁽⁶¹⁾. Home food availability, accessibility and visibility have been suggested as important components of the home food environment and are defined in **Figure 1.3**^(58, 62). Availability, accessibility and visibility of foods in the home has been associated with healthy eating habits and dietary intake during childhood⁽⁶²⁾. Current research methods for assessing the home food inventory includes open inventory and predefined inventory checklists^(58, 63, 64). No gold standard currently exists to examine the home food inventory⁽⁵⁸⁾. The strengths and limitations of the two methods are described in **Appendix A-1**⁽⁶⁴⁾.

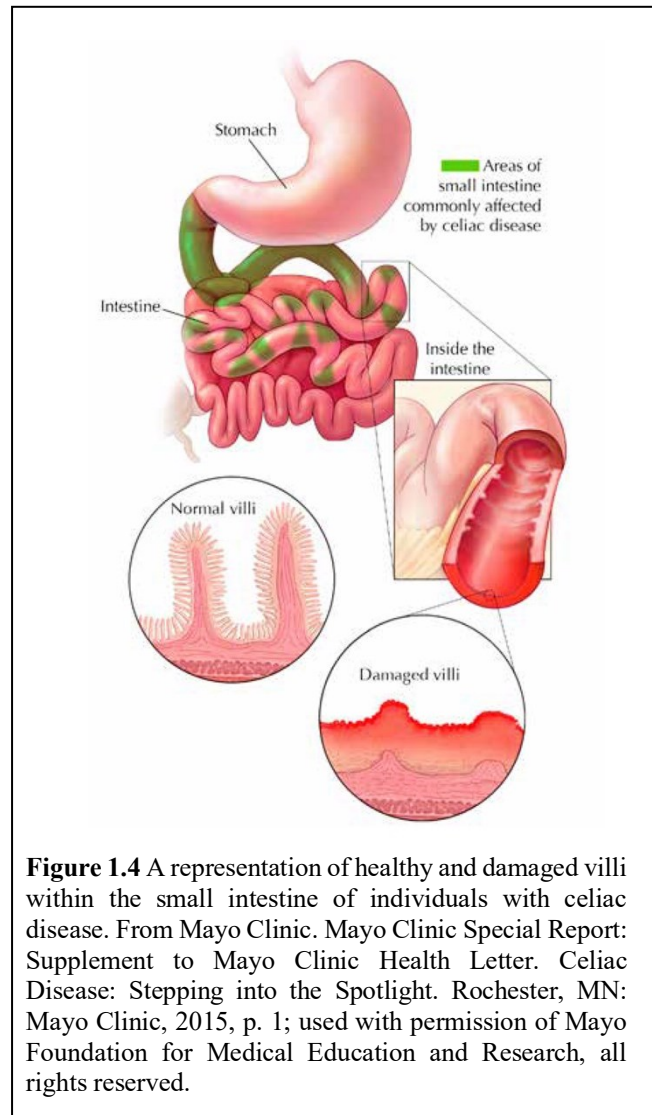


1.5 IMPLICATIONS OF DIETARY GUIDELINES IN THE PRESENCE OF CELIAC DISEASE

1.5.1 Celiac Disease

CD is an autoimmune disease where the presence of gluten, a protein found in wheat, rye or barley triggers an immune-mediated response in the body by attacking the lining of the small intestine. This results in mucosal damage to the intestinal villi whereby its primary role is to

promote nutrient absorption⁽⁶⁵⁾. Healthy villi resemble hair-like projections or in layman's terms, a fuzzy carpet. However, damaged villi from gluten ingestion in those with CD can resemble a flattened surface (**Figure 1.4**)⁽⁶⁶⁾. Due to inflammation and damage, some individuals may experience classical symptoms such as gastrointestinal symptoms (e.g. diarrhea, gas) while others may also or solely experience atypical symptoms (e.g. dermatitis herpetiformis, iron deficiency anemia)⁽⁶⁷⁾. Conversely, some children, youth and adults with untreated CD are asymptomatic and may be unaware that they have CD unless screened. Individuals who



present with conditions associated with CD (e.g. type 1 diabetes, first degree relatives) should be screened. In the short-term, if CD remains undiagnosed and/or left untreated, it can lead to a decrease in digestive enzymes (e.g. lactase) in the body as well as impaired nutrient absorption of fat-soluble vitamins (e.g. A, D, E, K), iron, vitamin B₁₂ and folate⁽⁶⁸⁾. Subsequently, other health

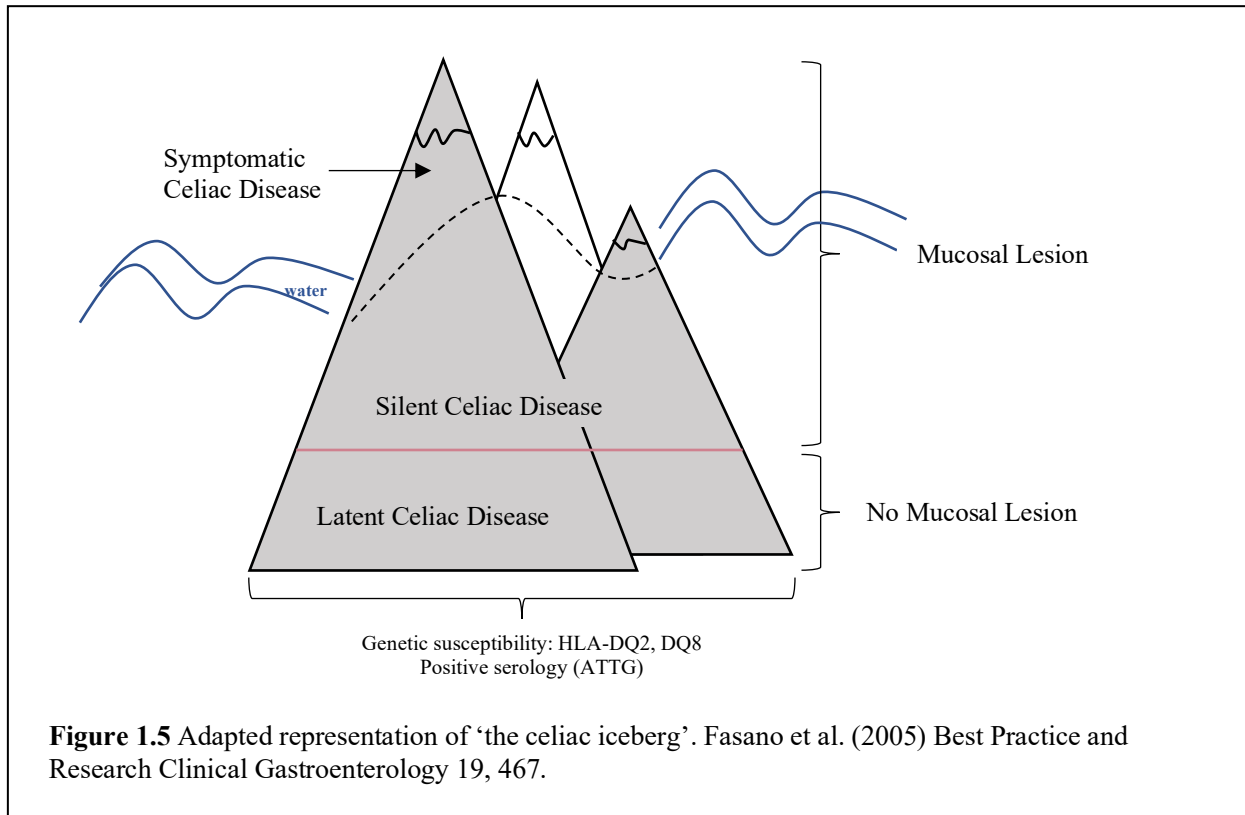
complications can include delayed growth due to nutrient malabsorption, poor bone health, anemia and/or gastrointestinal lymphoma⁽⁶⁷⁾.

The celiac iceberg has been used to explain symptomatic, silent and latent CD (**Figure 1.5**). The visible tip of the iceberg above water shows the proportion of individuals who present with symptoms and damaged villi. Just below the water line is silent CD where those without symptoms may still experience intestinal damage and positive serology. Deep below the water line is latent CD where individuals do not have symptoms but are at risk of developing CD. They are often genetically susceptible and have positive serology despite normal mucosa in the intestine⁽⁶⁹⁾.

CD results from a combination of genetic predispositions and environmental (gluten) factors⁽⁶⁷⁾. Genetic predispositions of CD are based on the presence of two haplotypes of human leukocyte antigen (HLA) referred to as HLA-DQ2 and HLA-DQ8⁽⁶⁸⁾. It is estimated that 40% of the American population carry one of these haplotypes but only 1% of the entire population develop CD⁽⁷⁰⁾. First degree relatives (i.e. parents, siblings, children) of those diagnosed with CD have a greater risk of developing CD. Particularly, siblings of those diagnosed with CD have the greatest risk of developing CD (up to 20%)⁽⁶⁸⁾. Those with type 1 diabetes or thyroid disease are also at an increased risk of developing CD. The risk of those with diabetes has been estimated between 2.4-16.4%⁽⁷⁰⁾. Down syndrome, Turner syndrome and Williams syndrome are other conditions commonly associated with an increased risk of developing CD⁽⁷¹⁾.

CD affects nearly 1 in 100 individuals worldwide⁽⁷²⁾. The reported prevalence in children (2.5 to 15 years) is between 3 to 13 per 1000 children or about 1:300 to 1:80 children⁽⁷¹⁾. There are approximately 350,000 Canadians currently diagnosed with CD and from 2000 to 2013, almost 16,000 Albertans were newly diagnosed with CD⁽⁷³⁾. At the Stollery Children's Hospital in Edmonton, there was an 11-fold increase of diagnoses from 2003 to 2007 with 149 children

diagnosed. The increased prevalence may likely be due to better screening tools^(74, 75). The prevalence of CD is estimated to range between 0.8–1.3% in Europe, 0.6–1.8% in Asia, 0.5–1.4% in North America, 0.5–1.1% in Africa, and 0.4–1.3% in South America⁽⁷²⁾.



1.5.1.2 The Gluten-Free Diet

The only treatment for CD at this time is to follow a strict and lifelong GFD. This means strict avoidance of all foods that contain gluten, including wheat and wheat-based foods which are staple foods in the Western diet⁽⁷⁶⁾. This restriction is necessary to treat and manage mucosal damage and the clinical symptoms associated with CD (e.g. abdominal pain)⁽⁷¹⁾. Depending on age, ethnicity and extent of intestinal damage, research suggests that it takes between 6 to 36 months to see a decrease in anti-transglutaminase (ATTG) levels and intestinal villi regrowth after starting a

GFD⁽⁷⁷⁻⁷⁹⁾. Recent 2021 data suggests that younger children (7-12 years), female sex and non-Caucasian ethnicity may be predictors of later serology normalization⁽⁷⁷⁾.

Those on a GFD can consume naturally-occurring GF foods (e.g. GF grains, fruits, vegetables, cheese, yogurt, eggs, unseasoned meat, poultry, fish and seafood) and derived GF products from GF ingredients (e.g. bread, pasta, snacks, breakfast cereals, baked goods) (**Table 1.3**)⁽⁸⁰⁾. However, children/youth face significant changes to their eating patterns and lifestyle as a result of following the GFD. There are a variety of factors that can impact their quality of life and adherence to the GFD (**Table 1.4**)⁽⁸¹⁻⁸³⁾. This is compounded with research showing that following a strict GFD can lead to suboptimal nutrient intake without the adequate supports (e.g. dietitian, physician) and resources (e.g. GFD education) to choose nutrient-rich GF foods⁽⁸⁴⁾.

Table 1.3 Sources of gluten-free and gluten containing foods.

Gluten-Free	Gluten Containing
Amaranth	Barley
Arrowroot	Bulgur
Buckwheat	Couscous
Cassava	Durum
Corn (Maize)	Einkorn
Dried legumes	Emmer
Flax	Farro
Millet	Kamut
Nuts	Malt
Quinoa	Rye
Rice	Semolina
Sago	Spelt
Sorghum	Triticale
Soy	Wheat
Tapioca	-
Teff	-

Gluten-free foods also include fruits and vegetables, cheese, yogurt, eggs, unseasoned meat, poultry, fish and seafood. This table provides examples but is not an exhaustive list.

Table 1.4 Factors influencing adherence and quality of life in pediatric celiac disease

Social <ul style="list-style-type: none">• Eating out• Travel• Social events• Social norms• Peer rejection• Social isolation/withdrawal
Cost <ul style="list-style-type: none">• GF food expenditure
GF food accessibility & availability <ul style="list-style-type: none">• Rural vs. urban• Large vs. small stores• Home food environment• Food labelling of GF foods
Time <ul style="list-style-type: none">• Food preparation time
GF food preferences <ul style="list-style-type: none">• Food taste• Food appearance• Food texture
Sociodemographic & disease related factors <ul style="list-style-type: none">• Age• Age at diagnosis• Sex• Family structure• Income• Education level• Family history of CD• Symptomatic• Ethnicity
Cognitive <ul style="list-style-type: none">• Knowledge of CD• Knowledge of GFD• Access to information• Ability to read food labels• Attitudes about the GFD
Emotional <ul style="list-style-type: none">• Anger• Depression• Anxiety• Stigmatization• Sadness• Guilt• Frustration• Sacrifice

GF: gluten-free; CD: celiac disease; GFD: gluten-free diet. Table is based on data from White et al. (2016), Xhakollari et al. (2019) and Russo et al. (2020).

1.5.1.2.1 Nutritional Considerations of the Gluten-Free Diet

Although consuming a GFD can be nutritious, emerging evidence in the last decade shows that the GFD may lead to suboptimal macronutrient and micronutrient intake in children and youth living with CD (**Appendix A-2**)⁽⁸⁵⁻⁹⁷⁾. Literature reviews have documented that children/youth with treated CD on the GFD are at risk of suboptimal nutrient intake for increased fat (total, saturated) and sugar as well as reduced folate, vitamin D, iron, calcium, magnesium and fibre^(27, 84, 98). This is more likely to occur when gluten-containing foods that are nutrient-dense (e.g. wheat) are removed from the diet and replaced with less nutrient-dense alternatives (e.g. white rice, corn,

potato)⁽⁸⁰⁾. This is particularly true for folate, since the fortification of GF grains in Canada is currently voluntary unlike gluten-containing grains where fortification is mandated⁽⁹⁹⁾. This notably includes youth of child-bearing potential where suboptimal intake of folate can lead to neural-tube defects⁽¹⁰⁰⁾. It has also been documented that children/youth with CD may be relying on processed and packaged GF foods which are often higher in fat and sugar, and lower in micronutrients⁽¹⁰¹⁻¹⁰³⁾. Suboptimal nutrient intake during critical periods of growth and development could lead to long-term health complications (e.g. poor bone health)⁽²⁷⁾.

Registered dietitians play an important role in educating patients who are newly diagnosed about the GFD in an effort to improve patient health outcomes^(104, 105). They are a vital resource to support and provide children/youth and their families with the required information to follow a nutrient-dense GFD. There are no comprehensive nutrition guidelines to assist dietitians and their patients (i.e. children/youth with CD and their parents/caregivers) manoeuvre the nutritional complexities of following the GFD. This gap in the literature needs to be addressed to adequately educate children/youth with CD and their families to help them successfully follow the GFD. Optimizing nutrient intake and diet quality in this population can lead to improved health outcomes and better quality of life for children/youth living with CD and following a strict GFD⁽¹⁰⁶⁾.

1.5.2 Rationale for a Gluten-Free Food Guide for Children and Youth

The current 2019 CFG and the ANGCY does not address the GFD or the nutritional inadequacies of the diet as described previously. It is estimated that about 29% of the Canadian population (10 million) purchase GF foods and of those, 3.5% have CD and follow a GFD⁽¹⁰⁷⁾. More than seven million Canadians who purchase GF products perceive them to be more nutritious than gluten-containing products or otherwise purchase them on behalf of a family member (e.g.

child who is on a strict GFD)⁽¹⁰⁸⁾. Perceived healthful-ness likely stems from social and traditional media coverages and consumer marketing strategies. However, many are unaware of the nutritional limitations associated with the GFD. Processed and packaged GF foods are often higher in fat, sugar and lower in micronutrients such as folate⁽¹⁰¹⁻¹⁰³⁾. In comparison to gluten-containing foods, extra fat and sugar may be added to GF foods to optimize texture and palatability due to the absence of gluten⁽¹⁰⁹⁾. Therefore, more education and tools on the GFD are needed to support Canadians, especially growing children/youth with CD. Also, the fortification of folate in GF grains is not mandatory, unlike wheat-based alternatives which can make it challenging for those on the GFD to meet folate requirements⁽¹¹⁰⁾. Many parents may be unaware of this and may not think to review and compare the nutrition labels of GF products prior to purchasing. Nevertheless, consuming a GFD can be nutritious but a uniform and consistent dietary guideline to educate Canadian children, youth and families on the limitations is lacking.

1.6 CONCLUSIONS

The development of a GF food guide for children/youth is warranted due to the nutritional limitations of the GFD and the unique nutritional environment. This diet has become highly popularized whereby many Canadians report purchasing and eating GF foods⁽¹⁰⁷⁾. A GF food guide is even more important for children/youth living with CD where the only treatment is a GFD. Therefore, a GF food guide will equip this population with reliable and accessible evidence-based resources to consume a nutritionally adequate diet. Otherwise, children/youth may experience suboptimal nutrient intake and impaired health outcomes without adequate support. A GF food guide will also assist health care professionals to educate children/youth and their parents on the GFD and provide strategies to overcome the nutritional limitations. The purpose of this thesis is

to describe the development and evaluation of a GF food guide for children and youth (4-18 years) and to describe potential factors (e.g. home food environment, food literacy) that may influence guide uptake by children/youth with CD, their parents and health care professionals.

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Chapter 2: Research Plan

2.1 STUDY RATIONALE

Celiac disease (CD) is an autoimmune disease that affects about 350,000 individuals in Canada⁽¹⁾. This disease results in damage to the small intestine when gluten, a protein found in wheat, rye or barley is consumed. The only treatment at this time is to follow a strict lifelong gluten-free diet (GFD)⁽²⁾. Although this diet can be nutritious, evidence suggests that the GFD is characterized as high in fat, added sugar and low in micronutrients such as folate and vitamin D⁽³⁻⁵⁾. This is particularly true for folate, since the fortification of gluten-free (GF) grains in Canada is currently voluntary unlike wheat-containing alternatives⁽⁶⁾. Suboptimal micronutrient intake in this population is worrisome as these nutrients are essential for growth and development of children and youth with CD⁽⁴⁾. This notably includes youth of child-bearing potential where suboptimal intake of folate can lead to neural-tube defects⁽⁷⁾. There are currently no comprehensive evidence-based pediatric nutritional guidelines that address the GFD and the nutritional limitations. This gap in literature needs to be addressed to educate children/youth with CD and their families to successfully manoeuvre the complexities of following the GFD. Otherwise, inadequate nutrient intake and diet quality may lead to long-term health complications and suboptimal quality of life⁽⁸⁾.

The home food environment has been shown to be a predictor of dietary intake and diet quality in children/youth⁽⁹⁻¹³⁾. Food literacy may also be a predictor of healthy eating in children/youth^(14, 15). Purchasing GF foods for the home are also more expensive and can place a heavy financial burden on families^(16, 17). This may impact food purchasing decisions, lead to obesogenic home food environments and potentially influence the uptake of guide recommendations by children/youth with CD and their families. For this reason, an evaluation is needed on the home food environment, food literacy and food purchasing patterns to better understand factors that may

affect adherence to guide recommendations. Evidence-based, comprehensive and easily accessible nutritional recommendations are warranted for children/youth with CD and their families.

2.2 OBJECTIVES AND HYPOTHESIS

Study 1: Chapter 3

- **Title:** Nutritional and methodological considerations of a pediatric gluten-free food guide for celiac disease.
- **Objective:** The study objective was to describe the methodological considerations in forming a GF food guide for Canadian children and youth (4-18 years) with CD.
- **Hypothesis:** The GF food guide will meet all macronutrient and micronutrient requirements of children/youth with CD consuming the GFD.

Study 2: Chapter 4

- **Title:** Evaluation of a pediatric gluten-free food guide by children and youth with celiac disease, their parents and health care professionals.
- **Objective:** The study objective was to conduct an evaluation on the GF food guide for content, layout, feasibility and dissemination strategies from end-stakeholder users (children/youth with CD, their parents/caregivers and health care professionals).
- **Hypothesis:** The GF food guide for children/youth with CD will contain evidence-based content that is feasible and usable with understandable nutritional information for children/youth with CD, their parents/caregivers and health care professionals.

Study 3: Chapter 5

- **Title:** Food environment and youth intake may influence uptake of gluten-free food guide recommendations in celiac disease.

- **Objective:** The objective was to examine the home food environment, parental food literacy, food purchasing patterns and youth dietary intake in households of youth with CD, and how these factors may influence uptake of food guide recommendations by children/youth with CD, their parents/caregivers and health care professionals.

In **Chapter 3**, methodological and nutritional considerations of the GF food guide were studied through dietary intake, pre-guide stakeholder consultations and diet simulations⁽¹⁸⁾. In **Chapter 4**, a cross-sectional study design which included focus groups and an online survey was conducted to obtain a comprehensive evaluation by stakeholders on guide content, layout, feasibility and dissemination strategies⁽¹⁹⁾. Additional factors that may influence guide uptake were assessed in **Chapter 5** through a case study analysis examining the home food environment, parental food literacy, food purchasing patterns and youth dietary intake. This manuscript is currently under review by a peer review journal. The findings from this thesis aim to improve nutritional care within multi-ethnic community and clinical-based settings for children/youth with CD and their families in Canada. Results also aim to contribute to evidence-based, informative and easily accessible resources for this population and their families.

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Chapter 3: Nutritional and Methodological Considerations of a Pediatric Gluten-Free Food Guide for Celiac Disease

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3.1 ABSTRACT

The gluten-free diet (GFD) is the only treatment for celiac disease (CD). While the GFD can be nutritious, increased reliance on processed and packaged gluten-free (GF) foods can result in high fat, sugar and lower micronutrient intake in children/youth with CD. Currently, there are no evidence-based nutrition guidelines that address the GFD. The objective of this cross-sectional study was to describe the methodological considerations in forming a GF food guide for Canadian children and youth (4-18 years) with CD. Food guide development occurred in three phases: i) evaluation of food intake and dietary patterns of children/youth on the GFD, ii) pre-guide stakeholder consultations with 151 health care professionals and 383 community end-users, and iii) development of 1260 GFD simulations that addressed cultural preferences and food traditions, dietary patterns and diet quality. Stakeholder feedback identified nutrient intake and food literacy as important topics for guide content. With the exception of vitamin D, the diet simulations met 100% macronutrient and micronutrient needs for age-sex. The pediatric GF plate model recommends intake of >50% fruits and vegetables, <25% grains and 25% protein foods with a stronger emphasis on plant-based sources. Vitamin D fortified and unsweetened milk or a plant-based alternative and other vitamin D rich sources are important to optimize vitamin D intake. The

GF food guide can help children/youth consume a nutritiously adequate GFD and inform policy makers regarding the need for nutrition guidelines in pediatric CD.

3.2 INTRODUCTION

Celiac disease (CD) is an autoimmune disorder where the consumption of gluten, a protein found in wheat, rye and barley, triggers intestinal villous atrophy and leads to intestinal damage. This destruction subsequently leads to the malabsorption of essential nutrients that can cause the clinical symptoms and complications of CD. The only treatment for CD at this time is lifelong adherence to the gluten-free diet (GFD)^(1, 2).

The GFD has become highly popularized for its perceived health benefits and incidence of food intolerance. However, many children following the GFD may be relying on processed and packaged GF foods which can increase the risk of unhealthy dietary patterns⁽³⁻⁷⁾. Many gluten-free (GF) processed foods are high in fat and sugar which results in significantly higher intakes of fat and sugar in the diets of children/youth with CD⁽⁷⁻⁹⁾. Common micronutrients of concern related to the Western GFD are low folate and vitamin D intake^(3, 5, 10). Low folate intake in children/youth consuming the GFD is likely due to the lack of a folate fortification policy related to GF grains and hence the low folate content of gluten-free (GF) processed foods^(4, 5, 10-12). This can make it challenging for children/youth with CD to eat a nutritiously dense diet. This is of significant public health concern as children/youth consuming the GFD are at increased risk of developing micronutrient deficiencies which may contribute to deficits in growth and development. This is particularly relevant to females of childbearing potential where suboptimal micronutrient deficiencies (e.g. folate) can lead to increased risk for adverse maternal and infant outcomes⁽¹³⁾.

Currently there are no comprehensive evidence-based nutrition guidelines that address the GFD and the available general nutrition guidelines in Canada do not address the nutritional inadequacies of the GFD. A GF food guide is essential to ensure that children who follow the GFD and their families can make informed food choices to consume a nutritious diet. The study objective was to describe the methodological considerations in forming a GF food guide for Canadian children and youth (4-18 years) with CD. We hypothesized that the GF guide will meet all macronutrient and micronutrient requirements of child/youth with CD consuming the GFD.

3.3 METHODS

Three different phases informed the content of the GF food guide for Canadian children/youth (4-18 years) with CD on the GFD: i) a comprehensive evaluation of food intake and dietary patterns to identify nutrients of concerns⁽⁵⁾, ii) pre-guide stakeholder consultations (e.g. parents of children with CD, health care professionals [HP], adults with CD) to inform food guide content, and iii) development of GFD simulations taking into consideration cultural preferences and food traditions, diet patterns and diet quality. This cross-sectional study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research participants were approved by the University of Alberta Human Research Ethics Board – Health Panel (Pro00033867, Pro00065489). Written informed consent/assent was obtained from participants and/or their responsible caregivers.

i) Evaluation of Food Intake and Dietary Patterns

A detailed examination of food intake from a multi-ethnic cohort of children/youth with CD and commercially available GF foods in the marketplace was previously reported^(5, 12). This included an in-depth analysis of diet patterning using cluster analysis which illustrated that >80%

of children with CD consume a Western diet (high fat, moderate-high carbohydrate). Low folate intake was likely secondary to the lack of folate-dense foods in the diet (e.g. legumes) and the lower folate content of GF foods (e.g. grains) purchased by families of children/youth^(5, 12).

ii) Pre-Guide Stakeholder Consultations

Pre-guide stakeholder consultations were conducted across Canada via online surveys with HP (e.g. dietitians) and community end-users (e.g. parents of children with CD, adults with CD). Surveys were launched using REDCap software through various health professional organizations (e.g. Canadian Association of Gastroenterology, College of Dietitians of Alberta) and through local chapters of the Canadian Celiac Association (e.g. Edmonton, Calgary) (**Appendix B-1**)^(14, 15). Survey content addressed demographic information (e.g. province, urban/rural, type of HP, length of CD diagnosis) and perceptions regarding GF food guide content (e.g. relevant nutrition and food literacy topics, and guide layout). Thematic analysis and descriptive statistics were used to analyze open and close-ended questions.

iii) Diet Simulations of Nutritionally Adequate Gluten-Free Diets for Children/Youth

Diet simulations were designed so that when evaluated, the nutrient content met relative dietary reference intake values for macronutrient and micronutrient intake for age-sex⁽¹⁶⁾. Simulations were made to represent a 24-hour dietary intake pattern for children/youth (females and males) between 4-18 years to ensure that age-appropriate estimated average requirements (EAR) or adequate intakes were met. This methodology was modeled after Health Canada's methodological approach for the preparation of the 2007 and the 2019 Canada's Food Guide (CFG)^(17, 18). Simulations were created from an in-depth analysis of dietary patterns of Canadian children/youth with CD^(3, 5, 10). This included a comprehensive evaluation of GF foods available in Canadian grocery stores^(4, 7, 8, 12). Simulations were altered to meet the macronutrient and

micronutrient recommendations for dietary patterns across age-sex using Food Processor Nutrition Analysis Software (SQL 11.0.124, ESHA Research, Salem, OR, USA) and the Canadian Nutrient File⁽¹⁹⁾ (**Figure 3.1**). The average nutrient content of GF bread and GF breakfast cereal was calculated using food labels based on the top twelve brands for GF breads and the top twenty brands for GF cereals available to consumers in Canada as identified in phase one (**Appendix B-2**)^(5, 12). While the simulations evaluated the content of all macronutrients and micronutrients, an enhanced focus was placed on the intake of fat, added sugar, fibre, vitamin B12, vitamin D, folate, calcium, iron, sodium and zinc. The gluten content of all diet simulations was assessed using the Osborne method with a cut-off value of <10mg/day to indicate a safe gluten threshold^(5, 10, 20). Cuisines representing various cultures were chosen based on the ethnic diversity of the Canadian population and to reflect the global prevalence of CD⁽²¹⁾. Diet simulations (>40%) reflected a plant-predominant diet with fruits, vegetables, grains and plant-based proteins (e.g. legumes, tofu, nuts and seeds)⁽²²⁾. Numerous food substitution lists were developed prior to the diet simulations to ensure that diets encompassed different foods and a representation of different ethnicities and dietary patterns were incorporated into the guide (**Appendix B-2**)^(5, 10, 23-33). Substitutions and alterations to food items and food servings were made until diets were nutritionally adequate and fell within macronutrient, micronutrient and calorie ranges for age-sex (**Appendix B-3**)^(16, 25, 33).

The nutritional adequacy of the diet simulations were assessed by diet quality index scores (Mediterranean Diet Quality Index in children and adolescents [KIDMED] and the Canadian Healthy Eating Index [HEI-C])^(34, 35). KIDMED ranged from 0 to 12 with >8 indicating ‘optimal Mediterranean diet’, 4-7 indicating ‘improvement needed to adjust intake to Mediterranean patterns’ and ≤ 3 indicating ‘very low diet quality’⁽³⁴⁾. The HEI-C was subcategorized based on adequacy (maximum score of 50), moderation (maximum score of 40) and variety (maximum

score of 10). An overall score of >80 indicated ‘good/optimal’ diet quality, 51-80 indicated ‘needs improvement’ and ≤ 50 signified ‘poor’ diet quality⁽³⁵⁾. Food guide servings were calculated from the diet simulations according to the 2007 CFG and Alberta Nutrition Guidelines for Children and Youth (ANGCY)^(36, 37).

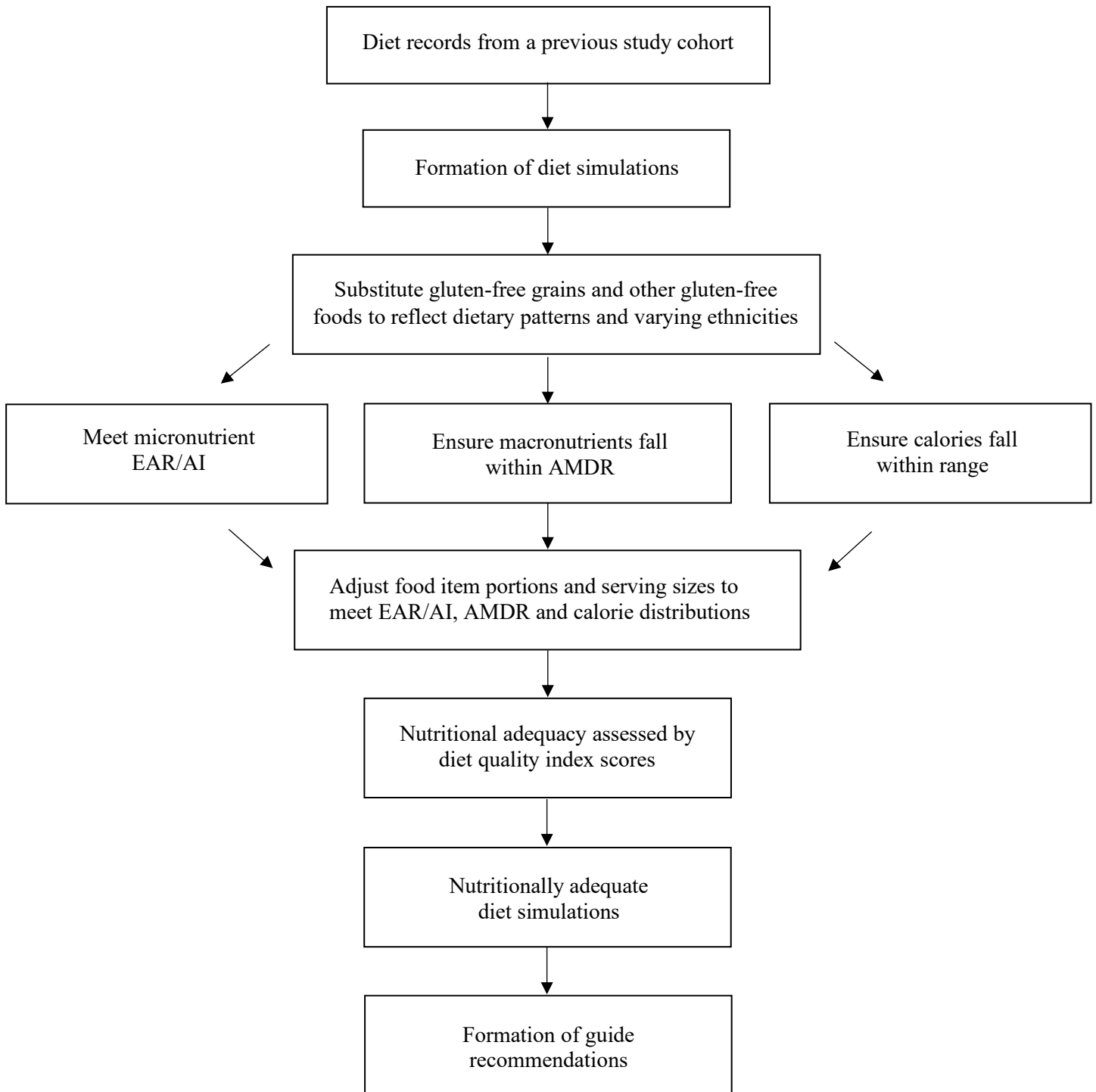


Figure 3.1 The diet simulation process used to inform the content of the gluten-free food guide. EAR: estimated average requirement; AI: adequate intake; AMDR: acceptable macronutrient distribution range. Dietary data on children/youth with celiac disease was used to develop diet simulations⁽⁵⁾. Diets were adjusted using Food Processor Nutrition Analysis Software (SQL 11.0.124, ESHA Research, Salem, OR, USA), the Canadian Nutrient File⁽¹⁹⁾ and manufacturer information to reflect dietary patterns, cultural preferences and food traditions of the Canadian population, and were based on the global prevalence of celiac disease among the Canadian population⁽²¹⁾. To meet Health Canada’s dietary reference intake values⁽¹⁶⁾ and the Alberta Nutrition Guidelines for Children and Youth⁽³⁶⁾ recommendations, nutrient dense foods were added, or the serving sizes of nutrient dense foods were adjusted to meet the EAR/AI. Proportions of food items and food group servings were adjusted until macronutrients and calories fell within ranges. Diet quality of these nutritionally adequate diets were assessed by the Mediterranean Diet Quality Index in children and adolescents⁽³⁴⁾ and the Canadian Healthy Eating Index⁽³⁵⁾.

3.4 RESULTS

Stakeholder Consultations: Pre-Guide Formation

The HP (n=151) and community end-users (n=383) from a variety of provinces and territories across Canada completed the online surveys. HP respondents included Registered Dietitians (80%, n=121), Pediatric Gastroenterologist and Pediatricians (11%, n=16), Family Physicians (3%, n=4), Registered Nurses (3%, n=4), Social Workers (3%, n=5), and others (<1%, n=1). The HP (17%, n=22 of 127) reported seeing over five cases of CD per month and 37% (n=56) reported working with the pediatric CD population for >10 years. Most community participants were between 31-40 years (>35%) and 41-50 years (>25%). Over 65% of community end-users (n=256) reported having CD and 42% (n=160) reported having at least one child or grandchild diagnosed with CD.

Feedback from the HP and members of the community for guide content was related to micronutrient concerns (iron [65% professionals vs. 72% community, $P>0.05$], vitamin D [60% professionals vs. 69% community, $P=0.048$], folate [50% professionals vs. 36% community, $P=0.003$], added sugars [63% professionals vs. 48% community, $P=0.002$] and fat [23% professionals vs. 30% community, $P>0.05$]) in GF foods. Community end-users also focused on calcium (55%) and fibre (62%) as important topics (**Figure 3.2A-B**). Food literacy topics related to reading food labels (77% professionals vs. 60% community, $P<0.001$), GF processed foods (68% professionals vs. 43% community, $P<0.001$), eating out at restaurants (64% professionals vs. 62% community, $P>0.05$) and grocery shopping (66% professionals vs. 41% community, $P<0.001$) were identified by both groups as important guide content. The HP and community members felt that addressing cultural preferences and food traditions were also needed (47% professionals vs. 21% community, $P<0.001$). Guide content related to CD (81%) and lactose intolerance (25%) were reported as important by community end-users but addressing a wheat allergy was important to both groups (33% professionals vs. 26%

community, $P>0.05$) (**Figure 3.2C-D**). Over 80% of HP requested that the GF food guide be available in both electronic and hardcopy formats while 80% of the community preferred electronic only.

Diet Simulation Results

There was a total of 1260 diet simulations created for the GF food guide to ensure that the guide met the nutritional needs of children/youth (4-18 years) diagnosed with CD. Each age-sex category had a total of 210 diets created across all dietary patterns. Diet simulations were created for Western (n=150), First Nations, Inuit and Métis (n=102), East Indian (n=150), Somalian (n=150), Chinese (n=150), Brazilian (n=150) and Iranian (n=102) cuisines, as well as lactose-free (n=102), lacto-ovo (n=102) and vegan (n=102) diets.

Gluten, Macronutrient and Micronutrient Content of the Diet Simulations

The median [interquartile range] gluten content of all diet simulations was 4.3mg/day [2.6-5.5]. Macronutrient distributions across all diet simulations and all ages ($20.9\pm 2.2\%$ protein, $28.1\pm 2\%$ fat, $52\pm 3\%$ carbohydrate) were not significantly different between simulated dietary patterns ($P>0.05$). With the exception of vitamin D, diet simulations met 100% EAR and 80-100% of recommended dietary allowance (RDA) for all micronutrients based on age-sex (**Table 3.1**). Only 23% of the diet simulations met the EAR (10 μ g or 400IU) for vitamin D and only 5% met the RDA (15 μ g or 600 IU). To achieve the EAR for vitamin D, the diet simulations included an average of 2.5 servings of fortified fluid milk (or 3 servings of a fortified unsweetened plant-based beverage) and 1 serving of fish. When fish was not included in a diet simulation, 3.5 servings of fortified fluid milk (or 4 servings of a fortified unsweetened plant-based beverage) and 2 eggs or 1 serving of fortified yogurt was used instead. When a vitamin D supplement (10 μ g or 400 IU) was included in a simulation, only 2-2.5 servings of fortified fluid milk or an unsweetened plant-based beverage was needed to meet the RDA. The diet simulations were able to provide enough folate across all ages-sexes without supplementation (100% EAR were

met). Higher folate-containing food items (e.g. legumes, spinach, oranges) were added to the diets to meet the EAR.

Assessment of Diet Quality and Food Group Intake of the Diet Simulations

KIDMED and the HEI-C scores were indicative of good/optimal diet quality in 100% and 93.5% of the diet simulations, respectively. **Figure 3.3A-C** outlines the daily number of servings based on each food group that children with CD need to eat to meet macronutrient and micronutrient needs. This led to the formation of a plate model where >50% represents fruits and vegetables (F&V), <25% GF grains and 25% protein foods with a stronger emphasis on plant-based protein sources and those higher in vitamin D (e.g. fish) (**Appendix B-4**). Fluid milk and/or an unsweetened plant-based alternative that is fortified with calcium and vitamin D is included as the primary beverages of choice with a particular focus to increase vitamin D intake.

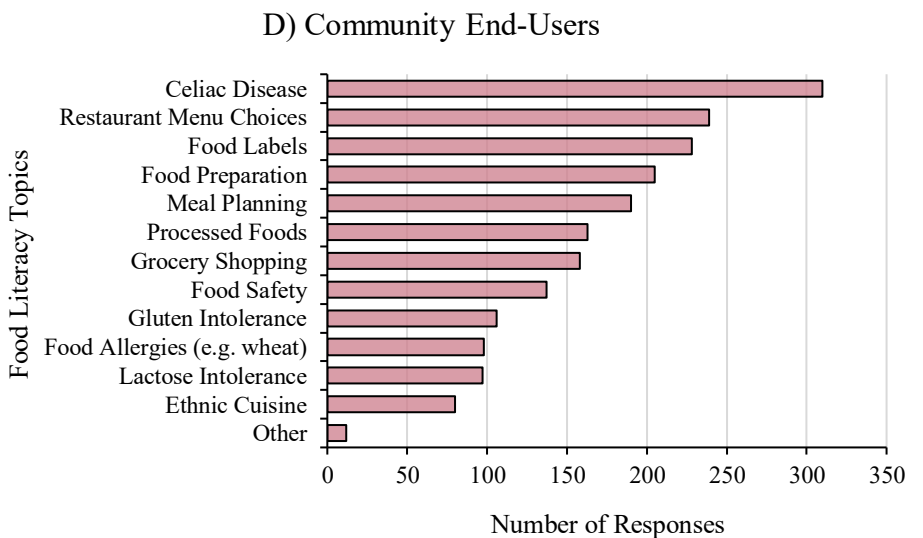
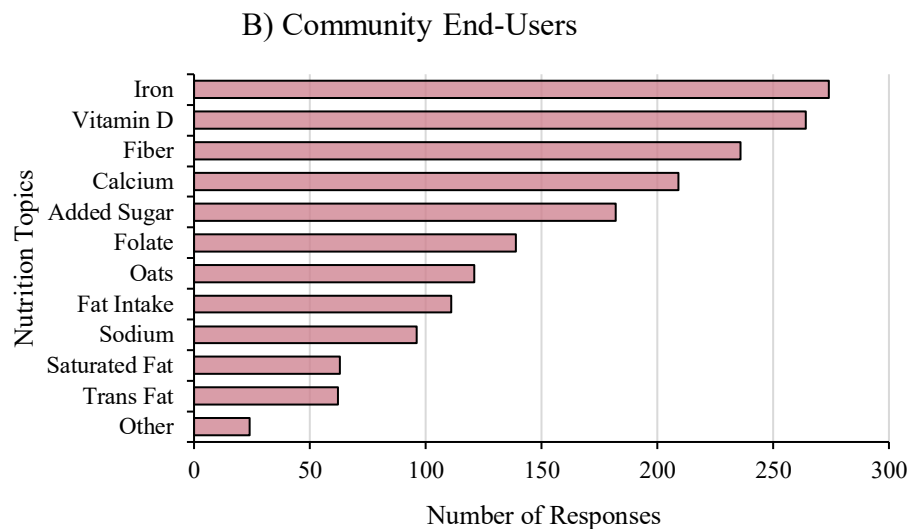
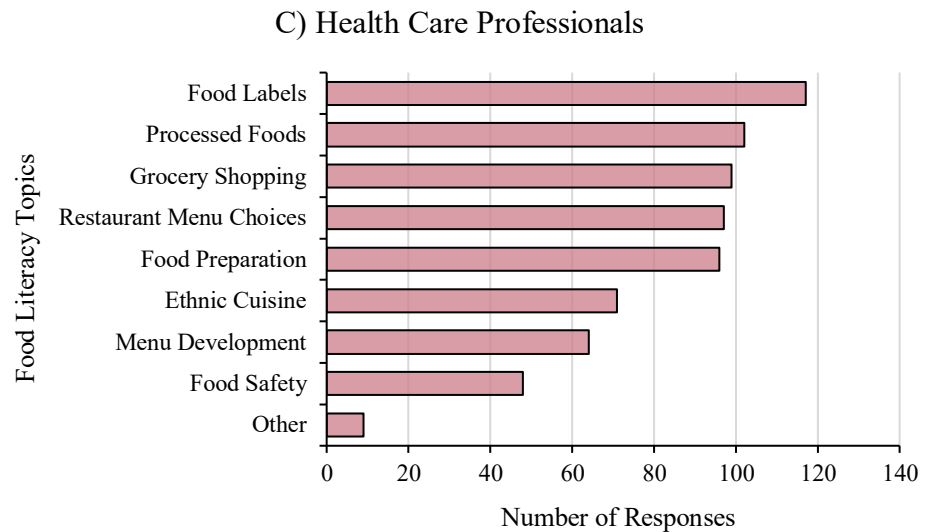
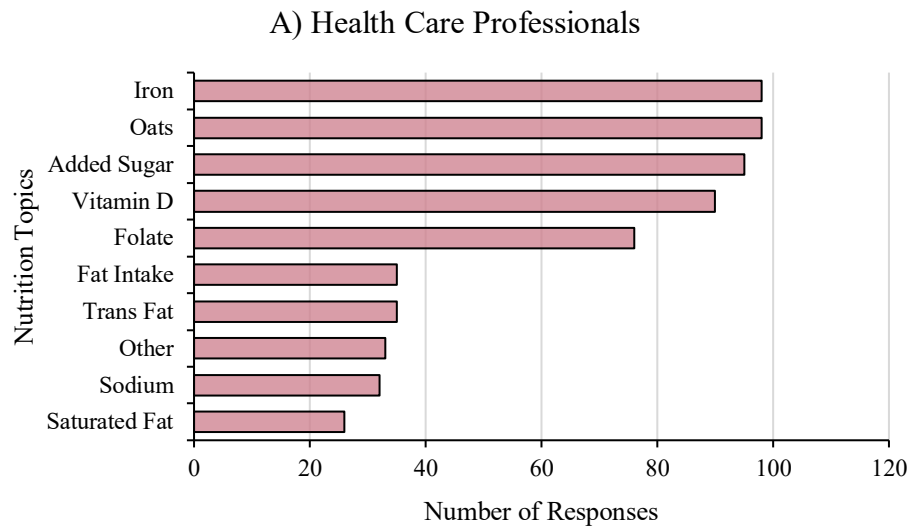


Figure 3.2A-D Important gluten-free food guide topics identified during pre-guide stakeholder consultations related to A) and B) nutrition topics and C) and D) food literacy topics. Online surveys were completed by stakeholders which included health care professionals (Registered Dietitians n=121, Gastroenterologists/Pediatricians n=16, Family Physicians n=4, Registered Nurses n=4, Social Workers n=5, and others n=1) and community end-users (n=383, e.g. parents of children with celiac disease, adults with celiac disease). Participants had the option to select ≥ 1 sub-topic from each of the two major topics if they felt that multiple sub-topics were important.

Table 3.1 Macronutrient and micronutrient summary from diet simulations based on age-sex.

Age-sex Distributions	Female (4-8y, n=210)	Male (4-8y, n=210)	Female (9-13y, n=210)	Male (9-13y, n=210)	Female (14-18y, n=210)	Male (14-18y, n=210)
Macronutrient Intake^a						
Calories (kcal) ^b	1421	1480	1631	1682	2071	2074
Protein (g)	73.3	77.4	86.3	89.4	110.3	110.5
Protein % ^c	20.7	20.9	21.2	21.2	21.3	21.3
Carbohydrate (g)	191.7	200.2	220.2	226.0	275.2	275.3
Carbohydrate % ^c	53.9	54.1	54.0	53.8	53.2	53.1
Fat (g)	44.8	46.8	51.7	52.4	66.1	65.5
Fat % ^c	28.4	28.5	28.5	28.1	28.7	28.4
Sat Fat ^d (g)	10.7	11.1	12.3	12.7	14.7	15.4
Sat Fat %	6.8	6.7	6.8	6.8	6.4	6.7
MUFA ^e (g)	16.0	17.3	19.3	18.5	25.4	24.1
MUFA %	10.1	10.5	10.6	9.9	11.0	10.4
PUFA ^f (g)	11.7	12.0	13.5	13.9	17.7	17.1
PUFA %	7.4	7.3	7.5	7.5	7.7	7.4
Fibre (g)	26.3	29.7	30.5	30.9	36.8	38.2
Fibre %AI ^g	105.2	118.8	117.3	99.7	141.5	100.5
Micronutrient Intake^a						
Vitamin B12 (mg)	4.9	4.8	5.5	5.8	6.7	7.1
Vitamin B12 %EAR ^h	490.0	480.0	366.7	386.7	335.0	355.0
Vitamin B12 %RDA ⁱ	408.3	400.0	305.6	322.2	279.2	295.8
Vitamin D (µg)	7.5	6.8	8.2	8.5	10.6	9.9
Vitamin D %EAR	75.2	68.3	82.4	84.8	105.9	98.9
Vitamin D %RDA	50.2	45.5	55.0	56.6	70.6	66.0
Folate (DFE µg) ^j	398.1	436.9	449.3	485.3	566.2	607.4
Folate %EAR	248.8	273.1	179.7	194.1	171.6	184.1
Folate %RDA	199.1	218.5	149.8	161.8	141.6	151.9
Calcium (mg)	1212.0	1188.6	1458.5	1402.8	1579.6	1605.0
Calcium %EAR	151.5	148.6	132.6	127.5	143.6	145.9
Calcium %RDA	121.2	118.9	112.2	107.9	121.5	123.5
Iron (mg)	12.0	13.1	14.0	14.1	17.5	18.0
Iron %EAR	292.7	319.5	245.6	239.0	221.5	257.1

Age-sex Distributions	Female (4-8y, n=210)	Male (4-8y, n=210)	Female (9-13y, n=210)	Male (9-13y, n=210)	Female (14-18y, n=210)	Male (14-18y, n=210)
Iron %RDA	120.0	131.0	175.0	176.3	116.7	163.6
Sodium (mg)	1406.1	1389.2	1618.0	1647.4	1692.1	1691.2
Sodium %AI	117.2	115.8	107.9	109.8	112.8	112.7
Sodium %UL ^k	74.0	73.1	73.5	74.9	73.6	73.5
Zinc (mg)	9.2	10.7	11.8	12.5	14.6	14.4
Zinc %EAR	230	267.5	168.6	178.6	200.0	169.4
Zinc %RDA	184.0	214.0	147.5	156.3	162.2	130.9

^a Reference ranges for nutrient intake were based on guidelines from Health Canada⁽¹⁶⁾ and the Food and Agriculture Organization of the United Nations⁽²⁵⁾

^b Calorie (kcal) range for female/male age ≤ 6=1200-1500, age 7-13=1500-1800, ≥14=2000-2300

^c Acceptable macronutrient distribution range: carbohydrate, 45-65%; protein, 10-30%; fat, 25-35%⁽¹⁶⁾. All diet simulations (100%, n=1260) based on age-sex met carbohydrate and protein recommendations. 94% (n=1187) met fat recommendations with the remainder having fat intakes in the range of 23-25% of total energy intake

^d Sat Fat, saturated fat; recommended <10%⁽²⁵⁾

^e MUFA, monounsaturated fatty acids; recommended <10%⁽²⁵⁾

^f PUFA, polyunsaturated fatty acids; recommended >3%⁽²⁵⁾

^g AI, adequate intake

^h EAR, estimated average requirement

ⁱ RDA, recommended dietary allowance

^j DFE, dietary folate equivalent

^k UL, tolerable upper intake level

%EAR/RDA/AI/UL for select nutrients were determined by dividing the nutrient intake by the EAR/RDA/AI/UL based on age-sex and then multiplying by 100

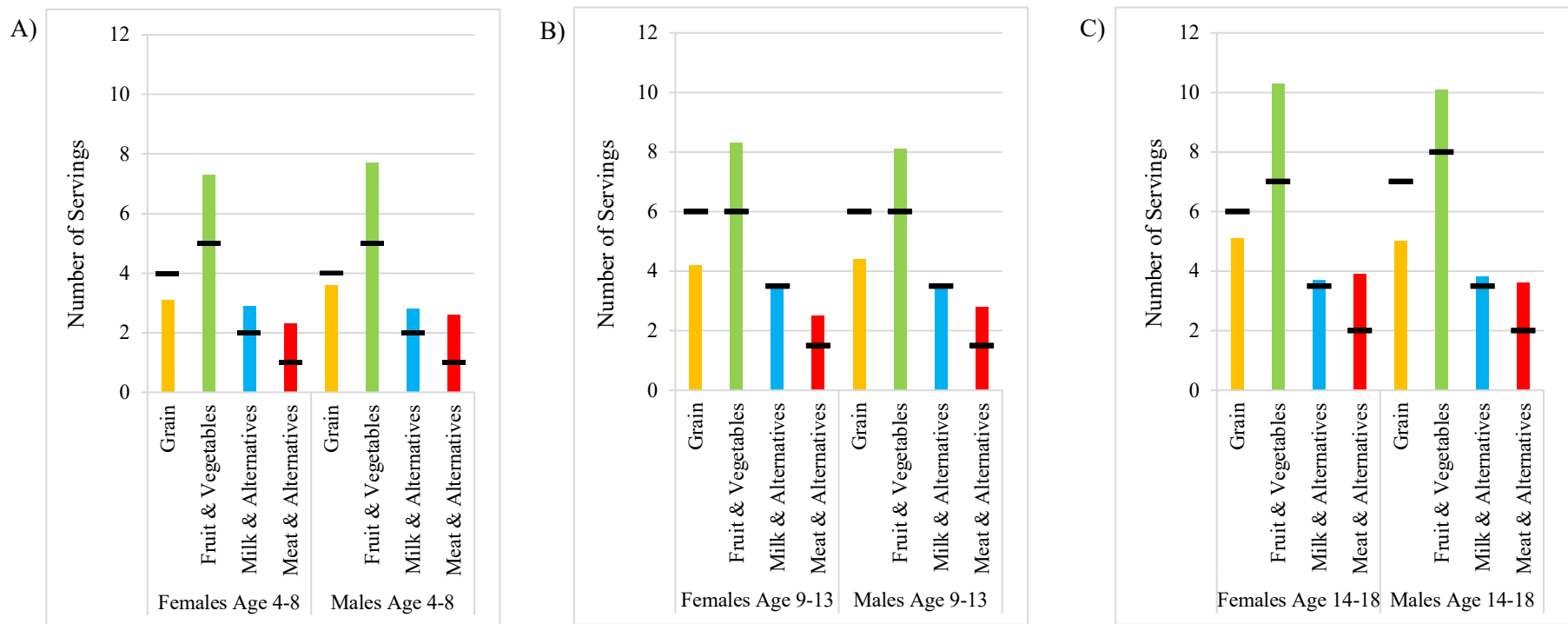


Figure 3.3A-C Recommended number of food group servings for children and youth with celiac disease A) ages 4 to 8 years, B) ages 9 to 13 years and C) ages 14 to 18 years. Servings are based on nutritionally adequate gluten-free diet simulations. The black horizontal bar indicates recommended servings based on the four food groups according to the 2007 Canada’s Food Guide and the Alberta Nutrition Guidelines for Children and Youth.

3.5 DISCUSSION

The development of a GF food guide was in response to end-stakeholder users (e.g. parents of children with CD, health professionals) identifying a need for universally available nutrition guidelines on the GFD^(5, 10). Most families and their children with CD understand the need to follow a GFD, but many do not have in-depth knowledge related to the nutritional limitations⁽³⁸⁾. Almost 80% of Canadian adults report seeing a dietitian at least once at time of CD diagnosis but longitudinal follow up has been reported at 15% with some clinics only conducting dietitian-led follow up if requested^(38, 39). This is potentially due to limited resources (e.g. dietitian), extended clinic wait times, or those with CD reverting to the internet for quicker access despite the possibility for inaccurate information. Therefore, accessible and evidence-based GF nutrition guidelines are also warranted for children/youth with CD. A GF food guide will help educate families and their children on the complexities of nutrient intake, label reading and maneuvering complex food environments (e.g. school, social gatherings, travel). The methods used to inform the development of the GF food guide were based on standard methodological approaches used to develop the 2007/2019 CFG and the ANGCY^(17, 18, 22, 36). The study objective was to describe the methodological considerations in forming a GF food guide for Canadian children and youth (4-18 years) with CD.

The GF pre-guide consultations yielded similar themes compared to the 2019 CFG regarding fat and added sugar, but micronutrient intake (e.g. folate) was a unique theme for the GF food guide due to the nature of the GFD⁽⁴⁰⁾. The GFD can be nutritious, but many individuals inadvertently consume more fat and added sugar from GF processed products^(3, 5, 10). This is likely due to GF processed grains where fat and sugar have been added to replace the loss of taste and texture when gluten is removed^(4, 6). This is concerning as a higher intake has been associated with

obesity and chronic disease⁽²²⁾. As a result, the development of the diet simulations was critical to ensure that dietary patterns for age-sex were nutritionally adequate for children/youth by primarily focusing on the consumption of whole foods and reducing the intake of ultra-processed GF foods. This will ensure that the GF food guide can meet the nutritional needs of children with CD while providing evidence-based information to follow a healthy eating pattern while on the GFD.

The GFD simulations address the concerns of fat and sugar intake and improve diet quality after modeling the GFD using the Dietary Approach to Stop Hypertension and the Mediterranean-style dietary pattern⁽²²⁾. These dietary patterns have been associated with lower cardiovascular risk factors and disease risk, respectively⁽²²⁾. The simulations also focused on a plant-predominant diet (e.g. fruits, vegetables, legumes, nuts and seeds) which was highlighted in the 2019 CFG. It placed a larger focus on the regular intake of plant-based foods with less emphasis on animal-based⁽²²⁾. Limited amounts of animal-based foods (meat, poultry, fish) in conjunction with a plant-predominant diet can be part of a healthy diet and lower chronic disease risk factors such as blood pressure⁽⁴¹⁾.

The incorporation of more plant-based foods (i.e. legumes, F&V) into the diet simulations helped achieve the EAR for folate. Unlike the 2019 CFG where folate is not a nutrient of concern due to wheat fortification, suboptimal intake in children on the GFD has been observed without a mandated fortification of GF grains^(5, 10-12). Fortunately, the diet simulations identified that by following a plant-predominant diet pattern, folate requirements can be met across all ages-sexes without supplementation (100% EAR met). This was achieved by incorporating higher folate containing foods (e.g. pulses, spinach, oranges) into the simulations. This finding is extremely encouraging since the GF food guide can help educate families who are following the GFD to better meet their nutrient requirements. Nevertheless, advocacy for nutrient fortification (e.g.

folate) of GF foods, particularly GF grains continues to remain a priority so that the burden of meeting nutritional requirements does not fall solely on the child with CD and their family. This is especially needed when dietary intake is highly impacted by preferences, food traditions, multiple food allergies and intolerances, and/or from a food insecurity perspective where recommendations may not be practical on a routine basis.

The diet simulations met the EAR for all micronutrients (e.g. calcium) except for vitamin D where by diet alone was challenging to meet due to the limited food supply of vitamin D rich sources. In order to meet the EAR for vitamin D, numerous servings per day of fortified fluid milk or unsweetened plant-based alternatives in addition to fish or eggs would need to be consumed by children. This intake is likely not practical on a routine basis due to taste preferences and the higher cost of vitamin D rich sources (e.g. fish) which could be impacted by food insecurity. Despite recently proposed updates to vitamin D fortification in Canada, it is still currently challenging to meet vitamin D needs⁽⁴²⁾. This is worrisome as the risk of suboptimal vitamin D intake is of concern especially in Canada with the northern latitude^(43,44). No known information is available on Health Canada's website identifying whether daily vitamin D intake can be achieved by following the 2019 CFG recommendations⁽⁴⁵⁾. Though, a recent study analyzing the 2019 CFG suspects that most Canadians will not meet their vitamin D needs due to the plate's de-emphasis of milk products and/or fortified plant-based alternatives⁽⁴⁶⁾. Moreover, the 2019 CFG emphasizes water as the beverage of choice with little focus on calcium and vitamin D fortified fluid milk or plant-based alternatives⁽⁴⁵⁾. Without a doubt, water is important for adequate hydration but choosing fortified fluid milk or unsweetened plant-based alternatives in its place provides the added benefit of vitamin D for bone health⁽⁴³⁾. Previous reports on the 2007 CFG also indicate that meeting vitamin D ($\geq 10\mu\text{g}$) by diet alone is not routinely achievable without drastically increasing dietary intake or

a routine vitamin D supplement⁽¹⁷⁾. Therefore, parents of children with CD should seek dietary advice from a physician or dietitian on vitamin D supplementation until fortification policies are re-evaluated. Until then, the GF food guide will encourage purchasing and consuming fortified calcium and vitamin D fluid milk or unsweetened plant-based alternatives in addition to other rich vitamin D sources (e.g. fish, eggs) whenever possible to increase nutrient intake. It is worth noting that those who primarily follow a vegetarian or vegan diet may also benefit from choosing vitamin B₁₂ fortified foods to optimize intake given that most naturally rich sources are found in animal-based foods⁽²³⁾.

The methodology behind the GF food guide was used to justify the rationale for the proportion of fruits, vegetables, grains and protein foods on the GF plate. Compared to the 2019 CFG plate model⁽⁴⁵⁾, the GF plate will put more emphasis on the consumption of F&V (>50% of the plate) with reduced servings of GF grains (<25% of plate). Protein foods will represent 25% of the plate with a focus on plant-based (e.g. legumes, tofu, nuts and seeds) and vitamin D rich sources (e.g. fish). Fortified fluid milk and/or unsweetened plant-based alternatives will be included as the primary beverage of choice. The total number of servings per day of GF grains is recommended to be lower than the 2007 CFG and ANGCIY^(36, 37). This was implemented due to the higher fat and sugar content of many GF processed grain products^(4, 6-8, 47). By reducing the proportion of grains, it also allowed for more emphasis on F&V intake to enhance micronutrient (e.g. folate) and fibre intake.

The layout of the GF food guide is in the form of a plate to mirror the 2019 CFG plate model⁽⁴⁵⁾. In 2018, it was noted that 12 countries officially use the plate model as their primary food guide format while many other countries use the pyramid⁽⁴⁸⁾. The plate model has been preferred by both adults and children in parts of the world, like Australia⁽⁴⁹⁾. The key features that

have been noted include visual ease, organized design, ability to clearly show food group proportions, the ease of interpretation, and being conducive to children's learning⁽⁴⁹⁾. The 2019 CFG uses photos of real food items which has also been identified as a preferred aesthetic feature compared to cartoon depictions^(45, 49). Real photos will be incorporated into the GF food guide while considering the unique nutritional attributes of GF foods and age-appropriate food selection.

Post-guide stakeholder consultations to evaluate food guide content and strategies for food guide dissemination and uptake are in progress. End-stakeholder consultations will include HP community end-users and professional organizations such as the Canadian Celiac Association, Health Canada, Canadian Association of Gastroenterology, and/or the Canadian Nutrition Society. This will ensure that guideline content has been scientifically and peer reviewed. This will also ensure that guideline uptake can occur and will be devoid of potential sources of bias. Nutrition champions and an informed process to critically evaluate nutrition guideline content is important in all phases of guidelines development⁽⁵⁰⁻⁵⁴⁾.

The intake of F&V has notoriously been low in children and it is important to acknowledge that this could impact guide uptake^(55,56). To address this barrier, visually appealing supplementary educational materials (e.g. handouts, videos with recipes) will be developed to help educate parents and their children on how to incorporate more F&V into their meals and snacks. This may include additional tips on increasing F&V accessibility within the home, parental role modeling, allowing children to taste foods multiple times, or focusing on developing food skills to promote greater F&V intake⁽⁵⁵⁾. Eating F&V on a budget will also need to be addressed as guide uptake may be affected by the feasibility of purchasing F&V on a regular basis.

The GF food guide will include various cuisines that reflect cultural preferences and food traditions. This will ensure that the guide is tailored and applicable to meet the needs of culturally

diverse populations. This is important as evidence indicates that adherence to nutritional guidelines may be a concern for youth of multi-ethnic backgrounds⁽⁵⁷⁾. This will also complement the 2019 CFG which focuses heavily on cultural preferences and food traditions⁽²²⁾.

The supplementary educational materials (e.g. handouts and videos) will further address healthy eating habits and food environments (home, community). Likewise, improving food literacy (e.g. grocery shopping, label reading, food preparation) will promote informed food choices and the consumption of nutritious meals⁽²²⁾. This is needed for children with CD as they enter adulthood due to the complexities of buying and eating safe and healthy GF foods.

3.6 CONCLUSIONS

The content of the GF food guide was derived by using important methodological approaches. This included pre-guide consultations and the evaluation of dietary patterns and nutrient intake through diet simulations. A GF food guide is needed to adequately educate families and their children with CD due to the complexities of the GFD. Evidence-based and easily accessible resources will provide educational opportunities to help children and their families make informed foods choices to consume a nutritious GFD. Important nutrients of concern for children with CD on the GFD are fat, sugar, folate and vitamin D. With the exception of vitamin D, all micronutrient and micronutrient needs are met with this GF food guide. This nutritional and methodological analysis highlights the need for policy makers to support the development of dietary guidelines for specialized therapeutic diets and to advocate for nutrient fortification of GF foods particularly when diets represent the main treatment strategy.

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Chapter 4: Evaluation of a Pediatric Gluten-Free Food Guide by Children and Youth with Celiac Disease, their Parents and Health Care Professionals

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4.1 ABSTRACT

There are currently no universal evidence-based nutrition guidelines that address the gluten-free diet (GFD) for children/youth (4-18 years). A gluten-free (GF) food guide was created to help children/youth with celiac disease (CD) and their families navigate the complexities of following a GFD. Guide formation was based on pre-guide stakeholder consultations and an evaluation of nutrient intake and dietary patterns. The study objective was to conduct an evaluation on guide content, layout, feasibility and dissemination strategies from end-stakeholder users (children/youth with CD, parents/caregivers, health care professionals). This is a cross-sectional study using a multi-method approach of virtual focus groups and an online survey to conduct stakeholder evaluations. Stakeholders included children/youth (4-18 years), their parents/caregivers or other adults in the celiac community (n=273) and health care professionals (n=80) with both pediatric and CD experience from across Canada. Thematic analysis was performed on focus group responses and open-ended survey questions until thematic saturation was achieved. Chi-square and Fisher’s exact statistical analyses were performed on demographic and close-ended survey questions. Stakeholders positively perceived the guide for content, layout, feasibility, ethnicity and

usability. Stakeholders found the material visually appealing and engaging with belief that it could effectively be used in multi-ethnic community and clinical-based settings. Guide revisions were made in response to stakeholder consultations to improve food selection (e.g. child-friendly foods), language (e.g. clarity) and layout (e.g. organization). The evaluation by end-stakeholders provided practical and patient-focused feedback on the guide to enable successful uptake in community and clinical-based settings.

4.2 INTRODUCTION

Celiac disease (CD) is an autoimmune disease where the ingestion of gluten drives the autoimmune process. The only treatment for this disease is a strict gluten-free diet (GFD). Consuming this diet requires a major lifestyle change as adherence is necessary to avoid long-term health complications (e.g. poor bone health, lymphoma)^(1, 2). This also means a major behavioural shift in food selection, food literacy and food purchasing patterns⁽³⁻⁶⁾. While it is possible to consume a nutritious GFD⁽⁷⁾, this is a major challenge for children/youth and their families. Evidence has shown that the GFD is characterized by high levels of fat, sugar and low intakes of several micronutrients (e.g. folate, vitamin D) and low diet quality⁽⁸⁻¹⁰⁾. The lack of nutrient fortification (e.g. folate) in processed gluten-free (GF) grains and suboptimal dairy intake are major contributors to low micronutrient intake in children/youth with CD^(8, 11-13).

Education on the GFD in newly diagnosed children/youth and their families is critical to manoeuvre the nutritional complexities of following a GFD⁽⁶⁾. However, access to dietitians with specialized knowledge in CD and the GFD can be limited within the community⁽¹⁴⁾. The 2019 Canada's Food Guide (CFG) provides Canadians with voluntary guidance regarding healthy eating behaviors for chronic disease prevention; however, these guidelines do not take into account the

unique nutritional considerations of the GFD^(15, 16). To address this important gap, our team has reported on the methodological and nutritional considerations of a newly developed GF food guide for Canadian children/youth with CD (4-18 years)⁽⁷⁾. This report illustrates that a GF plate model which reflects >50% fruits and vegetables (F&V), 25% protein and <25% GF grains is recommended to support children/youth in meeting their nutritional needs (**Figure 4.1**)⁽⁷⁾. The key messages of the GF food guide focus on F&V intake, limiting highly processed GF foods and emphasizing key nutrients (e.g. vitamin D, folate, iron, calcium, fibre)⁽⁷⁾. In addition, messaging that encourages children/youth to enjoy their food is important to foster healthy eating habits. A major difference between the plate model of the GF food guide compared with the 2019 CFG is the recommendation to include fortified and unsweetened milk or a plant-based alternative to ensure that growing children/youth with CD meet their calcium and vitamin D needs^(7, 15).

Formative evaluations have previously been used to refine healthcare innovations before being widely distributed to end-stakeholders. This helps researchers make timely and appropriate changes to improve uptake⁽¹⁷⁻¹⁹⁾. This approach was used to ensure that the GF food guide and the supplementary educational materials translated into feasible and useable materials within multi-ethnic community and clinical-based settings across Canada. The study objective was to conduct an evaluation on the GF food guide for content, layout, feasibility and dissemination strategies from end-stakeholder users (children/youth, their parents/caregivers and health care professionals [HP]). We hypothesize that the GF food guide for children/youth with CD will contain evidence-based content that is feasible and usable with understandable nutritional information for children/youth, their parents/caregivers and HP.

GLUTEN-FREE FOOD GUIDE FOR CHILDREN & YOUTH



*Protein foods include both animal protein (beef, fish, poultry, pork and eggs) and plant protein (pulses, tofu, nuts and seeds).

Figure 4.1 The gluten-free food guide for children and youth with celiac disease. This guide is a two-page document. Illustrated above is the first page which includes the gluten-free plate model and the following four key messages: 1) fill more than half your plate with fruits and vegetables to meet your nutrient needs, 2) eat protein foods from plant and/or animal-based sources, 3) eat gluten-free grain foods, 4) include a vitamin D and calcium fortified and unsweetened milk or plant-based beverage with your meal. The second page of the gluten-free food guide (not shown) includes an additional six key messages: 5) choose foods that are rich sources of folate, iron and fibre, 6) eat less gluten-free processed foods to limit saturated fat, added sugar and sodium intake, 7) read food labels and ingredient lists for gluten and nutrition content, 8) cook at home more often, 9) drink water throughout the day, 10) enjoy gluten-free foods. All key messages were adapted based on the recommendations outlined in the 2019 Canada's Dietary Guidelines⁽¹⁶⁾.

4.3 METHODS

This is a cross-sectional study using a multi-method approach of virtual focus groups and an internet survey to conduct post-guide stakeholder evaluations. Stakeholders were consulted from across Canada to obtain their perception on the content and layout of the GF food guide for children and youth (4-18 years). This included a convenience sample of the celiac community (e.g. children/youth with CD, their parents/caregivers, adults with CD) and HP (e.g. dietitians, physicians, nurses). The detailed inclusion criteria is outlined in **Table 4.1**.

Gluten-Free Food Guide for Children and Youth

The GF food guide consists of a two-page document that is accompanied by 22 supplementary educational handouts and four videos (**Figure 4.1, Appendix C-1**). The first page of the food guide shows the GF plate model which illustrates the recommended distribution of food groups on the plate with four key messages. The second page provides a total of six key messages targeted towards children/youth living with CD on the GFD. These messages were based on the healthy eating recommendations for the Canadian population (≥ 2 years) outlined in the 2019 Canada's Dietary Guidelines that were vetted and validated by Health Canada⁽¹⁶⁾. The supplementary educational materials cover a variety of different nutrient and lifestyle topics (>20 topics) to support the unique needs of children/youth with CD.

Participant Recruitment

Focus group participants and internet survey respondents were recruited using recruitment flyers and newsletters that were disseminated through a variety of electronic communication channels across Canada. These included health organizations (e.g. Alberta Health Service), provincial regulatory bodies (College of Dietitians of Alberta), professional organizations

(Canadian Celiac Association, Canadian Association of Gastroenterology,) and/or community run social media pages.

Table 4.1 Stakeholder inclusion criteria.

Focus Group Stakeholders	Inclusion Criteria*
Children/Youth	A current resident of Canada, has a diagnosis of CD, between 8-18 years of age, has not previously completed a survey on the GF food guide.
Parents/Caregivers	A current resident of Canada, has a child/youth (4-18 years) diagnosed with CD, has not previously completed a survey on the GF food guide.
Health Care Professionals	A current resident of Canada, currently practicing or has previously practiced with a pediatric population, experience in CD (primary or specialty care), has not previously completed a survey on the GF food guide.
Survey Stakeholders	Inclusion Criteria*
15-18 years	A current resident of Canada, has a diagnosis of CD, has not previously participated in a focus group on the GF food guide.
≥19 years [†]	A current resident of Canada, has a diagnosis of CD.
Parents/Caregivers	A current resident of Canada, has a child/youth (4-18 years) diagnosed with CD, has not previously participated in a focus group on the GF food guide.
Health Care Professionals	A current resident of Canada, currently practicing or has previously practiced with a pediatric population, experience in CD (primary or specialty care), has not previously participated in a focus group on the GF food guide.

CD: celiac disease; GF: gluten-free.

*Exclusion criteria: non-Canadian resident; focus group: ≤7 years of age; survey: ≤14 years of age.

[†]Survey eligibility was expanded to include all adults ≥19 years of age with CD (even those without a child with CD) to ensure that all perspectives were ultimately considered.

Focus Groups

Focus groups were conducted virtually between September 2020 to January 2021 using Zoom Video Communications Inc[®] V5.54⁽²⁰⁾. Each focus group was approximately 60-minutes in duration. Separate focus groups were conducted for youth alone (12-18y), parents and their children (8-18y), parents of children/youth (4-18y) and for HP alone. Focus groups were facilitated by two trained and arm's length moderators including a graduate student (S.C, RD) and a research assistant (C.L, BSc) who also made field notes during each focus group. An interview guide was used that consisted of 12 open-ended questions which were vetted by experts in the field (**Appendix C-2**). Questions were used to formally probe participants on their perception about the guide and the supplementary educational materials (e.g. handouts, videos) developed by our team.

Thematic Analysis

Each focus group was audio recorded using two external voice recorders (Sony IC recorder ICD PX312[®]) with permission from all participants. Recordings were transcribed verbatim, de-identified and audited independently for accuracy by three trained reviewers. Data was collected until data saturation was achieved. Transcripts were independently reviewed by two co-investigators. Data was evaluated by an investigator (C.L) and coded to identify themes. This was cross verified by a second investigator (S.C) and then data was sorted into themes and sub-themes. Themes were sorted using Microsoft Excel. Both deductive and inductive coding approaches were applied to identify themes⁽²¹⁾. Data was reviewed until thematic saturation was achieved.

Internet Surveys

REDCap[®] software was used to administer an anonymous internet survey to the celiac community and HP between November 2020 and February 2021^(22, 23). The 31-item survey contained open and close-ended questions related to the GF food guide for children/youth and the

supplementary educational materials. Ethics approval was obtained from the Human Research Ethics Board at the University of Alberta (Pro00103128). Informed consent and/or assent was obtained from all focus group participants and implied consent was obtained from all online survey respondents.

Statistical Analysis

Statistical analysis was performed using Statistical Analysis Software (SAS; version 9.4 SAS Institute, Care, NC, USA). Chi-square and Fisher's exact statistical analyses were performed on demographic and close-ended survey questions. Statistical significance was set at $P < 0.05$.

4.4 RESULTS

Stakeholder Consultations

Demographic Factors

The celiac community (n=273) and HP (n=80) provided their perceptions on the GF food guide and the supplementary educational materials (**Table 4.2, Appendix C-3**). No significant differences in geographic location were noted between focus group participants and survey respondents and/or between survey respondents whose responses were included in the analysis versus those excluded ($P > 0.05$).

Themes and Sub-themes

Similar themes and sub-themes were identified from the focus group participants and the survey respondents (**Figure 4.2, Table 4.3, Appendix C-4**). All stakeholders provided comprehensive evaluations and few differences were noted between the feedback received from children versus youth.

Table 4.2 Demographic data.

Variables, n (%)	Focus Group Participants*						
	Celiac Community (n=29)			Health Care Professionals (n=38)			
	Child [†]	Youth [‡]	Parent	Dietitian	Physician	Nurse	
Sample Size	4	10	15	33	4	1	
Sex							
Female	3 (75)	9 (90)	15 (100)	33 (100)	3 (75)	1 (100)	
Male	1 (25)	1 (10)	-	-	1 (25)	-	
Location[§]							
Western Canada	3 (75)	7 (70)	9 (60)	21 (64)	2 (50)	-	
Eastern Canada	1 (25)	3 (30)	6 (40)	12 (36)	2 (50)	1 (100)	
Area of Practice							
Clinical	-	-	-	30 (91)	4 (100)	1 (100)	
Community				3 (9)	-	-	
Age, years							
Median [IQR]	11 [10.8-11]	14 [13-16]	-	-	-	-	
Min:Max	10:11	12:16					
Survey Respondents							
	Celiac Community (n=244) [¶]				Health Care Professionals (n=42) [¶]		
	15-18y	≥19y [#]	Parent (+) [#]	Parent (-) [#]	Dietitian	Physician	Nurse
Sample Size^{**}	3	140	22	79	33	6	2
Location^{§**}							
Western Canada	3 (100)	86 (61)	15 (68)	48 (61)	19 (58)	2 (33)	-
Eastern Canada	-	54 (39)	7 (32)	31 (39)	14 (42)	4 (67)	2 (100)
Years of Practice^{**}							
Median [IQR]	-	-	-	-	13 [5-18]	11 [6-13]	25 [21-30]
Min:Max					1:33	5:18	16:34

CD: celiac disease; IQR: interquartile range; y: years.

*A total of 19 focus groups were conducted: n=11 with health care professionals and n=8 with the celiac community (n=2 with youth only, n=3 with parents and children, n=3 with parents only).

[†]8-11 years.

[‡]12-18 years.

[§]Western Canada: British Columbia, Alberta, Saskatchewan, Northwest Territories, Yukon. Eastern Canada: Manitoba, Ontario, Quebec, New Brunswick, Nova Scotia, Prince Edward Island, Newfoundland and Labrador, Nunavut.

[¶]n=28 health care professionals and n=149 celiac community members completed all survey responses; n=14 health care professionals and n=95 celiac community members completed partial survey responses. Respondents were not required to answer all survey questions.

[#]≥19y: an adult with CD but who does not identify as a parent of a child/youth with CD; Parent (+): a parent with CD who has a child/youth with CD; Parent (-): a parent without CD who has a child/youth with CD.

^{**}n=1 health care professional responded 'prefer not to answer' to the survey question.

Gluten-Free Food Guide Content. Focus group participants, including children/youth supported the GF plate model and appreciated the variety of GF foods shown on the plate. Survey respondents equally reported satisfaction with the food items (community members [94%, n=211 out of 225], HP [89%, n=34 out of 38]). The F&V were described by children/youth from the focus groups as colourful and encouraging to eat but additional favorites were suggested (e.g. strawberries, melons). Red meat was a key item that HP and parents from across Canada considered important due to its iron content. Certain GF foods on the plate (e.g. quinoa, yogurt) were not easily identifiable by some focus group participants, but it was acknowledged that this was the same case for these individuals regarding the 2019 CFG plate model as well. HP believed that the inability to identify some foods on the plate could help spark positive conversation with children/youth and their parents related to preferences and food literacy including nutritional composition.

A stronger emphasis to include more affordable food options on the plate such as frozen or canned varieties of F&V were suggested. Root-based vegetables were also suggested, especially potatoes which were noted as staples in the North American diets of children⁽²⁴⁾. Feedback also advocated towards addressing seasonal availability and accessibility, particularly for families living in rural settings and/or in northern Canada.

Focus group participants, including children/youth supported fortified and unsweetened fluid milk or a plant-based alternative as the beverage of choice to increase their calcium and vitamin D intake. However, parents and HP also wanted additional clarification on why this piece differed compared to the 2019 CFG and more information on the recommended servings compared to water. HP also wanted to see more guidance on calcium whereby initially, the message in the GF food guide primarily targeted vitamin D.

Community (91%, n=160 out of 175) and HP (82%, n=28 out of 34) survey respondents agreed that the key messages outlined in the guide were understandable. Yet, they also desired more information on why these recommendations were made along with clearer language and examples of nutrient specific food items (e.g. folate) to help families put the recommendations into context. Focus group participants felt similarly but also believed that the supplementary educational materials would likely address some of these concerns.

Gluten-Free Food Guide Layout. Focus group participants appreciated that the GF plate model was visually comparable to the 2019 CFG. Yet, children/youth particularly liked that this guide only provided GF food options. Parents and HP thought the volume of food depicted on the plate was overwhelming for younger children, but younger children did not directly make a comment on this concern. Survey respondents shared this viewpoint and suggested to reduce the volume but keep the same variety to address this concern.

There was agreement on the design features of the guide with minor suggestions to improve spatial organization, scaling and graphic elements. The feedback was similar for the supplementary educational materials. Focus group participants, including children/youth described the guide as appealing, colorful and concise (i.e. two-pages). Parents did not consistently notice that the proportion of F&V on the plate was >50% and differed from the 2019 CFG. Children/youth more readily noticed this difference which some attributed it to being very familiar with the 2019 CFG. Parents felt that larger ‘spaces’ on the plate between the food groups and that strategically placing foods on the plate would make this more apparent.

Ethnicity. Children/youth and parents from the focus groups expressed that the plate model showed a good representation of cultures and food traditions. They felt that the food items (e.g. vegetables, rice, legumes) could easily be incorporated into a variety of traditional dishes.

Additional considerations on cultural representation (e.g. South Asian) and food suggestions (e.g. roti, bok choy, melons) were equally provided to better represent the Canadian population.

Feasibility. Children/youth acknowledged that eating >50% of F&V at meals and snacks would require more effort to prepare but could be achieved. Parents felt that more planning and preparation would be required and acknowledged that their children typically eat more GF grains due to preferences and convenience. Feasibility was not a theme frequently brought up by survey respondents.

Supplementary Educational Material Content. Parents and HP felt that the educational materials would help meet the unique needs of children/youth with CD. Survey respondents (community members [96%, n=161 out of 168], HP [97% n=31 out of 32]) shared similar viewpoints. However, some additional topics were requested by children/youth, parents and HP. This included information related to social events, cross-contamination, GF grains and flours (e.g. listing different types, how to cook and/or bake with them). Younger children also wanted more information on GF recipes while youth wanted information on eating out safely while on the GFD (e.g. fast foods, restaurants). It was also agreed upon that these materials should be available in different languages (e.g. French).

Useability. Focus group participants felt that the guide and the supplementary handouts would be useful to educate children/youth with CD. This was confirmed by survey respondents (community members [86%, n=128 out of 149], HP [90%, n=25 out of 28]). Video-based resources were not as popular (community members [77% n=114 out of 149], HP [54%, n=15 out of 28]). HP survey respondents were concerned about video length during clinic visits whereby parents felt that uptake would depend on the exact topic and the target audience of the videos (i.e. children/youth, parents, both). Still, most agreed that access to any of these resources would have been beneficial at

time of diagnosis and that they will benefit future children/youth with CD. Survey respondents (70%, n=123 out of 177) reported that both electronic and paper-based documents should be available to ensure equitable and convenient access to all demographics. This mixed response was shared by focus group participants.



Figure 4.2 Themes and sub-themes identified from the stakeholder evaluations. A total of eight themes and 18 sub-themes were identified from the evaluations conducted with virtual focus group participants and online survey respondents.

Table 4.3 Selected quotes from themed focus group responses generated by stakeholders.

Themes	Sub-themes	Child/Youth	Parent	Health Care Professional
Food Guide Content	Plate	<i>I think it looks pretty good and it gives a good explanation ..and it shows the food groups pretty well. [C10, 16y]</i>	<i>There's lots of different colours, there's lots of different [food] options. [P1]</i>	<i>The question is, will [the message] get misinterpreted ...that water is less important [than milk]? [HP41]</i>
	Food Selection	<i>Yeah, like it looks good. It ...like encourages me like that I want to eat more fruits and vegetables. [C15b, 15y]</i>	<i>...it was just all the fresh .. but also, more expensive ..vegetables and fruit. So, it would be nice if we could have ...some cabbage or ..some of the root vegetables on there ..it's more economical. [P2]</i>	<i>I know what the rice and the pasta is, I'm not totally clear what the other three things are [on the plate]. [HP40]</i>
		<i>...yeah I'm familiar with both [buckwheat and quinoa] ..and now that I look at it -it does look like quinoa ..I just didn't recognize them at first. [C14, 14y]</i>	<i>I'd like to see more variety of ..meats and maybe a few less beans. But I understand that beans are really important, but I don't think that that's reflective of what people would really be eating ..like on a day to day basis. [P13]</i>	<i>[Where is cheese?] Kids love cheese too, so. [HP8]</i>
	Key Messages	<i>I like the extra information on why ..some things are different from the normal food guide. [C9, 16y]</i>	<i>I guess as a parent I didn't understand ..point number three there 'be aware marketing can influence your food choices.' To me it [is] all about like reading the ingredients and about BROW. [P5]</i>	<i>...maybe when you emphasize the fact that you want ...more folate, should we be giving ..actual food examples? Because that might make it a bit more useful than just seeing the words. [HP24]</i>
	Language	<i>...it says 'include milk or fortified unsweetened plant-based beverages with your meal' -like I understand what milk is, but I don't understand what the next part is. [C14, 14y]</i>	<i>...my feeling is that [the term plant-based beverage has] become mainstream with many of my non-celiac acquaintances and friends. [P16]</i>	<i>... 'children with celiac disease need more specific foods high [or] fortified in folate, vitamin D, and iron.' I found that a little confusing. [HP38]</i>
Food Guide Layout	Food Groups	<i>I did see that it was more than half, I have [Canada's Food Guide] on my fridge ...so I see it every single day. I could spot the difference right away. [C14, 14y]</i>	<i>I actually didn't even notice there was more fruit and vegetables on it until you pointed it out. [P10]</i>	<i>It looks similar to [Canada's Food Guide] plate, aside from the fruits and veggies being bigger. [HP24]</i>
	Design	<i>...the information [is] really good because there's a visual component which is nice and easy to just take a glance at. [C9, 16y]</i>	<i>I find the plate to be very busy. I have to look super careful to see what is there ...it's not crystal clear where those dividing lines are and ...a little more space. between the food groups would be helpful. [P7]</i>	<i>Green is ...a colour that's associated with .. 'go' and 'good' so I think that it's nice that it's ..highlighted in green. [HP31]</i>

Themes	Sub-themes	Child/Youth	Parent	Health Care Professional
		<i>...the glass of milk just like looks like a rounded egg, maybe have like more dimensions? [C4, 14y]</i>	<i>I like[d] the colours and I liked the layout of it personally. I thought it was appealing to the eye. [P10]</i>	
Ethnicity	Language			<i>I'm just wondering ..will these resources be translated [to] other languages? [HP23]</i>
	Cultural Inclusion	<i>I think the rice is good because it's ...a universal food and ..I think vegetables and fruit they're all over the world ..it's seems to be okay. [C3, 13y]</i>	<i>I would say...there is a huge variety of food on that plate that you could incorporate into different meals. ...I think you've done a good job with that. [P7]</i>	<i>So long as it's foods that are familiar ...you know ..foods that they can get in ..rural communities and ..that apply [to] First Nations would be helpful. [HP11]</i>
		<i>Maybe sushi. [C5, 10y]</i>	<i>...more Asian vegetables and ..maybe some bok choy, some daikon, something that would be more recognizable to people from that culture. [P1]</i>	<i>...the breads, the wraps, the flatbreads of various ethnic cuisines aren't represented at all. [HP14]</i>
Feasibility	Realistic	<i>I don't think [eating more fruits and vegetables would be challenging]. ...I just think making more of an effort. [C15b, 15y]</i>	<i>I personally really like the proportions here and I'm lucky with my celiac child that this is how [they] eat. ...I think it's great and it is representative of where we're at this point. [P16]</i>	<i>I think as much as any healthy food message is feasible and realistic for kids, right? [HP38]</i>
		<i>...only time I eat vegetables is at supper because in the morning I just rush out the door with whatever for breakfast. And then at lunch I usually don't bring any vegetables to school. [C4, 14y]</i>	<i>Definitely there would be ...not enough grains... [my child] likes to have... more, and I would say we definitely don't have half of the plate of veggies... I need to pay more attention to that. [P9]</i>	<i>I don't know that it's really realistic. I'll be honest. I would say kids would... [gravitate towards] more of the fruits ...versus the veggies and this is just a common thread amongst kids in general, so ...not sure how realistic it is, but I'm hopeful. [HP42]</i>
	Additional Supports	<i>...maybe you should add a page in the [guide] with like some ...recipes that people can make. [C5, 10y]</i>	<i>...it was nice to see the photos [of different meal ideas] because it made me think 'oh we haven't made that in a while.' ...so, it is always nice to have just something to remind you or suggest a different option. [P16]</i>	<i>I think the Bento box ideas were really good. ...if you can include [that] as an addendum at the back of the guide? ... [HP13]</i>
	Overall Guide Messaging			<i>I think people need to know what they should be eating. I think we shouldn't be changing a food guide because we think it will be too challenging for people to meet. They need to</i>

Themes	Sub-themes	Child/Youth	Parent	Health Care Professional
				know what's the expectation ..of what they should be eating. [HP41]
Educational Material Content	Existing Handout Considerations	<i>In the restaurant dining part, do you have like restaurants listed that you could eat gluten free at? It would be really helpful if you could maybe do a little bit of research ...It's kinda hard to eat out sometimes. [C6, 13y]</i>	<i>I had never heard of pulses until I read this document. ...But I can say that ..once I read the definition it makes complete sense to me ...I think it was worded well to understand what it is now. [P14]</i>	<i>...we don't really want to have families too focused on the numbers [for nutrient requirements] ..more so just kinda thinking broadly about what foods are high. Maybe ..you could have a list of foods that are higher [compared] to ..the foods that are lower. [HP33]</i>
	New Topic Suggestions	<i>I think a handout with gluten-free flours would be good too. [C3, 13y]</i>	<i>...a handout for like extended family would be helpful. Because I know when my [child] was first diagnosed they just kinda thought I was over the top. [P8]</i> <i>... my one thought was it might be helpful to have handouts on how to cook the different type of grains. [P2]</i>	<i>I definitely would add in the cross-contamination. ...having a cross-contamination sheet they can go back to and review would be really helpful. [HP21]</i>
Educational Material Layout	Design	<i>I like how they made like the titles bold and like easy to find. [C8, 11y]</i>	<i>...the bottom ..is it fruit? ...that might be something you can take out ...because that does make it a little bit busier and that might help take away from the busy-ness. [P2]</i>	<i>...the dark on the dark is a little bit ..hard to see for anyone who'd be visually impaired... not much contrast. [HP38]</i>
	Organization	<i>...it's very easy [to] read and it was very clear to me. [C15a, 12y]</i>	<i>It almost looks like it needs to be spread over another page. Feels a bit like there's too much crowded, the colours are a bit much. [P1]</i>	<i>I think it looks pretty good ..it's quite clear and there isn't too much writing on it which is nice. [HP2]</i>
Useability	Usefulness	<i>I like the guide and I think it would've been really really helpful when I was first diagnosed, and it'll really help other people. [C5, 10y]</i>	<i>I think it's really really well done ..one thing I noticed in this is there's such a focus and emphasis on fruits and vegetables and ...those are often the most expensive foods so I feel like this could be really limiting for people who are on a budget, people affected especially by COVID and job loss. [P12]</i>	<i>...the plate... does look so similar to [Canada's Food Guide] plate. ...it might make the person that's newly diagnosed feel like part of the big population right? It's just that little tweak they have to make now. [HP14]</i>

Themes	Sub-themes	Child/Youth	Parent	Health Care Professional
			<i>...we probably use... the actual plate and food guide less... because... we're quite familiar with... what we need in our diet. But I think definitely the handouts would be important. [P15]</i>	<i>I think having it would be a good toolI try to see ...[patients/clients] as soon as possible but ...it could definitely get them started on [their] own and then you could clarify once you've seen them. [HP1]</i>
	Format	<i>I enjoy having paper more, but you don't always carry it around with you. ...So, the electronic version would be a lot easier. [C10, 16y]</i>	<i>...really important to have both because lots of people don't have access to printers or even for us, I feel like it took a lot of ink to print out. ...And it's nice to have it just up on your fridge or on your bulletin board or what not so I think both are really important. [P12]</i>	<i>... [If] English isn't [a family's] first language, ...sometimes it's good to have that paper copy that you can write on if you're working with an interpreter. [HP31]</i>
		<i>...if you made it into a website it would be a lot easier ...to find everything there. [C10, 16y]</i>	<i>I think an app would be amazing as well. ...it would be a great ..support or resource for [my child]. [P16]</i>	<i>I think a combination would be good ...especially right now ..with COVID-19. ...So, having a digital copy we can email a client ...and then when we do have [a] one on one in the office, it is nice to have that paper copy. [HP14]</i>
Other	Serving Size	<i>Personally, I think ..the visual representation is better because six servings in my head does not mean anything at all. [C3, 13y]</i>	<i>...it would still be nice to know the minimum [servings] ... so that I know my teenager's ...getting what they need, or I can at least work towards that. [P14]</i>	<i>I personally think that it's adding a little bit too much information having the serving sizes. I like this representation ...I think that it's a little easier to follow for families. [HP34]</i>

C: child/youth; y: years old; P: parent; HP: health care professional.

4.5 DISCUSSION

The intent of the GF food guide is to provide general nutrition guidelines for children/youth following the GFD. The plate model is to illustrate what proportions of food should be consumed to ensure a healthy GFD. Transitioning to a GFD can be challenging for children/youth with CD since dietary restrictions can impact their psychosocial wellbeing and differences in the nutrient density of GF foods may adversely impact macronutrient and micronutrient intake^(8, 25). Gluten restrictions can also result in stigmatization and social withdrawal among the pediatric population especially at school^(25, 26). Non-adherence by children/youth with CD can increase risk of health complications (e.g. poor bone health) as they struggle to restrict gluten-containing foods⁽²⁷⁾. The GF food guide and the supplementary educational materials address the unique nutritional needs for children/youth on the GFD⁽⁷⁾ (**Figure 4.1, Appendix C-1**). These resources aim to help children/youth and their families of diverse cultures all around the world navigate the complexities of following the GFD. Stakeholder consultations were conducted through a formative evaluation process to ensure that concepts related to content, layout, feasibility, usability and dissemination would be addressed within the GF guideline process. This evaluation was unique because it gathered feedback from children/youth, their parents and HP to evaluate these concepts.

Overall, stakeholders positively perceived the GF food guide and the associated educational materials. Children/youth liked that the GF plate model mirrored the plate model from the 2019 CFG because it made them feel less ‘different’ than their non-CD peers. Since the stakeholders perceived children/youth to already face many dietary restrictions, they advocated to display certain GF foods on the plate that they perceived children/youth to really enjoy (e.g. cheese, potatoes). Cheese is an important component of the diet in North America, is a rich source of calcium and some hard cheese can be a good option for those with CD who experience lactose

intolerance⁽²⁸⁻³¹⁾. While plant-based protein intake was emphasized within the GF food guide, parents and HP felt that animal-based sources (e.g. lean cuts of red meat) were also important in relation to the risk of suboptimal iron status at time of CD diagnosis⁽⁹⁾. While this may be perceived to add to saturated fat intake in children/youth, saturated fat intake in the diet simulations (which included these food choices) were well below current recommendations (<10% energy intake)⁽⁷⁾.

Stakeholders wanted additional clarifications as to why the GF food guide encourages fortified and unsweetened fluid milk or a plant-based alternative as the beverage of choice while the 2019 CFG encourages water. In growing children/youth, calcium and vitamin D are key nutrients for bone health⁽¹⁰⁾. Since this guide solely targets children/youth on the GFD and they are at risk of suboptimal vitamin D intake, this can be a practical solution to increase intake^(7, 32). These sources also contain protein, riboflavin, vitamin A and B₁₂ to contribute to nutritional adequacy in the diets of children/youth⁽²⁹⁾. For additional hydration, water is a healthy choice and is still encouraged to be consumed ad-libitum throughout the day. Dietary supplementation for calcium and vitamin D is an alternative option, but inconsistent adherence has been reported⁽³³⁾.

Knowledge Translation

Dissemination Strategies

The dissemination plan has been made with an intent to increase awareness about the GF food guide and the supplementary educational materials. This is important so that children/youth and their families know where to access reliable information since the burden of treatment falls heavily on them to strictly adhere to a GFD. When Health Canada launched the 2019 CFG, multiple dissemination strategies were observed including a Canada-wide press conference with media coverage, a website re-launch, social media presence and webinars^(15, 34, 35). The use of combined strategies, including one-way and mutually reinforcing strategies have been shown to

help create awareness and discussion⁽³⁶⁾. Standalone paper or electronic lay resources can be another strategy, but they need to be easily accessible to facilitate awareness, and unambiguous and clear to empower families to adopt them⁽³⁶⁾. Collaborating with frontline HP can also help reinforce standalone resources to patients/clients during clinic visits, answer their questions and address any misinformation or confusion⁽³⁶⁾. With support from HP, consistent information and trusted messaging can be better disseminated to Canadians⁽³⁷⁾. Endorsements made by well-known public figures (e.g. Registered Dietitian), nutrition champions (i.e. past focus group children/youth or parents) or trusted organizations such as provincial or territorial health authorities and/or the Canadian Celiac Association, including local chapters can also facilitate reach⁽³⁶⁾. Recurring dissemination strategies have also been pursued by Health Canada with the release of monthly newsletters and routine social media posts. This strategy permits the sender to expand reach and reminds the public that these evidence-based tools exist thus facilitating awareness and uptake⁽³⁶⁾. Guide dissemination directly to schools can be another strategy to reach families and their children/youth at a critical period of learning and growth. About 20% of surveyed Canadians reported receiving a copy of the CFG from their child's school⁽³⁸⁾.

Implications to Uptake

Stakeholder evaluations were proactively used to address potential factors that may inhibit or facilitate future guide uptake. A unique difference compared to the 2019 CFG is the greater proportion of F&V shown on the plate. Historically, children/youth have not met their serving recommendations⁽³⁹⁾ due to factors such as preferences and financial constraints^(40, 41). Children/youth were key stakeholders to inform food selections on the GF plate and cited that the variety and colours were appealing and engaging. Plates of food that are colourful have been preferred by children and visually appealing F&V have notably promoted intake^(42, 43). The plate

model also includes nutrient-rich examples of relatively affordable food options such as root-based vegetables (e.g. carrots, potatoes)⁽⁴⁴⁾. Frozen F&V were also included due to increased accessibility, longer shelf-life and year-round availability⁽⁴⁵⁾.

Conducting food literacy interventions will also be important to help support children/youth and their families voluntarily use these resources and improve the feasibility of recommendations. Interventions related to food skills (e.g. learning how to cook GF grains), label reading, meal planning and overcoming picky eating can empower families to prepare meals at home according to the GF plate model and key messages. Developing knowledge and skills earlier in life can help foster positive eating habits into adulthood and make these recommendations more feasible on a routine basis^(46, 47). Other possible facilitators to guide adoption may stem from aesthetic qualities of materials which can influence perceived usability, satisfaction and uptake^(48, 49). Future interventions may be needed to address behaviour change or time-barriers (e.g. full-time employment) which may prevent families from adopting and routinely following the guide.

In this study, strengths included the use of a multi-method approach with virtual consultations that allowed for pan-Canada feedback with cross-cultural input. This method helped obtain perceptions from across Canada where the accessibility and availability of GF foods can differ. Some limitations include the lack of information regarding socioeconomic status of study participants and the smaller sample size of the children/youth that participated. However, socioeconomic status was addressed and highlighted by both parents and HP as an important factor that may influence food guide uptake and adherence to not only food guide recommendations but with the actual GFD. This is likely due to the high costs⁽⁵⁰⁾ associated with GF food. One highlighted factor by parents in particular, was that the food guide should focus on less expensive GF food choices (e.g. root-based vegetables). Recruiting a larger sample size of children/youth

would have conferred increase rigor to the study design. However, we had a large representation of parents of children in both the focus groups and online surveys. This is highly relevant since parents are often the main influencer of the dietary intakes of younger children⁽⁵¹⁾ and would be the main users of the guide itself. Additional recruitment of older children/youth would have conferred increased strength as they take more authority over their food choices⁽⁵²⁾. The feedback included an evaluation of supplementary educational materials and the need for additional content. One important concept will be the inclusion of a bilingual GF food guide (English and French) and translation to other languages to reflect the needs of culturally diverse communities. This is important to ensure that all materials can be used internationally.

4.6 CONCLUSIONS

A GF food guide for children and youth addresses a major gap in the literature as there are currently no comprehensive evidence-based nutrition guidelines that focus specifically on the GFD. The evaluation of the GF food guide for content, layout, feasibility and dissemination strategies by end-stakeholders (children/youth with CD, their parents/caregivers and HP) provided practical and patient-focused feedback regarding the GFD. This information is critical to ensure that guide uptake is successful in community and clinical-based settings. Ongoing work will focus on guideline uptake in children/youth with CD.

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Chapter 5: Food Environment and Youth Intake May Influence Uptake of Gluten-Free Food Guide Recommendations in Celiac Disease

A version of Chapter 5 is currently under review as “Cyrkot S, Gidrewicz D, Anders S, Marcon M, Turner JM, Mager DR. (2021) Food environment and youth intake may influence uptake of gluten-free food guide recommendations in celiac disease. Can J Diet Pract Res. [Manuscript ID: DCJOURNAL-D-21-00072]”, and is being used in this thesis with permission from the publisher.

5.1 ABSTRACT

A gluten-free (GF) food guide for children and youth (4-18 years) living with celiac disease (CD) has been developed and extensively evaluated by stakeholders, including registered dietitians. A case study analysis was conducted on data from 16 households of youth with CD (12-18 years) to examine how factors related to parental food literacy, the home food environment and food purchasing patterns may influence GF food guide uptake by Canadian youth with CD and their families. Households were of higher socioeconomic status, parents had good food literacy and the home food availability of fruits, vegetables and GF grains was diverse. However, households also had a diverse supply of convenience foods and snack options. Youth reported consuming larger proportions of these foods (>35% dietary intake) and had suboptimal diet quality. Dietary intake of fruits and vegetables was below GF plate model recommendations by over 30%. Despite limited economical barriers, good parental food literacy and diverse food availability, meeting fruit and vegetable recommendations based on the pediatric GF plate model remains a major challenge. Ongoing strategies and healthy public policies are needed to support the uptake of GF food guide recommendations to improve the dietary intake and health outcomes of children/youth with CD.

5.2 INTRODUCTION

Celiac disease (CD) is an autoimmune disease that causes inflammation and villous atrophy to the small intestine when gluten is consumed⁽¹⁾. This disease affects 1% of the population and about 350,000 Canadians⁽²⁾. The only treatment is a strict and lifelong gluten-free diet (GFD)⁽¹⁾. However, the GFD has nutritional limitations including lower folate intake due to voluntary fortification of gluten-free (GF) grains and higher levels of fat and sugar in many packaged GF foods⁽³⁻⁶⁾. Our team recently developed a GF food guide to help children and youth (4-18 years) with CD meet their nutritional needs while on the GFD^(7, 8). The GF plate model recommends eating >50% fruits and vegetables (F&V), 25% protein and <25% grains with an emphasis on vitamin D and calcium fortified foods including unsweetened fluid milk or a plant-based beverage.

While the development of nutrition guidelines is important to ensure that Canadian children/youth with CD consume a nutritious GFD, it is also important to assess factors that may influence guideline feasibility, usability and uptake within the celiac community. This includes the need for a comprehensive evaluation of the home food environment, food literacy and the food purchasing patterns of youth (12-18y) with CD and their families. About 72-93% of dietary intake is consumed inside the home where parents can be gatekeepers and are responsible for determining which foods are available and in what quantity^(9, 10). The home food environment is important to evaluate because it can predict dietary intake and diet quality in children/youth⁽¹⁰⁻¹⁴⁾. The availability and accessibility of food has been associated with healthy eating habits during childhood⁽¹⁵⁾. This may be closely tied to attributes of food literacy where knowledge and food skills (i.e. ability to prepare meals)⁽¹⁶⁾ may influence home food availability, parental feeding practices and food decisions. In Canada, following a strict GFD is already more expensive than a non-GFD and some families may be purchasing more processed GF foods due to the belief that

they are more nutritious⁽¹⁷⁻²¹⁾. This perception and purchasing pattern may lead to financial constraints and thus non-adherence to the GFD, especially in families of lower socioeconomic status⁽²²⁾. An overabundance of nutrient-poor GF foods in the home may contribute to suboptimal diet quality in youth, regardless of whether nutrient-dense foods are also present⁽²³⁾.

This case study examined the home food environment, parental food literacy, food purchasing patterns and youth dietary intake in households of youth with CD. The analysis focused on how these factors may influence uptake of a recently developed pediatric GF food guide^(7, 8). Results will inform dietetic practice, strategies and policies to support the uptake of GF food guide recommendations to improve health outcomes for youth with CD and their families.

5.3 METHODS

This study presents a cross-sectional analysis of parent-youth dyads recruited between June 2019 and November 2020 from the celiac clinic at the Stollery Children's Hospital in Edmonton and the South Health Campus in Calgary, Alberta. Inclusion criteria was youth (12-18y) with a clinical diagnosis of CD (>6 months ago) by serology and/or biopsy. Exclusion criteria was youth with multiple food allergies or other diagnoses (e.g. type 1 diabetes) that would alter their dietary intake or food environment. Medical and sociodemographic data was collected from medical records and/or self-reported by the parent and/or youth.

Dietary Intake and Diet Quality

Youth dietary intake was collected using two 24-hour recalls (one weekday, one weekend day) using the multiple-pass method⁽²⁴⁾. Recalls have been well established in assessing food patterns in children/youth and to report intake in those with CD, with similar levels of variability as the 3-7 day food records⁽²⁵⁻²⁷⁾. Intake was analyzed using Food Processor Nutrition Analysis

Software (SQL 11.0.124, ESHA Research, Salem, OR, USA). Diet quality was assessed using the Canadian Healthy Eating Index (HEI-C). The HEI-C was subcategorized and scored based on adequacy (range 0-50), moderation (range 0-40) and variety (range 0-10). An total score of >80 indicated 'good', 51-80 indicated 'needs improvement' and ≤ 50 indicated 'poor' diet quality⁽²⁸⁾.

Food Literacy

The validated Nutrition Literacy Assessment Instrument[®] (NLit, Order #113874) assessed parental food literacy and was completed in REDCap[®] by parents⁽²⁹⁻³²⁾. The 64-item NLit consisted of six domains and addressed constructs on nutrition and health, energy sources in food, household food measurements (serving size), food label and numeracy, food groups and consumer skills. Scores ≥ 58 indicated 'likelihood of good nutrition literacy', 45-57 indicated 'possibility of poor nutrition literacy' and ≤ 44 indicated 'likelihood of poor nutrition literacy'^(29, 30).

Food Environment

The adapted Perceived Nutrition Environment Measures Survey[®] (NEMS-P) assessed parental perceptions about their food environment and was completed in REDCap[®] by parents⁽³¹⁻³³⁾. The 37-item NEMS-P addressed constructs related to the home food environment, food shopping, restaurant/eating out, thoughts/habits about food and general household questions⁽³³⁾.

The validated Home Food Inventory (HFI) tool was used to assess the home food availability in each household at a single point in time⁽³⁴⁾. The HFI included thirteen food categories and was adapted to include commonly consumed GF foods and to collect data on whether foods contained gluten. A trained researcher visited the home of each parent-youth dyad to complete the 200-item checklist with yes/no (1/0) options. In instances where the trained researcher was unable to visit the home (e.g. 2019 Coronavirus Disease [COVID-19]), the researcher completed this tool with the parent-youth dyad over the telephone. Higher scores for each food category represented greater

availability. A food item was marked as ‘yes’ if it was present anywhere in the home at the time of HFI completion. This involved checking the refrigerator, freezer, cupboards, pantry and other spaces where food may be stored (e.g. basement, garage). Additional information was collected for fruits, vegetables and bread to distinguish their processing levels (e.g. fresh, frozen)⁽³⁴⁾.

Receipt Collection

Households collected food receipts for 14-days to capture the food availability within the home food environment⁽³⁵⁾. Receipts were collected from any establishment where food was purchased (e.g. grocery store, restaurant). The receipt data (e.g. store, date of purchase, price, food items) was coded by a researcher and items were categorized by product type (e.g. fruits, vegetables). Limited line-item data was complemented with an online search (e.g. store website) using product barcodes to obtain additional details about each food item (e.g. weight, brand). Food items that could not be accurately characterized (<1% of all purchases) and non-food items were excluded from further analysis. Ethics approval was obtained from the Human Research Ethics Board at the University of Alberta (Pro00087877) and the Conjoint Health Research Ethics Board at the University of Calgary (REB19-1110). Informed consent and assent was obtained from parent-youth dyads prior to study enrollment.

Statistical Analysis

Data analysis was completed using SAS 9.0 statistical software (SAS, Version 9.4; SAS 124 Institute Inc., Cary, NC, USA). Data was expressed as median [interquartile range] to account for non-parametric variables, unless otherwise specified. The Shapiro-Wilk test was conducted to assess the normality of distributions. An analysis of variance or a Mann-Whitney test was used to compare differences between dietary intake, food literacy, food availability and sociodemographic factors including COVID-19 across households. A *P* value of <0.05 was considered significant.

5.4 RESULTS

Anthropometric and Demographic Characteristics

This study included fifteen maternal-youth dyads and one paternal-youth dyad. Anthropometric and demographic data is presented in **Table 5.1**. Ten parent-youth dyads were recruited prior to COVID-19 and six parent-youth dyads were recruited during COVID-19.

Dietary Data

Compared to the pediatric GF plate model, youth consumed 18% F&V, 14% protein foods (dairy, plant/animal-based sources), 22% grains, and 46% other foods (e.g. snacks) and condiments (**Figure 5.1A-B**)⁽⁷⁾. Over the evaluated two-day period, youth consumed a median of five (min-max: 0-8) different sources of F&V (e.g. banana, cucumber), four (min-max: 2-7) different sources of protein foods (e.g. dairy=milk, cheese; plant=beans, vegetarian meatballs; animal-based=chicken, beef) and two (min-max: 1-3) different sources of grains (e.g. bread, rice). In contrast, youth consumed a median of five (min-max: 1-9) different sources of ‘other foods’ (e.g. pop, frozen/fast food pizza, microwavable popcorn). This intake coincided with youth diet quality that reflected ‘needs improvement’ (**Table 5.1**). Three youth did not report eating any fruits and one did not report eating any vegetables over the two-days. Prior to COVID-19, youth dietary intake for grains was lower than during COVID-19 (4.2 [3.2-4.6] vs. 8.2 [7.4-8.3], $P<0.0001$). No other dietary differences were noted pre or during COVID-19 ($P>0.05$) (**Appendix D-1**).

Nutrition Literacy Assessment Instrument

The median parental NLit score (58.0 [55.0-60.0], min-max: 36-62) indicated a ‘likelihood of good nutrition literacy’. The lowest median score (5.5 [4.8-6.0], min-max: 3-8) was obtained in the household food measurement domain which tested serving size knowledge (**Table 5.2**).

Table 5.1 Anthropometric, demographic and dietary data.

Youth Characteristics (n=16)	Results
Age (years)	14.6 [14.3 – 15.3]
Sex (female:male)	12:4
Weight	56.5 [50.3 – 64.6]
Weight-z*	0.4 [-0.2 – 0.89]
Height	162.2 [158.4 – 165.7]
Height-z*	0.1 [-0.3 – 0.6]
BMI	21.7 [20.2 – 23.2]
BMI-z*	0.7 [0.1 – 1.1]
ATTG (U/mL) [†]	4.4 [2.7 – 8.7]
CD Duration (years)	1.8 [1.3 – 4.0]
CD Family History (Y:N)	6:10
Food Groups	
Fruits and Vegetables	4.2 [2.0 – 6.1]
Grain Product	4.8 [4.1– 7.6]
Milk and Alternatives	2.0 [1.1 – 3.2]
Meat and Alternatives	1.7 [1.4 – 2.7]
Diet Quality	
Total	54.9 [46.8 – 67.2]
Adequacy	31.1 [28.9 – 38.3]
Moderation	20.0 [16.9 – 25.6]
Variety	5.0 [3.8 – 5.0]
Maternal and Paternal Characteristics	
Age (years)	
Maternal	48.0 [44.8 – 50.3]
Paternal	45.5 [41.5 – 50.2]
Maternal Ethnicity	
Caucasian:Other	14:2
Paternal Ethnicity	
Caucasian:Other	14:2
Maternal Education	
≤ Highschool	1
≥ College or University Degree	15
Paternal Education	
≤ Highschool	4
≥ College or University Degree	11
Other	1
Marital Status of Participating Parent ^{‡§}	
Married/Living with Partner	14
Divorced [¶]	2
Employment Status of Participating Parent ^{‡§}	
Unemployed, not seeking ^{**}	3
Part-time (<35h/wk)	3
Full-time (>35h/wk)	10

Household Characteristics	Results
Household Income	
<\$50,000	0
\$50,000 – 74,999	1
\$75,000 – 99,999	3
\$100,000 – 124,999	3
\$125,000 – 150,000	3
>\$150,000	6
Neighborhood Type [‡]	
City:Suburban:Rural	4:7:5
Homeowner:Renter [‡]	15:1
Motor Vehicles in Household [‡]	2.0 [2.0 – 2.5]
Household Size	
Total	4 [4 – 5]
Children/Youth	2 [2 – 3]
Household Food Availability ^{††}	
GF:GF & Gluten	2:14
Household Members on GF diet	1 [1 – 2]
Households Following Western:Vegetarian Diet	15:1

BMI: body mass index; ATTG: anti-transglutaminase; CD: celiac disease; Y: yes; N: no; GF: gluten-free. Data is represented as median [interquartile range] or frequency.

*Weight, height and BMI z-scores were calculated according to the World Health Organization standards⁽³⁶⁾.

[†]Missing data on n=1.

[‡]The participating parent is the parent actively participating in the case study.

[§]Data was pulled from the Perceived Nutrition Environment Measures Survey[®].

[¶]Participating parents who reported a divorced marital status also reported full-time employment and their household was reported as the youth's primary residence.

^{**}Participating parents who reported being unemployed were in two-parent households.

^{††}GF refers to households who reported only having GF foods available in the home. GF & Gluten refers to households who reported having both GF and gluten-containing foods available in the home.

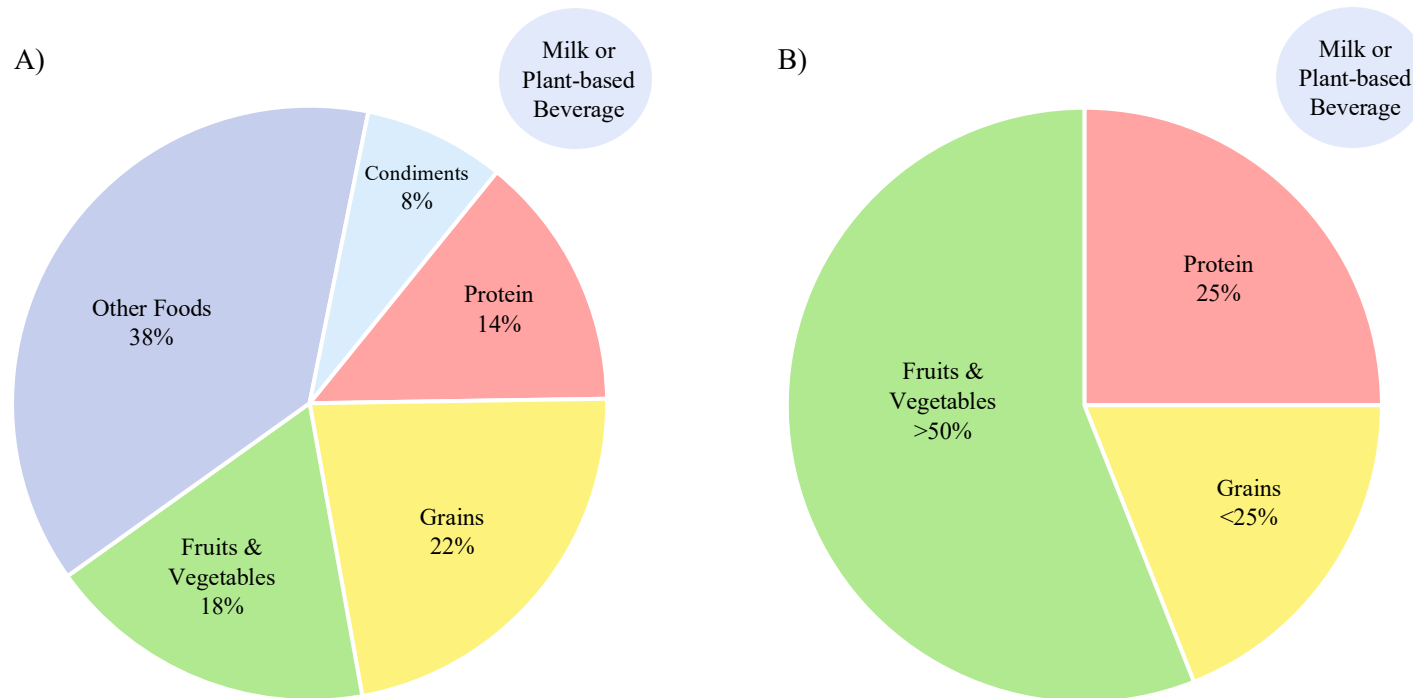


Figure 5.1A-B The average daily proportion of foods consumed from each food group by A) youth with celiac disease on the gluten-free diet (n=16) in comparison to B) gluten-free food guide recommendations for children and youth. ‘Other foods’ include foods such as convenience foods (e.g. pizza, french fries), prepared desserts (e.g. cookies, cakes/cupcakes/pies, muffins, brownies/bars), snack foods (e.g. potato chips, tortilla chips, popcorn), candy/chocolate and beverages (e.g. <100% fruit juice, lemonade, soda pop). ‘Condiments’ include food items such as ketchup, butter, mayonnaise and salad dressing. Youth consumed on average one serving per day of fluid milk or a plant-based beverage. When combined as part of the protein group, the daily proportion of dietary intake was 17% protein, 22% grains, 17% fruits and vegetables, 37% other foods and 7% condiments.

Table 5.2 Parental nutrition literacy assessment scores.

	Items	Median Score [IQR]	Min-Max Score
NLit Total Score	64	58.0 [55.0 – 60.0]	36 – 62
NLit Domains			
Nutrition and Food	10	10.0 [9.0 – 10.0]	7 – 10
Energy Sources in Food	10	10.0 [9.8 – 10.0]	7 – 10
Household Food Measurements	9	5.5 [4.8 – 6.0]	3 – 8
Food Label and Numeracy	10	10.0 [9.0 – 10.0]	3 – 10
Food Groups	16	15.0 [14.0 – 15.0]	11 – 16
Consumer Skills	9	9.0 [8.0 – 9.0]	5 – 9

NLit: Nutrition Literacy Assessment Instrument[®]; IQR; interquartile range.

Responses are based on n=16 participating parents.

Food Availability

The diversity of F&V available in the home was higher (11.5 [8.5-14.5], min-max: 4-19; 14.0 [12.0-15.0], min-max: 9-18) compared to the diversity purchased based on the receipt data (5.5 [4.0-7.0], min-max: 3-11; 8.0 [4.5-9.0], min-max: 2-10) ($P<.0001$) (**Table 5.3**). Households during COVID-19 had significantly more types of gluten-containing flour (2.0 [1.0-3.0], min-max: 0-3 vs 1.0 [0.0-1.0], min-max: 0-2, $P=0.01$) and gluten-containing whole wheat bread products (1.5 [1.0-2.0], min-max: 1-2 vs 0.5 [0.0-1.0], min-max: 0.0-1.0, $P=0.002$) in the home compared to pre-COVID households. Food diversity was not correlated with youth age (>and<median), parental employment, reported household income or parental NLit ($P>0.05$).

Food Purchasing Patterns

Household bi-weekly median grocery food expenditure was \$550.00 [\$460.00-637.10] (min-max: \$286.00-928.80, excluding provincial sales tax). Median grocery food expenditure collected pre-COVID (n=10, \$474.28 [417.35-615.91], min-max: \$285.96-627.08) was significantly lower than during-COVID (n=6, \$633.61[579.9-837.68], min-max: \$394.43-928.76) ($P=0.03$). About 81% (n=13) of households reported weekly food shopping frequencies while 19% (n=3) reported shopping once every 1-2 weeks. All households (n=16) reported grocery shopping in at least two

different stores. Mothers were reported as the primary grocery shopper (n=14) and about 81% (n=13) reported usually or always using a grocery list. Food shopping and thoughts/habits about food are presented in **Appendix D-2**.

Table 5.3 Diversity of food availability.

	Items	Home Food Inventory*		Receipts**		P value
		Median [IQR]	Min-Max	Median [IQR]	Min-Max	
Fruit	23	11.5 [8.5 – 14.5]	4-19	5.5 [4.0 – 7.0]	3-11	<.0001
By Processing Level						
Fresh	23	6.0 [4.5 – 7.5]	2-10	5.0 [3.5 – 6.5]	1-8	0.1
Canned	23	2.5 [1.0 – 3.5]	0-6	0.0 [0.0 – 0.0]	0-4	0.0007
Frozen	23	3.0 [0.5 – 5.0]	0-10	0.0 [0.0 – 1.0]	0-3	0.004
Dried	23	1.0 [0.0 – 2.0]	0-10	0.0 [0.0 – 0.0]	0-0	0.007
By Type‡						
Citrus	4	2.0 [1.5 – 2.5]	0-4	1.0 [1.0 – 1.0]	0-2	0.001
Berries	4	3.0 [1.0 – 4.0]	0-4	1.0 [0.5 – 2.0]	0-3	0.004
Stone	4	1.0 [0.0 – 2.0]	0-4	0.0 [0.0 – 1.0]	0-2	0.01
Pome	2	1.0 [1.0 – 1.5]	1-2	0.5 [0.0 – 1.0]	0-2	0.001
Tropical	6	4.0 [2.0 – 4.0]	0-5	2.0 [1.0 – 2.0]	0-3	0.005
Grapes	1	1.0 [0.0 – 1.0]	0-1	0.5 [0.0 – 1.0]	0-1	0.3
Melons	1	0.0 [0.0 – 0.5]	0-1	0.0 [0.0 – 0.0]	0-1	0.7
Mixed	1	0.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-2	0.5
Vegetables	20	14.0 [12.0 – 15.0]	9-18	8.0 [4.5 – 9.0]	2-10	<.0001
By Processing Level						
Fresh	20	9.0 [6.5 – 10.0]	5-13	6.5 [3.5 – 8.0]	1-9	<.0001
Canned	20	2.5 [1.0 – 4.0]	0-7	0.0 [0.0 – 1.0]	0-2	0.0009
Frozen	20	3.5 [3.0 – 6.5]	0-7	0.0 [0.0 – 0.5]	0-3	<.0001
Dried	20	1.0 [0.0 – 2.0]	0-7	0.0 [0.0 – 1.0]	0-1	0.02
By Type§						
Leafy Greens	2	1.0 [1.0 – 2.0]	0-2	1.0 [0.0 – 1.5]	0-2	0.2
Cruciferous	3	1.0 [1.0 – 2.5]	0-3	1.0 [0.0 – 1.5]	0-2	0.06
Deep Orange/Yellow/Red	6	5.0 [3.5 – 5.0]	1-6	2.0 [1.0 – 2.5]	0-4	<.0001
Potatoes	1	1.0 [1.0 – 1.0]	0-1	1.0 [0.0 – 1.0]	0-1	0.01
Mixed	1	1.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-1	0.03
Other	7	5.0 [4.0 – 6.0]	4-6	2.5 [1.0 – 3.0]	1-3	<.0001
Grains						
Whole Grains¶						
GF	5	3.0 [2.0 – 4.0]	1-5	0.0 [0.0 – 0.5]	0-1	<.0001
Gluten	5	1.0 [0.0 – 2.0]	0-3	0.0 [0.0 – 0.0]	0-1	0.0002
Whole Grain Bread#						
GF	5	1.0 [0.5 – 2.0]	0-3	0.0 [0.0 – 0.5]	0-2	0.005
Gluten	5	1.0 [0.0 – 1.0]	0-2	0.0 [0.0 – 1.0]	0-2	0.04
White Bread**						
GF	7	1.5 [1.0 – 3.0]	1-3	0.5 [0.0 – 1.0]	0-3	0.002
Gluten	7	1.0 [0.0 – 2.0]	0-3	1.0 [0.0 – 2.0]	0-3	0.5
Pasta††						
GF	1	1.0 [1.0 – 1.0]	1-1	0.5 [0.0 – 1.0]	0-1	0.0005
Gluten	1	0.5 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-1	0.06

	Items	Home Food Inventory [*]		Receipts ^{*†}		P value	
		Median [IQR]	Min-Max	Median [IQR]	Min-Max		
Flour ^{‡‡}	GF	18	4.0 [3.0 – 6.0]	2-13	0.0 [0.0 – 0.0]	0-1	<.0001
	Gluten	3	1.0 [0.0 – 2.0]	0-3	0.0 [0.0 – 0.0]	0-1	0.0002
Whole Grain Crackers	GF	1	1.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-0	0.0001
	Gluten	1	0.0 [0.0 – 0.0]	0-1	0.0 [0.0 – 0.0]	0-0	0.07
<100% Whole Grain Crackers	GF	1	0.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-1	0.3
	Gluten	1	1.0 [0.5 – 1.0]	0-1	0.0 [0.0 – 0.0]	0-1	<.0001
Cereal ^{§§}	< 6g sugar	1	1.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 0.5]	0-1	0.03
	≥ 6g sugar	1	1.0 [1.0 – 1.0]	1-1	0.0 [0.0 – 1.0]	0-1	0.0001
Other Foods							
Microwaveable & Quick Foods ^{¶¶}	GF	8	2.0 [1.5 – 3.0]	0-5	1.0 [0.5 – 2.0]	0-5	0.07
	Gluten	8	1.0 [0.0 – 2.5]	0-4	0.0 [0.0 – 0.0]	0-1	0.003
Prepared Desserts ^{###}	GF	7	1.5 [0.5 – 3.0]	0-4	0.5 [0.0 – 1.5]	0-5	0.1
	Gluten	7	1.5 [0.5 – 3.0]	0-4	0.0 [0.0 – 1.0]	0-3	0.02
Chips & Other Snacks ^{***}	GF	8	5.0 [2.0 – 5.0]	1-6	3.0 [1.5 – 3.0]	1-4	0.01
	Gluten	8	0.0 [0.0 – 1.0]	0-2	0.0 [0.0 – 0.0]	0-2	0.2
Candy ^{†††}	GF	5	2.0 [1.0 – 3.0]	0-5	1.0 [0.5 – 2.0]	0-4	0.2
	Gluten	5	0.0 [0.0 – 1.0]	0-1	0.0 [0.0 – 1.0]	0-3	0.3
Beverages ^{†††}		5	2.0 [1.0 – 3.0]	0-5	1.5 [1.0 – 2.5]	0-4	0.5

IQR: interquartile range; GF: gluten-free. Data is based on n=16 households and is represented as median [interquartile range], min-max.

A P value of <0.05 was considered significant.

^{*}Median time lapse (in days) between last day of receipt collection and completion of home food inventory: 4.5 [1.8-10.5], min-max: (-14)-71.

[†]Households collected receipts for a median (in days) of 14.0 [14.0 – 16.3], min-max: 14-42.

[‡]Citrus: grapefruit, lemons and/or limes, oranges, tangerines/clementines. Berries: blueberries, cranberries, raspberries, strawberries. Stone: apricots, nectarines, peaches, plums. Pome: apples, pears. Tropical: avocado, bananas, dates, kiwi, mango, pineapple. Grapes: any variety (i.e. red, green). Melons: any variety (e.g. watermelon, cantaloupe, honeydew). Mixed: mixed varieties of fruit i.e. fruit cocktails.

[§]Leafy Greens: lettuce, spinach or other leafy greens. Cruciferous: broccoli, cabbage, cauliflower. Deep orange/yellow/ red: beets, bell peppers, carrots, squash, sweet potatoes, tomatoes. Potatoes: white, yellow and red varieties. Mixed: mixed varieties of vegetables i.e. peas/carrot/corn blends. Other: asparagus, celery, corn, cucumbers, green beans, mushrooms, peas.

[¶]Rice, quinoa, buckwheat, instant oats, steel-cut oats, barley, bulgur, couscous.

[#]Bread/buns, English muffins, bagels, flour-based tortilla, pita bread.

^{**}Bread/buns, English muffins, bagels, flour-based tortilla, corn-based tortilla, pita bread, croissants.

^{††}any variety of pasta.

^{‡‡}Includes flours such as all purpose, whole wheat, rye, gluten-free blends, rice, corn, tapioca, nut, soy, quinoa, arrowroot.

^{§§}Data separated by GF versus gluten-containing cereal was not available for home food inventory.

^{¶¶}Pizza, hot pockets, pizza rolls or bagel snacks, burritos or other Mexican snacks, chicken nuggets, french fries, egg rolls, ramen noodles.

^{###}Cookies, cakes/cupcakes/pies, muffins, brownies/bars, other snack cakes, pastry/rolls/doughnuts, pudding or gelatin desserts.

^{***}Potato chips, corn chips, tortilla chips, cheese curls or puffs, pretzels, bagel chips, popcorn, granola bars.

^{†††}Chocolate, hard candy, gummies, fruit snacks, chewy candy.

^{†††}Pop, iced tea or lemonade, sport drinks, 100% fruit juice, <100% fruit juice.

5.5 DISCUSSION

This study provides insight into parental food literacy, the home food environment, food purchasing patterns and youth dietary intake in households affected by CD. These factors are important to consider in assessing the uptake of GF food guide recommendations in youth with CD and their families, and the implications to dietetic practice. Households demonstrated good parental food literacy, had diverse food availability and the means to purchase and replenish foods within their homes. Households had about 50% of assessed fruits and 70% of assessed vegetables present in their homes compared to another study using the HFI tool where food-secure households with non-CD children had about 30% and 50%, respectively⁽³⁷⁾. Findings of the present study support the premise that guide uptake and adherence to recommendations should be high among this population. However, households also had a diverse supply of convenience foods and snacks at home. Youth consumed a large proportion of these foods and had a median diet quality categorized as ‘needs improvement’. Intake was heavily weighted in favour of these nutrient-poor foods from the perspective of the GF plate model. This resulted in reduced F&V and protein intake with ‘other foods’ taking up >1/3 of the plate. These proportions are below the GF food guide recommendations and the 2019 Canada’s Food Guide^(7, 8, 38). The findings provide insight that even when the home food environment is diverse and socioeconomic factors of food insecurity are not present, youth may still choose less nutrient-dense foods. This is not unexpected as historically, most do not meet Canadian guidelines for F&V⁽³⁹⁾. The findings are consistent with other reviews showing that food availability (i.e. physical environment) is not the only barrier to intake^(40, 41).

Social factors, particularly family meal frequency has been positively associated with F&V intake in youth⁽⁴²⁾. However, qualitative data reported by youth suggests that parental work schedules are a major barrier to family mealtime⁽⁴³⁾. The present study demonstrated that youth of

parents employed full-time ate more ‘other foods’ (e.g. snacks, convenience foods) compared to youth of parents working part-time or unemployed (data not shown). Likewise, youth have reported making food decisions based on convenience despite demonstrating an understanding that F&V are more nutrient-dense⁽⁴⁴⁾. Employed parents may also spend less time meal planning, shopping and preparing foods with a higher reliance on serving convenience foods due to time constraints⁽⁴⁵⁾. Dietitians can help families understand the importance of family mealtime and provide strategies (e.g. planning meals ahead) to prepare quick nutrient-dense dishes at home during busy workweeks. Improving at-home food visibility and accessibility may be another strategy to ensure that youth have easy and quick access to nutrient-dense food options which are ready-to-eat and prepared in a manner that they prefer (e.g. washed and chopped F&V)⁽⁴¹⁾. Dietitians also have an opportunity to help families recognize the importance of parental role modeling and involving youth in grocery shopping and food preparation which has been associated with increased F&V intake in youth^(46, 47). A systematic review found that parental dietary intake is associated with youth dietary intake, particularly F&V⁽¹³⁾. Reducing the availability of nutrient-poor foods at home may also have merit as greater availability of high-fat foods has been associated with a greater intake of energy from fat and snacks in youth. Particularly, greater at-home availability of high-fat desserts/snacks was related to lower F&V intake⁽⁴⁸⁾. Although these strategies may help improve at-home dietary intake, youth may still turn to eating nutrient-poor foods outside the home. Targeting food environments in community settings (e.g. schools, recreational facilities) that focus on healthy food procurement policies and/or the consideration of other policy development (e.g. taxation of sugar-sweetened beverages/snacks) may be effective strategies to facilitate healthy food choices in youth, particularly in those with disposable incomes^(49, 50). Instilling self-efficacy can also empower youth to make healthy food choices

inside/outside the home which has been associated with reduced intake of nutrient-poor snacks⁽⁵¹⁾. Dietitians can also facilitate connecting youth to community health promotion programs (e.g. kitchens, gardens) where services are aimed to enhance food literacy and thus dietary intake. A systematic review found that community kitchens can possibly improve nutritional intake and garden interventions in children and youth have had a small but positive influence on F&V intake^(52, 53). Interventions that are age-sex specific may also help improve dietary outcomes due to different stages of maturation^(13, 51).

The plate model serves as a guide for meals/snacks to determine recommended proportions (e.g. fill more than half your plate with F&V)⁽⁷⁾. The GF food guide does not require families to measure serving sizes to follow a healthy eating pattern which may increase guide usability as study findings showed that this appeared to be an area that parents were least knowledgeable about.

Households of lower socioeconomic status may face greater barriers to following guide recommendations and consuming nutritious foods. This is important in the context of food affordability and accessibility (e.g. store access) where purchasing GF foods (e.g. GF grains) are more costly and likely compounded with social and food literacy barriers^(17, 54). Dietitians play an important role to identify those living in food insecure households and to provide them with education on nutritious food options as well as practical strategies to reduce food costs and access to community services to avoid long-term health complications. Dietitians are also valuable in the role of advocacy for healthy public policies that support lower income households (e.g. food assistance programs, income policies, subsidized housing) and healthy food environments for equitable access to nutritious GF foods.

The COVID-19 global pandemic resulted in higher grocery food expenditure during COVID compared to pre-COVID. Families also had higher amounts of gluten-containing flour and whole

wheat bread products in their homes during COVID-19. Increased grocery food expenditure was not unexpected as recent research suggests that the general population was purchasing more foods, particularly non-perishable items due to the fear of a food shortage and/or a desire to limit their outings outside the home⁽⁵⁵⁻⁵⁷⁾. Thus, gluten-containing flours and breads were likely being stocked up for non-CD family members. Moreover, a study found that >75% of parents did not report having any problems finding GF foods for their children and they did not feel that their child's adherence to the GFD was compromised during lockdown⁽⁵⁸⁾. Families have also reported higher amounts of energy-dense snacks and prepared desserts in the home during COVID-19⁽⁵⁶⁾ but this was not consistent with current study findings. However, youth were consuming more GF grains during COVID compared to pre-COVID. This may be attributed to youth consuming more meals at home and snacking throughout the day due to the public health stay-at-home restrictions⁽⁵⁹⁾.

5.6 CONCLUSIONS

Results provide the insight that higher-income, food literate and food secure households with diverse at-home food availability may still find following GF food guide recommendations challenging as evident by suboptimal youth dietary intake and quality. This also suggests greater implications for households of lower socioeconomic status. Future directions include the need for larger scale intervention trials that address youth behavioral cues related to food consumption patterns in varying food environments (e.g. outside the home).

5.6.1 Relevance to Practice

Dietitians play an important role in assessing the risk for poor nutrient intake in youth with CD on the GFD. Youth consumed a larger proportion of 'other foods' (e.g. snacks), which possibly displaced the intake of F&V and protein foods. This has relevance to dietetic practice as the GF

food guide emphasizes plant-based food sources in addition to unsweetened fluid milk and plant-based beverages that are fortified with calcium and vitamin D. Therefore, implementing health promotion strategies in line with guide recommendations and directed at youth remains a priority. Advocacy efforts for public policies related to healthy and affordable food environments for diverse youth with CD and their families are also warranted.

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Chapter 6: Discussion and Conclusions

6.1 INTRODUCTION

Celiac disease (CD) is an immune-mediated disease and the only known treatment is to follow a strict gluten-free diet (GFD)⁽¹⁾. Although it is possible to consume a nutritionally adequate GFD, the literature demonstrates that children/youth with CD on the GFD are at risk of suboptimal nutrient intake (e.g. vitamin D, folate)⁽²⁻⁶⁾. This is likely amplified when children/youth living with CD and their parents/caregivers have inadequate knowledge related to the nutritional limitations of the GFD. Current standard of care practices for those newly diagnosed involves a registered dietitian who plays an important role in educating children/youth and their parents on the GFD⁽⁷⁾. However, some celiac clinics in Canada have increased referral rates with limited dietitian resources⁽⁸⁾. Some communities may also have limited access to these professionals on a routine basis which may limit routine follow-up⁽⁹⁾. This is particularly concerning and leaves families vulnerable to misinformation about the GFD when obtained from other sources. To our knowledge, there are no comprehensive evidence-based nutrition guidelines to support this population.

Many factors are considered when developing nutrition guidelines, particularly a gluten-free (GF) food guide. These include a) an environmental scan of the food environment, b) an assessment of dietary patterns for a target population (e.g. children/youth with CD), c) guideline formation, d) pre-and-post stakeholder evaluations for content, layout and dissemination, and e) testing of guidelines (e.g. food guide) in community and/or clinical settings for factors influencing uptake and clinical outcomes among the population of interest. An evaluation of the food environment may focus on home, retail, school and/or hospitality sectors. An assessment of dietary patterns is important in pre-guide formation to determine appropriate guideline content. An evaluation of the food environment and/or food literacy is also important in food guide formation

to evaluate factors that may influence adoption of food guide recommendations. These factors are key in the overall cycle of food guide creation, testing and evaluation. They are also important to help the targeted population of children/youth with CD eat a nutritious GFD.

This thesis focused on GF food guide development, pre-and-post guide evaluation and an analysis of some of the factors that may influence guide uptake in households of children/youth with CD (**Figure 6.1**). In this thesis, **Chapter 3** provided important data regarding the nutritional and methodological considerations in developing a GF food guide for children/youth with CD (4-18 years)⁽¹⁰⁾. Guide formation included a comprehensive evaluation of dietary patterns, the formation of nutritionally complete diet simulations and pre-guide stakeholder consultations (e.g. parents and health care professionals [HP]). The GF food guide was then formally evaluated in **Chapter 4** by end-stakeholders (children/youth, their parents and health professionals) using virtual focus groups and an online survey on guide content, layout, feasibility and dissemination strategies⁽¹¹⁾. In **Chapter 5**, additional considerations were examined related to the home food environment, parental food literacy, food purchasing patterns and youth dietary intake in the context of how these factors may influence uptake of guide recommendations. This paper is under review by a peer review journal. This analysis represented preliminary data and further analysis is required before overall conclusions can be made about the factors influencing food guide uptake. Special considerations related to the Coronavirus Disease 2019 (COVID-19) global pandemic were also considered in this chapter. Thesis findings aim to contribute to evidence-based, informative and easily accessible nutrition guidelines for Canadian children/youth with CD and their families in multi-ethnic community and clinical-based settings.

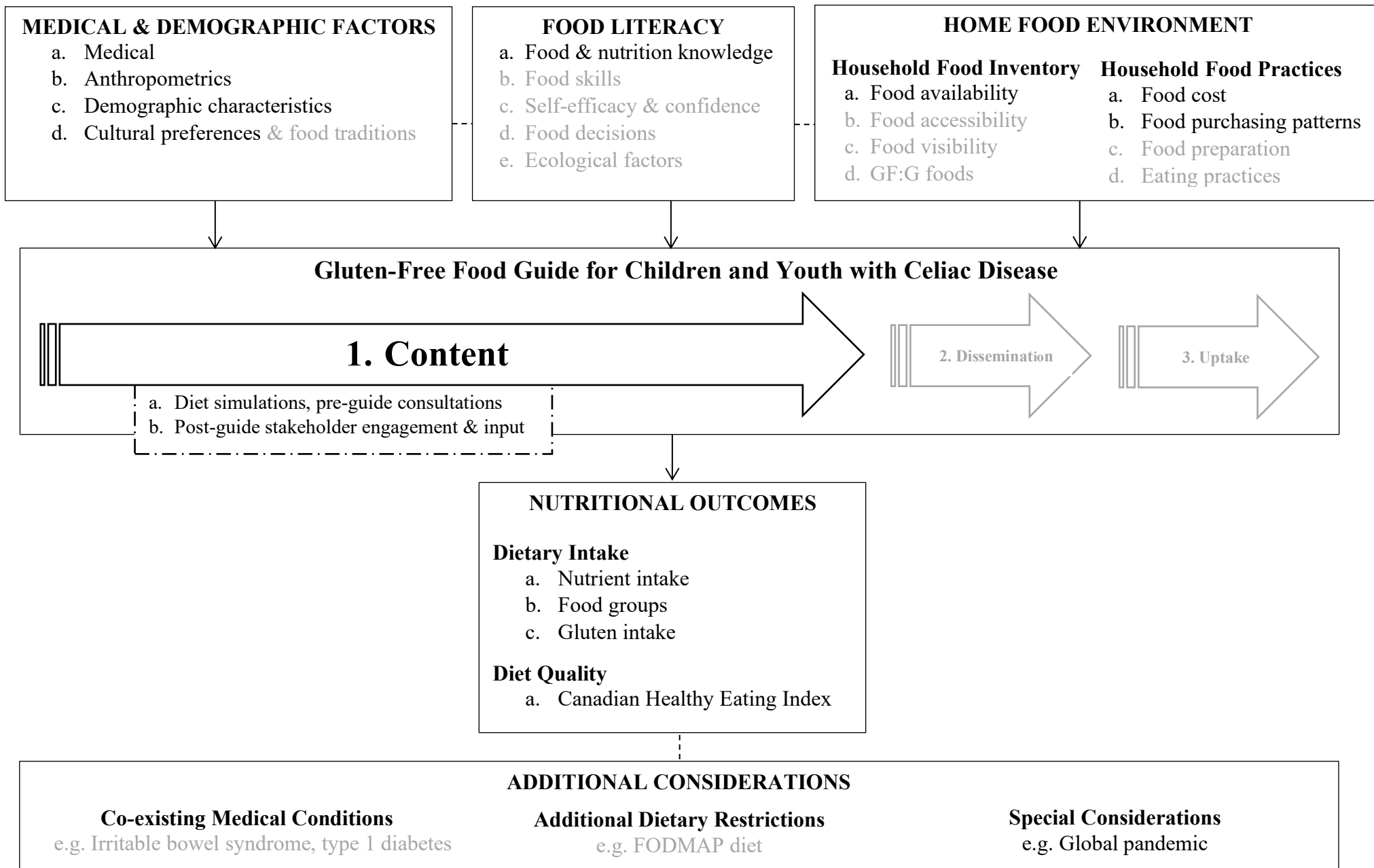


Figure 6.1 Conceptual framework of factors that may impact the uptake of a gluten-free food guide by children/youth and their families. GF: gluten-free; FODMAP: fermentable oligosaccharides, disaccharides, monosaccharides and polyol. Factors in grey coloured typeface were not explored in this thesis.

6.2 SUMMARY OF RESEARCH FINDINGS AND CLINICAL IMPLICATIONS

6.2.1 Nutritional and Methodological Considerations of a Pediatric Gluten-Free Food Guide for Celiac Disease

The first study in this thesis (**Chapter 3**) examined the nutritional and methodological considerations of the GF food guide⁽¹⁰⁾. Results demonstrated that children and youth (4-18y) with CD can meet 100% of their nutritional requirements (with the exception of vitamin D) by following a GF plate model that represents >50% fruits and vegetables (F&V), 25% protein foods (from animal and predominantly plant-based sources) and <25% grains. We hypothesized that the GF food guide would meet all macronutrient and micronutrient requirements of child/youth with CD consuming the GF diet. With the exception of meeting vitamin D requirements, we were able to demonstrate this. This similar weakness is suspected in the recently developed 2019 Canada's Food Guide (CFG)⁽¹²⁾. A major reason for not meeting vitamin D in the GFD simulations for children/youth was due to the limited sources of naturally-rich or vitamin D fortified foods in Canada (e.g. fish, egg yolks)^(13, 14). Meeting dietary requirements would have meant the daily consumption of an unrealistic amounts of these single food items. Some children/youth also eat some vitamin D rich sources less frequently. For instance, a research study in Alberta found that only 10% of children (10-11 years) reported eating more than three servings of fish per month⁽¹³⁾. Conversely, the same study in Alberta found that 60% of their participants consumed more than seven glasses of fluid milk each week⁽¹³⁾. Fluid milk and/or an unsweetened plant-based alternative that is fortified with calcium and vitamin D appears to be a more practical option to optimize vitamin D intake. This differs from the 2019 CFG which encourage water as the beverage of choice⁽¹⁵⁾.

Folate was initially a nutrient of concern in the GFD due to the lack of routine fortification of GF grains⁽¹⁶⁾. Nonetheless, folate needs could be met because diet simulations were adapted to include folate-rich sources such as plant-based protein sources (e.g. legumes) and F&V in order to meet nutrient needs for age-sex. However, meeting folate requirements will not be without its challenges as it is well known that most children/youth in Canada do not meet their recommended servings of F&V and they can also be expensive^(17, 18). For this reason, advocacy for nutrient fortification of folate in GF foods, especially GF grains is needed to provide this population with nutritious alternatives. This is important to ensure that the burden of meeting nutrient requirements (i.e. folate, vitamin D) does not fall solely on children/youth with CD and their families. Meanwhile, the GF food guide will be used to educate this population in multi-ethnic community and clinical-based settings. This will help households make informed GF food choices based on the current food environment in Canada. Future iterations of the GF food guide would need to consider changes to folate fortification policies. However, it is unlikely that toxic levels of folate intake would be a major concern with current levels of dietary folate intake (e.g. green leafy vegetables, legumes), even if fortified sources of GF grains were consumed in the diet.

One of the major strengths in guideline content was that it was based on diet simulations that examined the influence of ethnic cuisines in populations with a high prevalence of CD. This also reflected the ethnic diversity of Canada (e.g. South Asian, South American, European, Middle East) and varying diet patterns (vegetarian, vegan). Additionally, the GF food guide was designed based on the plate model which has been used in over 10 countries⁽¹⁹⁾. This design is a strength as during the focus groups (**Chapter 4**), participants felt that utilizing the same design as the 2019 CFG would promote inclusivity and help their children/youth living with CD feel less ‘different’ than their non-CD peers who follow CFG. Research also suggests that the plate model is preferred

by both adults and children due to factors such as ease of interpretation and visual appeal⁽²⁰⁾. The plate model is also accompanied by supplementary educational materials (22 handouts, 4 videos) that provide tips regarding different nutritional concerns, meal preparation and food purchasing (**Appendix C-1**). Current materials are in English and French versions only, but plans are in progress for translation into Hindi and Punjabi. Translation to other languages is also important and the overall strengths of guideline content and uptake may be improved with these additions.

6.2.2 Evaluation of a Pediatric Gluten-Free Food Guide by Children and Youth with Celiac Disease, their Parents and Health Care Professionals

The second study in this thesis (**Chapter 4**) was conducted to obtain an evaluation from stakeholders on guide content, layout, feasibility and dissemination strategies⁽¹¹⁾. We hypothesized that stakeholders would consider the food guide content as evidenced-based with usable and feasible recommendations. With some exceptions, we were able to prove this hypothesis with the GF plate model and accompanying educational materials. We showed that stakeholders, including children/youth, positively perceived the evidence-based GF food guide and the supplementary educational materials in terms of content and layout. Stakeholders found the deliverables to be visually appealing, engaging and useable. They believed that newly and already diagnosed children/youth with CD and their families would benefit from these resources. The HP believed that these tools would also support their ability to provide evidence-based and high quality clinical care to their patients, but recommended minor revisions to content and layout of the deliverables. Minor revisions were made to the GF food guide and the educational materials based on feedback from children/youth, their parents and HP to improve food selection (e.g. child-friendly food options), language (e.g. clarity) and layout (e.g. organization) (**Figure 4.1**).

A strength in this study was the use of mixed methodology (i.e. focus group and survey) to elicit feedback from children/youth, their parents and HP. This included the use of virtual technology which enabled a cross-Canada evaluation of food guide content. A challenge that occurred during this period was the ability to elicit feedback from HP due to the global pandemic where their availability to participate in research was limited. Despite this, we were able to elicit feedback from about 80 HP with CD experience in both primary and acute care centres across Canada and from over 250 children/youth with CD, their parents and adults with CD. A limitation in this approach may have been the difficulties for families of lower socioeconomic status without computers or without English fluency to participate in these consultations. This may have influenced overall perceptions regarding food guide content, particularly in families that experience food insecurity where the ability to follow guide recommendations may be adversely influenced. This highlights the need to engage policy makers in later stages where adoption of food guideline recommendations may be impacted.

A conferred strength of this study was the inclusion of children/youth with CD in the overall evaluation. This is an important first step to ensuring that food guide content is feasible and contains information that is relevant to the target population. While the use of virtual technology was useful to conduct focus groups with this target group, it may have limited interactive conversations between participants in the study. Therefore, face-to-face conversations can be an important way to elicit enhanced engagement, particularly in youth who may be reticent to voice their perspectives⁽²¹⁾. Furthermore, when recruiting this population in the future, there may be a benefit in approaching children/youth and their parents at in-person events (e.g. kids celiac support groups) where they may be more present. Although we planned to recruit children/youth at these types of events, many were cancelled due to COVID-19. The study was also shared on community-

run social media pages for CD, but it is possible that a larger proportion of parents compared to children/youth (with parental permission to use social media) followed these pages. Despite this, 14 children/youth were recruited to participate in the virtual focus groups (with an additional three survey respondents).

6.2.3 Food Environment and Youth Intake may Influence Uptake of Gluten-Free Food Guide Recommendations in Celiac Disease

A case study analysis (**Chapter 5**) examined the home food environment, parental food literacy, food purchasing patterns and dietary intake of 16 youth with CD and their families. This study was conducted to explore some of the potential factors that may influence food guide uptake in households of youth with CD.

In this case study, we showed that participating parents were food literate and that the home food environment related to F&V was diverse. Food purchases indicated that households were able to actively replenish foods within their homes. All of these findings support the belief that guide uptake and adherence to guide recommendations should be high. However, one major noted exception was that households also had a diverse supply of convenience foods and snack options within the home. Youth with CD reported eating a large proportion of these foods (>35% of dietary intake) and had diet quality classified as ‘needs improvement’. Intake of F&V were also much lower than recommended (approximately 17% of dietary intake). This suggests that even with diverse food availability within the home and good parental food literacy, a major challenge in guide uptake will be to increase F&V consumption in youth. This is not an unexpected finding since current data illustrates that children and youth have not typically met Canadian guidelines for F&V intake⁽¹⁷⁾. Hence a strong emphasis on dietary education along with practical tips to

increase consumption of F&V (meal planning and preparation) will be needed to help promote increased uptake. Some strategies were discussed in **Chapter 3**.

Factors that may have influenced study findings included the limited sample size (n=16 households) in two urban centres (Edmonton and Calgary) in Alberta. This may have limited the generalizability of study findings to other geographical locations across Canada (e.g. Western vs. Eastern, urban vs. rural settings). In addition, households were of higher socioeconomic status which limited generalizability to food insecure households. In addition, data for this study was collected before and during COVID-19. The global pandemic did not appear to change GF food availability in the home, but children/youth did report consuming more GF grains. This may be attributed to youth eating more meals at home and snacking more frequently as a result of the public health stay-at-home orders⁽²²⁾.

6.3 FUTURE DIRECTIONS

The findings from this thesis show that stakeholders are satisfied and positively perceive the pediatric GF food guide and the supplementary educational materials (i.e. handouts). Stakeholders believe that the guide can help newly and currently diagnosed children/youth with CD and their families manoeuvre the complexities of following the GFD. However, it is well known that following this diet can be challenging for newly diagnosed children/youth and their families⁽²³⁾. To address this, an intervention study will be underway to determine how effective the new deliverables are in teaching children/youth and their families about the GFD at time of CD diagnosis and the impact on clinical outcomes. There may also be merit in recruiting nutrition champions (e.g. past focus group participants) and public figures to increase guide awareness and promote uptake within the community of those already diagnosed⁽²⁴⁾. This includes increasing

awareness by targeting celiac-related organizations, community health centres, schools and a variety of social media channels which are utilized by children/youth and their families. Frontline HP will also need to be trained and educated on these deliverables. This effort will help spread consistent messaging across all community and clinical-based settings, and subsequently may help instill better trust between HP and their patients as a result of consistent messaging.

Future studies should also assess the effectiveness of individual versus group-based pediatric learning environments when HP use these resources as a teaching tool. This is critical as some celiac clinics in Canada have limited dietetic resources and teaching in a group-setting may be more practical and time-saving⁽⁸⁾. It may also be warranted to explore in-person versus virtual learning environments due to the COVID-19 public health measures (e.g. physical distancing). A recent study conducted in Halifax showed that families with CD who received videoconferencing education on the GFD felt that a virtual session successfully supported their learning needs⁽⁸⁾. The development of child-friendly interactive websites and mobile applications should equally be considered to provide users with convenient and easy access to all resources including any updates.

It will be important to continuously evaluate facilitators and barriers to guide uptake and adherence. This includes examining factors beyond those explored in this thesis. For example, most Canadians have heard of Canada's Food Guide but research demonstrates low adherence to guide recommendations⁽²⁵⁾. Therefore, educational interventions may be warranted to overcome possible barriers related to time-constraints (e.g. full-time employment) or to increase specific food literacy attributes beyond knowledge (e.g. food skills) which may impact whether a family follows guide recommendations. Interventions that incorporate community kitchens may be useful to address barriers that stem from an inability to prepare GF meals due to low self-efficacy in the kitchen. This can provide opportunities to learn skills related to preparing GF meals according to

the plate model and guide recommendations. These skills will become important as younger children become older, gain more autonomy and begin making their own food decisions when preparing GF meals. Educational interventions related to healthy eating on a budget, GF label reading and making food decisions to reduce the availability and visibility of less-healthy foods within the home may also be beneficial⁽²⁶⁾. Longitudinal intervention studies can also help measure changes to the home food environment, food literacy and food purchasing patterns at multiple timepoints as a result of exposure to guide recommendations. This is important since food availability and accessibility can be predictors of dietary intake in children/youth⁽²⁷⁻³¹⁾. It is also worth considering how co-existing medical conditions (e.g. type 1 diabetes) or additional dietary restrictions (e.g. low fermentable carbohydrate diet) may influence guideline uptake.

Ongoing evaluations of urban and rural retail food environments will be important as poor access to nutrient-rich and affordable foods may negatively impact home food environments, youth diet quality and thus guide uptake⁽³²⁾. Assessing this is warranted to inform and advocate for nutrition programs and policies to ensure that the burden of purchasing nutrient-dense GF foods does not fall solely on the consumer. This includes advocating for the evaluation of programs to subsidize nutrient-dense GF foods for families of lower socioeconomic status. This will be critical given that **Chapter 5** of this thesis provides insight that those of higher socioeconomic status may find following food guide recommendations challenging. Therefore, these challenges will likely only be amplified among families of lower socioeconomic status, reduced food literacy and a decreased variety of at-home food availability.

In **Chapter 5**, a case study analysis of 16 parent-youth dyads was conducted in Alberta. However, a subsequent cross-Canada longitudinal study with a larger sample size is needed to provide more insight over an extended period of time. This also includes expanding inclusion

criteria to children (<12 years) given that age may have affected our findings as youth (12-18y) may have more autonomy in making food decisions compared to younger children⁽³³⁾. Future research should also include developing and utilizing a validated home food inventory (HFI) tool that not only evaluates food availability but also comprehensively examines food visibility, quality and quantity of food within the home. To better understand barriers that prevent children/youth from following guide recommendations, it may be equally important to assess child/youth food literacy as well as their attitudes and behaviours towards GF dietary guideline recommendations.

6.4 FINAL CONCLUSIONS

This thesis comprehensively described the development and evaluation of a pediatric GF food guide for children and youth (4-18y) with CD. This included extensive stakeholder feedback (children/youth with CD, their parents/caregivers and HP) pre-and-post guide development. This process was important to ensure that guideline recommendations for the GFD were evidenced-based and feasible. This also ensured that children/youth and their families would have nutrition recommendations that support them to consume a nutritious and high quality GFD. The implications to the study findings include the need for further evaluation of dietary guideline efficacy on clinical outcomes and further evaluation of social and environmental factors in home and community settings that may influence GF food guide uptake. Consideration of current nutrient fortification policies within the Canadian food supply and healthy public policy related to food security is also very important. This will ensure that Canadian children/youth with CD and their families are able to meet their nutritional needs regardless of socioeconomic status. This is critical as the GFD is the only effective treatment for children/youth with CD.

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Appendix A-1 Strengths and limitations of home food inventory measures.

	Open Inventory	Predefined Inventory Checklists
Strengths	<ul style="list-style-type: none"> → Flexible → Accounts for all food items in the home (e.g. ethnic foods) → Able to compare to reported food intake 	<ul style="list-style-type: none"> → Easy to complete by participants and/or a trained researcher → Lower burden compared to open inventory format → Allows for a telephone/virtual interview or the checklist can be mailed or e-mailed to the participant to self-complete
Limitations	<ul style="list-style-type: none"> → High degree of burden to the participant → Intrusive → Time consuming → May only reflect a specific time point → Multiple home visits may be needed to capture all food items → Requires a highly trained researcher → Extensive amounts of data and analysis → Social desirability bias → Does not capture food purchased and consumed outside the home 	<ul style="list-style-type: none"> → May not account for all food items (e.g. ethnic foods) and thus dietary intake may not reflect captured at-home food availability → May only reflect a specific time point → Social desirability bias → Does not capture food purchased and consumed outside the home

Strengths and limitations summarized based on findings from Bryant et al. (2006).

Appendix A-2 Macronutrient and micronutrient intake while on a pediatric gluten-free diet.

Author, Year	Country	Sample	Age (y)	CD Dur (y)	GFD Dur (y)	Dietary Method	DQ Method	Calcium (mg or %DRI)	Fibre (g)	
Dietary Reference Intakes (DRI)								800-1100 ^a	25-38 ^b	
1	Alzaben <i>et al.</i> , 2016	Canada	32CD 32HC	4-18	2.3 ± 0.4y	-	24hR, FFQ	HEI-C	CD: 922±75 HC: 742±50	CD: 15.9±1.2* HC: 10.8±0.8*
2	Babio <i>et al.</i> , 2017	Spain	98 CD 98 HC	10-23	9.3±5.1	-	3dFR	-	CD: 601.9±252.3* HC: 681.2±259.8*	CD: 15.8±6.2 HC: 16.2±6.6
3	Balamtekin <i>et al.</i> , 2015	Turkey	28 CD 25 HC	3-18	-	4.0±3.3	3dFR	-	CD: 653.5±280.3 HC: 645.1±259.0	CD: 13.8±7.0* HC: 20.1±5.7*
4	Fernandez <i>et al.</i> , 2019	Spain	70 CD 67 HC	4-18	-	>1	24hFR	-	CD: 64.1 %DRI* HC: 74.7 %DRI*	CD: 16.3[13.1-20.9] HC: 15.9[13.6-20.0]
5	Forchielli <i>et al.</i> , 2015	Italy	205 CD	6-15	-	6.2±4.1	24hFR, FFQ	-	595.4±305	13.9±6.1
6	Kautto <i>et al.</i> , 2014	Sweden	37 CD 632 HC	13	-	-	FFQ	-	-	CD: 19.6±7.3 HC: 21.9±8.5
7	Lionetti <i>et al.</i> , 2020	Italy	120 CD 100 HC	4-16	-	2.6[1.4-4.3]	3dFR	-	-	CD: 12.6[10.9-16.7]* HC: 15.0[13.5-19.1]*
8	Mager <i>et al.</i> , 2019 [†]	Canada	104 CD 25 CON	2-18	1.9[1.0-3.6]	-	24hR	HEI-C	CD: 998[796-1297]* CON: 779[528-930]*	CD: 17.0±6.0* CON: 13.0±4.8*
9	Ohlund <i>et al.</i> , 2010	Sweden	25 CD	4-17	-	-	5dFR	-	168±52 %DRI	9.9±2.1
10	Salazar Quero <i>et al.</i> , 2015	Spain	37 CD	0-13	>1	-	FFQ	-	101.2±32.5 %DRI	12.6±5.2
11	Ting <i>et al.</i> , 2020	Australia	65 CD 65 HC	2-18	-	3.6±2.8	FFQ	-	CD: 1326.2[1053.2-1697.4] HC: 1215.5 [983.4-1461.9]	CD: 12.2±2.7 HC: 12.3±2.6
12	Tsiountsioura <i>et al.</i> , 2014	Scotland	26 CD 54 HC	4-18	-	-	FFQ	-	-	-
13	Zuccotti <i>et al.</i> , 2012	Italy	18 CD 18 HC	4-10	-	4.2[2.5]	FFQ, 24hR	-	CD: 695.4[398.9] HC: 459.0[285.0]	CD: 10.5[6.0] HC: 14.2[5.7]

Appendix A-2 (cont'). Macronutrient and micronutrient intake while on a pediatric gluten-free diet.

	Author, Year	Country	Sample	Age (y)	Folate-DFE (µg or %DRI)	Iron (mg or %DRI)	Mg (mg or %DRI)	Vit.B12 (µg or %DRI)	Vit.D (µg or %DRI)
	Dietary Reference Intakes (DRI)				160-330 ^a	4.1-7.9 ^a	110-340 ^a	1.0-2.0 ^a	10 ^a
1	Alzaben <i>et al.</i> , 2016	Canada	32CD 32HC	4-18	CD: 146.7±15.3* HC: 245.4±21.8*	CD: 10.1±0.7 HC: 9.9±0.6	-	CD: 3.4±0.4 HC: 3.7±0.3	CD: 5.3±0.7 HC: 4.6±0.5
2	Babio <i>et al.</i> , 2017	Spain	98 CD 98 HC	10-23	CD: 187.0±103.2* HC: 244.9±93.9*	CD: 7.5±3.0* HC: 10.1±3.3*	CD: 184.6±71.7* HC: 235.0±65.5*	-	CD: 1.6±1.5 HC: 1.8±1.8
3	Balamtekin <i>et al.</i> , 2015	Turkey	28 CD 25 HC	3-18	CD: 269.5±98.5 HC: 292.8±77.8	CD: 6.9±2.6* HC: 11.2±3.2*	CD: 200.5±68.3* HC: 247.6±65.3*	-	-
4	Fernandez <i>et al.</i> , 2019	Spain	70 CD 67 HC	4-18	CD: 67.5 %DRI* HC: 82.0 %DRI*	CD: 76.0 %DRI* HC: 103.1 %DRI*	CD: 74.4 %DRI* HC: 82.8 %DRI*	CD: 276.7 %DRI HC: 295.2 %DRI	CD: 10.0 %DRI HC: 13.2 %DRI
5	Forchielli <i>et al.</i> , 2015	Italy	205 CD	6-15	-	7.0±3.7	-	-	-
6	Kautto <i>et al.</i> , 2014	Sweden	37 CD 632 HC	13	CD: 98±19* HC: 108±27*	CD: 4.9±1.0 HC: 5.2±1.0	CD: 132±22* HC: 163±23*	CD: 3.2±1.4* HC: 3.7±1.5*	CD: 2.9±1.1 HC: 3.0±1.1
7	Lionetti <i>et al.</i> , 2020	Italy	120 CD 100 HC	4-16	-	-	-	-	-
8	Mager <i>et al.</i> , 2019 [†]	Canada	104 CD 25 CON	2-18	CD: 160[122-203]* CON: 284[192-365]*	CD: 9.3[7.5-11.8] CON: 10.8[8.5-12.7]	-	CD: 3.9[2.9-5.0] CON: 3.5±1.6	CD: 4.1 [3.0-6.0] CON: 3.7[2.4-5.3]
9	Ohlund <i>et al.</i> , 2010	Sweden	25 CD	4-17	-	145±38 %DRI	86±23% of DRI	460±384 %DRI	84±37 %DRI
10	Salazar Quero <i>et al.</i> , 2015	Spain	37 CD	0-13	262.7±332.8 %DRI	143.7±51.6 %DRI	-	424.7±253.9 %DRI	28.7±29.1 %DRI
11	Ting <i>et al.</i> , 2020	Australia	65 CD 65 HC	2-18	CD: 326.8±110.2 HC: 309.9±100.9	CD: 14.4±3.9 HC: 13.3±4.4	CD: 400.5[328.1-458.2] HC: 369.0[304.8-434.1]	-	-
12	Tsiountsioura <i>et al.</i> , 2014	Scotland	26 CD 54 HC	4-18	-	-	-	-	-
13	Zuccotti <i>et al.</i> , 2012	Italy	18 CD 18 HC	4-10	CD: 167.4[138.2] HC: 173.5[104.1]	CD: 6.4[2.4] CD: 7.2[3.2]	CD: 104.9[73.3] HC: 124.7[74.5]	CD: 3.8[3.0] HC: 2.3[3.9]	CD: 0.8[0.6]* HC: 3.1[2.8]*

Appendix A-2 (cont’). Macronutrient and micronutrient intake while on a pediatric gluten-free diet.

Author, Year	Country	Sample	Age	Vitamin K (µg)	Zinc (mg or %DRI)	Total Fat (%)	Sat. Fat (% or g)	Total Sugar (% or g)
Dietary Reference Intakes (DRI)				55-75 ^b	4.0-8.5 ^a	25-35% ^c	-	-
1	Alzaben <i>et al.</i> , 2016	Canada 32 CD 32 HC	4-18	CD: 49.8±8.5 HC: 48.0±10.5	CD: 7.8±0.5 HC: 7.5±0.6	CD: 31.4±1.5 HC: 30.3±1.1	CD: 11.8.9±0.6% HC: 11.1±0.6%	CD: 76.0±6.6g HC: 78.5±6.0g
2	Babio <i>et al.</i> , 2017	Spain 98 CD 98 HC	10-23	-	CD: 17.3±6.7* HC: 20.0±6.5*	CD: 40.2±5.9* HC: 38.1±5.9*	CD: 11.9±2.8% HC: 12.2±2.6%	CD: 17.5±5.6g* HC: 15.0±4.4g*
3	Balamtekin <i>et al.</i> , 2015	Turkey 28 CD 25 HC	3-18	-	CD: 5.9±1.8* HC: 9.2±2.1*	CD: 39.2* HC: 33.8*	-	-
4	Fernandez <i>et al.</i> , 2019	Spain 70 CD 67 HC	4-18	CD: 144.6 %DRI HC: 142.8 %DRI	CD: 65.6 %DRI HC: 67.5 %DRI	CD: 41.6[38.1-44.6] HC: 40.7[37.5-45.6]	CD: 14.2[12.8-15.5]% HC: 13.8[12.1-15.6]%	-
5	Forchielli <i>et al.</i> , 2015	Italy 205 CD	6-15	-	-	34.2±6.8	11.7±3.4%	17.5±6.6%
6	Kautto <i>et al.</i> , 2014	Sweden 37 CD 632 HC	13	-	CD: 5.1±1.0* HC: 6.1±1.0*	CD: 33±4* HC: 31±4*	CD: 14±2% HC: 14±3%	-
7	Lionetti <i>et al.</i> , 2020	Italy 120 CD 100 HC	4-16	-	-	CD: 37.5[32.8-40.5]* HC: 30.5[28.7-32.3]*	CD: 12.8[10-14.7]%^* HC: 8.8[7.8-10.4]%^*	CD: 14.5[10.4-17.6]%^* HC: 17.6[14.2-19.6]%^*
8	Mager <i>et al.</i> , 2019 [†]	Canada 104 CD 25 CON	2-18	-	CD: 8.9±3.5 CON: 9.0±3.4	CD: 34.0±7.0 CON: 33.0±8.0	CD: 13.0±3.0% CON: 12.0±4.0%	CD: 22.0±6.0%* CON: 21.0±7.0%*
9	Ohlund <i>et al.</i> , 2010	Sweden 25 CD	4-17	-	-	32.5±4.3%	14.5±2.2%	14.7±5.5%
10	Salazar Quero <i>et al.</i> , 2015	Spain 37 CD	0-13	-	61.5±19.3 %DRI	35.7±4.9	12.7±5.3%	-
11	Ting <i>et al.</i> , 2020	Australia 65 CD 65 HC	2-18	-	CD: 15.1±3.5* HC: 13.5±4.5*	CD: 35.0[31.5-38.0] HC: 34.0[31.0-37.0]	CD: 16.0±3.0% HC: 15.2±2.9%	-
12	Tsiountsioura <i>et al.</i> , 2014	Scotland 26 CD 54 HC	4-18	-	-	CD: 34.0[31.0-38.0] HC: 33.0[30.0-36.0]	CD: 15.0[14.0-17.0]%^* HC: 15.0[13.0-17.0]%^*	CD: 27.0[22.0-30.0]%^* HC: 26.0[24.0-30.0]%^*
13	Zuccotti <i>et al.</i> , 2012	Italy 18 CD 18 HC	4-10	-	CD: 8.4[1.6]* HC: 6.4[3.6]*	CD: 34.7[12.3]* HC: 38.7[8.0]*	CD: 19.5 [13.8]g HC: 18.1[14.2]g	-

Appendix A-2 (cont’). Macronutrient and micronutrient intake while on a pediatric gluten-free diet.

Author, Year	Country	Sample	Age (y)	GI	GL	DQ	Key Findings	
Dietary Reference Intakes (DRI)				-	-	-		
1	Alzaben <i>et al.</i> , 2016	Canada	32CD 32HC	4-18	CD: 54±2* HC: 48±1*	CD: 118±8* HC: 93±7*	^d Based on HEI-C. n=22>80; n=42≤80. No differences between groups. CD had ↑ fibre, GI, GL and ↓ folate intake compared to HC. CD had fibre, folate, vit. K and D intake <DRI. DQ was classified as ‘needs improvement’ for n=22, score ≤80. Sat. fat was >10% intake for CD and HC.	
2	Babio <i>et al.</i> , 2017	Spain	98 CD 98 HC	10-23	-	-	-	CD had ↑ % total fat and sugar intake compared to HC. CD has ↓ folate, calcium, iron and Mg intake compared to the HC. Both groups were <DRI for calcium, fibre and vit D. The DRI was met by 53% of CD for folate 57% for iron, 50% for Mg. Sat. fat was >10% intake for CD and HC.
3	Balamtekin <i>et al.</i> , 2015	Turkey	28 CD 25 HC	3-18	-	-	-	CD consumed ↓ fibre than HC with fibre and calcium intake <DRI for both CD & HC. CD consumed ↓ iron, Mg and zinc than HC but met DRI. CD consumed ↑ % total fat than HC and was >DRI.
4	Fernandez <i>et al.</i> , 2019	Spain	70 CD 67 HC	4-18	-	-	-	CD had calcium, folate, iron and Mg intake ↓ than HC and <DRI. CD and HC had fibre, vit. D and zinc <DRI and % total fat intake >DRI. Sat. fat was >10% intake for CD & HC.
5	Forchielli <i>et al.</i> , 2015	Italy	205 CD	6-15	-	-	-	CD consumed calcium and fibre <DRI. Sat. fat was >10% intake for CD & HC.
6	Kautto <i>et al.</i> , 2014	Sweden	37 CD 632 HC	13	-	-	-	CD consumed ↓ folate than HC, <DRI. CD consumed ↓ Mg, vitamin B ₁₂ and zinc than HC but met DRI. Fibre and vit. D <DRI in both groups. % total fat intake was ↑ in CD than HC and just below upper range of DRI. Sat. fat was >10% intake for CD & HC.
7	Lionetti <i>et al.</i> , 2020	Italy	120 CD 100 HC	4-16	-	-	-	CD had ↑ % total fat intake than HC and >DRI. CD had ↑ sat. fat intake than HC, >10% intake. CD had ↓ sugar intake than HC. CD consumed ↓ fibre than HC, both had fibre intake <DRI. KIDMED – CD: 6.5, HC: 6.8 = suboptimal adherence to the Mediterranean diet.

8	Mager <i>et al.</i> , 2019 [†]	Canada	104 CD 25 CON	2-18	CD: 55.0±6.0* CON: 50.0±5.0*	CD: 132.0±39* CON: 97.0±25*	CD: 65.4±10.9* CON: 60.9±12.7*	CD had ↑ calcium intake than CON and within DRI. CD had ↑ fibre intake than CON but <DRI. CD had ↓ folate intake than CON and 77% did not meet the DRI. Both groups had vitamin D intake <DRI. CD consumed ↑ total sugar than CON. CD had ↑ GI and GL than CON. DQ was classified as 'needs improvement' for both groups with CD having ↑ DQ than CON.
9	Ohlund <i>et al.</i> , 2010	Sweden	25 CD	4-17	-	-	-	CD had calcium, iron and vitamin B12 intake >DRI. Mg, vitamin D and fibre intake was <DRI. Sat. fat was >10% intake for CD & HC.
10	Salazar Quero <i>et al.</i> , 2015	Spain	37 CD	0-13	-	-	-	CD had fibre, vitamin D and zinc intake <DRI. % total fat was on the upper end of DRI. Sat. fat was >10% intake for CD.
11	Ting <i>et al.</i> , 2020	Australia	65 CD 65 HC	2-18	-	-	-	Fibre intake <DRI in both groups. Zinc intake was ↑ in CD than HC, both >DRI. CD and HC had % total fat on the upper end of the DRI. Sat. fat was >10% intake for CD.
12	Tsiountsioura <i>et al.</i> , 2014	Scotland	26 CD 54 HC	4-18	-	-	-	CD had % total fat on the upper end of the DRI. Sat. fat was >10% intake for CD.
13	Zuccotti <i>et al.</i> , 2012	Italy	18 CD 18 HC	4-10	CD: 297.5[226.2]* HC: 47.2[6.9]*	-	-	CD and HC had calcium, fibre and vitamin D intake <DRI. CD had intake of Mg <DRI while HC was >DRI, but no difference between groups. CD had % total fat intake ↓ HC but at the upper limit of DRI. CD had ↑ GI than HC.

Y: years; CD; celiac disease; Dur: duration; GFD: gluten-free diet; DQ: diet quality; DRI: dietary reference intake; HC; healthy controls; CON: control; DFE: dietary folate equivalent; Mg: magnesium; Vit.: vitamin; Sat.: saturated; GI: glycemic index; GL: glycemic load; HEI-C: Canadian Healthy Eating Index. Data is expressed as mean ± standard deviation, or median [interquartile range, 25-75% OR difference between 75th and 25th percentile] unless specified.

*Significant difference between groups, *P* value <0.05.

[†]Mager *et al.*, 2019 data is based on Cluster 1 data for a Western-diet.

^aBased on estimated average requirement.

^bBased on adequate intake.

^cBased on acceptable macronutrient distribution range.

^d:<50: poor; 51-80: needs improvement; >80: good diet quality.

Appendix B-1 Pre-guide consultations with stakeholders.

Health Professional Organizations	Community/Charity Organizations	Community Based Health Organizations
College of Dietitians of British Columbia	Canadian Celiac Association of Edmonton	Canada's Community Health Centres
College of Dietitians of Alberta	Canadian Celiac Association of Calgary	Association of Ontario Health Centre
College of Dietitians of Manitoba	Canadian Celiac Association of Kelowna	Manitoba Association of Community Health
College of Dietitians of Ontario	Canadian Celiac Association of Toronto	Nova Scotia Federation of Community Health Centres
New Brunswick Association of Dietitians	Canadian Celiac Association of Halifax	Association of Family Health Teams of Ontario
The Nova Scotia Dietetic Association	Canadian Nutrition Society	Canadian Association of Social Workers
Prince Edward Island Dietitians Registrations Board		
Newfoundland and Labrador College of Dietitians		
Canadian Nurses Association		
Canadian Pediatric Society		
Canadian Association of Gastroenterology		

List of organizations contacted to help disseminate an internet survey to health care professionals and community end-users. Surveys focused on demographic variables and perceptions regarding gluten-free food guide content during the pre-guide consultation phase in 2017.

Appendix B-2

Diet substitution list

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Supplementary Table A: Western^a diet substitution list

Food Item	Replace With
	Any foods that contribute more than 25% of calories or has more than 4 servings, needs to be reduced
Grains	
Needs bread	GF ^b diet substitution average white bread ^c
Needs cereal	GF diet substitution average cereal ^d
Needs crackers	Rice crackers
Needs pasta	Pasta, corn
Needs rice	Brown rice, medium
Needs oats	Rolled oats
White rice	Brown rice, medium or long
Cereal high in sugar	Reduce amount of sugary cereal to half and then add back the same amount of GF diet substitution average cereal
Instant oatmeal	Rolled oats
Tortilla chips, nacho	Tortilla chips, plain or yellow corn
Pancakes	Reduce amount to approximately 2 pieces
Cookies and cakes	Remove
Muffins	Remove, unless total calories do not reach 1600
Tortilla, wrap	Tortilla, corn, ready to bake or fry
Meat	1 fish diet per age group
Needs chicken	Chicken, breast, roast
Needs pork	Pork, tenderloin
Needs beef	Beef, ground crumble, pan fried, extra lean, well done
Chicken (fried, high fat)	Chicken, breast, roast
Chicken (battered, coated)	Chicken, breast, roast
Chicken (leg, dark meat)	Leave, unless total fat % is above AMDR ^e
Pork, high fat	Pork, tenderloin
Bacon	Remove
Back bacon	Remove, unless calories do not reach 1600 and sodium does not reach 1500
Ground pork	Pork, ground, extra lean
Beef, high fat	Beef roast, eye of round, roasted, lean
Ground beef	Beef, ground crumble, pan fried, extra lean, well done
Sausage/pepperoni	50/50 pork and beef ground
Deli ham	Ham, extra lean (5%), sliced
Pork ribs	Reduce amount
Chicken/pork skin	Remove
Needs a meat serving and vitamin D	Use fish, sockeye salmon or whitefish
Meat Alternatives	
Needs egg	Hard boiled eggs
Needs nuts/seeds	Choose from Health Canada Nutrient Value of Some Common Foods ^a , unsalted version
Needs a vegetarian meat option	Tofu (with calcium and magnesium)
Needs beans	Chickpeas/black beans/lentils/green peas, boiled, hummus
Peanut butter, fat & sugar added	Peanut butter, natural
Milk	
Needs milk	Skim
Needs cheese	Mozzarella cheese
Needs yogurt	Yogurt, plain, vitamin D fortified
Milk 1/2/3%	Skim milk
Cream	Remove unless it is less than 0.25 cups
Chocolate/strawberry milk	Skim milk
Condensed milk	Evaporated milk
Milk Shake	Skim milk

Eggnog	Remove
Hot chocolate made with milk	Remove unless it is less than 0.5 cups
Yogurt, flavoured, sweetened	Yogurt, plain, vitamin D fortified
Yogurt, plain	Yogurt, plain, vitamin D fortified
Drinkable yogurt	Yogurt, plain, vitamin D fortified
Danimal/Minigo fresh cheese	Leave as is
Cheese	Reduce amount to less than 50g
Marble cheese	Reduce the cheddar and mozzarella cheese to less than 25g each
Pudding	Remove
Ice cream	Remove
Milk Alternatives	
Needs a non-dairy milk	Soy drink, all flavours, enriched, unsweetened
Rice milk	Leave as is
Coconut milk	Leave as is
Soy milk/beverage	Leave as is
Soy cheese	Reduce amount to less than 50g
Soy/almond/coconut ice cream	Remove
Soy/almond/coconut yogurt	Double check if vitamin D fortified, if not replace with soy milk
Vegetables	Choose unsalted version Vegetable must contain one of the following: fresh, boiled, broiled Any vegetable can be selected in the Health Canada Nutrient Value of Common Foods ^a if needed to increase micronutrient levels
Canned vegetables	Fresh equivalent
Frozen vegetables	Leave as is, unless it contributes over 500mg of sodium
Deep fried vegetables	Fresh equivalent
Pickles	Leave as is, unless it contributes over 500mg of sodium
Chips	Remove
Iceberg lettuce	Romaine lettuce, fresh
Hash browns	Potato, baked with skin
French fries	Baked, potato with skin
Needs general vegetables	Choose from Health Canada Nutrient Value of Some Common Foods
Needs vegetables with dip	Carrots/celery/cucumber, fresh, sliced
Needs folate	Fresh spinach/kale (may consider romaine lettuce)
Needs fibre	Green peas, boiled or green beans, boiled
Needs folate and fibre	Edamame, unsalted
Needs calcium	Broccoli, boiled or bok choy, boiled
Needs vegetables without folate	Cabbage, boiled or mushrooms
Fruit	Any fruits that are present, do not remove, only add Fruit must have word fresh in its Food Pro entry
Fruit leather	Remove
Jam/fruit compote	Remove, consider it an added sugar other food item
Juice drink	Fresh fruit equivalent
Juice, fruit name	Fresh fruit equivalent
Cranberry juice	Dried cranberries
Needs fruit with more fibre	Pear
Needs fruit, general	Choose from Health Canada Nutrient Value of Some Common Foods ^a
Other Foods: Sugar	
Cookies	Remove, unless total calories are less than 1600
Candies, hard/soft, jellybeans	Remove
Pastries	Remove
Cakes	Remove
Tarts	Remove
Pie	Replace with fresh fruit equivalent
Apple pie	Apple, fresh
Coconut cream pie	Coconut milk
Lemon meringue pie	Remove
Quebec sugar pie	Remove
Fudge, caramel	Remove
Hazelnut/chocolate spread	Remove

Coke, cola, pop	Remove
Diet coke, cola, pop	Leave as it
Hot chocolate	Skim milk
Sugar	Remove, unless less than 1 Tbsp
Honey, molasses	Remove, unless less than 1 Tbsp
Maple syrup	Remove, unless less than 2 Tbsp
Chocolate syrup	Coco powder
Jelly, jam, marmalade	Remove
Whipped cream/cool whip	Remove
Chocolate bar with nuts	Almonds
Ice cream	Remove
Frozen yogurt	Yogurt, with vitamin D
Popsicle, sherbet	Remove, unless total calories less than 1600
Ketchup, barbeque sauce	Reduce to 1 Tbsp max
Juice drink	Orange juice with calcium and vitamin D
Granola	Leave as is, no more than 1 cup per day
Granola bars	Leave as is, no more than 1 per day
Sweet and sour sauce	No more than 0.25 cup per day
Sweet sauces	No more than 0.25 cup per day
Iced tea, sweetened	Tea, brewed
Frappuccino	Remove
Iced cap	Remove, unless broken down to coffee, milk and sugar, then remove sugar component
Vitamin water	Remove, too much sugar and the vitamins & minerals can be replaced with fruits & vegetables
Vitamin water zero	Leave as is
Other Foods: Oils	MUFA <14% ^f PUFA >3% ^g
Needs oil	Canola oil (use safflower oil or corn oil to increase PUFA)
Needs dressing	Homemade oil and vinegar
Mayonnaise	Leave as is, unless more than 1 Tbsp
Olive oil for dipping bread	No more than 2 Tbsp
Salad dressing	Reduce to 1 Tbsp max
Butter	Reduce to 1 tsp max
Mixed Foods	
Lasagna	Leave as is, unless more than 450g, then reduce
Restaurant pizza	Reduce amount to 2-3 slices max
Cream soup	1 cup max
Clear soup	1.5 cup max
Poutine	Reduce amount by 50-25%
Savoury pot pie	Reduce amount to 2-3 slices max
Spices	
Needs salt	Only add if AI ^h is not reached, add salt in 0.125 tsp increments

^a Western diet simulations had all additional food items and substitutions made from Health Canada Nutrient Value of Some Common Foods

^b GF, gluten free

^c Based on 12 commercially GF breads sold in Canada, represents the average nutrient content

^d Based on 20 commercially GF cereals sold in Canada, represents the average nutrient content

^e AMDR, acceptable macronutrient distribution range

^f MUFA, monounsaturated fatty acids

^g PUFA, polyunsaturated fatty acids

^h AI, adequate intake

Supplementary Table B: First Nations, Inuit and Métis^a diet substitution list

Food Item	Replaced With
Grains	
Bread	Bannock
Meat	
Pork, chicken, beef	Moose, deer
Fish	Salmon, whitefish, pike, walleye
Meat Alternatives	Refer to supplementary table A
Milk	Refer to supplementary table A
Milk Alternatives	Refer to supplementary table A
Vegetables	Refer to supplementary table A
Fruit	Any fruits that are present do not remove, only add
Needs fruit	Saskatoon berries, blueberries, raspberries

^a First Nations, Inuit and Métis diet simulations followed Eating Well with Canada's Food Guide - First Nations, Inuit and Métis guidelines

Supplementary Table C: East Indian^a diet substitution list

Food Item	Replace With
Grains	
Oats, cereal, pasta	Refer to supplementary table A
Bread	GF ^b roti
Rice	Brown, long grain
Rice with beans	Rice & dhal
Cereal	Idli
Meat	Do not add more meat products
Pork	Leave as is, do not add more
Beef	Leave as is
Chicken	Leave as is
Fish	Leave as is
Meat Alternatives	
Eggs, nuts, seeds, etc.	Refer to supplementary table A
Beans	Leave as is
Needs beans	Chickpeas, lentils, green peas, fenugreek seeds
Milk	Refer to supplementary table A
Cheese	Paneer
Milk Alternatives	Refer to supplementary table A
Vegetables	Choose unsalted version
Spinach/kale	Leave as is
Eggplant	Leave as is
Curry	Leave as is
Needs leafy greens	Cooked spinach, mustard leaves, fresh fenugreek seeds, boiled kale, boiled pumpkin leaves, boiled cowpeas leaves, boiled cassava leaves, boiled green sorrel, boiled amaranth leaves, cauliflower, cooked eggplant, boiled potato with skin
Carrots, raw	Boiled carrots, boiled onions, fresh tomatoes, cooked okra
Fruit	Any fruits that are present do not remove, only add
Needs fruit	Banana, papaya, mango, grapefruit, dates, guava, jackfruit, pineapple, sapota (sapodilla), custard apple, fresh coconut
Mixed Foods	
Pizza	Roti plus cheese

^a East Indian diet simulations were designed around the dietary requirements of Hinduism, Christianity and Islamic religions

^b GF, gluten free

Supplementary Table D: Somalian^a diet substitution list

Food Item	Replace With
Grains	
Oats, cereal, pasta, crackers	Refer to supplementary table A
Bread	Anjero
Corn	Soor
Rice	Iskudahkaris
Rice with beans	Cambulo
Meat	No pork
Pork	Goat, roasted
Beef	Leave as is
Chicken	Leave as is
Fish	Leave as is
Meat Alternatives	
Eggs, nuts, seeds, etc.	Refer to supplementary table A
Beans	Leave as is
Needs beans	Lentils
Milk	Refer to supplementary table A
Milk Alternatives	Refer to supplementary table A
Vegetables	Choose unsalted version
Spinach/kale	Leave as is
Eggplant	Leave as is
Needs leafy greens	Cooked spinach, cooked eggplant
Potatoes, fried/baked	Potato, boiled, with skin
Carrots, raw	Boiled carrots, boiled onions, fresh tomatoes, cooked okra, cooked spinach
Lettuce	Cooked spinach
Fruit	Any fruits that are present do not remove, only add
Fruit juice	Leave as is
Needs fruit	Bananas, papaya, mango, grapefruit
Mixed foods	
Pizza	Anjero plus cheese

^a Somalian diet simulations were created following Islamic dietary laws

Supplementary Table E: Chinese^a diet substitution list

Food Item	Replaced With
Grains	
Bread, oats	Refer to supplementary table A
Rice	Brown rice, medium
Cereal	Congee, brown and white rice
Pasta/noodles	Rice noodles
Meat	
Pork, chicken, beef	Leave as is
Needs folate and meat	Liver, kidney
Meat Alternatives	
Eggs, nuts, seeds, etc.	Refer to supplementary table A
Beans	Mung beans
Needs tofu	Tofu
Milk	
Milk	Leave as is
Needs milk	Refer to milk alternative below
Milk Alternatives	
Needs milk	Soy milk, fortified
Vegetables	Choose unsalted version All vegetables must be cooked
Broccoli	Leave as is, if raw select cooked version
Spinach	Leave as is, if raw select cooked version
Needs green vegetables/folate	Cooked Chinese cabbage, cooked Chinese broccoli, cooked eggplant
Potatoes, fried/baked	Potato, boiled with skin
Carrots, raw	Boiled carrots, boiled onions, lotus root
Needs green vegetables/calcium	Bok choy, Japanese mustard spinach
Fruit	Any fruits that are present, do not remove, only add
Fruit juice	Fresh fruit equivalent
Needs fruit	Papaya, mango
Spices/ Seasonings	
Soy sauce	Kikkoman gluten free (1 Tbsp)

^a Chinese diet simulations were designed following the Dietary Guideline for Chinese Residents

Supplementary Table F: Brazilian^a diet substitution list

Food Item	Replaced With
Grains	
White rice	Brown rice (plus 0.5 tsp oil)
Needs grains	Quinoa
Needs grains, corn	Cornmeal, corn- based quinoa
Oats	Leave as is
Needs cereal	Granola, corn flakes, cassava cake with coconut
Tortilla	Tapioca crepe
White bread	Corn bread, gluten free Udi's French bread (bread needs 1 serving of butter/margarine)
Needs crackers	Cassava crackers, oat thin crackers
Meat	
Needs beef	Beef tenderloin, beef rump roast, beef sirloin
Needs pork	Pork ribs, ham
Need chicken	Chicken thighs, chicken drumsticks, chicken heart, egg
Other meats	Lamb
Needs fish	Salted cod (soaked and rinsed), shrimp, steamed crab, steamed mussels, broiled oysters, boiled calamari, tilapia, salmon
Meat Alternatives	
Needs beans/legumes	Peanuts, green peas, fava beans, cowpeas, pinto beans, chickpeas, lentils, tofu, sprouted mung beans, green beans, snow peas
Needs seeds	Flax
Needs nuts	Chestnuts, pine nuts, almonds, hazelnuts, Brazil nuts, cashews, walnuts, pistachios
Milk	
Needs milk	Cow's milk
Needs yogurt	Yogurt, yogurt drink
Needs cheese	Mozzarella, gouda, American processed cheese, Monterey jack cheese, ricotta cheese, parmesan cheese, provolone, blue cheese, cottage cheese
Sour cream	No more than 2 Tbsp
Vegetables	
	Choose unsalted version Diets will have less vegetables than fruit
Potato	Cassava, yams, sweet potato, heart of palm, pumpkin squash, pumpkin, winter melon
Needs vegetables	Cooked mustard greens, cooked watercress, arugula, fennel, chayote, scarlet eggplant, okra, leeks, alfalfa sprouts
Popular vegetables	Carrots, green leaf lettuce, spinach, endive, kale, escarole, cooked collard greens, cooked cabbage, cooked Chinese cabbage, cooked broccoli, cooked zucchini, cooked beets
Fruit	
	Any fruit that are present do not remove, only add Diets will have more fruits than vegetables
Needs fruit	Acai berries, banana, tangerine, pineapple, avocado, persimmon, fig, papaya, mango, passion fruit, watermelon, honeydew melon, custard apple, jackfruit, starfruit, elderberries, soursop, rose apple, strawberry guava, loquat, breadfruit, sapoti/sapodilla, tamarind, lychee, Surinam cherry, pomegranate, kiwi, mulberries, Spondias dulcis, June plum, Byrsonima crassifolia, nance cherries, Malpighia emarginata, Barbados cherry, acerola
Mixed Foods	
Pizza	Reduce to no more than 2 slices
Needs oil	Olive oil
All added oil	Olive oil
Butter	Margarine with vitamin D

^a Brazilian diet simulations were designed following the Brazilian food guide

Supplementary Table G: Iranian^a diet substitution list

Food Item	Replaced With
Grains	
White rice	Brown rice
White bread	Lavash/Sangak, flatbread, Barbari
Pasta	Refer to supplementary table A
Oats	Refer to supplementary table A
Crackers	Refer to supplementary table A
Cereal/breakfast	Refer to supplementary table A (do not use as often)
Meat	No pork
Pork	Chicken, beef, lamb, salmon, meat kababs
Meat Alternatives	
Eggs	Baked omelette
Needs meat alternative	Pistachios, walnuts, peanuts, almonds, split peas, chickpeas, cowpeas, kidney beans, lentils, lima beans, pigeon peas, green peas
Milk	Refer to supplementary table A
Cheese	Feta, mozzarella
Milk Alternatives	Only use milk alternatives if present in original food record, otherwise do not use
Vegetables	Choose unsalted version
Needs vegetables	Potato, spinach, tomato, cucumber, zucchini, onions, garlic, carrot, coriander, watercress, fenugreek leaves, leeks, lettuce, parsley, red/green peppers, radish, snap beans, eggplant, cabbage, mint, basil, tarragon, Shirazi salad ²
Fruit	Any fruits that are present do no remove, only add
Needs fruit	Grapes, lemons, limes, dates, tamarind, banana, oranges, apple, pomegranates, figs, cherries, apricot, watermelon, cantaloupe, persimmon, mango, muskmelon, olive, plum. Tangerine, mulberry, sour cherry, strawberry, pear
Mixed Foods	
Pizza	Restrict to no more than 2 slices
Spices/Seasonings	
Needs seasoning	Standard stew seasoning

^a Iranian diet simulations were created following Islamic dietary laws

Supplementary Table H: Lacto-ovo^a diet substitution list

Food Item	Replace With
Grains	Refer to supplementary table A
Meat	Remove all meat products
Needs protein	Refer to meat alternatives below
Meat Alternatives	
Needs egg	Hard boiled eggs
Needs nuts/seeds	Choose from Health Canada Nutrient Value of Some Common Foods, unsalted version
Needs a vegetarian meat option	Tofu with calcium and magnesium
Needs beans	Chickpeas/black beans/lentils/green peas, boiled
Needs beans	Hummus
Peanut butter, fat and sugar added	Peanut butter, natural
Milk	Refer to supplementary table A
Milk Alternatives	Refer to supplementary table A
Vegetables	Refer to supplementary table A
Fruit	Refer to supplementary table A
Other Foods	Refer to supplementary table A
Mixed Foods	Refer to supplementary table A
Spices	Refer to supplementary table A

^a Lacto-ovo vegetarian diets consisted of no meat, fish, or poultry but included dairy and eggs

Supplementary Table I: Lactose-free^a diet substitution list

Food Item	Replaced With
Grains	Refer to supplementary table A
Meat	Refer to supplementary table A
Meat Alternatives	Refer to supplementary table A
Milk	
Cow's milk	Soy drink/beverage
Cow's milk products	Soy drink/beverage
Milk Alternatives	Refer to supplementary table A
Vegetables	Refer to supplementary table A
Fruit	Refer to supplementary table A
Mixed Foods	
Contains cow's milk/ cow's milk product	Remove/replace with lactose free alternative

^a Lactose-free diets were created by eliminating all cow's milk and products that contain cow's milk

Supplementary Table J: Vegan^a diet substitution list

Food Item	Replaced With
Grains	
Bread, cereal, pasta	Vegan alternative
Meat	Remove all meat products
Needs protein	Refer to meat alternatives below
Meat Alternatives	
Needs egg	Hard boiled eggs
Needs nuts/seed	Choose from Health Canada Nutrient Value of Some Common Foods
Needs vegetarian meat option	Tofu with calcium and magnesium
Needs beans	Chickpeas/black beans/lentils/green peas, boiled
Needs beans	Hummus
Peanut butter, fat & sugar	Peanut butter, natural
Milk	
Dairy & dairy products	Remove/replace with alternative (refer to milk alternatives below)
Milk Alternatives	Refer to supplementary table A
Vegetables	Refer to supplementary table A
Fruit	Refer to supplementary table A
Mixed Foods	
Contains dairy/animal products	Remove/replace with vegan alternative

^a Vegan diets excluded all meat, fish, poultry, dairy and eggs

Appendix B-3

Macronutrient and micronutrient recommendations

Supplementary Table A: Macronutrient recommendations.....	174
Supplementary Table B: Micronutrient recommendations.....	175

Supplementary Table A: Macronutrient recommendations

Macronutrient	AMDR^a (% Energy)
Carbohydrate	45-65%
Protein	10-30%
Fat	25-35%
Other	
Sugar	<10% ^b
Saturated Fat	<10% ^c
MUFA ^d	10-14% ^c
PUFA ^e	3-10% ^c
Age (years)	Calorie Range (kcal)
≤6	1200-1500
7-13	1500-1800
≥14	2000-2300

^a AMDR, acceptable macronutrient distribution range, based on guidelines from Health Canada

^b Based on guidelines from the World Health Organization

^c Based on guidelines from the Food and Agriculture Organization of the United Nations

^d MUFA, monounsaturated fatty acids

^e PUFA, polyunsaturated fatty acids

Supplementary Table B: Micronutrient recommendations

Nutrient DRI^a	Male & Female Age 4-8y^a	Female Age 9-13y	Male Age 9-13y	Female Age 14-18y	Male Age 14-18y
Folate EAR ^b (DFE µg) ^c	160	250	250	330	330
Folate RDA ^d (DFE µg)	200	300	300	400	400
Vitamin D EAR (µg)	10	10	10	10	10
Vitamin D RDA (µg)	15	15	15	15	15
Vitamin B12 EAR (µg)	1.0	1.5	1.5	2.0	2.0
Vitamin B12 RDA (µg)	1.2	1.8	1.8	2.4	2.4
Calcium EAR (mg)	800	1100	1100	1100	1100
Calcium RDA (mg)	1000	1300	1300	1300	1300
Iron EAR (mg)	4.1	5.7	5.9	7.9	7.7
Iron RDA (mg)	10	8	8	15	11
Sodium AI ^e (mg)	1200	1500	1500	1500	1500
Fibre AI (g)	25	26	31	26	38
Zinc EAR (mg)	4.0	7.0	7.0	7.3	8.5
Zinc RDA (mg)	5.0	8.0	8.0	9.0	11

^a DRI, dietary reference intake; micronutrient recommendations were based on Health Canada's DRI reference values

^b EAR, estimated average requirement

^c DFE, dietary folate equivalent

^d RDA, recommended dietary allowance

^e AI, adequate intake

Appendix B-4 Select nutrient breakdown coming from the protein group of the plate model.

Protein Group, 25% of the plate model	Western Diet*	Strict Vegan Diet*
Dairy‡	(% nutrient content)†	
Fortified milk/plant-based beverages		
Protein	22.5	30.4
Calcium	52.6	65.9
Vitamin D	74.6	96.9
Iron	1.5	20.0
Other dairy sources		
Protein	13.2	0.0
Calcium	18.2	0.0
Vitamin D	8.0	0.0
Iron	2.3	0.0
Animal-based protein§		
Protein	35.4	-
Vitamin B12	34.4	-
Folate	6.6	-
Iron	17.6	-
Zinc	14.4	-
Plant-based protein¶		
Legumes		
Protein	4.6	15.6
Vitamin B12	0.0	0.0
Folate	13.3	39.2
Iron	8.5	19.3
Zinc	2.2	15.8
Other plant-based protein sources		
Protein	4.9	25.3
Vitamin B12	0.0	0.0
Folate	3.5	7.4
Iron	8.0	14.6
Zinc	3.9	15.8

*Values are based on Western (n=102) and strict vegan diets (n=102)

†Represents average % nutrient content of total food items on a complete GF food guide plate coming from protein sources (dairy, animal-based, plant-based). Protein (g); calcium (mg); vitamin D (µg); vitamin B12 (µg); folate (µg); iron (mg); zinc (mg)

‡Dairy represents 13.5% (9.6% fluid milk and 3.9% other dairy sources) of the Western plate and 14.4% (14.4% of plant-based beverage, 0.0% other dairy sources) of the vegan plate. Dairy includes fortified fluid milk/plant-based beverages (e.g. cow's milk, soy beverages) and other dairy sources (e.g. cheese, yogurt)

§Animal-based protein represents 7.4% of the Western plate and 0.0% of the vegan plate. Animal-based protein includes sources such as poultry, meat, fish and eggs

¶Plant-based protein represents 4.1% (1.3% legumes, 2.8% other plant-based protein sources) of the Western plate and 10.5% (4.4% legumes, 6.1% other plant-based protein sources) of the vegan plate. Plant-based protein includes legumes (e.g. beans, chickpeas, lentils) and other plant-based protein sources (e.g. tofu, nuts & seeds); this excludes fruits, vegetables and grains

Appendix C-1 Supplementary educational materials.

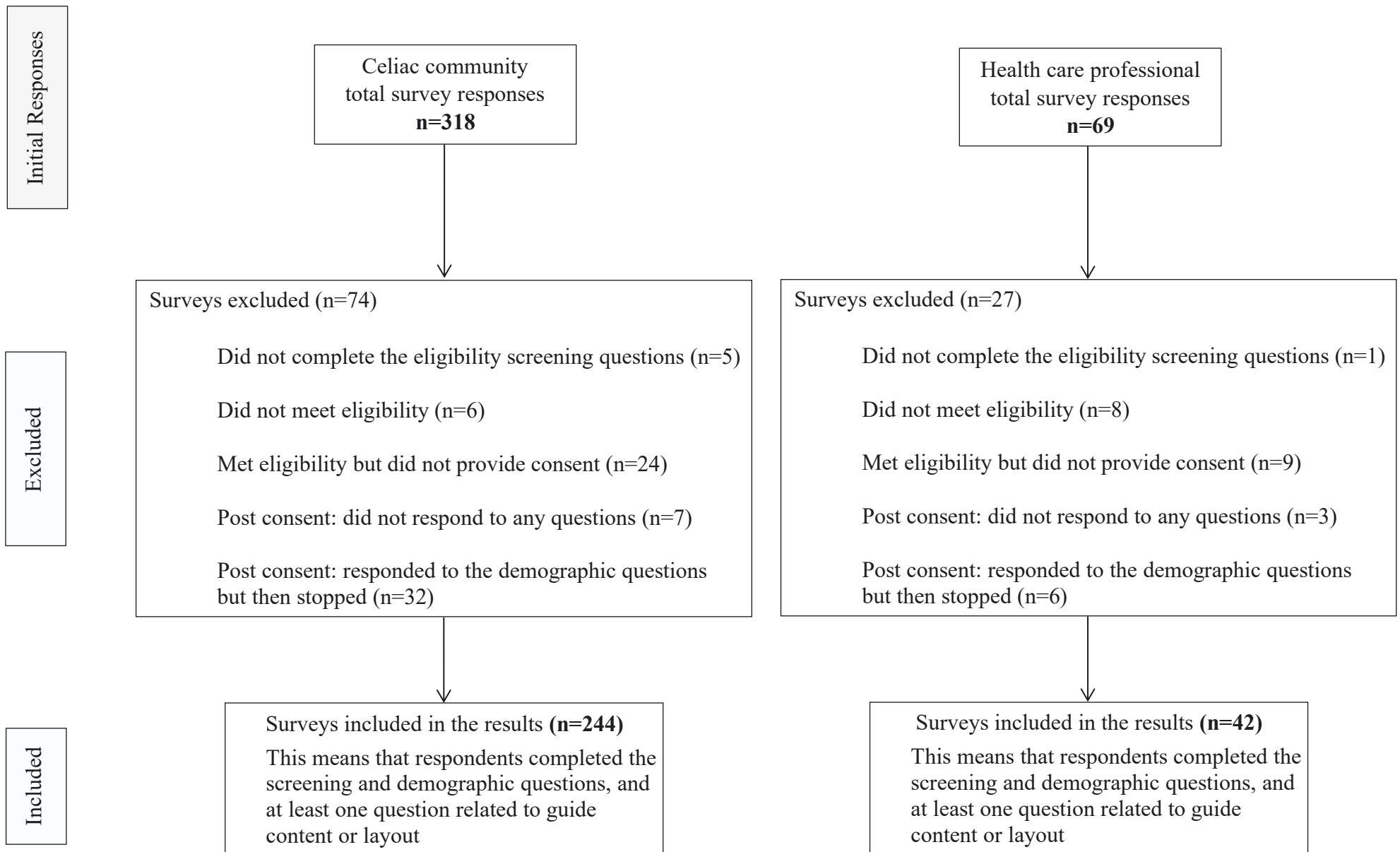
Educational Materials	Topics
Handouts (22 items)	<ul style="list-style-type: none"> • Breakfast • School Lunches • Healthy Snacks • Cross-Contamination • Eating Out • Reading Nutrition Facts Tables • Reading Ingredient Lists • Grocery Shopping • Eating on a Budget • Travel • Grains • Oats • Pulses • Fat & Sugar • Calcium • Fibre • Folate • Iron • Vitamin D • Lacto-ovo Vegetarian • Lactose Free • Vegan Diet
Videos (4 items)	<ul style="list-style-type: none"> • Food Preparation (related to different cuisines)

A list of supplementary educational materials. This list shows topics for which materials have been developed for by our team. The supplementary materials aim to provide resources in addition to the gluten-free food guide to help educate children/youth and their families with celiac disease. Each handout is approximately two pages and each videos ranges between two to eight minutes in duration.

Appendix C-2 Focus group prompting questions.

Health Care Professional Questions	Celiac Community Member Questions
1. Does the plate look appealing?	1. Do you like the way the plate looks?
2. Do you think the plate is realistic and feasible for children to consume?	2. Do you think that you/ your child would eat the recommended amounts at most meals?
3. What other information, if any, do you think should be added to these pages?	3. Is the information on these pages clear or confusing?
4. Comments on layout?	4. What do you think of the design? Colour? Font?
5. Do you think the plate is representative of foods that are present in different ethnic cuisines?	5. Do you think that plate has foods that are present in different ethnic cuisines?
6. Are there any other teaching material topics you think we should cover? Are any of the teaching material topics not relevant?	6. Are these teaching material topics you would be interested in learning more about? Any teaching material topics you would add?
7. Is it beneficial to have both paper and electronic-based materials? Is one more preferred than the other?	7. Do we need both paper and electronic-based materials? Is one better than the other?
8. Is the language on the folate handout appropriate for children and families?	8. Is the folate handout easy to understand?
9. What do you think of the layout?	9. What do you think of the design? Colour? Font?
10. Do you think this guide could be used in clinical practice in addition to dietetic counselling?	10. Would the guide have been useful when first diagnosed?
11. Overall, what do you like about the guide? What would you like to see improved?	11. Do you think it would be helpful for someone recently diagnosed as celiac?
12. Additional comments or feedback?	12. Additional comments or feedback?

Presented are the questions that the investigators explored with focus group participants. Questions were not always asked in the order listed or as written due to the natural progression of conversation and/or due to participant literacy levels.



Appendix C-3 Flow chart for included and excluded survey responses.

Appendix C-4 Selected quotes from themed survey responses generated by stakeholders.

Themes	Sub-themes	>19 years*	Parent (+)†	Parent (-)‡	Health Care Professional
Food Guide Content	Plate	<i>I like that it shows a variety of foods in each category. [Saskatchewan]</i>	<i>[I like the] variety of foods. Lots of color options. Lots of easily accessible foods. [Saskatchewan]</i>	<i>I like that there are examples of what you can use for each section and how much of it should fill the plate. [Nova Scotia]</i>	<i>[Important] to show the variety but the volumes seem overwhelming to a child. [RD, Alberta, 30y§]</i>
	Food Selection	<i>Also, even though...macaroni noodles are not necessarily the best nutritional choice if you are trying to appeal to youth it is an absolute must! [British Columbia]</i>	<i>Surprised red meat is not included in the photo. [Saskatchewan]</i>	<i>There could be beef in the protein section. [Quebec]</i>	<i>The North has limited supply of fresh fruit and vegetables - if there was a way to have a picture of frozen vegetables or fruits ...it would be more realistic here. [RD, Yukon, 29y]</i>
	Key Messages	<i>...I'm really glad to see "Enjoy your food" as a key message! [Ontario]</i>		<i>I like that there is specific information about dietary needs for children with celiac. [Manitoba]</i>	<i>I'd like to see more emphasis/mention on calcium rich foods. [RD, British Columbia, 6y]</i>
	Language	<i>If this is for children, the text [for the key messages are] a little too "adult" based. [Manitoba]</i>		<i>They are easy to read, in plain language. [New Brunswick]</i>	<i>Whole foods likely doesn't mean much to most people. [RD, Alberta, 6y]</i>
Food Guide Layout	Food Groups	<i>[Needs] better spacing between the segments on the plate. More "white space" to clearly show the division. [Ontario]</i>		<i>Each section is clearly divided. [Prince Edward Island]</i>	<i>...I really like the visual and how it incorporates the current food guide. [RD, Ontario, 20y]</i>
	Design	<i>I like that it is colourful. That makes it engaging. [Ontario]</i>	<i>Very colourful and eye catching especially for kids. [Saskatchewan]</i>	<i>Colourful with clear and easy descriptions. [Alberta]</i>	<i>Pictures are clear, I would like to see the font larger if possible. [RD, Ontario, 1y]</i>
		<i>...It is very "kid" friendly, such that the foods are easily identified. [Saskatchewan]</i>	<i>I like the layout, but I don't know what all of the foods are. [British Columbia]</i>	<i>It's not too much information. Layout is clean and doesn't distract</i>	<i>The bottom left corner [of the guide] seems empty compared to the rest -- is there a way to</i>

Themes	Sub-themes	>19 years*	Parent (+)†	Parent (-)‡	Health Care Professional
				<i>from the points provided. [Saskatchewan]</i>	<i>balance this without making the image too busy? [RN, Ontario, 16y]</i>
		<i>Small thing to consider, the plate and glass of milk are not proportionate. The glass is quite small in comparison. Just a thought. Otherwise appealing diagram. [Alberta]</i>	<i>Photo is a bit too busy. [Quebec]</i>		
Ethnicity	Language			<i>The issue we face as a francophone family is having access to recent information in French. ...Even if they're only available in web format (not printed), it would be very helpful. [New Brunswick]</i>	
	Cultural Inclusion	<i>...can't cover everything, just keep it basic and simple. [Saskatchewan]</i>		<i>I don't think these handouts are culturally adept... [British Columbia]</i>	<i>Very westernized diet; it would be beneficial to include traditional food and more cultural foods... [RD, Yukon, 1.5y]</i>
Feasibility	Realistic	<i>Seems realistic, not too exciting but I would've eaten most of that as a child. [Nova Scotia]</i>		<i>These are basic foods that are easily accessible and typically are pleasing to children. [New Brunswick]</i>	<i>Will they think they have to eat all of this food at one meal? [RD, Nova Scotia, 20y]</i>
		<i>Not all children/youth want to have a full plate - sometimes a variety of nibblies is the way to get them to eat. [British Columbia]</i>		<i>It might be overwhelming for caregivers new to celiac disease. [Ontario]</i>	

Themes	Sub-themes	>19 years*	Parent (+)†	Parent (-)*	Health Care Professional
	Additional Supports	<i>Really like the idea of cooking demonstrations [from videos], making them fun and easy to follow for kids to learn along with their parents. [Ontario]</i>		<i>...I wonder to add some example meals for children to model? What would breakfast, lunch and dinner look like per the plate idea. [Alberta]</i>	
	Overall Guide Messaging				
Educational Material Content	Existing Handout Considerations	<i>[Handouts] might be a bit old for some kids, maybe too mature, but not horrible. [Alberta]</i>		<i>I like that there are examples of what a meal might look like. I also like how it gives you an idea of what things you need to make a well balanced meal. [Nova Scotia]</i>	<i>More kid friendly examples [needed]. [RD, Alberta, 16y]</i>
	New Topic Suggestions	<i>Eating on vacation/travel. Provide tools for families on how to eat healthy and stay mindful of their gluten free choices when away from home. [Alberta]</i>	<i>Grain identification. [Saskatchewan]</i>	<i>...pointers on how children can navigate social situations on their own. This may include birthday parties, sleepovers, camps, visits with family members for large meals, etc. [New Brunswick]</i>	<i>Gluten-free kitchen (how to set up to avoid cross-contamination). [RD, Manitoba, 30y]</i>
Educational Material Layout	Design	<i>Simple but I would add pictures of the suggested breakfast. [Quebec]</i>	<i>Reduce the size of the green boxes as they are hiding the food pictures. Kids will more look at the picture than read at first. [Quebec]</i>	<i>Message is strong, but the dark font is difficult to read. [British Columbia]</i>	<i>It would be helpful to have the plate image here [in handouts] to frame how all of this fits together. [RD, Alberta, 6y]</i>
			<i>It's hard to read the black font on the purple/burgundy color and on the green boxes. But the content is good. [Saskatchewan]</i>		

Themes	Sub-themes	>19 years [*]	Parent (+) [†]	Parent (-) [‡]	Health Care Professional
	Organization	<i>I don't like the layout at all. It's a bit busy and the colours used makes the text hard to read. [Manitoba]</i>	<i>It's easy to follow and not overwhelming. [Alberta]</i>	<i>Simple and clear layout. [Ontario]</i>	<i>Easy to read. [RD, Ontario, 18y]</i>
Useability	Usefulness	<i>I have been celiac for 11yrs already. I know what I can eat already. [Alberta]</i>	<i>It would be a great tool for my 12 year old celiac as [they are] becoming more independent. [Saskatchewan]</i>	<i>I think these handouts would be very helpful ...I am now used to the diet but would even appreciate some of these handouts even now! [Alberta]</i>	<i>Yes, they would be helpful and provide a great and simplified visual. [RD, Yukon, 1.5y]</i>
	Format	<i>Use YouTube and other social platforms. [Saskatchewan]</i>	<i>Something to hang on the fridge is great for home and access electronically when out. [Saskatchewan]</i>	<i>Most people get their information online these days. [Ontario]</i>	<i>Nice to have both options - most families I use a combination already i.e. handout when ...in clinic, and email electronic to them as well. [RD, Ontario, 30y]</i>
Other	Serving Size	<i>Would also need [the guide] to be paired with a serving size explanation. [Ontario]</i> <i>Should add amounts i.e. 1 cup veggies. [British Columbia]</i>			

RD: Registered Dietitian; RN: Registered Nurse.

^{*}≥19 years: an adult with celiac disease but who does not identify as a parent of a child/youth with celiac disease. Few notable comments were made by the 15-18 year old respondents who completed the survey (n=3).

[†]Parent (+): a parent with celiac disease who has a child/youth with celiac disease.

[‡]Parent (-): a parent without celiac disease who has a child/youth with celiac disease.

[§][Role, province, years of practice].

Appendix D-1 Dietary intake and diet quality pre and during Coronavirus Disease 2019.

	Pre COVID-19 (n=10)	During COVID-19 (n=6)	P value
Food Groups			
Fruits & Vegetables	5.4 [1.9 – 6.2]	2.7 [2.1 – 4.0]	0.3
Grain Products	4.2 [3.2 – 4.6]	8.2 [7.4 – 8.3]	<.001
Milk & Alternatives	2.3 [1.1 – 3.0]	2.0 [1.2 – 3.7]	0.6
Meat & Alternatives	1.5 [1.3 – 3.4]	2.0 [1.8 – 2.6]	0.8
Diet Quality			
Total	54.9 [47.1 – 66.6]	59.5 [43.0 – 68.0]	0.7
Adequacy	31.3 [29.2 – 39.0]	29.9 [28.1 – 34.5]	0.9
Moderation	20.0 [17.5 – 22.5]	22.5 [12.5 – 27.5]	0.7
Variety	5.0 [0.0 – 5.0]	5.0 [5.0 – 5.0]	0.6
Macronutrient, %			
Protein	13.3 [11.5 – 15.8]	12.4 [11.6 – 16.7]	0.8
Carbohydrate	51.3 [46.1 – 58.2]	49.6 [45.7 – 61.3]	0.9
Fat	36.3 [32.2 – 36.8]	36.9 [28.8 – 43.5]	0.9
Saturated Fat	13.8 [11.5 – 15.0]	12.4 [8.7 – 14.6]	0.6

COVID-19: Coronavirus Disease 2019. Data expressed as median [interquartile range]. *P* value <0.05 was considered statistically significant. Define how diet quality was measured and define HEI-C cut-off values.

Appendix D-2 Home food environment, food shopping and thoughts and habits about food.

Questions	Yes	No			
Q1. Do you have these appliances in your home to cook or store food?					
a. Refrigerator	100	0			
b. Freezer	100	0			
c. Microwave	94	6			
d. Stove	100	0			
e. Oven	100	0			
f. Other Top Appliances	100	0			
	Never or rarely	Sometimes	Often	Almost always	
Q2. In your home how often do you have...					
a. Fruits and vegetables in the refrigerator.	0	0	0	100	
b. Candy or chips available to eat.	13	25	38	25	
c. Fruit available in a bowl or on the counter.	6	0	19	75	
d. Ice cream, cake, pastries, or ready-to-eat sweet baked goods (cookies, brownies, etc.).	0	44	38	19	
	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Strongly agree	
Q3. Please mark if you agree or disagree with the following statements.					
a. It is easy to buy fresh fruits and vegetables in my neighborhood.	0	6	0	94	
b. The fresh produce in my neighborhood is of high quality.	0	6	25	69	
c. There is a large selection of fresh fruits and vegetables in my neighborhood.	0	6	13	81	
	Not at all important	A little important	Somewhat important	Very important	
Q4. How important are each of the following factors in your decision to shop at the store where you buy most of your food?					
a. Near your home.	13	25	19	44	
b. Near or on the way to other places where you spend time.	13	25	13	50	
c. Your friend/relatives shop at this store.	81	6	13	0	
d. Selection of foods.	0	0	31	69	
e. Quality of foods.	0	0	19	81	

f. Prices of foods.	0	0	25	75
g. Access to public transportation.	88	6	6	0
	Very easy	Somewhat easy	Somewhat hard	Very hard

Q5. At the store where you buy most of your food, how hard or easy is it to get each of these types of foods?

a. Fresh fruits and vegetables	88	6	0	6
b. Canned or frozen fruits and vegetables	94	0	0	6
c. Lean meats	88	6	0	6
d. Candy and snack chips	94	0	0	6
e. Regular soda or other sugary drinks	94	0	0	6
	Very inexpensive	Not expensive	Somewhat expensive	Very expensive

Q6. At the store where you buy most of your food, how would you rate the price of fresh fruits and vegetables?

	0	44	50	6
	Not at all important	Somewhat important	Very important	

Q7. When you shop for food, how important to you is...

a. Taste	0	19	81	
b. Nutrition	0	19	81	
c. Cost	0	31	69	
d. Convenience	13	69	19	
	Never	Occasionally	Sometimes	Usually or always

Q8a. How often does your family eat evening meals together?*

	0	0	31	69
Q8b. How often does your family eat meals in front of the television, computer or phone with these devices turned on?	31	56	6	6

Questions were pulled from the Perceived Nutrition Environment Measures Survey® (Q1, 3, 4, 10, 11, 12, 22, 27, 28).

All responses are expressed as percentage and based on n=16 households.

*All parents who responded 'sometimes' were employed full-time.