Modified Texture Diet and Long Term Care: A Secondary Data Analysis of Making the Most of Mealtimes (M3) Project

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Background: Research has suggested that modified texture diets (MTDs) are prevalent among older adults living in long term care (LTC). Additionally, previous research has also suggested that modified texture food, especially pureed food, contains fewer calories and offers less nutritional quality compared to unmodified food; plus these diets are associated with a high prevalence of under-nutrition and weight loss among older adults in LTC. Residents who require pureed food are often highly vulnerable, with eating challenges and cognitive impairment, requiring total eating assistance. To date, it has been challenging to disentangle these inter-related factors to understand how to improve food intake for those requiring food texture modifications.

Purposes: 1) To examine the current prevalence of prescribed MTDs in Canadian LTC homes when applying standardized terminology and the resident characteristics that are associated with the prescription of a MTD. **2)** To determine if the pureed diet provided as planned for one week is different in energy, macronutrients, micronutrients, and fibre as compared to the regular texture diet; and examine what home characteristics may be associated with these differences. **3)** To examine the current dietary intake of residents in LTC homes consuming a pureed diet, compare this to the Dietary Reference Intake, and assess covariates that are associated with this intake. **4)** To examine if prescription of a MTD as compared to a regular texture diet is independently associated with the risk of malnutrition in residents of LTC homes when diverse relevant covariates are considered.

Methods and Findings: This thesis work is a secondary data analysis of the M3 project, a cross-sectional multi-site study across Canada, which collected data at the provincial, home, unit, staff, and resident levels from 639 residents across 32 LTC homes in four provinces (AB, MB, NB, ON). Four studies were part of this thesis work, and each method in more detail and respective findings are described below.

1) The use of MTDs and resident characteristics were identified from health records and standardized procedures. Homes used a variety of terms to describe MTDs. Diets were re-categorized using the International Dysphagia Diet Standardization Initiative (IDDSI) Framework: regular, soft, minced and moist, pureed, and liquidized. Modified texture (i.e., pureed, minced and moist, and soft and bite-sized) diets were prescribed to about 47% (n= 298) of residents in the M3 sample (n= 639) and prevalence was significantly different across provinces. Many resident characteristics that were found to be associated with the prescription of a MTD included: longer length of admission, risk of

dysphagia, dementia diagnosis, lower number of oral agents (e.g., vitamin/mineral supplementation and drugs), decreased number of vitamins/minerals, prescription of oral nutritional supplementation, lower body weight, higher weight loss, lower body mass index, decreased calf circumference, higher risk of malnutrition, requirement of physical assistance, more eating challenges, poor oral health status, more cognitive impairment, and more impairment in the activities of daily living.

2) A nutrient analysis of pureed (n= 32) and regular (n= 32) menus for the first week of the menu cycle was completed using Food Processor software for all 32 LTC homes. Findings suggest there were significant province and diet texture interactions for energy, protein, carbohydrates, fibre, and 11 of 22 micronutrients analyzed, with New Brunswick and Alberta having lower nutrient content for both menus as compared to Ontario and Manitoba. Within each province, similar trends were observed; some homes had significantly lower nutrient content for pureed diets, while others did not. Fibre and nine micronutrients were below DRI recommendations for both menus across the provinces, with variation existing across the sites within each province where some had more or less nutrients meet the specific DRI recommendations. Many home characteristics were found to be associated with a higher energy and protein provision from the regular and/or pureed texture menus, they included: for-profit status; larger homes; three, four, or five week menu cycles; a menu revision every 6−12 months; higher funding for raw food; and higher proportion of commercial food product use.

3) A three-day dietary intake was collected using weighed methods for main dishes and a standardized estimating protocol for side dishes and fluids; intake was analyzed using Food Processor software and only residents consuming a pureed diet (n= 67) were included. When protein, carbohydrate, and micronutrient intakes were compared to the appropriate DRI for females (n= 51) over the age of 70 years, this study found that the prevalence of inadequate intake for the sample widely ranged depending on the specific nutrient, although only six nutrients (vitamin B6, vitamin D, vitamin E, folate, calcium and magnesium) had potential inadequacy for 50% or more of the sample. Additionally, this study found that when adjusted for age and gender, only average number of staff assisting with a meal was independently associated with energy and protein intake for individuals consuming a pureed diet (n= 66). Specifically, as the number of staff increased during mealtimes the amount of energy and protein intake per kilogram of body weight decreased.

4) The MNA-SF score, use of MTDs, and resident characteristics were identified from health records and standardized procedures. This study found that prescribed diet texture, more specifically a pureed diet, was independently associated with risk of or malnutrition among residents living in LTC facilities (n= 364). Other independent covariates were being on oral nutritional supplementation, more cognitive impairment, more eating challenges (e.g., spitting food out of mouth), and a poor oral health rating, after adjusting for age and gender.

Overall Conclusion: In conclusion, the prevalence of prescribed MTDs was high and significantly different across provinces in Canada, with a number of resident characteristics associated with a prescribed MTD. There was variability in menu planning across provinces and LTC homes in the M3 sample, plus pureed menus tended to offer a lower amount for many nutrients as compared to the regular menu with some exceptions (e.g., vitamin D and calcium). Among residents consuming a pureed diet, inadequate nutrient intake existed for several nutrients, and specifically of concern were vitamin B6, vitamin D, vitamin E, vitamin K, folate, calcium, magnesium, potassium, and fibre. The number of staff assisting at mealtimes was the only variable independently associated with food intake in this group. Lastly, prescribed diet texture, more specifically a pureed diet, was independently associated with risk of or malnutrition among residents living in LTC facilities. This secondary data analysis of the M3 Project offers a more in-depth and comprehensive contribution to the limited research around older adults and helps to address many of the confounding factors of prior work. Interventions can be targeted to key gaps in care identified in this work.

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List of Abbreviations

AB: Alberta

ABS: Aggressive behaviour scale

ADL-LFS: Activities of daily living long form scale

AI: Adequate intake

ANOVA: Analysis of variance

BMI: Body mass index

CFG: Canada's Food Guide

CPS: Cognitive performance scale

DRI: Dietary Reference Intake

DRS: Depression rating scale

Ed-FED: Edinburgh Feeding Evaluation in Dementia Questionnaire

ESPEN: European Society of Clinical Nutrition and Metabolism

IDDSI: International Dysphagia Diet Standardization Initiative

LTC: Long term care

MB: Manitoba

MNA-SF: Mini Nutritional Assessment short-form

MTD: Modified texture diet

MTF: Modified texture food

M3: Making the Most of Mealtimes

NB: New Brunswick

ON: Ontario

PDC: Person-Directed Care

PS: Pain scale

RBS: Relational Behaviour Scale

RDA: Recommended dietary allowance

SD: Standard deviation

STAND: Screening Tool for Acute Neurological Dysphagia

Chapter 1
Introduction

1.1 Older adults in long term care

The absolute number of older adults (over the age of 65 years) is growing including those living in long term are (LTC) (1–7). In 2011, the number of older adults living in LTC in Canada was approximately 225,000, or 4.5% of the total older adult population (5,6,8). This proportion has increased over the years and will continue to grow as the number of older adults will not only rise but also live longer with chronic conditions that require care necessitating residential living (6,8–10).

Mealtimes are an important aspect in LTC, where multi-level and multi-factorial causes can impact food and fluid intake (11,12). Keller and colleagues have conceptualized three domains or categories of factors that potentially influence the food and fluid intake of LTC residents; these domains include mealtime experience, meal access, and meal quality (11). Resident, staff, dining room, LTC home and regional government characteristics or activities (e.g., policy) can influence these domains. The focus of this proposal is on the meal quality domain, and more specifically the quality of modified texture food with respect to nutritional requirements.

Older adults have unique energy and nutrient requirements because they require fewer calories but more of specific nutrients to promote good health (13–16). Nutrition plays a critical role in their quality of life, functional and cognitive status, and overall health, however, older adults have an increased risk of malnutrition, especially those living in LTC facilities (17). Older adults at risk of malnutrition are more likely to have poorer quality of life, be admitted to a hospital more often, have an increased risk of mortality and morbidity, a slower healing process, and unintentional weight loss (17–19). The main cause of malnutrition is inadequate nutritional intake and other factors such as the prescription of modified texture diets which may be nutritionally inadequate or poorly consumed can influence the risk of malnutrition in this population (11,18,20–28). Therefore, an aim of food provision in LTC should be quality nutrition through providing nutrient dense meals among older adults who are prescribed modified texture diets, commonly prescribed for those with eating difficulties and persons with dysphagia (7,29).

Dysphagia is defined as any difficulty in the swallowing process which includes any anatomical, physiological, neurological, or muscular deficits in the mouth, pharynx, larynx, or esophagus (26,30,31). Prebysphagia refers to characteristic changes in swallowing mechanisms of healthy older adults such as an old, slow but healthy swallow (30). Oropharyngeal dysphagia is the most common form of dysphagia; these individuals have a difficult time getting food to the back of the mouth to initiate swallowing (7,29,32). A less common type is esophageal dysphagia, where obstructions in the esophagus and regurgitation can possibly lead to aspiration (7,29,32). There are three main stages in swallowing but before these can occur the food must be recognized by the person as edible and the person must have the ability to self-feed (29,31,32). Those with cognitive or physical impairments such as dementia or stroke may have a challenge with recognizing food and self-feeding (31). The three main stages in swallowing include: oral, pharyngeal and esophageal (29,31,32).

Dysphagia is a significant problem in LTC and prevalence increases with age due to changes in the ability to chew and/or swallow; it is also more common in those with co-morbidities (30,33,34). The most common predisposing health conditions for dysphagia, include: stroke, dementia, Alzheimer's disease, Parkinson's disease neoplasms, cancer, gastroesophageal reflux, and other conditions that cause injury to the oral structures and esophagus (26,30,31). It is estimated that up to 74% of LTC residents have some level of dysphagia and prevalence rates could even be higher in those with dementia or stroke (7,30,35,36). Also, prevalence rates may be higher as the aging population is growing and the complexity of care in LTC residences has increased. Thus the most complex and challenging older adults to provide nourishment to are LTC residents (7,13,37).

Issues and complications can arise from dysphagia, which include: reduced food and fluid intake, impaired quality of life, diminished emotional well-being, loss of dignity, and poor self-esteem (23,26,29,30,38,39); and increased risk of choking, morbidity, and mortality (23,26,29,30). Overt aspiration is the major complication, but silent aspiration can also occur (29,32). Aspiration is the inhalation of any matter such as food, liquid, or saliva into the respiratory system below the vocal cord level (29,32). Silent aspiration is similar to overt aspiration however no explicit signs or symptoms such as choking or coughing occur (29,32). Other symptoms include persistent cough, recurrent pyrexia, recurrent pneumonia, chest pain, lung abscess, confusion, convulsions due to apnea, and even death due to asphyxiation, malnutrition and dehydration (29,32).

Dysphagia is a chronic syndrome in many older adults in LTC and is typically not reversible; management of dysphagia is the primary course of treatment through the modification of food and fluids to make them safe to swallow (7,29). To minimize the risk of any potential complications, older adults with dysphagia are commonly prescribed a modified texture diet (29,40). Modified texture foods are solids which have an altered texture and consistency, which can range from pureed to minced (26,29,41). Texture modifications are not only provided to those with dysphagia but are also prescribed for non-physiological reasons such as slow eating, self-feeding difficulties, and refusal to eat (35,40,42).

To date, research has suggested that modified texture diets are prevalent among older adults living in LTC (22,35,42–44). Additionally, previous research has suggested that modified texture food (MTF), especially pureed food, contains fewer calories and offers less nutritional quality compared to unmodified food (11,38,45–47). Further, MTFs, specifically the pureed texture, are associated with a high prevalence of under-nutrition and weight loss among older adults in LTC (11,20–27). However, there is limited rigorous research in this area; therefore, further research is needed to investigate the extent and impact of these problems in the LTC population and to inform future interventions to address these issues.

This thesis is written as four distinct but connected manuscripts to be submitted for publication. Paper 1 (Chapter 2) is focused on the prevalence of modified texture diets in Canadian LTC homes and the resident characteristics that are associated with prescription of these diets. Paper 2 (Chapter 3) is focused on the quality of the regular texture and modified texture menus as planned in Canadian LTC homes. Paper 3 (Chapter 4) is focused on the consumption of MTF, more specifically pureed food, in Canadian LTC homes and the factors associated with this intake. Paper 4 (Chapter 5) is focused on malnutrition and modified texture diets in Canadian LTC homes. An overall discussion concludes the thesis, which will synthesize the findings and discuss further steps for research.

Chapter 2
Prevalence of Modified Texture Diet Use in Long Term Care

2.1 Introduction

Modified texture diets (MTD) are commonly used in the long term care (LTC) context as they are a key management technique to nourish residents with dysphagia (7,29,35,40). It is crucial that these diets are safe to swallow for those who cannot eat regular texture food or have difficulty eating (22,35,42). Dietary modification includes modifying solid foods and liquids to alter their texture and consistency, which is considered important for the management of those with eating difficulties or dysphagia (26,29). The alteration of solids is referred to as modified texture foods (MTF) and this can range from blenderized to chopped (26,29,41). For example, dietary modification can be categorized into four levels according to the American National Dysphagia Diet, where modified texture foods include levels one (i.e., pureed), two (i.e., mechanically altered), and three (i.e., advanced) (26,29,32).

The National Dysphagia Diet was established to set guidelines around terminology for MTFs (26,29), but is only one of several such guidelines (26,29,32,48). The evidence base for such guidelines is limited and consistency in use of these terms and of the corresponding food textures is lacking (23,29,32,48). As a result the terminology used for dietary modification among health professionals (e.g., dietitians), healthcare providers (e.g., nursing staff), researchers, LTC facilities, and commercial providers varies considerably (22,23,48). This lack of consistent terminology has implications not only for those prescribing but for those consuming and providing this diet type, as it has created confusion and a variety of modified unstandardized textures (22,23). Several countries have developed and adopted national standardizations of terminology and definitions for modified texture foods, such as the United States, United Kingdom, Australia, Ireland, Japan, Sweden, and Denmark (22,26,48). However, Canada is not among one of those countries, as it is still in the process of developing national guidelines (22,23,48). Not only is there a need for national standards of MTFs for Canada, but consistent international terminology and definitions for MTFs is also necessary to provide safe and good quality products to consumers in our global economy (22,48). As a result, the International Dysphagia Diet Standardization Initiative (IDDSI) outlined a framework in 2015 for international standardized terminology around MTDs, including both foods and fluids (49).

Modified texture diets are anticipated to be prevalent among the LTC population in Canada, although prevalence across a diverse sample is elusive. Current estimates suggest that 15% to 30% of residents are prescribed a modified texture diet (22,35,42–44). However, few studies have investigated the extent and types of modified texture diets prescribed in the Canadian LTC context (22,35,42–44), with some only examining the prescription of pureed foods (35,44,50). Thus, the prevalence of MTF may be even greater in LTC with the inclusion of all prescribed modified texture diets. Another concern with research to date describing prevalence of MTF, is that many of these studies contained small sample sizes and/or investigated a single LTC home. Sample sizes of previous research ranged from 40 to 424 participants (35,42–44), two of the four studies were conducted at a single LTC home (35,44) and the other two in less than 10 homes from a limited geographic region (42,43). As a result, generalization on prevalence of MTF prescription in these studies is limited. Little is known about the range of MTF diet prescriptions provided for modified texture diets in the Canadian LTC context and the prevalence of MTF use within a representative sample is lacking.

Prescription of a modified texture is dependent upon the facility, the health professionals within this site, and the resident characteristics (19,23,41). Characteristics related to the prescription of a modified texture diet include: eating difficulties, inability to self feed, tooth loss, fatigue, chronic conditions, and physical and/or cognitive impairments such as dementia, stroke, multiple sclerosis, Parkinson's disease, and amyotrophic lateral sclerosis (19,27,36,51). Generally, characteristics of those prescribed MTF are sparsely documented (22,23,35,42,43), with studies only recording one or a few characteristics related to those prescribed modified texture diets (42,43), and only one study documenting a variety of associated characteristics in any detail (35). In this latter study which included 424 participants, only one LTC facility was represented in the sample and can thus not be generalized (35).

The existing prevalence studies on MTF are becoming out-dated and less relevant as the population of older adults and prescription of MTF is increasing in the LTC context (22,23). Determining a more generalizable prevalence estimate of prescribed modified texture diets will help to demonstrate the importance of this issue in nourishing vulnerable residents, and understanding their characteristics may support further research directions with respect to improving food intake and quality of life. Further, a better understanding of prevalence could support standardized terminology and consistency as well as procedures specific to LTC residents. Quality evidence is needed for making resident-level, the home-level, and government-level decisions and policy with respect to MTF (11). To address these research gaps, this study will attempt to answer the following research question and sub-questions: (1) What is the current prevalence of prescribed modified texture diets in

Canadian LTC homes represented in the Making the Most of Mealtimes (M3) sample, when applying standardized terminology; and (1a) Does the proportion of prescribed MTDs vary across provinces; and (1b) What are the resident characteristics of the M3 sample that are associated with the prescription of a MTD *(i.e. pureed, soft and bite-sized, and minced and moist)* and a pureed diet specifically?

2.2 Methodology

2.2.1 Sample and participants

The M3 study, a cross-sectional multi-site project across Canada, was designed to determine the associations between inadequate food and fluid intake among residents living in LTC and the multi-level influences and multi-factorial causes of this intake (52). The comprehensive data collection included gathering data at the provincial, home, unit, staff, and resident levels to ascertain the determinants of meal access, meal quality and the mealtime experience of residents, hypothesized to impact their food and fluid intake (11,52). The goal of the M3 study was to improve food and fluid intake among residents and thus nutritional status, and also to inform future intervention studies (11,52).

A total of 32 LTC homes were recruited across four different provinces (8 homes per province) in Canada: Alberta (AB), Manitoba (MB), Ontario (ON), and New Brunswick (NB) (52). Eligibility criteria for LTC homes included the following: 1) in operation for at least six months; and 2) having a minimum of 50 residents who met the resident eligibility criteria, which will be described below (52). For-profit and not-for profit homes were recruited and diversity in the sample was also attempted by including homes where a high proportion of individuals were from cultural minorities, independent operators and large corporations, rural or urban settings and faith-based homes (52). Within each LTC home, one to three units with residents that met the eligibility criteria were randomly selected and participants were then randomly sampled from the unit or units for participation (52). If it existed within the home, a behavioural or dementia unit was selected (52).

The eligibility criteria for residents were the following: 1) resided in the randomly chosen units; 2) were over the age of 65 years; 3) required a minimum of two hours per day of nursing care for activities of daily living; 4) resided in the LTC home for at least one month; and 5) either they or their decision maker provided informed consent for participation in the study (52). The exclusion criteria were as follows: 1) resided in the LTC home for less than a month; 2) were medically unstable (i.e. recent hospitalization); 3) were on short term admission to the LTC home; 4) required tube feeding; 5) residents who were not eating because they were on end of life care; 6) did not eat in the dining room on a routine basis; 7) had advanced orders excluding them from any research; or 8) they or their decision makers were unable to understand English, French and in the case of ON, Cantonese (52).

Based on inclusion and exclusion criteria, 20 residents from each home (n= 32 homes, 8 homes per province) were recruited, for a total sample of 639 participants (one participant withdrew consent) included into the study for data collection (52). Based on a given sample size of 639 participants, the prevalence of prescribed MTF (i.e., 15% to 30%) can be estimated with 95% confidence and a 5% margin of error (53,54).

2.2.2 Data collection and measures

To address the research questions, various resident characteristics were gathered from their health records or collected using standardized procedures by four highly trained provincial project coordinators (one per province) (52). The four provincial coordinators were comprehensively trained in person on all procedures and each coordinator trained two research assistants (n=8, 2 per province) on the collection of mealtime observation data including food intake (52). Those variables used in this analysis and collected from the medical record include: age, gender, supplementation (micronutrient, oral nutritional), length of admission (months), total number and type of major diagnoses using the InterRAI diagnostic checklist (stroke, dementia, Parkinson's disease, rheumatoid arthritis, osteoporosis, and osteoarthritis), total number of drugs and vitamins/minerals, current recorded weight and weight change in the last three months, calf circumference, body mass index (BMI), and prescribed diet texture per participant. Calf circumference was measured by the research staff using standardized measures (52) and BMI was calculated by using ulna length as an estimate of height also measured by the research staff (55–57). Ulna length was used as it is a more accurate calculation of BMI for older adults and has a higher sensitivity compared to using knee height (55,56,58). The most recent weight measure as completed by home staff was used for BMI. A calf circumference of ≤31 cm is associated with malnutrition risk, sarcopenia, and impaired physical function among this population (55,59,60). The calf circumference was categorized into two groups for the analysis; a calf circumference of ≤31 cm and a calf circumference of >31 cm. The BMI for each participant was categorized into two groups for the analysis; a BMI of <18.5 kg/m^2 and a BMI of ≥ 18.5 kg/m^2 since an individual with a BMI of <18.5 kg/m^2 is considered to be undernourished (61). Assessment of residents at risk of dysphagia was based on a composite measure (52). All residents currently prescribed thickened fluids were categorized as at ‘dysphagia risk’ (52). For those residents who could comply with a risk evaluation using the Screening Tool for Acute Neurological Dysphagia (STAND) assessment (i.e. water and applesauce swallowing test) (52,62) and demonstrated challenges, they were classified as at risk. Finally, a subset of individuals who could not comply with the STAND assessment, but demonstrated ‘sometimes’ or ‘often’ coughing and/or choking during two of the three days of meal observations, but were not already on thickened fluids were also categorized as ‘at risk’ for dysphagia (52).

The Mini Nutritional Assessment short-form (MNA-SF) was completed for each participant. The tool gathers information on changes in food intake, mobility, BMI, weight change, and dementia and depression diagnoses; the latter three aspects were obtained from the participants’ health record and BMI was calculated as described above. To complete the MNA-SF the project coordinators observed the participant and asked them or their care staff about mobility and changes in food intake. The MNA-SF identifies nutrition risk and provides a score from 0 to 14, where a score of ≥ 12 indicates satisfactory nutritional status and a score of ≤ 11 implies a risk of malnutrition (63,64). The MNA-SF score was used in a numerical manner for the analysis. This tool is commonly used to screen for malnutrition among long term care populations and is validated to identify risk of or malnutrition itself (19,63,64).

The oral health and dentition of participants was determined from the Oral Health Examination, where a dental hygienist completed a standardized oral assessment based on 13 items with sub-questions, each item pertained to a specific aspect of oral health observed (52,65). A summary item completed the assessment, which was a subjective rating by the hygienist based on their standardized assessment; using a rating from 1 to 5, the hygienist rated their belief that the oral health status of the resident could influence food intake of the participant (1= not/unlikely influenced; 5= food intake significantly impacted by oral health) (52). This single item provides a practical variable for categorizing participants’ oral health status. This item was further categorized into two groups (1, 2 vs. 3+, where 1 represents food intake not influenced by oral health and 5 represents food intake significantly influenced by oral health) for the analysis with consultation from a member of the M3 team who is an oral health expert (52). The average length of a meal per participant in minutes was also used in the analysis and determined from the average recorded for up to nine meals observed (52). Two research assistants in each of the four provinces observed food intake for three non-consecutive days, including a weekend day (52). One meal per day, they completed a more detailed assessment which included the standard and valid Edinburgh Feeding Evaluation in Dementia Questionnaire (Ed-FED) that assesses eating and feeding issues in older adults with dementia (52,66). This form also, tracks "other eating challenges" during mealtimes (i.e. chewing problems, lack of energy) (67–69). Each question is based on an ordinal scale (1= not applicable or never; 2= sometimes; 3=often) to make it consistent with the Ed-FED (66–69). The questions in the "other eating challenges" section were based on challenges derived by the research team to further capture eating challenges using the same scoring, but have not been tested for validity and reliability (52). The total score of each, Ed-FED and "other eating challenges", were separately averaged over the three meals observed for use in this analysis. Additionally, the single question on Ed-FED (i.e. Does the resident require physical help with feeding/eating?) was categorized into two groups for the analysis (0= no physical assistance required; 1= sometimes or often physical assistance is required to eat during mealtimes).

The interRAI LTCF assessment provided further information on resident characteristics, and relevant aspects included: cognitive performance scale (CPS) (CPS <2 or 3+, where 0 represents intact cognition and 6 represents very severe impairment), depression rating scale (DRS) (0-14), pain scale (PS) (0-3), activities of daily living long form scale (ADL-LFS) (0-28), and aggressive behaviour scale (ABS) (0-12) (52,70). All interRAI LTCF assessment scales were used in either an ordinal or categorical manner in the analysis. To ensure accuracy and currency, the items on interRAI LTCF assessment required for these scales was completed by the research staff by interviewing home staff familiar with the current care of the resident (52).

Lastly, dietary intake for participants in the M3 sample was determined by the weighing or estimating of food and fluid intake for three non-consecutive days, including a weekend day, to reduce within-subject variability and day-of-the-week effects (52,71). Weighing is considered the most accurate method, when a duplicate portion with chemical analysis is not possible (71). The main plates at breakfast, lunch, and dinner were weighed before consumption, one food at a time, and the remaining food was subtracted to determine the portion consumed (52). Any wasting or spillage of food was also subtracted (52). Side dishes and fluids at breakfast, lunch and dinner, but also any snacks between meals were estimated using a standardized protocol to ensure accuracy and consistency (52). Data collection of dietary intake for participants only occurred when they were present in the home for that meal (52). Subsequently, collected data was entered into the Food Processor software (Version 10.14.1) by the research assistants who collected the food consumption data using home recipes and the Canadian Nutrient File where appropriate for foods based on

Canadian fortification practices (52). Each day's energy and protein intake per participant was calculated and then subsequently the average across three days per participant was calculated and used in the analysis.

The IDDSI framework was used to streamline and categorize the prescribed diet texture labels for all residents (n=639) as a total of 67 different modified texture labels were used by the 32 homes included in this study. Specifically, five different levels of the IDDSI continuum were used in the analysis to categorize the texture labels; level three refers to a liquidized diet, level four refers to a pureed diet, level five refers to a minced and moist diet, level six refers to a soft and bite-sized diet, and level seven refers to a regular texture diet (49). Coding rules were created a priori to address this categorization. Where the prescribed texture as described from the resident chart was consistent with IDDSI terminology (e.g. soft; pureed) categorization was made. Where participants were prescribed more than one texture (e.g. minced/pureed) then the observed texture from the Food Intake Forms was used, either the texture for two of the three meals per observation day or the majority of food as consumed (e.g. first course is minced, main course is pureed, and dessert is pureed then resident would be considered a level four or pureed diet). Where the frequency of observed texture labels was equal, then the lower level of texture was used in the analysis to ensure that lower levels of MTD were not underreported. For other home labels for MTD, categorization was based on IDDSI descriptions and attempting to categorize the prescribed diet in the most logical or similar level (e.g. ground was coded as minced or level 5; diced was coded as soft and bite-sized or level 6).

2.2.3 Data analysis

A secondary data analysis was performed. Data were analyzed using Statistical Analysis System software for Windows (Version 9.4). To define the prevalence of prescribed MTD, descriptive statistics were used to tabulate the number and percentage of residents within the M3 sample for each of the IDDSI texture categories (i.e., regular, soft and bite-sized, minced and moist, pureed, and liquidized). Chi-square tests were performed to compare the prescribed diet textures across the four provinces. Statistical significance was set at $\alpha=0.05$.

To determine the resident specific characteristics of the M3 sample associated with the prescription of a modified texture diet**,** first descriptive statistics were used to compute means/medians for continuous variables (e.g., age, length of admission in months, total number of diagnoses, total number of drugs, total number of vitamins/minerals, energy and protein intake, current body weight, weight change, BMI, calf circumference, MNA-SF score, average length of meal, Ed-FED, other eating behaviours) and ordinal variables (e.g., interRAI LTCF scales). A Student's t-test was used for normally distributed continuous variables for comparison of these characteristics between any modified texture (e.g. liquidized, pureed, minced and moist, soft and bite-sized) and regular texture categories, and an analysis of variance was used across the IDDSI texture categories (i.e., soft and bite-sized, regular, minced and moist, pureed, and liquidized). Non-parametric tests were used for skewed continuous variables and for ordinal variables; Wilcoxon Rank Sum test was used for comparing characteristics between the modified texture and regular texture categories and Kruskal-Wallis's test was used for comparing characteristics across the IDDSI texture categories. Proportions were created for categorical variables (e.g., gender, type of major diagnoses, oral nutritional supplementation, BMI, calf circumference, Ed-FED, oral health rating, CPS) using descriptive statistics, then chi-square tests were performed to compare characteristics between the modified texture and regular texture categories, and also across the IDDSI texture categories. Statistical significance was set at $\alpha=0.01$ to adjust for a type one error due to the number of tests conducted. Clustering within homes and provinces was not accounted for through statistical methods because data being analyzed was only at the resident level.

2.3 Results

2.3.1 Prevalence of modified texture diets across the entire sample and provinces

Modified texture diets were prescribed to just under half of residents, specifically 47.10% (*N*=301) were on a MTD, with the most common MTD being minced and moist. Table 1 illustrates the prevalence of various IDDSI prescribed textures. The prevalence of the various IDDSI textures varied significantly by province ($\chi^2(12, N=639)=69.58$, $p<0.0001$ level), which is shown by the variation of proportion across the four provinces for each texture category. A total of 14.24% (*N*=91) of residents were prescribed a soft and bite-sized texture (AB=29%, MB=14%, NB=11%, ON=3%). Just under one quarter, 21.75% (*N*=139) of residents were prescribed a minced and moist texture (NB=26%, MB=22%, ON=21%, AB=18%). Fewer residents, 10.64% (*N*=68) were prescribed a pureed texture (NB=16%, AB=12%, ON=11%, MB=4%). Lastly, less than 1% (*N*=3) of the residents were prescribed a liquidized diet, where AB had two residents on a liquidized diet and MB had one resident prescribed this diet texture. These participants were omitted from bivariate analyses across the four prescribed diet textures, however they were included in the modified texture group when it was compared to the regular texture group.

2.3.2 Resident characteristics associated with prescription of a modified texture diet

Table 2 shows resident characteristics associated with the prescription of any modified texture versus a regular texture diet and Table 3 illustrates associations across the four IDDSI solid food categories. The mean age was not significantly different between those prescribed any modified texture diet when compared to residents on a regular texture diet, and also across the four IDDSI texture categories. Similarly, the proportion of females and males was not significantly different among modified and regular textures, or across the four IDDSI textures; the majority (70%) of participants were females. The length of admission was significantly longer for residents prescribed a MTD (mean= 33.50 months) than those on a regular texture (mean= 22.70 months) (Z= 4.42, $p<0.0001$). Across the four IDDSI categories, those prescribed a regular texture had the shortest length of admission, followed by soft and bite-sized, then minced and moist, and those prescribed a pureed diet had the longest length of admission (χ^2 (3, N=636)=27.46, $p<0.0001$).

Looking at some major diagnoses, the proportion of those at risk of dysphagia was significantly higher among residents prescribed a modified texture diet versus regular diet (67.77%, n=204 versus 51.48, n=174; χ^2(1, N=639)=17.50, $p<0.0001$). There was also significant variation across the four texture categories (χ^2(3, N=636)=20.05, p=0.0002). The proportion of residents with a dementia diagnosis was also significantly higher among those prescribed a modified texture diet versus regular (70.43%, n=212 versus 60.36%, n=204; χ^2(1, N=639)=7.12, $p<0.0001$). There was also significant variation across the four texture categories (χ^2(3, N=636)=20.57, p=0.0001) with dementia being most common in those consuming a pureed diet.

The average number of oral agents was higher among the regular texture group compared to the modified texture group (9.31, standard deviation (SD)=3.84 versus 8.59, SD=3.58; t(637)=2.45, p=0.01); likewise the average number of vitamins/minerals was also higher for the regular texture group (regular: 1.61, SD=1.15; modified: 1.32, SD=1.25; t(637)=3.05, p=0.002). Across the IDDSI categories, the soft and bite-sized group had the highest mean (9.53, SD=3.70) for the average number oral agents, as well as for the average number vitamins/minerals (1.69, SD=1.34); followed by the regular texture group, then the minced and moist group, and lastly the pureed group having the lowest averages, which were all significant (Table 3). However, the proportion of residents prescribed oral nutritional supplements was twice as high for the modified texture group compared to the regular texture group (44.52%, n=134 and 18.34%, n=62; χ^2(1, N=639)=51.30, $p<0.0001$). This proportion was also significantly increased across the different diet textures, where more than half (54.41%, n=37) of those prescribed a pureed texture were also prescribed oral nutritional supplements χ^2(3, *N*=636)=62.65, p<0.0001).

Residents on an MTD had an average body weight of 63.29 kilograms (kg) (SD=16.60), while those on a regular texture diet had a mean body weight of 70.62 kg (SD=17.07) (t(637)=5.48, p<0.0001). Among the four IDDSI categories, body weight significantly decreased as the texture level was further modified (F(3, 632)=14.42, p<0.0001). Across the four textures, mean change in body weight (from previous three months) increased for only the soft and bite-sized group (0.26 kg, SD=2.55) and decreased for the other three groups, with the minced and moist group having the largest decrease in body weight over the previous three months (-0.95 kg, SD=3.07); differences between the groups were significant (F(3, 528)=4.23, p=0.006). The average BMI was 23.97 kg/m^2 for the modified texture category with 13.51% (n=40) having a BMI <18.5 kg/m^2, whereas the average BMI was 26.57 kg/m^2 (SD=5.92) for the regular texture group with only 5.76% (n=19) having a BMI <18.5 kg/m^2. These differences between the two groups were significant (t(624)=5.82, p<0.0001; χ^2(1, *N*=626)=10.99, p=0.0009). Looking across the four textures, those prescribed a pureed texture had the lowest BMI (22.07 kg/m^2, SD=4.22) and highest proportion (19.12%, n=13) of residents with a BMI <18.5 kg/m^2; again, the differences between the four groups were significant (Table 3). The same trend existed for calf circumference where those on any modified texture had a significantly lower mean (31.89 cm, SD=4.55) and higher proportion (45.76%, n=135) of residents with a calf circumference of ≤ 31 cm compared to those on a regular texture diet (mean=34.33 cm, SD=4.74, t(624)=6.86, p<0.0001; 25.98%, n=86, χ^2(1, *N*=626)=26.72, p<0.0001). When comparing across the four groups, those on a pureed diet had the smallest mean calf circumference (29.54 cm, SD=3.95) and the highest proportion of residents with a calf circumference of ≤ 31 cm (65.67%, n=44); differences across the four groups were significant (Table 3). The mean MNA-SF score out of 14 was significantly lower for residents on an MTD (9.81, SD=2.68) versus those on a regular texture diet (11.37, SD=2.13) (t(636)=8.09, p<0.0001). The mean MNA-SF score was also significantly lower going across the four categories from not modified (i.e., regular) to most modified (i.e., pureed) (F(3, 631)=41.97, p<0.0001).

The proportion of residents requiring physical assistance during mealtimes was three times larger for those prescribed a modified texture diet when compared to residents on a regular texture diet (36.79%, n=110 versus 11.04%, n=37; χ^2(1, *N*=634)=58.79, p<0.0001). Across the four IDDSI categories, the proportion of residents requiring physical assistance during mealtimes increased significantly as the texture was further modified (i.e., from regular to pureed) (χ^2 (3, *N*=631)=158.74, p<0.0001). The average Ed-FED score significantly differed between the modified texture group (13.16, SD=2.60) and the regular texture group (11.67, SD=1.59) ($t(632) = -8.56$, $p<0.0001$). The same trend was observed, where the mean Ed-FED score increased significantly across the four IDDSI categories going from the regular texture group to the pureed group ($F(3, 627)=72.56$, $p<0.0001$). For those prescribed a modified texture diet, 55.91% (n=142) had an oral health status that likely affected food consumption, while 44.09% (n=138) of those prescribed a regular texture diet had a similar oral health status ($\chi^2(1, N=567)=7.83$, $p=0.005$).

For the interRAI LTCF scales, scores for two of the five scales included in this analysis were significant between the modified texture group and the regular texture group; similarly, the same scales were significant across the four IDDSI texture categories. The median CPS score was 3.00 for the modified texture category and 2.00 for the regular texture group ($Z= 8.83$, $p<0.0001$); 57.10% (n=193) of residents had a CPS score of ≤2 in the regular texture group compared to 29.73% (n=88) in the modified texture group ($\chi^2(1, N=634)=47.91$, $p<0.0001$). The median ADL-LFS score was also higher among those prescribed any modified texture diet compared to those on a regular texture diet (19.00 and 12.00, respectively; $Z= 10.82$, $p<0.0001$). Across the four categories, the median CPS and ADL-LFS scores significantly increased as the texture category was further modified ($\chi^2(3, N=631)=144.57$, $p<0.0001$ and $\chi^2(3, N=631)=166.26$, $p<0.0001$, respectively).

2.4 Discussion

2.4.1 Prevalence of modified texture diets

Our findings suggest that the prevalence of prescribed MTDs was high and significantly different across provinces in Canada. Few studies have examined the prevalence of MTDs and especially in the Canadian context, with one Canadian study examining only pureed diets (35). We believe this estimate to be an improvement from prior research; given the fixed sample size of 639, a 47% prevalence of prescribed MTD was estimated with 95% confidence and a 5% margin of error. Prior research was either conducted in a single LTC home and/or had small sample sizes (23,35,42–44); more specifically the Canadian study had a sample size of 424 participants but from one LTC home (35). To our knowledge, this is the first Canadian multi-site and multi-provincial study to determine prevalence of MTDs in a diverse sample of LTC residents using standardized terminology. Literature has estimated that 15% to 30% of residents are prescribed MTDs (23,35,42–44), however in this study 47% of residents were prescribed a MTD. This higher proportion could be explained by the more representative sample used in this study compared to prior studies or alternatively the increased complexity and longevity of residents in this study. Three studies reported the average age of the participants, which ranged from 80 years to 85 years (35,42,43); where the mean age in the M3 study was higher (~87 years) across prescribed diet textures. Furthermore, only one of the studies reported on comorbidity in the sample but across groups according to their dependence on eating (e.g., severe moderate, independent) and not across prescribed textures, making it difficult to know if participants on modified textures had two or more chronic conditions (42). However, literature suggests that older adults living in LTC have a higher number of comorbid conditions compared to community dwelling older adults (19,72,73). Lastly, prior studies on the prevalence of prescribed MTDs were conducted more than 13 years ago, which could explain the higher proportion of MTDs found in the M3 study, as residents are living longer and developing multiple chronic conditions over time (4–6,9,74).

Another possible explanation for the high prevalence of MTDs in the M3 sample could be related to using the IDDSI framework, which included all modified food texture levels (i.e., soft and bite-sized, minced and moist, pureed, and liquidized). Previous work may have limited their determination of prevalence to minced and pureed consumers. Yet, one previous study assessed the range of MTD including soft, minced, and pureed diets across nine homes in Australia and found that 67% of participants living in nursing homes were consuming a MTD; specifically 29% of participants were consuming a soft/minced diet and 38% were consuming a pureed diet (43). This even higher proportion consuming pureed food may be explained by the nature of the sample and the LTC settings used in the Australian study, which could differ from the Canadian context (43,75). Dependence on eating assistance was evaluated in the Australian study, where 50% of residents in the nursing homes were either partially or fully provided eating assistance from staff and this included all texture types (e.g., regular, minced/soft, pureed) (43). In the M3 study, 23.19% (n=147 of 634) of residents required physical assistance during mealtimes (i.e., often and sometimes), which is substantially lower compared to the proportion in the Australian study. Literature suggests that individuals on modified texture diets tend to require eating assistance and this could be for many reasons such as physical disabilities, chronic conditions, oral health problems, and sensory deficits (22,37,76); therefore this could be one explanation for the higher proportion of participants prescribed a MTD in the Australian study (43). The single Canadian study conducted to date found that about 25% of all residents received a pureed diet (2), whereas the current study found that only about 11% were prescribed a pureed diet. The lower prevalence in the M3 study could be related to the diverse sample of LTC homes used across provinces while the study by Cormier et al. (35) was conducted at a single LTC and rehabilitation hospital. Conducted over 20 years ago, reasoning for prescription of a pureed different could have been different, especially in a rehabilitation setting where patients could have been recovering from a variety of ailments necessitating MTD for a short period of time (e.g. stroke). Providers may also be more cautious in recent years about instituting pureed textures due to concerns over quality of the product (22), as well as quality of life for the consumer (77).

The IDDSI framework used to categorize prescribed diet textures helped with the lack of consistent terminology used by homes included in the M3 study; this work demonstrates the necessity of consistent terminology. The IDDSI framework is currently being implemented around the world (48,49,78) to promote consistent terminology for texture modified food from country to country (48). In the M3 study a total of 67 different modified texture labels were used by the 32 participating homes, possibly due to the lack of nationally standardized terminology in Canada (22,48). Going forward, use of an international standardized terminology could support consistent translation of research on MTDs globally. Standardized terminology could also be beneficial in practice. By labeling foods in a consistent manner, when a resident moves from one LTC facility to another or to a hospital, it will be safer and more accurate for physicians, nurses and other healthcare professionals to provide the appropriate texture. Despite the IDDSI framework, confusion could remain around labeling an individual participant's diet as we found in M3 that a good proportion (11.02%, n=58) had more than a single texture level prescribed.

2.4.2 Resident characteristics

The M3 study also provided the opportunity to more comprehensively characterize the residents who received MTD (Table 2), and specifically a pureed diet (Table 3). In general, findings are consistent when any MTD was compared to a regular texture (Table 2) or the four categories of texture were compared (Table 3); notable differences will be discussed. A number of characteristics were found to be associated with a prescribed MTD and various specific textures which have been sparsely reported in previous literature (35,42,43). In this study, age did not differ between the MTD group and the regular group, and also across the four IDDSI categories. This finding was similar to that of Nowson and colleagues (43) but contrary to what Cormier and colleagues (35) found which was that pureed consumers were older. As discussed previously, the latter was based in a single site whereas the study by Nowson et al. (43) was conducted at multiple LTC homes making the sample population more representative and diverse, consistent with the M3 sample. Is it not surprising that the majority of participants were female, with no noted differences by MTD; this finding is consistent with previous studies (35,42,43) due to the demography of LTC residences. However, again Cormier et al. (35) found that the proportion of female residents was higher (82.7% versus 70.8%, p=0.006) for those receiving a pureed diet compared to the rest of their sample, which may speak to the type of patients/residents included as some were from a rehabilitation hospital.

In this study, the length of admission was longer for the MTD group and the pureed group, which suggests residents were potentially more complex, or if they had dementia, more progressed. This is confirmed by the higher proportions of residents who had a dementia diagnosis among the modified texture and pureed categories compared to the regular texture category; the average CPS score was higher among those prescribed a pureed diet with the majority of the group scoring above three which denotes cognitive impairment. Cormier et al. (35) also found in their sample that participants receiving pureed diets were more likely to have dementia, and cognitive deficits was reported as the most common reason for being prescribed this texture. In M3, the proportion of residents who were at risk of dysphagia and those rated to likely have food consumption affected by their oral health was greater among the modified texture groups and especially in the pureed group. However, the proportions across the four prescribed diet textures were not significantly different from one another, but the proportion of the modified texture group in general was significantly higher compared to the regular texture group. This may be due to the smaller numbers in each category for this four group comparison. Cormier et el. (35) noted in their study that physiological and/or mechanical problems were the most common reasons to be cited for residents being prescribed a pureed diet. Physiological and mechanical problems encompassed choking and swallowing and also poor dentition (35); these issues were highest among pureed consumers in the M3 study. This result is not surprising as these reasons are often the rationale for a resident to be prescribed a MTD (19,27,35,36,51).

Interestingly, energy and protein intake were not significantly different between the modified texture and regular texture groups, whereas existing literature shows that those on a modified texture diet consume significantly less energy and protein when compared to those consuming a regular texture diet (38,43,79). These seemingly contrary results may be explained in a variety of ways. First, this discrepancy could mean that the assessment of intake was biased; perhaps staff members involved with eating assistance ensured residents on MTDs ate all of their food on the days food intake were being measured by the research assistants. The proportion of residents requiring physical assistance during mealtimes was three times greater for the modified texture group as compared to the regular texture group. However, this finding could also be explained by possible interventions recently implemented into LTC practice to support food intake, thus energy and protein intake could have been increased for residents on MTDs. Possible interventions put in place could be around eating assistance, restorative dining, nutrient density of the food, and person centered care (e.g., second helpings), which could support those residents on MTDs to consume higher energy and protein per day as compared to those on regular texture diets (80–84). The percentage of residents receiving oral nutritional supplementation was significantly higher in the modified texture group compared to the regular texture group, which would also help increase the energy and protein intake among individuals receiving modified textures. Lastly, ingredients or food products high in protein may have been added to some of the pureed recipes during production (85–88), as there were larger discrepancies across the four textures for daily protein intake but not energy intake. This finding suggests that these enhancements could have been made which resulted in a higher protein intake but not necessarily energy intake among residents consuming pureed food. Each explanation for the comparable energy and protein intake between the MTD group and the regular texture group is plausible; however, it is unknown which one is playing a role in the intake level since the M3 study is a cross-sectional study design thus causality cannot be inferred and there was no data collected regarding specific interventions taking place at the LTC homes during the study period. Yet, weight loss in the past three months was significantly different across the four prescribed textures but not significantly different between the modified texture group as a whole compared to the regular texture group. Those prescribed a minced and moist texture potentially had more weight loss in the past three months than those on a pureed texture, while the regular texture group has almost no weight loss and the soft and bite-sized group had had an increase in weight. Individuals on pureed diets required more eating assistance (79%) during mealtimes and do receive a higher level of assistance (22,37,76). However, individuals on minced and moist diets did not receive eating assistance to the same extent (29%). A possible explanation for the increase in weight for the soft and bite-sized group is that dentition and oral health issues were addressed with prescription of this texture (22,37,75).

Anthropometric measurements for nutritional status measured in this study, such as body weight, BMI, and calf circumference tended to be lower on average among residents in the modified texture categories indicating a higher chance that residents' nutritional status could be at risk. The lower MNA-SF score among the modified texture groups further supports this finding, as lower scores imply the person could be at risk of malnutrition (63,64). Perhaps, the higher proportion of oral nutritional supplementation observed in this study among residents prescribed MTDs is justified by the anthropometric measurements that indicated nutritional status was at risk. The M3 study revealed that individuals prescribed MTDs and more specifically pureed diets were more dependent on others for eating assistance; as the proportion of those requiring physical assistance during mealtimes was significantly higher among the MTD group and even higher for the pureed group specifically. Further, the scores on the ADL-LFS scale and Ed-FED scores were significantly higher among the modified texture group and the highest in the pureed group, which indicated these participants were less self-sufficient to perform activities of daily living (e.g., bathing, dressing) and had more eating challenges such as requirement of close supervision, spillage while eating/feeding, refusal to open mouth, and receiving verbal prompting. However, there is this confounding issue between consuming a pureed diet and malnutrition because of the increased probability of cognitive impairments and eating assistance in individuals who consume this diet texture (22,37,75,76,89). Therefore the root cause of malnutrition is difficult to untangle and determine a causal relationship between receiving a pureed diet and increased risk of under-nutrition (22,37,75,76,89).

The mean number of vitamins and minerals was significantly different across the four prescribed textures, where the pureed group was prescribed the lowest number of vitamins and minerals. The low use of micronutrient supplements among the pureed group could mean individuals on this prescribed texture diet are getting adequate micronutrient intake from food and therefore do not have to be supplemented. As mentioned previously, there is a strong correlation between consuming pureed foods and requiring eating assistance (22,46), thus the pureed group may be consuming adequate food intake because they are receiving the physical assistance they need (37,89). Furthermore, pureed food may have been enhanced with the addition of nutrient dense foods (e.g., dairy products such as milk and cheese, red peppers substituted for green peppers) during production, which supports nutritional status and the micronutrient intake of residents to meet their respective dietary reference intake (22,85–88). Another plausible explanation for the low usage of vitamins and minerals among the pureed group is the high proportion (54.41%) of residents receiving oral nutritional supplementation in this group. Oral nutritional supplementation contains micronutrients in addition to protein and energy (90,91), therefore the pureed group could likely have sufficient micronutrient intake to meet the dietary reference intake and would not be prescribed vitamins and minerals so they do not reach toxicity. Finally, as cognitive impairment progresses, providing any pills to residents, especially if they exhibit signs of dysphagia can be challenging (92). There may have been a concerted effort to eliminate less relevant preparations from the prescribed medication list of these residents.

Resident characteristics not only play a vital role in the prescription of MTDs but also in the consumption of these modified textures (19,27,36,51). These characteristics can be variable, resulting in more individualized approaches at the point of food consumption, making standardization of MTDs challenging (77). For example, a person who has had a stroke may be able to eat minced meat except when they are tired or staff may alter the consistency of foods at the table side based on the current status of the resident (77). Staff, family, and resident concerns about safety and aspiration or choking risk also influence the quality and types of MTF provided (77).

2.4.3 Strengths and limitations

Due to the design of the study, which is cross-sectional in nature, causality with respect to why diets are prescribed cannot be inferred; however understanding the prevalence of various diets prescribed in LTC and the characteristics of residents who are prescribed these diets is a much-needed first step. A limitation of this study was that the textures as prescribed could not be assessed using the testing methods described by the IDDSI framework for foods, thus the proportion in each IDDSI category could be slightly under or over estimated based on our criteria for categorizing home labels for diets. Having the ability to test the food would yield a more accurate prevalence rate but the process would have been unrealistic for such a large sample size. Further, homes likely used their own criteria for determining if a diet was a specific modified texture. For example, one of the testing methods to assess if mashed potatoes are pureed is the IDDSI fork drip test, where food would not drip continuously through the prongs but sit in a mound above the fork (49). At the home level, it is unknown if LTC facilities in this study used a guideline such as IDDSI when assessing the modified texture food being served. Yet, it is unlikely that IDDSI itself was used as this is only a recent standardization of terminology. It is therefore possible that what a home labeled as pureed was inaccurate according to the IDDSI framework. Furthermore, the texture stated on the resident chart review, which was gathered from the resident's health record, may not have been updated with the most recent prescribed texture or may have been different from what was actually consumed. Again, this could lead to a bias in the prevalence of MTDs in the M3 study sample. There was unfortunately no way around these limitations at the time this study was conducted. Now that the IDDSI framework is available, researchers could test products to determine their consistency with terminology used.

In this study, risk for dysphagia could have been overestimated. When a resident could not do the STAND screening and they were not already on thickened fluids, mealtime observations were used to provide a sense of dysphagia risk. Observations at three meals were used to determine this risk by either: 1) the resident coughed sometimes or often and 2) the resident choked sometimes or often during mealtime observations. Both of these items were created for this study as additional questions on eating challenges that were collected in addition to Ed-FED. Consistent with the Ed-FED scaling, the 'sometimes' and 'often' categories were not quantified; therefore observations were subjective and could have varied from one research assistant to another.

As compared to previous studies, this study contains several strengths. A large sample size (n=639) of residents from 32 LTC homes across four provinces from the M3 study was used to estimate prevalence of MTDs, making this the most representative LTC sample used to date in the Canadian context. Further, this is the first Canadian study to use standardized terminology to categorize different texture labels using a diverse LTC sample. Additionally, a comprehensive set of resident characteristics were available to better describe whom was prescribed an MTD; previous work has documented only a few resident characteristics or has only recorded characteristics from residents in a single LTC facility (35,42,43).

2.5 Conclusion

Research regarding the prevalence of MTDs and resident characteristics associated with prescription is needed since the existing literature is dated and scarce in the LTC context. Such data can raise awareness on the importance of quality MTD for nourishing residents and help to identify subgroups more likely to consume these foods. This study showed that prevalence of prescribed MTDs was high and diverse across regions of Canada. Several resident characteristics were associated with being prescribed a MTD in LTC and most of these are logical. Some notable differences suggest success with strategies to improve these foods (e.g. similar protein and energy consumption across textures) or to improve the nutritional status of MTD consumers (i.e., use of oral nutritional supplements). These findings also demonstrate the value of using standardized terminology and can be used to inform policy with respect to IDDSI use for LTC. Further work is needed to assess prescribed textures using the IDDSI framework testing methods to ensure accuracy of prevalence when the IDDSI framework is fully implemented in Canada and is adopted by LTC homes across this country. Moreover, additional research should further explore the adequacy of food intake among those consuming MTDs and use of MTDs in relation to malnutrition and other health-related outcomes.

Table 1. Shows that the prevalence of various IDDSI textures varied significantly by province (n= 639).

Province	**IDDSI Texture Categories**					
	Regular	Soft & Bite-sized	Minced & Moist	Pureed	Liquidized	**Total Row (n)**
Alberta	39.38% (63)	29.38% (47)	18.13% (29)	11.89% (19)	1.25% (2)	160
Manitoba	59.12% (94)	13.84% (22)	22.01% (35)	4.40% (7)	0.63% (1)	159
New Brunswick	47.50% (76)	10.63% (17)	26.25% (42)	15.63% (25)	0% (0)	160
Ontario	65.63% (105)	3.13% (5)	20.63% (33)	10.63% (17)	0% (0)	160
Total Column % (n)	52.90% (338)	14.24% (91)	21.75% (139)	10.64% (68)	0.47% (3)	Total n= 639

A Chi-Square test was performed. Data are % (n). Proportions of various diet textures are significantly different across provinces, χ^2= 69.58, p<0.0001 level.

Table 2. Resident characteristics associated with the prescription of a modified vs. regular texture diet (n= 639).

Resident Characteristics	**Diet Prescription**		**Total (n)**	**t-value/ χ^2 value**	**P-value**
	Regular Texture	**Modified Texture**			
Number of residents on prescribed diet texture, % (n)	52.90 (338)	47.10 (301)	639	--	--
Age (years), mean (SD)	86.53 (8.02)	87.05 (7.62)	639	-0.84	0.40
Gender, % (n)					
Female	69.53 (235)	68.11 (205)	639	0.15	0.70
Male	30.47 (103)	31.89 (96)			
Length of admission (months), mean (SD) [median]	22.70 (20.80) [17.00]	33.48 (31.93) [24.00]	639	Z= 4.42	<0.0001
Number of diagnoses, mean (SD)	5.38 (2.04)	5.45 (2.00)	639	-0.48	0.63
Type of major diagnoses, % (n)					
Dysphagia risk	51.48 (174)	67.77 (204)	639	17.50	<0.0001
Stroke	28.11 (95)	23.92 (72)	639	1.45	0.23
Dementia	60.36 (204)	70.43 (212)	639	7.12	0.008
Parkinson's disease	6.21 (21)	7.97 (24)	639	0.75	0.39
Rheumatoid arthritis	7.69 (26)	3.99 (12)	639	3.91	0.05
Osteoporosis	27.22 (92)	34.55 (104)	639	4.03	0.05
Osteoarthritis	42.31 (143)	36.88 (111)	639	1.96	0.16
Number of drugs, mean (SD)	7.70 (3.55)	7.27 (3.32)	639	1.58	0.12
Number of vitamins/minerals, mean (SD)	1.61 (1.15)	1.32 (1.25)	639	3.05	0.002
Number of oral agents, mean (SD)[a]	9.31 (3.84)	8.59 (3.58)	639	2.45	0.01
Oral nutritional supplementation, % (n)	18.34 (62)	44.52 (134)	639	51.30	<0.0001
Energy intake (kcal), mean (SD)	1573.94 (407.13)	1560.54 (431.18)	639	0.40	0.69
Protein intake (grams), mean (SD)	57.33 (17.34)	59.18 (19.18)	639	-1.28	0.20
Current body weight (kg), mean (SD)[b]	70.62 (17.07)	63.29 (16.60)	639	5.48	<0.0001
Body weight change (kg), mean (SD)[c]	-0.01 (2.91)	-0.57 (3.22)	535	2.12	0.03

Body mass index[d] (kg/m^2), % (n)					
BMI <18.5 kg/m^2	5.76 (19)	13.51 (40)	626	10.99	0.0009
Mean (SD)	26.57 (5.92)	23.97 (5.24)	626	5.82	<0.0001
Calf circumference (cm), % (n)					
≤ 31 cm	25.98 (86)	45.76 (135)	626	26.72	<0.0001
Total mean (SD)	34.44 (4.74)	31.89 (4.55)	626	6.86	<0.0001
Mini-Nutritional Assessment short-form (MNA-SF) score, mean (SD)	11.37 (2.13)	9.81 (2.68)	638	8.09	<0.0001
Average length of meal (minutes), mean (SD)	39.91 (11.83)	40.48 (14.28)	637	-0.54	0.59
Physical assistance required during mealtimes, % (n)					
Yes[e]	11.04 (37)	36.79 (110)	634	58.79	<0.0001
Ed-FED, mean (SD)	11.67 (1.59)	13.16 (2.60)	634	-8.56	<0.001
Oral health rating, % (n)					
Affect on consumption	44.09 (138)	55.91 (142)	567	7.83	0.005
interRAI LTCF scales					
Cognitive performance, % (n)					
≤2	57.10 (193)	29.73 (88)	634	47.91	<0.0001
Mean (SD) [median]	2.27 (1.48) [2.00]	3.55 (1.86) [3.00]	634	Z=8.83	<0.0001
Depression, mean (SD) [median]	2.40 (3.08) [1.00]	2.22 (2.71) [1.00]	634	Z=-0.17	0.87
Activities of daily living, mean (SD) [median]	11.80 (7.16) [12.00]	18.58 (7.03) [19.00]	634	Z=10.82	<0.0001
Aggressive behaviour, mean (SD) [median]	1.68 (2.92) [0.00]	2.12 (3.18) [0.00]	632	Z=2.05	0.04
Pain, mean (SD) [median]	0.55 (0.76) [0.00]	0.49 (0.72) [0.00]	635	Z=-0.82	0.41

Modified texture diets= soft and bite-sized; minced and moist; pureed; or liquidized. Used Student-test for normally distributed continuous variables. Non-parametric tests were used for skewed continuous variables and for ordinal variables; Wilcoxon Rank Sum test was used for comparing characteristics between the modified texture and regular texture categories. Chi-Square tests were used for categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). t-values are presented for numerical data. Wilcoxon scores are presented for skewed numerical data and ordinal data. χ^2 values are presented for categorical data. Abbreviations: SD= standard deviation; Ed-FED= Edinburgh Feeding Evaluation in Dementia Questionnaire.

[a] Number of oral agents= (vitamins/minerals + drugs).

[b] Most recent weight= Most recent weight measurement available – if weight0 was not available then weight1, weight2, weight3 was used etc.

[c] Body weight change in last 3 months.

[d] Body mass index calculation is based on ulna length of residents.

[e] Physical assistance required during mealtimes: yes=often + sometimes.

Table 3. Resident characteristics associated with prescribed diet textures (n= 636).

Resident Characteristics	Diet Prescription				Total (n)	F-value/ χ^2 value	P-value
	Regular	Soft & Bite-sized	Minced & Moist	Pureed			
Number of residents on prescribed diet texture, % (n)	53.14 (338)	14.31 (91)	21.86 (139)	10.69 (68)	636	--	--
Age (years)	86.53 (8.02)	86.78 (7.95)	87.39 (7.61)	86.90 (7.24)	636	0.40	0.76
Gender, % (n)							
Female	69.53 (235)	72.53 (66)	61.15 (85)	75.00 (51)	636	5.67	0.13
Male	30.47 (103)	27.47 (25)	38.85 (54)	25.00 (17)			
Length of admission (months), mean (SD) [median]	22.70 (20.80) [17.00]	25.89 (26.81) [20.00]	36.09 (31.51) [27.00]	37.65 (37.74) [28.00]	636	27.46	<0.0001
Number of diagnoses, mean (SD)	5.38 (2.04)	5.92 (1.93)	5.40 (2.00)	4.99 (2.02)	636	3.01	0.03
Type of major diagnoses, % (n)							
Dysphagia risk	51.48 (174)	72.53 (66)	61.87 (86)	72.06 (49)	636	20.05	0.0002
Stroke	28.11 (95)	26.37 (24)	28.06 (39)	13.24 (9)	636	6.79	0.08
Dementia	60.36 (204)	58.24 (53)	69.78 (97)	86.76 (59)	636	20.57	0.0001
Parkinson's disease	6.21 (21)	6.59 (6)	11.51 (16)	2.94 (2)	636	6.43	0.10
Rheumatoid arthritis	7.69 (26)	7.69 (7)	2.88 (4)	1.47 (1)	636	7.08	0.07
Osteoporosis	27.22 (92)	38.46 (35)	29.50 (41)	39.71 (27)	636	7.19	0.07
Osteoarthritis	42.31 (143)	36.26 (33)	39.57 (55)	32.35 (22)	636	2.94	0.40
Number of drugs, mean (SD)	7.70 (3.55)	7.84 (3.34)	7.35 (3.33)	6.47 (3.16)	636	2.79	0.04
Number of vitamins/minerals, mean (SD)	1.61 (1.15)	1.69 (1.34)	1.20 (1.19)	1.04 (1.16)	636	7.89	<0.0001
Number of oral agents, mean (SD)[a]	9.31 (3.84)	9.53 (3.70)	8.55 (3.47)	7.51 (3.37)	636	5.76	0.001
Oral nutritional supplementation, % (n)	18.34 (62)	29.67 (27)	48.20 (67)	54.41 (37)	636	62.65	<0.0001
Energy intake (kcal), mean (SD)	1573.94 (407.13)	1640.29 (432.63)	1492.72 (425.58)	1588.24 (395.76)	636	2.54	0.06
Protein intake (grams), mean (SD)	57.33 (17.34)	60.76 (17.07)	56.44 (18.54)	62.22 (21.35)	636	2.43	0.06
Current body weight (kg), mean (SD)[b]	70.62 (17.07)	66.86 (18.68)	64.35 (15.59)	57.10 (13.62)	636	14.42	<0.0001
Body weight change (kg), mean (SD)[c]	-0.01 (2.91)	0.26 (2.55)	-0.95 (3.07)	-0.91 (4.13)	532	4.23	0.006
Body mass index (kg/m^2)[d], % (n)							
BMI <18.5 kg/m^2	5.76 (19)	8.99 (8)	12.50 (17)	19.12 (13)	623	14.54	0.002
Total mean (SD)	26.57 (5.92)	25.33 (6.03)	24.18 (4.78)	22.07 (4.22)	623	15.31	<0.0001
Calf circumference (cm), % (n)							
≤ 31 cm	25.98 (86)	30.34 (27)	45.59 (62)	65.67 (44)	623	46.99	<0.0001
Total mean (SD)	34.44 (4.74)	33.31 (4.69)	32.18 (4.20)	29.54 (3.95)	623	24.97	<0.0001
Mini-Nutritional Assessment short-form (MNA-SF) score, mean (SD)	11.37 (2.13)	11.12 (2.12)	9.69 (2.79)	8.41 (2.25)	635	41.97	<0.0001
Average length of meal, mean (SD)	39.91 (11.83)	42.66 (12.84)	40.85 (14.98)	37.08 (14.40)	634	2.56	0.05
Physical assistance required during mealtimes, % (n)							
Yes[e]	11.04 (37)	13.19 (12)	29.93 (41)	79.41 (54)	631	158.74	<0.0001
Ed-FED, mean (SD)	11.67 (1.59)	11.66 (1.79)	13.05 (2.38)	15.16 (2.48)	631	72.56	<0.0001
Oral health rating, % (n)							
Affect on consumption	44.09 (138)	50.00 (42)	57.02 (65)	60.38 (32)	564	8.73	0.03
interRAI LTCF scales							
Cognitive performance scale, % (n)							
≤2	57.10 (193)	51.14 (45)	27.74 (38)	7.35 (5)	631	76.87	<0.0001
Mean (SD) [median]	2.27 (1.48) [2.00]	2.48 (1.65) [2.00]	3.47 (1.69) [3.00]	5.01 (1.38) [6.00]	631	144.57	<0.0001
Depression, mean (SD) [median]	2.40 (3.08) [1.00]	2.16 (2.78) [1.00]	2.46 (2.95) [1.00]	1.87 (2.06) [1.00]	631	0.95	0.81
Activities of daily living, mean (SD)	11.80	15.13	17.89	24.10	631	166.25	<0.0001

[median]	(7.16) [12.00]	(6.91) [16.00]	(6.13) [18.00]	(5.33) [27.00]			
Aggressive behaviour, mean (SD) [median]	1.68 (2.92) [0.00]	1.52 (2.58) [0.00]	2.46 (3.56) [0.00]	2.28 (3.04) [1.00]	629	9.03	0.03
Pain, mean (SD) [median]	0.55 (0.76) [0.00]	0.56 (0.85) [0.00]	0.49 (0.70) [0.00]	0.42 (0.58) [0.00]	632	1.01	0.80

Used ANOVA for normally distributed continuous variables. Non-parametric tests were used for skewed continuous variables and for ordinal variables; Kruskal-Wallis's test was used for comparing characteristics across the IDDSI texture categories. Chi-Square tests were used for categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). F-values are presented for numerical data. χ^2 values are presented for categorical, skewed, and ordinal data. Abbreviations: SD= standard deviation; Ed-FED= Edinburgh Feeding Evaluation in Dementia Questionnaire. The three residents prescribed a liquidized diet were excluded from this analysis because the sample size was too small to test for significance, thus n=636.

[a] Number of oral agents= (vitamins/minerals + drugs).

[b] Most recent weight - Most recent weight measurement available – if weight0 was not available then weight1, weight2, weight3 was used etc.

[c] Body weight change in last 3 months.

[d] Body mass index calculation is based on ulna length of residents.

[e] Physical assistance required during mealtimes: yes= often + sometimes.

Chapter 3
Quality of the Regular and Modified Texture Menus as Planned in Long Term Care

3.1 Introduction

Menu planning in long term care (LTC) is an essential activity to support the nutritional needs of older adults who are often nutritionally compromised (22,39,89,93). Menu planning in this context needs to consider the characteristics of residents in the facility (i.e. needs and preferences), the practicalities of food production, and the nutritional content of the provided food (i.e. variety, quality, and balance) to promote health, food intake, nutritional status, and quality of life (93,94). This manuscript will focus on the nutritional quality of menus as planned in LTC. Both regular and modified texture menus for LTC are planned in Canada according to the current Canada's Food Guide (CFG) and Dietary Reference Intake (DRI) values (46,85,94,95). Planned menus are based on these guidelines in order to provide residents with a variety of nutritionally balanced meals while delivering choice and meeting their individual needs and preferences (85,93,94). However, planned menus have been previously found to be insufficient in protein, energy, and micronutrients (45–47,96); this issue may be exacerbated for texture modified menus, especially pureed menus (45–47,85,97). When modified texture menus are contrasted with regular textures, they contain fewer calories and offer less nutritional quality as compared to unmodified texture food (11,38,45–47).

Four studies to date have investigated the pureed diet as provided to residents in LTC, with two conducted in the Canadian LTC context (46,47) providing perspectives on the potential challenges and differences in menu planning. Dahl and colleagues determined the quantity of protein from direct nutrient analysis of 29 duplicate collections of pureed foods offered for only two days of a seven-day menu using standard portions across 20 LTC homes (46). The investigators wanted to evaluate the adequacy of protein offered to LTC residents consuming a pureed diet within and between Saskatchewan (n= 8) and Ontario (n= 12) to demonstrate potential regional differences due to menu planning practices or policy (46). The duplicate portion was analyzed for total protein intake using the Kjeldahl method (46). Daily protein provided differed among LTC homes within Saskatchewan and Ontario, with more protein being provided on average to residents in Ontario (46). The duplicate meals from Saskatchewan (n= 14) provided 57.9 ± 7.9 grams of protein a day on average, whereas duplicate diets from Ontario (n= 15) offered 85.4 ± 31.1 grams of protein per day on average (46), demonstrating that region was an important factor in protein content of menus, potentially due to differences in menu planning protocols. Although duplicate meals with direct analysis is a rigorous method of data collection, this analysis did not cover the entire menu cycle within each home and only contrasted protein content.

Durant investigated whether residents on a pureed diet were provided with fewer calories during a five-week cycle menu as compared to a regular texture diet at a 70-bed rural LTC home in Nova Scotia using duplicate portions (47). Size and weight of portions were confirmed from duplicate trays and then a nutrient analysis of the five-week cycle menu was completed to determine nutrient content of served food using the Food Processor SQL software package (47). The mean total energy content over the five-week menu cycle differed significantly between the pureed and regular texture diet with daily energy provision being 21% greater for the unmodified texture (47). This difference could have a profound impact on residents offered the pureed menu (47). Also, the mean levels for all three macronutrients was significantly lower in the pureed menu (47). Protein differed by seven (74 ± 7 grams versus 67 ± 2 grams; $p < 0.001$), carbohydrates by 65 (320 ± 38 grams versus 255 ± 6 grams; $p < 0.001$), and fat by 20 grams per day (63 ± 9 grams versus 43 ± 7 grams; $p < 0.001$) (47).

Similar studies have been conducted in the United States and Denmark (45,96). Johnson and colleagues examined the nutrient values of pureed menus and regular menus for a 28 day cycle in one LTC home in the United States (96). Unlike the prior two studies, they did not complete a full duplicate portion of served food but rather used the average portion sizes actually served from the planned menu for their nutrient analysis and weighed representative samples of each menu item each day for the 28-day cycle. They analyzed standardized recipes with the Nutritionist III software (96). The regular diet as planned contained more calories (2153 versus 1786 calories) and micronutrients than the pureed diet, except for vitamin B_6 and zinc (96). Finally, the Danish study specifically examined modified texture menus as served and compared these to energy dense and standard menus in 10 homes. Beck and Hanson evaluated the nutritional composition, including energy, protein, fat, and carbohydrates, of 96 weighed meal samples with a focus on energy dense menus, standard menus, and texturally modified menus (i.e. chopped and blended) (45). Although not a complete analysis of all foods on the menu was completed, results indicated that nutrient content varied considerably among the 10 kitchens (45). Nutrient composition of the energy and protein dense menu and the texture modified menu differed significantly ($p < 0.001$ for energy, protein, and fat) from the Danish recommendations, in that anywhere from 50% to 100% of the menus were below recommendations for energy, protein, and fat (45).

In addition to menu planning the availability and use of commercially prepared MTF may also influence nutrient quality of products. Currently there are no national or provincial standard guidelines for preparing in-house MTFs (23,48). This has many implications such as inconsistent use and confusion around terminology for MTF as well as food particle size, variation in nutritional and sensory quality, and safety of the MTF (11,23,48). This has lead to some homes choosing commercial over in-house production for MTF. Considerations to use commercial products is dependent on: menu requirements such as variety, choice, food groups, and comparable menu items between regular non-modified food and MTF; cost, as commercial products tend to be more expensive but also commercial bulk purchasing needs vary with the number of residents requiring MTF; acceptability and palatability since some food can be challenging to modify in-house; and standardization to ensure consistency and quality in a product which may be more challenging to provide in-house (e.g. meat products) (23,86). Furthermore, in-house pureed products tend to be altered from the regular recipe that may or may not be standardized, thus it is hard to obtain the accurate nutritional value of these foods (22,98,99).

To date the limited literature has suggested a variation in the nutritional quality of both in-house and commercially prepared MTFs (100,101). For example, Ilhamto and colleagues investigated the effect of ingredients and preparation methods on nutritional properties of pureed turkey and carrots and contrasted commercial products with an in-house recipe cooked in the lab (100). They found differences in macronutrient content per 100 grams dependent on the recipe used and the commercial provider. Similarly, Ettinger and colleagues found nutritional differences among commercial brands for three food products (101). Thus, although some LTC homes may choose to use commercial products due to their standardization, ease of use and perhaps better sensory appeal, their nutrient content varies and choice of brand and product needs to be carefully made. To date, these are the only two studies comparing in-house production of pureed food to commercially sourced pureed food. Both of the studies contained small sample sizes (n= 8; n= 10) of pureed products and analyzed up to three different types of products (turkey, carrots, bread) (100,101), which limits the generalizability of results to the variety of different meals used in LTC settings across Canada. However, both of the studies analyzed the nutrient content in the products with accuracy and precision by using direct chemical analysis (100,101).

Research to date demonstrates potential variability and deficit in terms of nutrient content of pureed menus, and that commercial and in-house pureed products vary in their nutritional quality. However, these studies have been based on limited samples of foods, days of the menu or based on the complete analysis of a menu from only a single home. Regional differences are likely (46), but before it can be concluded that MTF menus require special attention to ensure nutrient quality, a study on a more generalizable sample of home menus is required. If deficits are found, such an analysis could support advocacy for improved menu planning protocols and quality of food in LTC. This study will attempt to answer the following research question: Across all provinces and homes included in the Making the Most of Mealtimes (M3) sample, is the pureed diet provided as planned for one week significantly different in energy, macronutrients (i.e., protein and carbohydrates), micronutrients, and fibre as compared to the regular texture diet? This study will also aim to answer the following sub-questions: (a) Are these differences province specific (AB, MB, ON, NB); and (b) Are differences home specific and for energy and protein, what home characteristics may be associated with these differences?

3.2 Methodology

3.2.1 Sample and participants

The M3 study, a cross-sectional multi-site study across Canada, was undertaken to determine the associations between inadequate food and fluid intake among residents living in LTC and the multi-level influences and multi-factorial causes of this intake, which can lead to malnutrition within this population (52). The comprehensive data collection includes gathering data at the provincial, home, unit, staff, and resident levels to ascertain the determinants of meal access, meal quality and the mealtime experience of residents, which can impact their food and fluid intake (52). The goal of the M3 study was to improve food and fluid intake among residents and thus malnutrition, and also to inform future intervention studies (52).

A total of 32 LTC homes were recruited across four different provinces (8 homes per province) in Canada: Alberta (AB), Manitoba (MB), Ontario (ON), and New Brunswick (NB) (52). Eligibility criteria for LTC homes included the following: 1) operation of at least six months; and 2) having a minimum of 50 residents who met the resident eligibility criteria (52). For-profit and not-for profit homes were recruited and diversity in the sample was also attempted by including homes with special characteristics such as a high proportion of individuals who were cultural minorities, independent operators and large corporations, rural or urban settings and faith-based homes (52). The current home menus at the time of data collection were gathered for the nutrient and energy analysis

(52), with a total of 32 menus collected for this analysis. There were no homes that were unable or unwilling to provide the menus for this analysis.

3.2.2 Data collection and measures

A nutrient and energy analysis of the current LTC home menu was completed for regular and pureed textures during data collection to determine nutritional quality of menus as planned (52). Eight highly trained research assistants (two per province) who were involved in direct food weighing and assessing of meals for the main study, analyzed these menus (52). Unlike a typical external researcher, they had intimate knowledge of the menu items from seeing them served to residents (52). The analysis was only conducted for the first week of the menu cycle and for the first choice only for listed food products (52); for this analysis snacks were excluded from the menus for consistency purposes because less than half (n= 13) of the 32 LTC homes included snacks in the planned menu (including all homes from Ontario). Prior work, suggests that a single week is sufficient to demonstrate differences where they exist among homes (85). To accurately analyze the menu, home recipes, specific food product labels, and standard portion sizes were identified and incorporated into the analysis; where necessary the research assistants consulted with cooks or dietary food service supervisors to clarify items (52). The two research assistants per home worked in tandem, checking each other's nutrient analysis of recipe items (52). Nutrient analysis was completed using Food Processor software (Version 10.14.1) using the Canadian Nutrient File where appropriate for foods that varied in fortification practices with the United States Department of Agriculture Nutrient File (52). A code-book was created per province to promote consistency in database choices for selected menu items (52). A random check of menu items was completed by the first author to ensure accuracy in use of the Canadian Nutrient File for key foods across provinces; this check was especially focused for provinces that showed significant differences from the others to confirm that differences were not a result of the provincial research assistant bias in recipe/food item selection from the database. For the analysis of food and fluid items in the first menu week, the energy and nutrients (macronutrients and micronutrients) per day per texture was determined and then was averaged for the week to determine the nutritional quality of the planned menu provided to participants.

A site survey was completed by each LTC home, which captures characteristics of each facility (e.g., home sector, age of home, number of LTC beds per home), key aspects of menu planning and food production (e.g., menu cycle length, last revision of menu, menu planning based on

CFG and other guidelines, food preparation methods, proportion of commercial food use, production of modified texture foods, and availability of recipes for modified textures prepared from the regular texture, raw food cost), and other pertinent services in the home (e.g., dietitian time) (52). This survey was typically completed by the director of food services and other key personnel in the home (e.g., food service supervisor, dietitian) (52). Those variables used in this analysis and collected from the site survey include: home sector, age of home, number of beds per LTC home, menu cycle length, last full revision of the menu, guidelines for menu planning, dietitian time, raw food cost, methods of food preparation used, the proportion of commercial versus in-house production of regular and modified texture foods, production of modified texture foods, and recipe availability for modified texture foods. These variables were used in this analysis to describe the characteristics of the LTC homes in the M3 study.

3.2.3 Data analysis

A secondary data analysis was performed. Data was analyzed using Statistical Analysis System software for Windows (Version 9.4). First, descriptive statistics was used to compute means for continuous (i.e. age of home, number of beds, menu cycle length, and proportion of commercial food use) and frequencies for the categorical home-level variables (i.e. home sector, last revision of the menu, menu planning based on CFG and other guidelines, food preparation methods, production of modified texture foods, and availability of recipes for modified textures prepared from the regular texture). Additionally, descriptive statistics were used to compute means for continuous diet variables by home (i.e. energy, macronutrients, micronutrients, and fibre), where means of food offered to participants were expressed per day per texture. An average of these variables per week/menu was then created per home. To determine the home characteristics associated with energy and protein provision for regular and pureed texture menus, a Student t-test was used to contrast intake to categorical variables with two levels and a one-way analysis of variance (ANOVA) was used for variables with more than two levels, as well a Pearson's correlation test was performed for continuous variables. Also, Student t-test was used to contrast the average nutrient composition of the planned pureed menu to the regular texture menu in each LTC home. Then, a two-way ANOVA was used to compare menus across homes within a province for each texture. Next, an average pureed week and regular week was created for the entire province, allowing for comparisons using a two-way ANOVA to determine any differences across provinces in regular and pureed menus. The DRI for those 70+ years was used as well for comparisons across these analyses manually. The recommended dietary allowance (RDA) or adequate intake (AI) for males was used for comparisons so it would encompass recommended levels for both genders, since levels for some nutrients were higher for males. To adjust for a type one error due to multiple tests conducted within home and among province, statistical significance was set at $\alpha=0.01$ for comparisons.

3.3 Results

3.3.1 Characteristics of the long term care homes

Table 4 illustrates characteristics of the LTC homes across the four provinces in the M3 study, while Table 5 and 6 display the home characteristics associated with energy and protein provision across the 32 LTC homes in the M3 study. The home sector sampled in each province varied, half of the LTC homes (n= 4) in Alberta were for-profit while the other half (n= 4) was non-profit. In Manitoba, three LTC homes were for-profit and five were non-profit, meanwhile in New Brunswick, a single LTC home was for-profit and the rest (n= 7) were non-profit. Lastly, in Ontario only two LTC homes were for-profit while the other six homes were non-profit. Home sector was significantly associated with the daily average of energy and protein provided by both textures (Table 5 and 6; $p<0.1$); with for-profit homes providing significantly higher amounts when compared to non-profit homes across both textures (Table 5 and 6; $p<0.01$). Manitoba (mean= 35.35 years, range: 14-70) and New Brunswick (mean= 34.88 years, range: 5-47) tended to have older LTC homes compared to Alberta (mean= 28.63 years, range: 4-51) and Ontario (mean= 25.88 years, range: 11-59). Of the LTC homes sampled across the provinces, Alberta, Manitoba, and Ontario had larger facilities as the number of beds per LTC homes in those three provinces was higher as compared to New Brunswick (Table 4). The number of beds was positively and significantly associated with only energy provision from the regular texture menu across the 32 LTC homes, with more energy provided by homes that had more beds ($r= 0.18$, $p= 0.007$). Manitoba had the shortest menu cycle length (median= 3 weeks, range: 3-5 weeks), followed by Alberta (median= 4 weeks, range: 3-4 weeks), Ontario (median= 4 weeks, range: 3-5 weeks), and New Brunswick (median= 4 weeks, range: 3-6 weeks). There were significant associations between menu cycle length and energy and protein provided by both textures across the 32 homes (Table 5 and 6; $p<0.01$); with a menu cycle of six weeks providing significantly lower protein and energy intake than three, four, and five week menu cycles (Table 5 and 6; $p<0.01$). Looking at the last full revision of the planned menu, seven of the eight LTC homes sampled in Ontario made a revision less than six months from the date of the study period; whereas Manitoba and

New Brunswick both had six homes that completed less than a six month revision, however Alberta only had four LTC homes revising their menu in this time frame (Table 4). There were also significant associations between menu revision and energy and protein provided by both textures across the 32 homes (Table 5 and 6; $p<0.01$); with a revision of more than 18 months providing significantly lower amounts of energy and protein across textures, and a menu revision of 6−12 months providing significantly higher amounts of energy for only the pureed texture (Table 5 and 6; $p<0.01$). All the 32 LTC homes in the M3 study planned the menus according to CFG, meanwhile three homes in Ontario and Alberta and only one home in Manitoba and in New Brunswick used other guidelines in addition to CFG to plan menus (Table 4). Alberta had the highest dietitian time (mean= 22.48 hours/week, range: 15-37.50 hours), followed by Manitoba (mean= 21.81 hours/week, range: 7.50-38.75 hours), Ontario (mean= 16.55 hours/week, range: 7-35 hours), and New Brunswick (mean= 13.83 hours/week, range: 0-37.50 hours). Further, Ontario had the highest amount of funding allocated to raw food, followed by Manitoba, Alberta, and New Brunswick (Table 4). Raw food cost was positively and significantly associated with only energy provided by the pureed texture across 32 LTC homes, with more energy provided by homes that had higher funding ($r= 0.23$, $n= 224$, $p= 0.001$). For the methods of food preparation primarily used, all eight LTC homes in Ontario used the traditional/convention system only. As for the other three provinces there was a mix between using the traditional/convention system, the ready prepared system (bulk or individual reheat), and both methods across the eight LTC homes per province (Table 4). Manitoba had the highest proportion of commercially prepared food with no further preparation needed (mean= 30.00%, range: 20-100%). While Alberta, New Brunswick, and Ontario had an average proportion between 10% and 15% of commercially prepared food with lower ranges as well (Table 4). The proportion of commercial food use across the 32 LTC homes was positively and significantly associated with only energy provision from the regular texture menus ($r= 0.18$, $n= 224$, $p= 0.006$). For the production of modified texture foods in the home, most of the LTC homes in Ontario (n= 5 of 8) modified from the regular texture and the other three LTC homes used a combination of purchased modified texture food and modification from the regular texture. Where as in the other three provinces, the eight LTC homes in each province used a mix of modifying from the regular texture, purchasing the modified texture, and both methods (Table 4). Again, Ontario had the highest number of LTC homes (n= 6 of 8) that had recipes available for the modified texture prepared from the regular texture (Table 4). However, some LTC homes in the other three provinces had no recipes available for the modified texture prepared from the regular texture or had recipes for only some modified texture items (Table 4).

3.3.2 Comparison of planned menus across the 32 long term care homes in four provinces

Table 7 illustrates the nutrient content of the regular and pureed texture menus averaged across the 32 LTC homes from four provinces in Canada. Across the provinces, the average amount of energy offered per day from the pureed menus was 1800.89 calories (SD)= 507.19) and 2057.69 calories (SD= 396.98) from the regular texture menus. A two-way ANOVA comparing province and texture for energy revealed the main effects, province ($F(3, 440)= 81.45$, $p<0.0001$) and menu texture ($F(1,440)= 56.26$, $p<0.0001$), which were modified by a significant interaction effect between province and menu texture ($F(3,440)= 6.76$, $p= 0.0002$). The presence of a significant interaction between province and menu texture means that differences in energy provision by province was not consistent by menu type; in some provinces pureed diets had higher energy, while in others regular menus had the higher value. For protein, the pureed menus had on average 82.17 grams (SD= 23.55) per day to offer while the regular menu had 86.43 grams (SD= 20.78). The main effects of province ($F(3, 440)= 42.78$, $p<0.0001$) and menu texture ($F(1,440)= 5.39$, $p= 0.02$) were also modified by a significant interaction effect between province and food texture ($F(3, 440)= 4.84$, $p= 0.003$). The amount of protein offered daily in both of the menus exceeded the RDA of 56 grams per day for those 70+ years. Likewise, main effects, province ($F(3, 440)= 89.20$, $p<0.0001$) and menu texture ($F(1, 440)= 68.07$, $p<0.0001$) were influenced by the significant interaction effect between province and food texture ($F(3, 440)= 7.62$, $p<0.0001$) for carbohydrates. The mean carbohydrate provided per day by the pureed planned menu was 229.17 grams (SD= 66.92) and 265.69 grams (SD= 52.07) by the regular texture menu. This average daily amount of carbohydrates was also well above the RDA of 130 grams per day for those over the age of 70. Further, the pureed menu offered a lower amount of daily fibre on average across the provinces compared to the regular texture menu (16.89 grams, SD= 5.64 versus 20.78, SD= 5.04), and again the main effects of province ($F(3, 440)= 16.22$, $p<0.0001$) and menu texture ($F(1, 440)=66.87$, $p<0.0001$) were modified by the significant interaction effect between province and menu ($F(3, 440)= 4.38$, $p= 0.005$). The RDA for fibre is set at 30 grams per day for those over the age of 70 however, both menus provided less than the recommended level of fibre with the pureed menu offering half the recommended amount. Across the four provinces, New Brunswick and Alberta had lower averages for all three macronutrients across both textures, and for fibre New Brunswick had the lowest average compared to the other three provinces, which were more similar in fibre content for both menus.

As for the micronutrients analyzed, 11 of the 22 nutrients had a significant interaction effect between province and menu texture ($p<0.01$), meaning that across provinces the micronutrient values were significantly different and there were also differences between textures, however the difference between regular and pureed was not consistent across provinces (e.g. differences were not consistently lower for pureed foods). These micronutrients were: vitamin B1, vitamin B2, vitamin B6, folate, copper, magnesium, manganese, phosphorus, potassium, selenium, and sodium (Table 7). Across the four provinces, seven of the 11 micronutrients offered an average amount per day above the RDA or AI for both the pureed and regular texture menus, which included vitamin B1, vitamin B2, copper, manganese, phosphorus, selenium, and sodium (Table 7). However, the amount of vitamin B6, folate, magnesium, and potassium provided daily across the four provinces was below the RDA or AI (Table 7). A total of five micronutrients of the 22 analyzed revealed that both main effects, province and texture, were significant ($p<0.01$) meaning that the pureed texture offered lower amounts of the five micronutrients across all provinces with New Brunswick having significantly lower values; the five micronutrients were vitamin E, vitamin K, pantothenic acid, iron, and zinc (Table 7). Vitamin E, vitamin K, and zinc averages per day across the four provinces were below the RDA or AI for those 70+ years for both texture menus, although the average amount of pantothenic acid and iron were above the AI and RDA, respectively, for both pureed and regular menus across provinces (Table 7). Furthermore, province effect was the only significant main effect for the final four of the 22 micronutrients ($p<0.01$) assessed meaning that averages significantly varied by province but not by texture; these were vitamin B2, vitamin C, vitamin D, and calcium. Vitamin B2 and vitamin C were offered in daily amounts that were well above the RDA level for both menu textures, however the provided daily amount of vitamin D and calcium fell below the RDA across both textures (Table 7). Lastly, there were no significant main effects for both vitamin A and vitamin B12 ($p>0.01$) meaning that there were no differences across province or texture; these micronutrients were both offered in amounts above the RDA for those over the age of 70 across the two textures (Table 7). Looking across the two textures over all homes, almost all micronutrients were provided in lower amounts per day for the pureed texture, however this was not the case for vitamin C (pureed: 123.61 milligrams, SD= 61.32; regular: 122.62 milligrams, SD= 61.67), vitamin D (pureed: 8.16 micrograms, SD= 4.40; regular: 7.45 micrograms, SD= 3.79), calcium (pureed: 1007.59 milligrams, SD= 464.09; regular: 987.90 milligrams, SD= 377.77), and potassium (pureed: 3081.00 milligrams, SD= 1052.35; regular: 3075.86 milligrams, SD= 789.58), which were higher for the pureed texture when compared to the regular texture (Table 7).

3.3.3 Comparison of planned menus across the eight long term care homes in Alberta

Table 8 illustrates the nutrient content of the regular and pureed texture menus across the eight LTC homes in Alberta. The average quantities of energy, macronutrients and all micronutrients offered across the eight homes were lower for the pureed texture when compared to the regular texture, except for vitamin C (pureed: 111.88 milligrams, SD= 51.32; regular: 104.04 milligrams, SD= 49.96), vitamin D (pureed: 6.05 micrograms, SD= 3.47; regular: 5.16 micrograms, SD= 2.84), and calcium (pureed: 898.57 milligrams, SD= 393.45; regular: 849.47 milligrams, SD= 372.52).

Across the LTC homes in Alberta, the average amount of energy per day provided by the pureed texture was lower than regular texture, 1720.23 calories (SD= 382.51) and 2066.81 (SD= 434.12), respectively. The main effects of site ($F(7, 96)= 24.59$, $p<0.0001$) and menu texture ($F(1, 96)= 53.09$, $p<0.0001$) were modified by a significant interaction effect between site and texture ($F(7, 96)= 3.22$, $p= 0.004$). This means that homes significantly varied in their energy content of menus and that there were also significant differences by texture, however not all homes and a lower energy content for the pureed menu as compared to the regular menu. On the other hand, there were no significant interaction effect between site and texture for protein, carbohydrates, and fibre offered by the planned menus ($p>0.01$). The pureed menu consistently offered less protein daily, an average of 10 grams, compared to the regular texture menu and both were above the RDA of 56 grams, at 78.41 grams (SD= 16.85) and 88.34 grams (SD= 23.64), respectively; main effects were significant for both site ($F(7,96)= 7.12$, $p<0.0001$) and texture ($F(1,96)= 9.48$, $p= 0.003$). As for carbohydrate, the pureed menu offered a mean of 209.82 grams daily where the regular texture offered 253.17 grams daily, both amounts were above the RDA of 130 grams (102,103). Further, the site and texture main effects were both significant ($F(7, 96)= 25.07$, $p<0.0001$; $F(1, 96)= 61.46$, $p<0.0001$, respectively). Lastly, 17.44 grams (SD= 4.42) of fibre was provided daily on average across the eight homes from the pureed menu and 22.46 grams (SD= 4.79) from the regular texture menu; again, the main effect of site ($F(7, 96)= 7.85$, $p<0.0001$) and main effect of texture ($F(1, 96)= 48.02$, $p<0.0001$) were both significant. The amount of fibre offered per day was below the RDA of 30 grams for both textures.

Of the 22 micronutrients analyzed, there were significant interaction effects between the site and menu texture for 11 of the micronutrients ($p<0.01$; Table 8), meaning that there were differences among sites and that the differences between regular and modified textures were not consistent by site. They included the following: vitamin B12, vitamin B3, vitamin B6, vitamin C, vitamin D, vitamin E, folate, calcium, magnesium, potassium, and selenium (Table 8). The average amount of vitamin B2, vitamin B3, vitamin C, and selenium provided daily across the eight homes was above the RDA for both menu textures (Table 8). Meanwhile, across the eight homes the average amount for vitamin D, vitamin E, folate, calcium, magnesium, and potassium offered per day was below the RDA or AI for both menu textures (Table 8). However, vitamin B6 (mean= 1.32 milligrams, SD= 0.65) as offered daily was below the RDA of 1.7 milligrams for only the pureed texture. Seven of the 22 micronutrients had significant main effects for both site and texture ($p<0.01$; Table 8); with pureed always providing a lower content than regular for the following nutrients: vitamin B1, vitamin K, iron, manganese, phosphorus, sodium, and zinc. Of the seven micronutrients, vitamin K and zinc were the only two that had an average amount below the AI and RDA, respectively, for both textures; the average amounts for the other five nutrients were above the RDA or AI across the pureed and regular texture menus (Table 8). Two micronutrients of the 22 analyzed, pantothenic acid and copper, had significant effects for texture only ($p<0.01$, Table 8), while site differences were not significant; pureed amounts were lower than regular across all homes but were above the AI/RDA, for both of the menu textures (Table 8). Lastly, no significant main effects of site or texture were observed for vitamin A and vitamin B12 ($p>0.01$, Table 8) meaning that pureed was no different from regular in any of the eight homes and the eight homes were not significantly different from each other. Only the average daily amount of vitamin A for the pureed texture, 810.20 RAE, (SD= 464.99), was below the RDA of 900 RAE, while the average amount of vitamin B12 provided per day was above the RDA of 2.4 micrograms for both textures (Table 8).

3.3.4 Comparison of planned menus across the eight long term homes in Manitoba

Table 9 illustrates the nutrient content of the regular and pureed texture menus across the eight LTC homes in Manitoba. Looking across both textures in this province across all homes, the pureed menu contained lower quantities for energy, macronutrients and almost all of the micronutrients when compared to the regular texture menu. Exceptions were protein, vitamin D, calcium, and potassium which were provided at higher levels in the pureed menu than the regular menu across the eight LTC homes in Manitoba.

Across the LTC homes in Manitoba, the average amount of energy per day provided by the pureed texture was lower than regular texture, 2088.10 calories (SD= 492.06) and 2295.40 (SD= 360.23), respectively. The main effects, site ($F(7, 96)= 27.26$, $p<0.0001$) and texture ($F(1, 96)= 18.45$, $p<0.0001$) were modified by a significant interaction effect between site and texture ($F(7, 96)= 3.84$, $p= 0.001$), meaning that differences among homes for the two textures was not consistent, with some pureed menus having a higher energy content. On the contrary, the pureed texture provided a higher average amount of daily protein compared to the regular texture, 92.30 grams (SD= 23.67) and 90.65 (SD= 20.57), respectively; the quantities for both textures exceeded the RDA set at 56 grams per day for those 70+ years. The two-way ANOVA revealed a significant main effect of site ($F(7, 96)= 28.92$, $p<0.001$) and a non significant main effect of texture ($F(1, 96)= 0.44$, $p= 0.51$) and there was no interaction ($F(7, 96)= 1.75$, $p= 0.11$), meaning that were site to site differences only in protein content, but protein content was consistently higher for pureed. For carbohydrates, a total mean of 303.78 grams (SD= 47.14) was provided from the regular texture, meanwhile the pureed texture offered less carbohydrate per day, 268.50 grams (SD= 58.28). The daily averages offered from both of the textures were above the RDA of 130 grams. The main effects, site ($F(7, 96)= 21.37$, $P<0.001$) and texture ($F(1, 96)= 31.60$, $p<0.0001$) were modified by a significant interaction effect between site and texture ($F(7, 96)= 4.93$, $p<0.0001$). A daily average of 16.85 grams (SD= 6.27) of fibre was provided by the pureed menu while the regular menu provided 21.81 grams (SD= 5.17) of fibre daily. The main effects, site ($F(7, 96)= 12.04$, $P<0.001$) and texture ($F(1, 96)= 43.84$, $p<0.0001$) were modified by a significant interaction between site and texture ($F(7, 96)= 7.32$, $p<0.0001$). Lastly, the RDA of 30 grams of fibre per day was not reached by either the regular texture or pureed texture menu, where the pureed texture offered about half of the RDA for fibre.

Of the 22 micronutrients analyzed, there were significant interaction effects observed between the site and menu texture for 14 of the micronutrients ($p<0.01$, Table 9), meaning that sites were significantly and textures significantly different, but there was not consistency by site with some home having a higher content for pureed as compared to regular menu. They included the following: vitamin B3, vitamin D, vitamin E, folate, pantothenic acid, calcium, copper, magnesium, manganese, phosphorus, potassium, selenium, sodium, and zinc. When comparing the average amount per day of these micronutrients provided from the menus to the RDA or AI, the following nutrients exceeded their respective levels for both textures (i.e. pureed and regular): vitamin B3, pantothenic acid, copper, manganese, phosphorus, selenium, and sodium (Table 9). However, the daily averages for vitamin D, vitamin E, magnesium, potassium, and zinc were lower than the RDA or AI levels for both menu textures; with vitamin D and vitamin E being offered at half the RDA level for both pureed and regular textures (Table 9). However, the average amount of calcium was below the RDA for only the regular texture menu and the average amount of folate was below the RDA for only the pureed menu texture (Table 9). A total of four micronutrients had significant main effects for both site ($p<0.01$) and texture ($p<0.01$), but no significant interaction. The four micronutrients were vitamin B1, vitamin B6, vitamin K, and iron, with the pureed diet being consistently lower across homes for these nutrients.

Both the pureed and regular textures offered average daily amounts of vitamin B1 and iron that were above the RDA, but vitamin B6 and vitamin K were below the RDA for both textures (Table 9). The two-way ANOVA revealed that vitamin A, vitamin B2, vitamin B12, and vitamin C had significant site effects only ($p<0.01$); the amounts per day provided by both of the menu textures were above the RDA (Table 9).

3.3.5 Comparison of planned menus across the eight long term care homes in New Brunswick

Table 10 illustrates the nutrient content of the regular and pureed texture menus across the eight LTC homes in New Brunswick. Across the menu textures, the pureed menu contained lower amounts for energy, macronutrients and almost all the daily micronutrients provided when compared to the regular texture menu; the only exception was vitamin C, where 94.91 milligrams (SD= 60.23) was offered by the pureed texture and 83.71 milligrams (SD= 40.01) from the regular texture (Table 10).

Across these eight LTC homes, the pureed menu provided a mean of 1286.62 calories (347.33) per day and the regular texture menu provided almost 50% more calories per day (1727.89, SD= 310.99). For energy, the two main effects of site ($F(7, 96)= 36.13$, $p<0.0001$) and texture ($F(1, 96)= 172.89$, $p<0.0001$) were modified by a significant interaction effect between site and texture ($F(7, 96)= 4.32$, $p= 0.0003$). Likewise, the two main effects of site ($F(7, 96)= 26.69$, $p<0.0001$) and texture ($F(1, 96)= 45.70$, $p<0.0001$) were modified by a significant interaction effect between site and texture for protein ($F(7, 96)= 4.61$, $p= 0.0002$). The average daily amount of protein across the eight homes for the pureed texture was also lower when compared to the regular texture, 61.54 grams (SD= 17.07) and 73.95 grams (SD= 15.76), respectively. Nonetheless, the amount of protein provided from both of the textures was above the RDA of 56 grams per day for those 70+ years. Furthermore, the pureed menu offered an average of 164.54 grams (SD= 53.96) of carbohydrate per day and the regular texture offered 227.40 grams (SD= 44.84); both were beyond the RDA of 130 grams per day. The two-way ANOVA analysis revealed the main effects, site ($F(7, 96)= 43.21$, $p<0.0001$) and texture ($F(1, 96)= 176.01$, $p<0.0001$), again modified by a significant interaction effect between site and texture ($F(7, 96)= 4.07$, $p= 0.0006$). Lastly, for fibre the main effect of site ($F(7, 96)= 11.65$, $p<0.0001$) and texture ($F(1, 96)= 50.53$, $p<0.0001$) did not have an interaction ($F(7, 96)= 2.18$, $p= 0.0429$), this means that the pureed menu offered significantly lower amounts of fibre compared to the regular texture across the homes and there were also significant differences among the eight homes. The average amount of fibre offered across the eight LTC homes was 13.65 grams (SD= 4.82) per day for the pureed texture and 18.35 grams (SD= 4.42) for the regular texture. When the average amounts were compared to the RDA, they did not meet the recommended levels of 30 grams per day for both textures.

For a total of 13 micronutrients of the 22 analyzed in this study, the main effect of site and texture was modified by a significant interaction effect between site and texture ($p<0.01$, Table 10). The 13 micronutrients were: vitamin B1, vitamin B2, vitamin B3, vitamin B6, vitamin C, vitamin E, pantothenic acid, calcium, iron, potassium, selenium, sodium, and zinc. Vitamin B2, vitamin B3, iron, and selenium met the RDA for both textures but vitamin B6, vitamin E, calcium, potassium, and zinc did not meet the RDA for both the pureed and regular textures (Table 10). Average across homes for vitamin B1, pantothenic acid, and sodium were below the RDA for only the pureed texture menu and vitamin C was below the RDA for the regular texture only (Table 10). Five micronutrients had significant main effects for site ($p<0.01$) and texture ($p<0.01$), and they included: folate, vitamin K, magnesium, manganese, and phosphorus (Table 10), with pureed diets have consistently lower nutrient content. The quantities for folate, vitamin K, magnesium provided per day were below the RDA for both textures; meanwhile phosphorus met the RDA for both menu textures and manganese was below the RDA for the pureed texture only (Table 10). Vitamin A, vitamin B12, and vitamin D had a significant main effect for site only ($p<0.01$) and no interaction with texture or differences between textures, meaning that values only varied by site and within site, and there was no difference in amounts offered when comparing the regular and pureed texture menus. Both vitamin A and vitamin B12 were offered in amounts that met the RDA for both of the textures (Table 10). However, the amount of vitamin D provided daily did not met the RDA for the regular and pureed texture menus (Table 10). Copper was the single micronutrient which had a significant main effect for texture only ($F(1, 96)= 8.17$, $p= 0.01$) with the pureed menus lower than the regular texture. When comparing the amount of copper provided daily by the two textures, only the pureed menu did not meet the RDA of 0.9 milligrams per day.

3.3.6 Comparison of planned menus across the eight long term care homes in Ontario

Table 11 illustrates the nutrient content of the regular and pureed texture menus across the eight LTC homes in Ontario. Most macronutrients and about half of the micronutrients were provided in lower amounts for the pureed texture as compared to the regular texture. The nutrients that were in higher amounts for the pureed menu included: protein, vitamin A, vitamin B2, vitamin B6, vitamin B12, vitamin D, calcium, copper, magnesium, phosphorus, potassium, and sodium.

The regular and pureed menus offered a comparable amount of energy per day across the eight sites, 2140.65 (SD= 220.56) and 2108.59 (SD= 278.64) respectively. The two-way ANOVA revealed the main effects, site ($F(7, 96)=4.67$, $p= 0.0002$) and texture ($F(1, 96)=0.65$, $p= 0.4235$), that were modified by a significant interaction effect between site and texture ($F(7, 96)= 3.89$, $p= 0.0009$). Similarly minimal difference was seen for protein; there was a roughly four gram difference provided daily between the two menu textures with the pureed texture providing 96.41 grams (SD= 18.83) and 92.77 grams (SD= 17.28) for the regular texture. Both of the daily values were above the RDA of 56 grams for those over the age of 70. The site and $F(7, 96)= 22.61$, $p<0.0001$) and texture effects ($F(1, 96)= 2.82$, $p= 0.10$) were modified by a significant interaction effect between the main effects ($F(7, 96)= 2.70$, $p= 0.01$), meaning that some homes had a lower protein content for their pureed menu. Additionally, the average daily amount of carbohydrates across homes provided by both textures was very alike and above the RDA of 130 grams per day; the pureed menu offered 274.08 grams (SD= 36.59) per day and the regular menu offered 278.42 grams (SD= 4.89). The significant main effects of site ($F(7, 96)= 3.95$, $p= 0.0008$) and texture ($F(1, 96)= 0.55$, $p= 0.46$) were again modified by a significant interaction effect between site and texture ($F(7, 96)= 2.92$, $p= 0.01$). The analysis for fibre revealed different results, where the main effects of site ($F(7, 96)= 3.41$, $p= 0.003$) and texture ($F(1, 96)= 1.11$, $p= 0.30$) were significant, but there was no interaction. A mean of 19.61 grams (SD= 5.31) per day was provided from the pureed menu and 20.52 grams (SD= 4.89) from the regular texture menu, both below the recommended level of 30 grams per day.

For less than half (n= 8) of the 22 micronutrients analyzed, the main effects of site and texture were modified by a significant interaction effect between site and texture ($p<0.01$, Table 11). The eight nutrients were vitamin B2, vitamin B12, calcium, manganese, phosphorus, potassium, selenium, and zinc. The daily amounts of all eight micronutrients provided by both menu textures exceeded their respective RDA or AI, except for calcium and potassium (Table 11). Calcium was below the RDA of 1200 milligrams for only the regular texture while potassium was below the AI of 4700 milligrams for both textures (Table 11). The analyses revealed that a total of 12 of the 22 micronutrients had only significant site effects ($p<0.01$) while the texture effects were not significant ($p>0.01$). This means that values only varied by site and within site, there was no difference in amounts offered when comparing the regular and pureed texture menus. These included the following micronutrients: vitamin A, vitamin B1, vitamin B3, vitamin B6, vitamin C, vitamin D, vitamin E, folate, copper, iron, magnesium, and sodium. Almost all of these micronutrients were at or above the RDA or AI, as offered daily by both textures; exceptions were vitamin D, vitamin E, and folate were all less than the RDA for both menu textures (Table 11). However, the analyses revealed that two micronutrients, vitamin K and pantothenic acid had no significant main effects or interaction effects between site and texture ($p>0.01$, Table 11). Plus, the quantities per day provided by both of the textures were above the RDA (Table 11).

3.4 Discussion

This study provides an illustration of the energy, macronutrient, micronutrient, and fibre content of both regular texture and pureed texture LTC menus in Canada. To date, this is the most comprehensive menu analysis of both textures. Previous studies have investigated the pureed menu texture only (46), one or a few macronutrients (45,46), or were based on a single site (47,96). To our knowledge, this is the first study to examine the energy, macronutrient, micronutrient, and fibre content of menus for both regular and pureed textures in more than 30 LTC homes from various regions. Using the average across provinces (Table 7), this study found that pureed menus offered a non-significant lower amount for the majority of nutrients as compared to the regular menu. However, there were significant province and diet texture interactions for energy, protein, carbohydrates, fibre, and 11 of 22 micronutrients analyzed ($p<0.01$), with New Brunswick and Alberta having lower nutrient content for both menus as compared to Ontario and Manitoba. Fibre and nine micronutrients were below DRI recommendations for both menus across the provinces. Within each province, similar trends were observed; some homes had significantly lower nutrient content for pureed diets, while others did not. Specifically in Ontario, there were fewer differences in micronutrients between pureed and regular textures, with some micronutrients actually higher in the pureed menu.

The significant interactions observed between province and diet texture suggested that in some of the provinces the values for energy, protein, carbohydrates, fibre, and 11 micronutrients were significantly different between textures, with differences existing at the province level, but these differences were not consistently lower for the pureed texture. When only the main effects observed were significant for both province and menu texture for the five micronutrients, it suggested that the pureed texture was consistently and significantly lower than the regular texture for every province, but that there were also significant differences among the four provinces, with New Brunswick having the lowest values. When province was the only significant main effect, which was the case for four micronutrients; this indicated that differences only existed between provinces and not between textures.

Within each province, significant interactions between the site and diet texture indicated that in some LTC homes the values for energy, macronutrients, micronutrients, and fibre were significantly different between the two textures, suggesting that these differences existed at the single home level and this difference was not always lower for the pureed texture. When only the main effects observed were significant for both site and menu texture for some micronutrients, it suggested that the texture was significantly lower for the pureed texture, except in Ontario, and that there was a significant difference in content among the eight LTC homes in each province. When site was the only significant main effect, which was the case for several micronutrients within each province, this indicated that differences existed only between homes. Where the main effect for texture was found, the regular or pureed texture was significantly different from one another but there were no differences found among the eight LTC homes in each province. Fewest site and texture differences were evident in Ontario LTC homes. Further, it was found that home level characteristics were significantly associated with energy and protein provision of regular and pureed texture menus across the 32 sites, which could contribute to the variation and difference found in nutrients across the provinces and sites. For-profit homes were providing significantly higher amounts of energy and protein when compared to non-profit homes across both textures, as well the number of beds was positively associated with energy provision from the regular texture. Facilities with these characteristics are providing more food or more nutrient dense products which suggests that possibly more investment is being put into menu planning, potentially as food is a key factor for residents choosing a home.

These findings illustrate provincial and home level variation in the amount of energy, macronutrients, micronutrients, and fibre as offered by the menus in the M3 study. This is similar to the findings of Dahl and colleges who examined the protein content of menus from Ontario and Saskatchewan, and found that not only did protein levels differ between LTC homes within each province but there were regional differences between the two provinces (46). Furthermore, a study by Beck and Hanson assessed macronutrients of meal samples and found that the nutritional content varied among the 10 kitchens that participated in the study (45). Another two studies, which conducted a menu analysis of the regular texture and pureed texture in one home, found that the pureed texture menu was significantly lower in macronutrients and micronutrients compared to the regular texture menu (47,96). This was different from the findings in the M3 study, where in some

LTC homes the pureed texture menus provided more nutrition than the regular texture menus. This demonstrates the importance of analyzing menus across homes and regions to yield more representative findings. This menu analysis of the M3 homes confirms the studies from Dahl and colleagues and Beck and Hanson that menu planning is often regional or home specific (45,46). Additionally, this study adds a more comprehensive nutrient analysis of both regular and pureed texture menus, as a total of 64 menus from 32 LTC homes across four provinces were examined. Finally, this study analyzed energy, protein, carbohydrates, fibre, and 22 micronutrients of regular and pureed textures, whereas the majority of previous literature had assessed single nutrients or only macronutrients, with many studies leaving out micronutrients (45–47).

The variation found at the home and provincial levels could be a further indication that national or provincial guidelines are not consistently applied; all homes indicated that they at minimum used CFG for planning menus, yet considerable variation with respect to the DRI was found for regular and pureed textures. Except for Ontario, which requires clinical dietitians to provide care, including menu review (95), if pureed textures were statistically different from regular textures, they were consistently lower. As well in Ontario, fewer nutrients were planned at levels below the DRI than the other three provinces, with New Brunswick homes more likely to have nutrients from both textures below the DRI. This has implications for the LTC context (23,48), especially for pureed textures. Differences across and within provinces could be explained by the variable use of interventions and guidelines where the focus may have been to increase the amount of nutrients for menus of modified textures. For example, homes in Ontario may be more likely to conduct their own nutrient analysis, at least for some of their menu, to ensure they are meeting targets. Food focused interventions include fortification of foods with infant cereal, skim milk powder, and powders containing both vitamins and minerals, or high energy and protein snacks (88,104,105), and these could also have varied among homes and provinces.

Generally, the amount for macronutrients, micronutrients, and fibre was lower for the pureed texture compared to the regular texture menu; however several micronutrients were surprisingly provided at higher levels for the pureed menu. Those in common, across and within the four provinces included vitamin D and calcium; this finding could be explained by the addition of nutrients to pureed food during preparation methods (e.g., dairy products to create energy-dense meals by increasing energy and protein but also calcium and vitamin D amounts would improve) or by purchasing commercial food that is fortified (104,106,107). The number of macronutrients, micronutrients, or fibre provided at higher levels for the pureed menu ranged from one to four in

Alberta, Manitoba, and New Brunswick which was similar to the four nutrients at the national level across the provinces. In Ontario, the pureed menu on average offered higher amounts for protein and 11 micronutrients, though not all significantly different. In addition to the clinical dietitian time allocated to menu reviews noted above that explains why ON was higher for most nutrients as compared to other provinces for both textures, practices specific to MTF may explain differences seen among provinces in pureed menus when compared to the DRI. First, the proportion of food production that is commercially prepared with no further preparation needed was lowest among LTC homes in Ontario. Previous studies have suggested variation in the nutritional quality of commercially prepared modified texture foods (100,101). The higher proportions of commercially prepared modified texture food used in the other provinces, could possibly explain why more interaction effects between site and texture were observed for Alberta, Manitoba, and New Brunswick when compared to Ontario. Yet, proportion of commercial food was only positively associated with energy provision from the regular texture menus across the 32 homes. Secondly, Ontario had no LTC homes that only purchased modified texture foods while the other provinces did and Ontario had the highest number of homes that only modified from the regular texture foods made in the home. Ontario also had the highest number of LTC homes that had recipes available for modified textures prepared from the regular texture. Previous work has suggested variation in the nutritional quality of in-house pureed food due to recipe variation (100,101). When homes do not have standardized recipes for modified texture menu items this could lead to inconsistencies between the textures and possibly a lowered nutritional quality for pureed foods as quality would depend on the staff members (i.e., chefs) preparing the foods (46,86). Lastly, as some homes modified foods for the pureed menu from the regular texture menu and other homes purchased commercially prepared modified texture foods, this can lead to variations in nutrient content provided between the menus and homes (100,101).

The findings from this study demonstrate that the current menu planning guidelines do not always meet the DRI for those 70+ years and variation existed not only across provinces but also across LTC homes within each province. Alberta and Manitoba had similar findings compared to the provincial level in that ten and nine, respectively, of the 22 nutrients analyzed were below the RDA or AI for either texture. New Brunswick had the highest number of nutrients below the RDA or AI, which was a total of 15 for either texture; meanwhile Ontario had the lowest number, which was five for either texture. There were no existing menus that were able to meet the DRIs for all macronutrients, micronutrients, and fibre in both food textures. Several menus did meet the recommended levels for the majority of nutrients, these planned menus came from Manitoba and

Ontario and had the highest number of nutrients meet the DRIs for both textures (i.e., 6 of the 22 micronutrients analyzed for Manitoba and 6-7 of 22 micronutrients analyzed for Ontario). This may be attributed to increased money spent on food as Ontario had the highest amount of dollars allocated to the raw food cost (mean= 8.49, range: 7.33-12.50); as well 7 of 8 Ontario homes had completed a full menu revision less than six months before the study period, therefore possibly increasing the nutrient quality of the menus to meet DRIs (108). Regulations with respect to raw food cost allocation and menu planning appear to have improved the nutrient density of Ontario menus. Not surprisingly, New Brunswick had the least amount of nutrients on average that met the RDA or AI and also had the lowest amount of dollars allocated to raw food (mean= 7.20, range: 6.30-7.88). Raw food cost was positively associated with only energy provided by the pureed texture; this suggests that homes are able to offer pureed menus with more energy dense foods when increased funding is being provided (108), making these menus more comparable to regular texture ones. This finding can possibly be further explained by the portion sizes across the provinces, where Ontario had an average weight of 2735.41 grams across the eight LTC homes (regular menu weight= 2704.41 grams; pureed menu weight= 2766.41 grams) and New Brunswick had an average of 1981.45 grams across the eight LTC homes (regular menu weight= 2151.08 grams; pureed menu weight= 1813.81 grams). The difference of about 750 grams could explain why the Ontario menus on average met the DRIs as essentially more food is being offered. Further, the estimated consumption of food among LTC residents is about 50% of food provided (18,28), which would make meeting recommendations even harder, especially for residents in New Brunswick. An inadequate provision of nutrition can exacerbate malnutrition in LTC facilities, where the prevalence is already high, estimated between 40% to 80% (27,33,45,109–115), therefore it is important to provide menus that at minimum meet recommendations. When taking a more in-depth look at the type of foods provided by these menus from Manitoba and Ontario, they contained ingredients that are known to increase the micronutrient content of recipes and help reach DRIs as suggested by prior research (85). Some of these foods or ingredients offered by the menus included: green peas, carrots, beets, green beans, Brussels sprouts, spinach, asparagus, bran, black beans, peanut butter, 2% milk, cheese, canola oil, and margarine. This study further shows that when using nutrient dense foods and ingredients, the nutrient quality of the menus can come close to meeting the DRIs. Previous research has created super-menus, which are nutrient dense and provide low volume portions (85). These menus were found to meet recommendations for most of the micronutrients analyzed, and when compared to current menus in LTC, super menus provided statistically significant higher amounts of micronutrients and also came closer to meeting DRIs for vitamin D, vitamin E, and potassium (85). Additionally, a menu cycle of six weeks provided significantly lower protein and energy intake compared to three, four, and five week menu cycles, as well as menu revisions of more than 18 months provided significantly lower amounts of energy and protein across the textures. This suggests that a longer menu does not provide more nutrient density and revising menus of three, four, or five weeks in length on an annual basis is a good practice to promote meeting DRIs.

Vitamin D was consistently below the RDA for both the regular and pureed texture across the provinces and within each province. Calcium was also below the RDA for both textures across the provinces and for Alberta and New Brunswick, however for Manitoba and Ontario calcium was below the RDA for the regular texture menu only. The inadequacy of these nutrients is potentially of less of a concern as supplementation guidelines in LTC recommend vitamin D and calcium be given to residents to prevent falls and fractures (116–118) due to the inherent challenges in meeting the DRI through food alone in this age group. Therefore, with supplementation residents would likely meet the RDA levels needed daily (116–118). Lastly, preparation methods for modified texture foods used in Manitoba and Ontario may have increased the amount of calcium provided so RDA levels were met for the pureed menu and not the regular texture menu. An example would be adding dairy products such as skim powder or fortifying pureed foods to increase micronutrient values (88,104,105,107). Lastly, home sector was significantly associated with energy and protein provided by the menus across the 32 LTC homes. On average for-profit homes offered a higher amount of energy and protein for both textures, as mentioned previously, compared to non-profit homes; these non-profit homes may not have had the resources (e.g. time, financial support) for thorough menu planning and reviews, as well as the funding to provide nutrient dense foods. With the majority of homes being non-profit in this study (68.75%, n= 22) this could explain why menus could not meet DRIs across diet textures.

3.4.1 Strengths and limitations

Due to the design of the study, which is cross-sectional in nature, causality with respect to factors that result in higher quality menus cannot be inferred; however this is the first study to consider menu planning from different regions and a diverse set of homes, providing insight to factors worthy of further exploration and consideration. A limitation of this study was that not all LTC homes in each province provided menus that included snacks; therefore snacks were not included in this analysis. With the inclusion of snacks, the planned menus would have provided a higher amount of energy and macronutrients, and potentially micronutrients and fibre depending on the types of food on offer, potentially coming closer to meeting the recommended levels. Another limitation of this study is that several of the pureed menus did not have standardized recipes, so the pureed products were altered from the regular recipes. Although the analysts attempted to be methodical in how they calculated the potential nutrient intake of these foods, the preparation methods for in-house pureed products could have differed from one cook to another and could have been altered from the original recipe that may or may not even be standardized; therefore an accurate nutritional value may have been difficult to acquire. Lastly, a recipe analysis for food based on ingredients using Food Processor software is a cost-effective substitute for a chemical analysis which is time-consuming and expensive to conduct (119). A chemical analysis of duplicate portions is considered the gold standard to obtain accurate information on nutritional quality (71), and this has been done in previous research conducted on pureed foods in the LTC context (46). However, nutrient analysis based on recipes comes with limitations, which include: accuracy of ingredients in recipes, accuracy of product labels, finding appropriate nutrient values for each ingredient, reliable and up to date composition data, converting units and household measures to weights, assigning weight change factors due to cooking the food, and errors in the nutrient analysis program based on recipe contents (71,119,120). Despite these limitations, a recipe analysis of LTC menus is an appropriate method because of the large sample size used in this study (52,120). Use of the same software database and code-book supported consistency across provinces and research assistants who analyzed the menus. Despite these limitations, this study also contained several strengths. To date this is the most comprehensive and thorough menu analysis, as a total of 32 LTC homes from across four provinces provided their planned menus (45–47,85,96). Additionally, a variety of LTC homes were sampled, this included both for-profit and not-for-profit, independent operators and large corporations, rural and urban settings, and cultural and faith based homes. This is a sufficient nutrient analysis to represent Canadian LTC menus for regular and pureed textures, although there is the potential for provincial differences as noted in this analysis. Steps were taken by the research assistants to ensure an accurate nutrient analysis of menus, recipes, and product labels by consulting with cooks or dietary food service managers to clarify items and portion sizes. Also, research assistants who worked together in each province checked each other’s nutrient analysis of items and the codebook in each province aided the research assistants to be consistent in database choices for the menu items.

Future research should focus on consumption of both regular and modified texture foods, including pureed foods since consumption is very different from provision among residents. It is estimated that on average residents living in LTC consume about 50% of food offered (18,28). If planned menus are not meeting DRIs for all nutrients in addition to poor food intake, then residents in LTC will have nutritionally inadequate diets and possibly negative health consequences such as malnutrition (27,33,45,109–115). Future research could also examine planned menus with the inclusion of snacks to determine if provision of snacks in addition to breakfast, lunch, and dinner meals would help menus reach recommended levels for nutrients. Lastly, future research should consider cost-effective menus that can provide nutrient-dense foods menus in LTC. Research on strategies to support nutrient density is required with knowledge translation on how to improve menus.

3.5 Conclusion

This study demonstrates the variability in menu planning in Canadian LTC and the need for improved menu planning protocols, including a complete nutrient analysis, to ensure planned diets meet nutrient requirements regardless of texture. In the Canadian context, menu planning is often regional or home specific and this study further illustrates this issue. Attention needs to be brought to the standardization of recipes for regular and pureed textures to promote consistency in nutrient content across LTC homes and regions. With careful consideration of resident needs and deliberate menu planning, most vitamin and mineral needs can be met while supplementation or fortification can help meet recommended levels for all nutrients to reduce the risk of malnutrition in this population. Additionally, homes and regional governments are encouraged to require a complete nutrient analysis of menus to promote menus that meet the DRI. This study confirms prior research that suggests an iatrogenic effect of food provision to malnutrition in LTC. As noted by home and regional differences, when greater importance is placed on menu planning, potentially due to regulations and standards, this situation can be improved.

Table 4. Characteristics of the LTC homes across the four provinces in the M3 study (n= 32).

Home Characteristics	**Province**			
	Alberta	**Manitoba**	**New Brunswick**	**Ontario**
Home Sector, % (n)				
For-profit	50.00 (4)	37.50 (3)	12.50 (1)	25.00 (2)
Non-profit	50.00 (4)	62.50 (5)	87.50 (7)	75.00 (6)
Age of home in years, mean (range)	28.63 (4 – 51)	35.35 (14 – 70)	34.88 (5 – 47)	25.88 (11 – 59)
Number of beds per LTC home, mean (range)	151.53 (100 – 226)	161.91 (57 – 233)	87.25 (50 – 200)	138.88 (84 – 238)
Menu cycle length in weeks, median (range)	4 (3 – 4)	3 (3 – 5)	4 (3 – 6)	4 (3 – 5)
Last full revision of the menu, % (n)				
Less than 6 months	50.00 (4)	75.00 (6)	75.00 (6)	87.50 (7)
6-12 months	37.50 (3)	25.00 (2)	12.50 (1)	12.50 (1)
13-18 months	12.50 (1)	0	0	0
More than 18 months	0	0	12.50 (1)	0
Menu planning based on Canada's Food Guide (CFG), % (n)	100.00 (8)	100.00 (8)	100.00 (8)	100.00 (8)
Menu planning based on other guidelines % (n)	37.50 (3)	12.50 (1)	12.50 (1)	37.50 (3)
Dietitian time (hours per week), mean (range)	22.48 (15.00 – 37.50)	21.81 (7.50 – 38.75)	13.83 (0 – 37.50)	16.55 (7.00 – 35.00)
Raw food cost, mean (range)*	7.45 (6.13 – 8.28)	7.83 (6.16 – 8.97)	7.20 (6.30 – 7.88)	8.48 (7.33 – 12.50)
Methods of food preparation primarily used, % (n)				
Traditional/conventional system	62.50 (5)	50.00 (4)	62.50 (5)	100.00 (8)
Ready prepared system (bulk or individual reheat)	0	25.00 (2)	37.50 (3)	0
Both methods used[a]	37.50 (3)	25.00 (2)	0	0
Proportion of food production is commercially prepared[b], median (range)	10.00 (2 – 70)	30.00 (20 – 100)	15.00 (2 – 60)	10.00 (0 – 30)
Production of modified texture foods in the home, % (n)				
Modified from regular texture in home	37.50 (3)	50.00 (4)	37.50 (3)	62.50 (5)
Purchased modified texture	12.50 (1)	12.50 (1)	25.00 (2)	0
Both methods used[c]	50.00 (4)	37.50 (3)	37.50 (3)	37.50 (3)
Recipes are available for modified textures prepared from the regular texture, % (n)**				
Yes	25.00 (2)	37.50 (3)	25.00 (2)	75.00 (6)
Only some items	37.50 (3)	25.00 (2)	37.50 (3)	25.00 (2)
No	25.00 (2)	25.00 (2)	12.50 (1)	0

Descriptive statistics were used to compute means for continuous variables and frequencies for the categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). Total n= 32, where * n= 27 and ** n= 28.

[a] Both methods used= traditional/conventional and ready prepared systems used.

[b] Proportion of food production is commercially prepared with no further preparation needed.

[c] Both methods used= modified from regular in-home & purchased.

Table 5. Home characteristics associated with energy and protein provision for regular texture menus over seven-day average of 32 LTC home from four provinces.

Home Characteristics		Energy			Protein		
		kcal per day	**Statistical value**	**P-value**	**grams per day**	**Statistical value**	**P-value**
Home Sector, % (n)							
For-profit	31.25 (10)	2255.20 (381.16)	5.32[a]	<0.0001	95.30 (18.70)	4.49[a]	<0.0001
Non-profit	68.75 (22)	1967.91 (371.76)			82.40 (20.47)		
Number of beds per LTC home, median (IQR)	126.00 (87.50-190.00)	2057.69 (396.98)	0.18[b]	0.007	86.43 (20.78)	0.15[b]	0.03[b]
Menu cycle length in weeks, median (IQR)							
3 weeks[d]	40.63 (13)	2107.82 (418.82)[g]	8.13[c]	<0.0001	83.80 (19.07)[g]	8.93[c]	<0.0001
4 weeks[e]	40.63 (13)	2035.93 (370.43)[g]			90.15 (22.16)[g]		
5 weeks[f]	12.50 (4)	2187.55 (302.61)[g]			94.03 (16.29)[g]		
6 weeks[g]	6.25 (2)	1613.51 (281.07)[d,e,f]			64.16 (11.51)[d,e,f]		
Last full revision of the menu, % (n)							
Less than 6 months[h]	75.00 (24)	2087.57 (389.33)[k]	12.11[c]	<0.0001	87.26 (21.25)[k]	6.18[c]	0.0005
6-12 months[i]	18.75 (6)	2111.89 (323.56)[k]			89.91 (17.22)[k]		
13-18 months[j]	3.13 (1)	1790.75 (182.04)			74.52 (11.30)		
More than 18 months[k]	3.13 (1)	1282.14 (243.33)[h,i]			57.49 (8.56)[h,i]		
Dietitian time (hours per week), median (IQR)	16.95 (13.00-22.50)	2057.69 (396.98)	0.12[b]	0.07	86.43 (20.78)	0.05[b]	0.49
Raw food cost, median (IQR)*	7.67 (7.10-8.25)	2057.69 (396.98)	0.13[b]	0.08	86.43 (20.78)	-0.08[b]	0.26
Proportion of commercial food, median (IQR)	17.5 (10 – 30)	2057.69 (396.98)	0.18[b]	0.006	86.43 (20.78)	-0.11[b]	0.12

Statistical tests were performed to compare home characteristics with energy and protein provision for regular texture menus across 32 LTC homes from four provinces. Total n= 32, where * n= 27.
Abbreviations: kcal= kilocalorie, IQR= interquartile range.
[a]A Student t-test was performed and statistical value is a t-value.
[b]A Pearson's correlation test was performed and statistical value is a Pearson correlation coefficient.
[c]An ANOVA was performed and statistical value is a F-value.
[d, e, f, g, h, i, j, k]Values with different superscripts indicate a significant difference at p< 0.01.

Table 6. Home characteristics associated with energy and protein provision for pureed texture menus over seven-day average of 32 LTC homes from four provinces.

Home Characteristics		Energy			Protein		
		kcal per day	Statistical value	P-value	grams per day	Statistical value	P-value
Home Sector, % (n)							
For-profit	31.25 (10)	2023.52 (421.96)	4.63[a]	<0.0001	94.03 (16.29)	3.56[a]	0.0005
Non-profit	68.75 (22)	1699.69 (511.52)			64.16 (11.51)		
Number of beds per LTC home, median (IQR)	126.00 (87.50-190.00)	1800.89 (507.19)	0.05[b]	0.44	82.17 (23.55)	0.13[b]	0.05
Menu cycle length in weeks, median (IQR)							
3 weeks^{d}	40.63 (13)	1767.68 (484.23)^{f,g}	11.37[c]	<0.0001	79.45 (20.23)^{f,g}	12.34[b]	<0.0001
4 weeks^{e}	40.63 (13)	1805.88 (404.82)^{f,g}			85.09 (21.83)^{g}		
5 weeks^{f}	12.50 (4)	2159.64 (678.46)^{d,e,g}			95.69 (30.47)^{g}		
6 weeks^{g}	6.25 (2)	1266.69 (326.21)^{d,e,f}			53.82 (9.10)^{d,e,f}		
Last full revision of the menu, % (n)							
Less than 6 months^{h}	75.00 (24)	1776.35 (473.28)^{i,k}	16.16[c]	<0.0001	81.80 (22.07)^{k}	11.21[c]	<0.0001
6-12 months^{i}	18.75 (6)	2106.24 (477.17)^{h,j,k}			91.78 (24.60)^{k}		
13-18 months^{j}	3.13 (1)	1437.43 (199.95)^{i}			74.99 (13.27)		
More than 18 months^{k}	3.13 (1)	921.05 (60.74)^{h,i}			40.55 (3.03)^{h,i}		
Dietitian time (hours per week), median (IQR)	16.95 (13.00-22.50)	1800.89 (507.19)	-0.10[b]	0.13	82.17 (23.55)	-0.02[b]	0.79
Raw food cost, median (IQR)*	7.67 (7.10-8.25)	1800.89 (507.19)	0.23[b]	0.001	82.17 (23.55)	0.06[b]	0.41
Proportion of commercial food, median (IQR)	17.5 (10 – 30)	1800.89 (507.19)	0.04[b]	0.52	82.17 (23.55)	-0.07[b]	0.31

Statistical tests were performed to compare home characteristics with energy and protein provision for pureed texture menus across 32 LTC homes from four provinces. Total n= 32, where * n= 27.
Abbreviations: kcal= kilocalorie, IQR= interquartile range.
[a]A Student t-test was performed and statistical value is a t-value.
[b]A Pearson's correlation test was performed and statistical value is a Pearson correlation coefficient.
[c]An ANOVA was performed and statistical value is a F-value.
[d, e, f, g, h, i, j, k]Values with different superscripts indicate a significant difference at $p< 0.01$.

Table 7. Comparison of pureed and regular menus as planned for one week across the 32 LTC homes from four provinces.

Across All Provinces					
Nutrients	**RDA (70+ M) AI* (70+ M)**	**Regular Menu**		**Pureed Menu**	
		Mean	**SD**	**Mean**	**SD**
Calories (kcal)	n/a	2057.69	396.98	1800.89[a]	507.19
Protein (g)	56	86.43	20.78	82.17[a]	23.55
Carbohydrates (g)	130	265.69	52.07	229.17[a]	66.92
Fibre (g)	**30**	**20.78**	**5.04**	**16.89[a]**	**5.64**
Vitamin A (RAE)	900	1033.30	628.33	937.39	511.43
Vitamin B1 (mg)	1.2	1.61	0.56	1.31[a]	0.64
Vitamin B2 (mg)	1.3	2.27	0.78	2.20[b]	0.97
Vitamin B3-NE (mg)	16	33.59	11.58	27.04[a]	13.49
Vitamin B6 (mg)	**1.7**	**1.62**	**0.56**	**1.38[a]**	**0.65**
Vitamin B12 (mcg)	2.4	5.42	4.90	4.95	3.08
Vitamin C (mg)	90	122.62	61.67	123.61[b]	61.32
Vitamin D (mcg)	**20**	**7.45**	**3.79**	**8.16[b]**	**4.40**
Vitamin E (mg)	**15**	**6.54**	**2.63**	**5.24[b,c]**	**2.88**
Folate-DFE (mcg)	**400**	**359.77**	**120.99**	**255.64[a]**	**124.21**
Vitamin K (mcg)	**120***	**105.94**	**102.93**	**82.19[b,c]**	**96.92**
Pantothenic Acid (mg)	5*	22.15	49.53	10.09[b,c]	33.05
Calcium (mg)	**1200**	**987.90**	**377.77**	**1007.59[b]**	**464.09**
Copper (mg)	0.9	1.35	0.92	1.02[a]	0.58
Iron (mg)	9	12.90	3.77	10.69[b,c]	3.93
Magnesium (mg)	**420**	**304.25**	**85.61**	**254.16[a]**	**100.96**
Manganese (mg)	2.3*	4.19	1.44	2.87[a]	1.40
Phosphorus (mg)	700	1441.94	378.87	1337.39[a]	442.56
Potassium (mg)	**4700***	**3075.86**	**789.58**	**3081.00[a]**	**1052.35**
Selenium (mcg)	55	112.36	39.48	83.05[a]	47.80
Sodium (mg)	2300*	3138.97	831.36	2775.40[a]	920.48
Zinc (mg)	**11**	**10.21**	**3.49**	**8.77[b,c]**	**4.09**

An ANOVA was performed between the regular texture menus (n= 32) and the pureed texture menus (n= 32) across the 32 LTC homes from four provinces. Abbreviations: RDA= recommended dietary allowance; AI= adequate intake; M= male; SD= standard deviation; kcal= kilocalorie; g= gram; mg= milligram; mcg=microgram; RAE= retinol activity equivalent; NE= niacin equivalents; DFE= dietary folate equivalent. Bold text represents values under the RDA or AI.
*Represents an adequate intake rather than a recommended dietary allowance.
[a] Represents a significant interaction effect of province and texture between the two menu textures, $p<0.01$.
[b] Represents a significant province effect between the two menu textures, $p<0.01$.
[c] Represents a significant texture effect between the two menu textures, $p<0.01$.

Table 8. Comparison of pureed and regular menus as planned across the eight LTC homes from Alberta.

Across LTC Homes in Alberta					
Nutrients	**RDA (70+ M) AI* (70+ M)**	**Regular Menu**		**Pureed Menu**	
		Mean	**SD**	**Mean**	**SD**
Calories (kcal)	n/a	2066.81	434.12	1720.23[a]	382.51
Protein (g)	56	88.34	23.64	78.41[b,c]	16.85
Carbohydrates (g)	130	253.17	47.86	209.82[b,c]	47.05
Fibre (g)	**30**	**22.46**	**4.79**	**17.44[b,c]**	**4.42**
Vitamin A (RAE)	**900**	1056.56	793.58	**810.20**	**464.99**
Vitamin B1 (mg)	1.2	1.73	0.59	1.31[b,c]	0.57
Vitamin B2 (mg)	1.3	2.14	0.83	2.13[a]	0.92
Vitamin B3-NE (mg)	16	37.69	12.35	27.22[a]	11.03
Vitamin B6 (mg)	**1.7**	1.75	0.70	**1.32[a]**	**0.65**
Vitamin B12 (mcg)	2.4	5.18	5.11	4.61	2.12
Vitamin C (mg)	90	104.02	49.96	111.88[a]	51.32
Vitamin D (mcg)	**20**	**5.16**	**2.84**	**6.05[a]**	**3.47**
Vitamin E (mg)	**15**	**7.26**	**2.59**	**5.65[a]**	**2.55**
Folate-DFE (mcg)	**400**	**331.99**	**84.91**	**219.06[a]**	**82.72**
Vitamin K (mcg)	**120***	**106.45**	**78.47**	**69.60[b,c]**	**84.36**
Pantothenic Acid (mg)	5*	31.53	57.08	8.65[c]	14.67
Calcium (mg)	**1200**	**849.47**	**372.52**	**898.57[a]**	**393.45**
Copper (mg)	0.9	1.57	1.08	0.97[c]	0.25
Iron (mg)	9	13.65	3.47	10.97[b,c]	3.14
Magnesium (mg)	**420**	**310.63**	**82.78**	**237.12[a]**	**67.87**
Manganese (mg)	2.3*	4.49	1.37	2.75[b,c]	1.18
Phosphorus (mg)	700	1363.72	389.84	1249.18[b,c]	359.76
Potassium (mg)	**4700***	**2887.06**	**728.51**	**2783.11[a]**	**746.73**
Selenium (mcg)	55	118.53	36.65	84.70[a]	32.96
Sodium (mg)	2300*	3232.23	953.30	2763.64[b,c]	824.63
Zinc (mg)	**11**	**10.89**	**3.94**	**9.03[b,c]**	**4.21**

An ANOVA was performed between the regular texture menus (n= 8) and the pureed texture menus (n= 8) across the eight LTC homes in Alberta. Abbreviations: RDA= recommended dietary allowance; AI= adequate intake; M= male; SD= standard deviation; kcal= kilocalorie; g= gram; mg= milligram; mcg=microgram; RAE= retinol activity equivalent; NE= niacin equivalents; DFE= dietary folate equivalent. Bold text represents values under the RDA or AI.

*Represents an adequate intake rather than a recommended dietary allowance.

[a] Represents a significant interaction effect of site and texture between the two menu textures, $p<0.01$.

[b] Represents a significant site effect between the two menu textures, $p<0.01$.

[c] Represents a significant texture effect between the two menu textures, $p<0.01$.

Table 9. Comparison of pureed and regular menus as planned across the eight LTC homes from Manitoba.

Across LTC Homes in Manitoba					
Nutrients	**RDA (70+ M) AI* (70+ M)**	**Regular Menu**		**Pureed Menu**	
		Mean	**SD**	**Mean**	**SD**
Calories (kcal)	n/a	2295.40	360.23	2088.10[a]	492.06
Protein (g)	56	90.65	20.57	92.30[b]	23.67
Carbohydrates (g)	130	303.78	47.14	268.50[a]	58.28
Fibre (g)	**30**	**21.81**	**5.17**	**16.85[a]**	**6.27**
Vitamin A (RAE)	900	999.76	479.19	899.94[b]	507.54
Vitamin B1 (mg)	1.2	1.59	0.70	1.30[b,c]	0.71
Vitamin B2 (mg)	1.3	2.56	0.90	2.45[b]	1.04
Vitamin B3-NE (mg)	16	29.93	13.96	24.39[a]	15.64
Vitamin B6 (mg)	**1.7**	**1.48**	**0.56**	**1.29[b,c]**	**0.67**
Vitamin B12 (mcg)	2.4	5.48	1.99	5.24[b]	2.24
Vitamin C (mg)	90	150.38	72.85	143.45[b]	69.61
Vitamin D (mcg)	**20**	**9.13**	**2.62**	**9.78[a]**	**4.53**
Vitamin E (mg)	**15**	**6.84**	**3.35**	**4.77[a]**	**3.90**
Folate-DFE (mcg)	**400**	404.95	161.46	**265.98[a]**	**155.33**
Vitamin K (mcg)	**120***	**91.09**	**72.31**	**59.88[b,c]**	**60.40**
Pantothenic Acid (mg)	5*	6.58	2.74	6.14[a]	2.98
Calcium (mg)	**1200**	**1152.22**	**407.26**	1256.04[a]	532.98
Copper (mg)	0.9	1.09	0.51	0.95[a]	0.56
Iron (mg)	9	12.48	5.57	9.55[b,c]	5.58
Magnesium (mg)	**420**	**305.57**	**117.96**	**269.55[a]**	**130.71**
Manganese (mg)	2.3*	4.00	1.57	2.74[a]	1.54
Phosphorus (mg)	700	1496.11	438.48	1452.91[a]	494.90
Potassium (mg)	**4700***	**3271.29**	**949.82**	**3566.86[a]**	**1361.29**
Selenium (mcg)	55	108.83	56.08	76.73[a]	62.45
Sodium (mg)	2300*	3350.36	760.48	3092.65[a]	1046.49
Zinc (mg)	**11**	**9.72**	**4.06**	**8.27[a]**	**4.54**

An ANOVA was performed between the regular texture menus (n= 8) and the pureed texture menus (n= 8) across the eight LTC homes in Manitoba. Abbreviations: RDA= recommended dietary allowance; AI= adequate intake; M= male; SD= standard deviation; kcal= kilocalorie; g= gram; mg= milligram; mcg=microgram; RAE= retinol activity equivalent; NE= niacin equivalents; DFE= dietary folate equivalent. Bold text represents values under the RDA or AI.

*Represents an adequate intake rather than a recommended dietary allowance.

[a] Represents a significant interaction effect of site and texture between the two menu textures, $p<0.01$.

[b] Represents a significant site effect between the two menu textures, $p<0.01$.

[c] Represents a significant texture effect between the two menu textures, $p<0.01$.

Table 10. Comparison of pureed and regular menus as planned across the eight LTC homes from New Brunswick.

Across LTC Homes in New Brunswick					
Nutrients	**RDA (70+ M) AI* (70+ M)**	**Regular Menu**		**Pureed Menu**	
		Mean	**SD**	**Mean**	**SD**
Calories (kcal)	n/a	1727.89	310.99	1286.62[a]	347.33
Protein (g)	56	73.95	15.76	61.54[a]	17.07
Carbohydrates (g)	130	227.40	44.84	164.27[a]	53.96
Fibre (g)	**30**	**18.35**	**4.42**	**13.65[b,c]**	**4.82**
Vitamin A (RAE)	900	959.42	775.79	901.44[b]	639.42
Vitamin B1 (mg)	**1.2**	1.39	0.39	**0.94[a]**	**0.53**
Vitamin B2 (mg)	1.3	1.86	0.71	1.64[a]	1.08
Vitamin B3-NE (mg)	16	30.52	7.26	20.90[a]	10.75
Vitamin B6 (mg)	**1.7**	**1.45**	**0.34**	**1.08[a]**	**0.49**
Vitamin B12 (mcg)	2.4	5.43	8.05	4.08[b]	4.90
Vitamin C (mg)	**90**	**83.71**	**40.01**	94.91[a]	60.23
Vitamin D (mcg)	**20**	**6.19**	**4.24**	**6.06[b]**	**3.52**
Vitamin E (mg)	**15**	**4.90**	**1.58**	**4.08[a]**	**1.65**
Folate-DFE (mcg)	**400**	**320.91**	**114.63**	**188.12[b,c]**	**99.87**
Vitamin K (mcg)	**120***	**68.13**	**48.63**	**42.83[b,c]**	**37.85**
Pantothenic Acid (mg)	**5***	5.40	1.47	**4.68[a]**	**1.68**
Calcium (mg)	**1200**	**795.95**	**322.27**	**644.77[a]**	**340.33**
Copper (mg)	**0.9**	1.40	1.34	**0.80[c]**	**0.86**
Iron (mg)	9	11.83	2.53	9.36[a]	2.90
Magnesium (mg)	**420**	**278.59**	**71.34**	**183.37[b,c]**	**78.40**
Manganese (mg)	**2.3***	4.35	1.56	**2.28[b,c]**	**1.37**
Phosphorus (mg)	700	1298.59	352.51	1001.32[b,c]	324.40
Potassium (mg)	**4700***	**2655.84**	**654.30**	**2284.03[a]**	**620.10**
Selenium (mcg)	55	103.35	28.80	56.83[a]	32.49
Sodium (mg)	**2300***	2828.36	769.63	**2030.11[a]**	**650.05**
Zinc (mg)	**11**	**8.97**	**2.67**	**6.56[a]**	**3.04**

An ANOVA was performed between the regular texture menus (n= 8) and the pureed texture menus (n= 8) across the eight LTC homes in New Brunswick. Abbreviations: RDA= recommended dietary allowance; AI= adequate intake; M= male; SD= standard deviation; kcal= kilocalorie; g= gram; mg= milligram; mcg=microgram; RAE= retinol activity equivalent; NE= niacin equivalents; DFE= dietary folate equivalent. Bold text represents values under the RDA or AI.

*Represents an adequate intake rather than a recommended dietary allowance.

[a] Represents a significant interaction effect of site and texture between the two menu textures, $p<0.01$.

[b] Represents a significant site effect between the two menu textures, $p<0.01$.

[c] Represents a significant texture effect between the two menu textures, $p<0.01$.

Table 11. Comparison of pureed and regular menus as planned across the eight LTC homes from Ontario.

Across LTC Homes in Ontario					
Nutrients	**RDA (70+ M)**	**Regular Menu**		**Pureed Menu**	
	AI* (70+ M)	**Mean**	**SD**	**Mean**	**SD**
Calories (kcal)	n/a	2140.65	220.56	2108.59[a]	278.64
Protein (g)	56	92.77	17.28	96.41[a]	18.83
Carbohydrates (g)	130	278.41	34.30	274.08[a]	36.59
Fibre (g)	**30**	**20.52**	**4.89**	**19.61[b]**	**5.31**
Vitamin A (RAE)	900	1117.46	353.60	1138.00[b]	343.01
Vitamin B1 (mg)	1.2	1.71	0.44	1.71[b]	0.51
Vitamin B2 (mg)	1.3	2.50	0.40	2.59[a]	0.44
Vitamin B3-NE (mg)	16	36.22	9.79	35.67[b]	11.59
Vitamin B6 (mg)	1.7	1.80	0.48	1.84[b]	0.56
Vitamin B12 (mcg)	2.4	5.61	1.53	5.89[a]	1.76
Vitamin C (mg)	90	152.37	49.37	144.21[b]	48.24
Vitamin D (mcg)	**20**	**9.34**	**3.45**	**10.75[b]**	**3.87**
Vitamin E (mg)	**15**	**7.15**	**1.96**	**6.48[b]**	**2.41**
Folate-DFE (mcg)	**400**	**381.25**	**89.78**	**349.40[b]**	**80.93**
Vitamin K (mcg)	120*	158.11	157.33	156.47	134.27
Pantothenic Acid (mg)	5*	45.11	74.29	20.88	63.52
Calcium (mg)	**1200**	**1153.98**	**239.87**	1230.98[a]	242.47
Copper (mg)	0.9	1.34	0.28	1.37[b]	0.27
Iron (mg)	9	13.65	2.39	12.88[b]	2.29
Magnesium (mg)	420	322.21	53.05	326.59[b]	50.10
Manganese (mg)	2.3*	3.91	1.18	3.72[a]	1.06
Phosphorus (mg)	700	1609.36	234.11	1646.15[a]	284.52
Potassium (mg)	**4700***	**3489.26**	**487.78**	**3690.02[a]**	**582.97**
Selenium (mcg)	55	118.73	28.74	113.94[a]	38.83
Sodium (mg)	2300*	3144.90	755.16	3215.21[b]	610.33
Zinc (mg)	11	11.24	2.63	11.21[a]	2.97

An ANOVA was performed between the regular texture menus (n= 8) and the pureed texture menus (n= 8) across the eight LTC homes in Ontario. Abbreviations: RDA= recommended dietary allowance; AI= adequate intake; M= male; SD= standard deviation; kcal= kilocalorie; g= gram; mg= milligram; mcg= microgram; RAE= retinol activity equivalent; NE= niacin equivalents; DFE= dietary folate equivalent. Bold text represents values under the RDA or AI.

*Represents an adequate intake rather than a recommended dietary allowance.

[a] Represents a significant interaction effect of site and texture between the two menu textures, $p<0.01$.

[b] Represents a significant site effect between the two menu textures, $p<0.01$.

[c] Represents a significant texture effect between the two menu textures, $p<0.01$.

Chapter 4
Consumption of Modified Texture Food in Long Term Care

4.1 Introduction

Typically with age there is a decline in energy expenditure, thus food consumption is often reduced in older adults (14–16). This reduction can lead to a decline in macronutrient and micronutrient intake if the nutrient density of food is not maintained or improved (14–16). Poor food intake is considered the primary cause of malnutrition and poor food intake has many other negative consequences for older adults, including weight loss, muscle wasting, reduced functional status (e.g., self-eating ability), impaired psychosocial wellbeing (e.g., depression), weakened immunity, hospitalization, poor quality of life, morbidities, and mortality (11,33,111–115,121–126).

Inadequate diets are prevalent for older adults in long term care (LTC), as frailty, risk factors that impair food intake, and a high number of co-morbidities are more common among many of these residents (11,17,18,72,112,127–130). It is estimated that the average consumption of food offered in LTC is about 50% (18,28) which can lead to inadequate intake of micronutrients and macronutrients. In addition to poor food intake, planned menus in LTC are often insufficient in providing sufficient protein, energy, micronutrients, and recommended servings from Canada's Food Guide to residents; without careful planning texture modified menus, especially pureed textures, are prone to inadequate nutrient composition (45–47,85,96,97).

There are various known causes of poor food intake, some of which are related to conditions common among the older adult LTC population such as dementia (i.e. communication ability), depression (i.e. lack of appetite), stroke/cancer history (i.e. need for help with eating), poor oral health (i.e. dentition), and dysphagia or swallowing difficulties (15,27,72,89,130). These conditions are also commonly associated with a prescription of modified texture foods (MTF) (42,131); thus, older adults with a prescribed modified texture diet tend to consume less nutrients than those consuming a regular texture diet (38,43,46,96,98).

The multi-factorial causes of poor food intake for older adults consuming MTFs in LTC can be mediated by factors such as provision of adequate eating assistance, social stimulation, and person-centred care (132–141). Eating assistance executed by staff, volunteers, family, or friends can increase the consumption of food for residents through encouragement, prompting, reminding, and physical assistance (132,137–141). Social stimulation and person-centred care often co-exist with eating assistance, and these two aspects can increase food consumption for a resident by fulfilling these resident needs and promoting psychosocial interactions which is believed to foster eating during mealtimes (132–141). Other ways to increase food and nutrient consumption is through the promotion of so called "super-menus" or by fortification (i.e. vitamins, minerals added to selected foods), and/or reformed foods (21,85,88,142,143). "Super-menus" contain food components with a high nutrient density and a low volume while meeting dietary references for intake (85); an example would be to substitute water for milk products during preparation and cooking methods to maximize both macronutrients and micronutrients (85,100,107,144).

To date, research has suggested that there is variation in the consumption of energy, macronutrients, and micronutrients of pureed food. Dahl and colleagues weighed three to five days of food intake for 20 LTC residents who consumed a pureed diet to determine the variation of protein intake between two LTC homes in Saskatchewan (46). They found that daily protein consumption was 54±19g/day and energy intake was 1074±202g/day for 75 days of dietary intake (46); the large standard deviations demonstrate the variability in intake. Johnson and colleagues assessed the food intakes of two groups of female residents over the age of 65, those who consumed pureed diets (n= 20) and those who received regular diets (n= 31) in the same LTC home by estimating the percentage of each menu item consumed (none, 25%, 50%, 75%, or all) (96). Regular diet as planned contained more calories and micronutrients than the pureed diet, except for zinc and vitamin B_6 (96). Yet, there were no significant differences in the energy and nutrient intakes of women receiving the regular or pureed diets (96); both diets met current recommended allowances (96). Massoulard and colleagues assessed food consumption of 87 older adults from four LTC homes in France across three diet textures (e.g., regular: n= 49, chopped: n= 12, and mixed: n= 26) using either a one day weighed food intake or a diet survey (145). There was no difference in caloric intake among the three diet textures, however protein intake was significantly different and participants consuming a mixed texture (1.2 g/kg/d, p<0.0005) had higher protein intake as compared to those on a normal (1.0 g/kg/d) or chopped diet (1.0 g/kg/day) (145). These findings could be hypothesized to be due to higher staff to resident ratios allowing staff to be more attentive to assisting residents who consumed modified texture food, or by the food service making quality in-house pureed with nutrient dense recipes (e.g., nutritive fluids used for blenderizing rather than water). Yet, these three studies did not assess any covariates for food intake, which are believed to mediate food consumption for residents prescribed MTFs.

Nowson and colleagues assessed a one-day dietary intake of 139 older adults in one Australian LTC home, by weighing each food item offered then estimating the proportion of each food item left on the plate to estimate consumption (43). Specifically they assessed macronutrients, fibre, calcium, and vitamin D intake in three diet types (full, soft, pureed) for three meals breakfast, lunch, and dinner (43). Those on soft and pureed diets consumed significantly less energy, protein, calcium, and fibre compared to those on a full diet; however, the nutrient density did not differ between the three diet types as served (43). Wright and colleagues compared a weighed 24-hour dietary intake of energy and protein in 30 older adults consuming a texture modified diet to 25 older adults consuming a regular hospital diet in a elderly and neurology ward in one hospital in the United Kingdom (38). Individuals consuming a texture modified diet had significantly lower intakes of energy (927 versus 1462 calories, $p < 0.0001$) and protein (40g versus 60g, $p < 0.003$) compared to individuals who consumed the normal hospital diet (38). As well, the energy and protein intake was more likely to be low for those on the modified texture diet when compared to the estimated requirement (38). This suggests that even if MTFs are planned to provide the nutrient requirements, other factors influence consumption leading to potentially inadequate intake. Nowson and colleagues did assess eating ability (i.e. no impairment versus impaired) and eating assistance (i.e. self feeding, partially self-fed, and full self-fed) for intake of the three diet types in their sample (43). They found no differences in daily nutrient intake between those with eating impairments and those with no impairments and they also found that self-feeding ability had no effect on energy, protein, calcium, and fibre intakes (43). Wright and colleagues assessed whether participants consuming a texture modified diet finished their meals and if they received the correct meal ordered; they found that only 13% finished their meal and also 13% had the correct food delivered (38). This could partially explain the lower dietary consumption in this group (38). A single day of intake may not be sufficient to fully determine potential differences in intake and their association with potential mediators. Other covariates that could have influenced food intake were not assessed in either study.

Bannerman and colleagues examined a three-day dietary intake of 15 residents consuming a regular diet as compared to 15 residents consuming modified texture diets using weighed food assessment methods (79). Residents consuming a modified texture diet had significantly lower intakes of energy (1312±326 calories versus 1569±260 calories, $p<0.024$) (79). There were no significant differences between the groups for consumption of protein and when energy, protein, non-starch polysaccharides, and fluid were compared to the United Kingdom requirements (79). However, all but protein were below the United Kingdom's dietary reference values for both groups (79). Bannerman and colleagues assessed eating assistance and found that energy and fluid intake were lower in participants that required eating assistance (i.e. 13/15 in modified texture group and 4/15 in regular group) compared to individuals who were independent (79). To date, this is the best study to assess food intake in MTF, however it was conducted in a single home and it did not exclusively examine residents consuming pureed diets to determine what influences intake specifically in this group. As well only a few relevant covariates were assessed (79).

Research to date has limitations for determining the adequacy of pureed food consumption and the factors that are associated with this intake. The majority of the studies assessed participants consuming a modified texture diet and did not solely focus on pureed diets; this is a gap in the existing literature that needs to be addressed as residents on this texture are found to have inadequate intakes. Variation exists in how food intake is assessed, and with single days (38,43,145) or visually estimating the intake (38,43,96) impacting the accuracy of results. Most studies are based on small sample sizes of pureed consumers and were conducted in only one or two settings (46,96), therefore they lack generalizability. Few compared the modified texture diet to requirements (38,79,96), with two of the studies contrasting consumption with the Dietary Reference Intake (DRI) (79,96). Even within pureed consumers there is variation in food intake, with some individuals consuming more than others because of the numerous factors that are associated with pureed consumption (e.g., eating assistance, dementia) (38,43,79), as well individuals on a pureed diet tend to consume less than regular (46,96). Existing research did not investigate a variety of covariates beyond eating assistance that may explain why differences in MTF consumption were observed (38,43,79); these covariates are often very highly associated with consumption of a pureed diet (19,21,25–27,33,34,36,40,51,95,100,101,137,146–149) and are thus confounders when making contrasts across textures. Key covariates to consider are use of commercially prepared food which can vary in sensory appeal and nutrient quality (21,100,101,146), the requirement of eating assistance and prompting (19,25–27,33,34), the amount of time to eat (40,95,137,147–149), and oral health and dysphagia (19,27,36,51). A better understanding of the importance of covariates which lead to variation in consumption with pureed consumers is needed as prior work has shown considerable variation, with some eating nutrients close to regular texture consumers (29,55). This study will answer the following research questions: a) How does the current dietary intake (energy; carbohydrates; protein; micronutrients; fibre) of residents in LTC homes represented in the Making the Most of Mealtimes (M3) sample consuming a pureed diet compare to the DRI? and b) What covariates are associated with energy and protein intake within this group?

4.2 Methodology

4.2.1 Sample and participants

The M3 study, a cross-sectional multi-site study across Canada, was designed to determine the associations between inadequate food and fluid intake among residents living in LTC and the multi-level influences and multi-factorial causes of this intake (52). The comprehensive data collection included gathering data at the provincial, home, unit, staff, and resident levels to ascertain the determinants of meal access, meal quality and the mealtime experience of residents, hypothesized to impact their food and fluid intake (11,52). The goal of the M3 study was to identify how to improve food and fluid intake among residents and thus nutritional status, and also to inform future intervention studies (11,52).

A total of 32 LTC homes were recruited across four different provinces (8 homes per province) in Canada: Alberta (AB), Manitoba (MB), Ontario (ON), and New Brunswick (NB) (52). Eligibility criteria for LTC homes included the following: 1) in operation for at least six months; and 2) having a minimum of 50 residents who met the resident eligibility criteria, which will be described below (52). For-profit and not-for profit homes were recruited and diversity in the sample was also attempted by including homes where a high proportion of individuals were from cultural minorities, independent operators and large corporations, rural or urban settings and faith-based homes (52). Within each LTC home, one to three units with residents that met the eligibility criteria were randomly selected and participants were then randomly sampled from the unit or units for participation (52). If it existed within the home, a behavioural or dementia unit was selected (52).

The eligibility criteria for residents were the following: 1) resided in the randomly chosen units; 2) were over the age of 65 years; 3) required a minimum of two hours per day of nursing care for activities of daily living; 4) resided in the LTC home for a least one month; and 5) either they or their decision maker provided informed consent for participation in the study (52). The exclusion criteria were as follows: 1) resided in the LTC home for less than a month; 2) were medically unstable (i.e. recent hospitalization); 3) were on short term admission to the LTC home; 4) required tube feeding; 5) residents who were not eating because they were on end of life care; 6) had advanced orders excluding them from any research; 7) they did not eat in the dining room, or 8) they or their decision makers were unable to understand English, French and in the case of Ontario, Cantonese (52). Based on inclusion and exclusion criteria, 20 residents from each home (n=32 homes, 8 homes per province) were recruited, for a total of 639 participants (one participant withdrew consent) included into the study for data collection (52). For this analysis, only residents consuming pureed food were analyzed (n= 67) as a prior analysis has examined covariates associated with energy and protein intake in the entire sample (52).

4.2.2 Data collection and measures

Four provincial project coordinators (one per province) were comprehensively trained in person on all procedures and each coordinator trained two research assistants (n= 8, 2 per province) on the collection mealtime observation data including food intake (52). Dietary intake for participants in the M3 sample was determined by the weighing or estimating of food and fluid intake for three non-consecutive days, including a weekend day, to reduce within-subject variability and day-of-the-week effects (52). Weighing is considered the most accurate method, when a duplicate portion with chemical analysis is not possible (71). Thus, the main plates at breakfast, lunch, and dinner were weighed before consumption, one food at a time, and the remaining food was subtracted to determine the portion consumed (52). Any wasting or spillage of food was also subtracted (52). Side dishes and fluids at breakfast, lunch and dinner, but also any snacks between meals were estimated using the following protocol to ensure accuracy: predetermined portions in the detailed production menu of the LTC home were used; portion or cup sizes were measured before estimation occurred to confirm volumes; meal components were checked with the food service manager and/or dietary staff to ensure that substitutions were not made; and confirmed with staff and family whether any other food or fluids were consumed including oral nutritional and micronutrient supplements (52). Data collection of dietary intake for participants only occurred when they were present in the home for that meal (52).

Subsequently, collected data was entered into the Food Processor software (Version 10.14.1) by the trained research assistants (n= 8, 2 per province) who collected the food consumption data using the Canadian Nutrient File where appropriate for foods based on Canadian fortification practices (52). The diet texture consumed during mealtimes (breakfast, lunch, dinner) and between meals (snacks) was noted by the research assistants on the food intake form during mealtime observations (52). Only residents consuming a pureed diet were considered in this analysis (n= 67) and residents had to have a minimum two days (six of nine meals) of food intake data (52); however one participant had a missing current body weight and as the outcome variables were energy and protein intake per kilogram body weight, this participant was removed from the regression analysis. Further, only females (n= 51) were included in the analysis comparing food consumption to the DRI since these recommendations are gender specific and the sample size of male participants (n= 16) was insufficient for the nutrient adjustment procedure (102). This comparison to the DRI only included dietary intake (including any oral nutritional supplement drinks) and excluded micronutrient supplementation (e.g. pill formulations). Each day's energy, macronutrient, micronutrient, and dietary fibre intake per participant was calculated and then subsequently the average across three days per participant was calculated. Values for energy, protein, micronutrients, and fibre were compared with DRI values obtained from the United States National Academy of Sciences and Institute of Medicine (103,150–153). Daily energy and protein intake per kilogram of body weight was calculated for each participant using their current recorded weight, then averaged across the three days and used in the multivariate analysis (52). This was used to standardize intake based on body size to examine potential covariates that could explain variance in food intake among those consuming this texture. Body mass index (BMI) was calculated by using the ulna length as an estimate of height (52,55–57), which was assessed by the four project coordinators using standardized measures (52). Ulna length was used as it is a more accurate calculation of BMI for older adults and has a higher sensitivity compared to using knee height (55,56,58). The BMI for each participant was categorized into three groups for the analysis; a BMI of <18.5 kg/m^2 which indicates the individual is underweight, a BMI of 18.5 kg/m^2 to 24.9 kg/m^2 which indicates normal weight, and a BMI of ≥ 25.0 kg/m^2 which indicates overweight (61,154).

Based on the prior literature discussed above, the following covariates were considered in the bivariate and subsequent multivariate analysis. The various resident characteristics gathered from their medical records or collected using standardized procedures by the project coordinators that were used in this analysis included: age, gender, total number and type of major diagnoses using the InterRAI diagnostic checklist (stroke, dementia, Parkinson's disease, rheumatoid arthritis, osteoporosis, and osteoarthritis), supplementation (oral nutritional, micronutrient), total number of drugs, if family routinely brings in food for the resident, and the prescribed diet texture per participant (52). The interRAI LTCF assessment provided further information on resident characteristics, and relevant aspects included: cognitive performance scale (CPS) (CPS <2 or 3+, where 0 represents intact cognition and 6 represents very severe impairment) and the activities of daily living long form scale (ADL-LFS) (52,70). The interRAI LTCF assessment scales were included as a covariates and were used in either an ordinal or categorical manner for the analysis (52). To ensure accuracy and currency, the research staff completed the interRAI LTCF assessment by interviewing home staff familiar with the current care of the resident (52).

Assessment of residents at risk of dysphagia was based on a composite measure (52). All residents currently prescribed thickened fluids were categorized as at 'dysphagia risk' (52). For those residents who could comply with a risk evaluation using the Screening Tool for Acute Neurological Dysphagia (STAND) assessment (i.e. water and applesauce swallowing test) (52,62) and demonstrated challenges, they were classified as at risk. Finally, a subset of individuals who could not comply with the STAND assessment, but demonstrated 'sometimes' or 'often' coughing and/or choking during two of the three days of meal observations, but were not already on thickened fluids were also categorized as 'at risk' for dysphagia (52). The oral health and dentition of participants was determined from the Oral Health Examination, where a dental hygienist completed a standardized oral assessment based on 13 items with sub-questions, each item pertained to a specific aspect of oral health observed (52,65). A summary item completed the assessment, which was a subjective rating by the hygienist based on their standardized assessment; using a rating from 1 to 5, did the hygienist believe the oral health status could influence food intake of the participant (1= not/unlikely influenced; 5= food intake significantly impacted by oral health) (52). This single item provides a practical variable for categorizing participants' oral health status. This item was further categorized into two groups (0, 1 vs. 2+) for the analysis with consultation from a member of the M3 team who is an oral health expert (52).

The Mini Nutritional Assessment short-form (MNA-SF) was completed for each participant. The tool gathers information on changes in food intake, mobility, BMI, weight change, and dementia and depression diagnoses; the latter three aspects were obtained from the participants' health record and BMI was calculated as described above. To complete the MNA-SF the project coordinators observed the participant and asked them or their care staff about mobility and changes in food intake. The MNA-SF identifies nutrition risk and provides a score from 0 to 14, where a score of ≥ 12 indicates satisfactory nutritional status and a score of ≤ 11 implies a risk of malnutrition (63,64). The MNA-SF score was used in a numerical manner for the analysis. This tool is commonly used to screen for malnutrition among long term care populations and is validated to identify risk of or malnutrition itself (19,63,64).

Further, the two research assistants in each of the four provinces who observed food intake for three non-consecutive days, including a weekend day, also completed other mealtime observations (52). For one meal per day, they completed a more detailed assessment which included the standard and valid Edinburgh Feeding Evaluation in Dementia Questionnaire (Ed-FED) that assesses eating and feeding issues in older adults with dementia (52,66). This form also, tracks "other eating challenges" during mealtimes (i.e. chewing problems, lack of energy) (67–69). Each question is based on an ordinal scale (1= not applicable or never; 2= sometimes; 3=often) to make it consistent with the Ed-FED (66–69). The questions in the "other eating challenges" section were based on challenges derived by the research team to further capture eating challenges using the same scoring, but have not been tested for validity and reliability (52). The total score of each, Ed-FED and "other eating challenges", were separately averaged over the three meals observed for use in this analysis. Additionally, the single question on Ed-FED (i.e. Does the resident require physical help with feeding/eating?) was left categorized as three groups for analysis (0= no physical assistance required; 1= sometimes physical assistance is required; and 2= often physical assistance is required to eat during mealtimes). Other individual questions from Ed-FED and "other eating challenges" were categorized into two groups for the analysis (0= never/not applicable; 1= sometimes or often). The average length of a meal per participant in minutes was also used in the analysis and determined from the average recorded for up to nine meals observed (52). The number of staff providing eating assistance to each resident during mealtimes was recorded by the research assistants and the median number for up to nine meals observed was used in this analysis (52). Information regarding the quality of eating assistance provided to the resident was gathered from the Relational Behaviour Scale (RBS), also completed by two research assistants per province at one meal per day over three days (i.e. including a weekend day) for each resident that required full eating assistance (155). The RBS contains three questions each scored from one to seven (1= low intensity of relational care and 7= high intensity of care) (155), and the total score for each meal was averaged for up to three meals and used in the analysis.

4.2.3 Data analysis

A secondary data analysis was performed. Data were analyzed using Statistical Analysis System software for Windows (Version 9.4). To examine resident characteristics, descriptive statistics were used to compute means for continuous variables and proportions for categorical variables; a Student t-test was used to contrast numerical resident characteristics between females and males, while a Chi-square test was used contrast categorical characteristics by gender. The dietary consumption for participants over the three non-consecutive days was averaged to compute the mean intake for continuous nutrient variables (i.e. dietary values for energy, protein, micronutrients, and fibre). The average intake by nutrient was adjusted for within participant variation using the procedure proposed by the National Research Council for estimating usual dietary intake distributions

(156,157). The data was log-transformed before using an analysis of variance (ANOVA) to obtain the intra-individual variability for each nutrient for the adjustment procedure (156,157). Then percentile distributions were calculated for each nutrient and compared to the appropriate DRI values to determine the proportion of participants below the Estimated Average Requirement (EAR). This procedure is known as the EAR cut-point method, which used the adjusted distribution of "usual" intake to determine the percentage of pureed consumers with potentially inadequate diets for the whole M3 sample (71,102,157). This method was compared to the percentile distributions to estimate the prevalence of inadequate intake within the group and was calculated by determining the percentage of individuals in the group with usual intakes below the EAR, which is the median usual intake value at which 50% of the population needs are met (71,102,157). For nutrients without an EAR and fibre, the Adequate Intake (AI) value was used instead to compare the median intake for that nutrient (71,102,157). In this case, groups with median intakes at or above the AI value were assumed to have a low prevalence of inadequate intakes, however no assessment of inadequate intake can be performed (71,102,157). The EAR cut-point method cannot and was not used for energy since the intake and requirement are strongly correlated. Therefore the energy, carbohydrate, protein, and dietary fibre intakes among BMI categories within the group of female pureed consumers was assessed using an ANOVA and then Tukey's test for multiple comparisons. Statistical significance was set at $\alpha = 0.05$.

To determine factors significantly associated with pureed food consumption, only the three-day average energy and protein intake per kilogram (kg) of body weight was used as the dependent variable. Multiple linear regression analysis was used to determine those factors significantly and independently associated with energy and protein intake while adjusting for relevant covariates. The average energy and protein intake per kilogram of body weight, the dependent variables, are continuous and were used in a numerical manner for this analysis. Further, energy and protein intake were modeled per kilogram to account for the body weight of participants. All ordinal variables were dichotomized for analysis except the variable regarding physical assistance required during mealtimes, which was left into the three categories. First, bivariate analyses were conducted between average energy intake per kg and all relevant covariates to determine which variables would be included. All covariates from the bivariate analyses with a p-value of <0.30 were added to the model for the dependent variable, adjusting for age and gender. Subsequently, using backwards elimination, variables within the model that contributed the least based on their R square value were manually deleted from the model at each step until at least all variables in the model had a p-value of <0.05, which was based on the smallest decreases in the model sum of squares value as non-significant variables were removed. This method was repeated until no variable could be eliminated without adversely affecting the R square value in the final model. Further, multicollinearity was assessed by inspection of the correlation matrix to detect high correlations (R square values) among independent variables; Pearson correlations of >0.60-0.70 between independent variables was a sign that multicollinearity existed in the model. Appropriate steps were taken to remove the collinearity that was present between two covariates (i.e. total eating assistance as per RBS and physical assistance required during mealtimes), where separate regression analyses were run for each collinear covariate in the model; the final models were identical. Further, clustering within homes and provinces was not accounted for through statistical methods because covariates included in multivariable analyses were only at the resident level. To understand the final model, an ANOVA was used to compare the Ed-FED score, "other eating challenges" score, and the length of the meal across the number of staff assisting during mealtimes (e.g., 0, 1, 2), while chi-square tests were performed to compare several questions from the Ed-FED score and "other eating challenges" sections across the number of staff assisting during mealtimes. Statistical significance was set at $\alpha = 0.05$.

4.3 Results

4.3.1 Resident characteristics

Table 12 displays the characteristics of residents consuming a pureed diet as a whole and also by gender. Female participants made up the majority of the sample, 76.12% (n= 51), while 23.88% (n= 15) were male; there were no significant differences between females and males across the resident characteristics. The mean age for the 67 participants from the M3 sample who consumed a pureed diet was 87.12 years (standard deviation (SD)= 7.58); with a comparable average age across each gender. Further, a large proportion of the sample had a risk of dysphagia, 73.13% (n= 49), and a diagnosis of dementia, 86.57% (n= 58); these findings were comparable across each gender (refer to Table 12). The mean number of diagnoses for this sample was 4.97 (SD= 2.14) and the mean number of drugs prescribed in this sample was 6.25 (SD= 2.97). More than half of the sample was on oral nutritional supplementation (56.72%, n= 38) and micronutrient supplementation (61.19%, n= 41); again these findings were comparable across each gender (Table 12).

4.3.2 Resident intake and comparison to the dietary reference intake

Table 13 displays the energy, nutrient, and fibre intake relative to the BMI for female residents consuming a pureed diet. More than half (58.82%, n= 30) of the participants had a BMI that was considered to be in the normal weight category (18.5 kg/m^2 - 24.9 kg/m^2) as defined by Health Canada. A total of 11 participants (21.57%) had a BMI that was considered underweight (< 18.5 kg/m^2) while 10 participants (19.61%) had a BMI that was considered overweight (≥ 25.0 kg/m^2). There were no statistically significant differences across the BMI categories for energy, carbohydrate, protein, and dietary fibre intake ($p>0.05$, Table 13). A trend was found across the nutrient comparisons with an increased intake for those in the highest BMI category. However, an opposite trend was found for energy and protein intake per kilogram of body weight, where intake standardized for body weight was highest for the underweight category.

Table 14 illustrates the estimated usual intake percentile distributions for nutrients with EAR values for female residents consuming a pureed diet. The estimated prevalence of inadequacy for protein for the sample was more than 10% but less than 25%. A total of 17 micronutrients with EAR values were analyzed in this analysis. The results indicated that the sample of residents had an estimated prevalence of inadequacy of less than 5% for only two micronutrients; they were niacin and vitamin C. Nutrients where more than 50% were estimated to have an inadequate intake using the EAR cut point method were: vitamin B6, magnesium, calcium, vitamin D, vitamin E and folate. Table 15 shows the estimated usual intake percentile distribution for dietary fibre and nutrients with AI values for female residents consuming a pureed diet. Five micronutrients with AI values were analyzed in this analysis. The median intake for dietary fibre was 10.70 grams and it was well below the AI value of 21 grams; 99% of participants consumed less than this recommendation. The median intakes for vitamin K (41.63 micrograms) and potassium (2174.59 milligrams) were below their respective AI values for those over the age of 70 years.

4.3.3 Exploratory characteristics of residents consuming pureed diets

Both energy and protein intake standardized for body weight followed a normal distribution, with standard deviations being relatively large (Figure 1 and 2). With the recognition that there is variation in intake, this analysis explored what resident-level factors may explain this variation. Results from the multiple linear regression analysis illustrating variables independently associated with energy intake (calories) per kilogram of body weight for consumers of a pureed diet, while adjusting for age and gender are presented in Table 17. A significant regression equation was found using the backward elimination method for energy intake ($F(3, 62)= 2.95$, $p= 0.04$, $R^2= 0.13$). This regression analysis revealed that age and gender did not significantly predict energy intake (calories) per kilogram of body weight for residents consuming a pureed diet (Table 17) and the only independently associated variable was the number of staff assisting during mealtimes. This association was negative indicating that the higher the number of persons assisting the individual at meals then the lower their energy intake was during that meal ($\beta= -6.74$, $SE= 2.38$, $t(62)= -2.84$, $p= 0.01$). A similar model was built for protein intake (grams) per kilogram of body weight (Table 18; ($F(3, 62)= 4.60$, $p= 0.01$, $R^2= 0.18$) with the only significant covariate being the number of staff assisting during mealtimes ($\beta= -0.43$, $SE= 0.12$), $t(62)= -3.59$, $p= 0.001$). Due to this negative association, it was hypothesized that residents consuming more pureed food might have had more eating challenges, resulting in more than one staff member attempting to assist the resident. Table 19 illustrates Ed-FED and "other eating challenges" scores and specific questions and their association with the number of staff assisting during mealtimes for residents consuming a pureed diet. The Ed-FED total score was significantly associated with the number of staff assisting during mealtimes, as well as the total score for "other eating challenges". Scores were higher among individuals that had one or two staff assisting them during meals compared to no staff assisting, meaning these individuals had more eating and feeding challenges. There were some aspects of the Ed-FED and "other eating challenges" that were significantly associated with the number of staff assisting during mealtimes. Specifically, a higher proportion of residents who sometimes or often required close supervision, required verbal prompting or physical help while eating were more likely to have one or two staff assisting them during mealtimes. Other specific challenges also appeared to be more common for those requiring two persons to assist, however due to the small numbers in this category, were not significant in this exploratory analysis.

4.4 Discussion

4.4.1 Resident intake and comparison to the dietary reference intake

Our findings suggest that energy, carbohydrate, protein, and dietary fibre intakes increased across the three BMI categories (i.e., underweight, normal weight, overweight) for the sample of female residents living in LTC consuming a pureed diet, but the increases were not statistically significantly different. There was an opposite trend when energy and protein were standardized by body weight in kilograms, with still no significant differences of intake between the BMI categories.

The distribution for energy and protein intake per kilogram of body weight displayed variation and intake was quite normally distributed (Figure 1 and 2). This study also compared protein, carbohydrate, and micronutrient intakes to the appropriate DRI for those over the age of 70 years and found that the prevalence of inadequate intake for the sample widely ranged depending on the specific nutrient, although only six nutrients (vitamin B6, vitamin D, vitamin E, folate, calcium and magnesium) had potential inadequacy for 50% or more of the sample. Few studies have examined the dietary intake of residents living in LTC consuming pureed diets. To our knowledge, this is the first Canadian multi-site and multi-regional study to determine the dietary intake of energy, carbohydrates, protein, micronutrients, and dietary fibre in a diverse sample of LTC residents consuming a pureed diet and compare those intakes to the DRI.

Of the six studies that investigated consumption of MTDs among residents living in LTC, only two studies measured the BMI of participants. A study from Scotland found that 60% (n= 9 of 15, three sites) had a BMI of less than 18.5 kg/m^2 (79), and a study from France found that 8.05% (n= 7 of 87, four sites) were malnourished based on a composite measure including a BMI of less than 21 kg/m^2 (145). The current study from a more representative sample found a proportion with a low BMI that is between this range at 21.57%. Differences may be due to lack of representativeness of samples from prior studies due to recruitment of participants from few sites (< 5) as well as inclusion of other modified textures in the sample (55,56). According to the European Society of Clinical Nutrition and Metabolism (ESPEN) an individual with a BMI of less than 18.5 kg/m^2 is diagnosed as malnourished (61). Based on the findings of this study, a pureed diet is not necessarily a key contributor to being malnourished in LTC, which is inconsistent with prior work (38,79,145) and in this study only with pureed consumers, malnutrition as measured by MNA-SF was not associated with energy and protein intake. Prevalence of malnutrition was found to be lower in this study compared to prior research possibly because of the many factors that play a role in the risk of malnutrition (19,27). This sample may have a higher proportion of individuals consuming adequate levels of nutrition due to provision of person-centred care, quality eating assistance, and/or nutrient dense diets, therefore weight loss might have been reduced.

Previous literature examining the energy, carbohydrate, protein, and dietary fibre intakes across BMI categories in a LTC population consuming pureed or MTDs is very limited. One study did assess intakes across nutritional status based on BMI, weight loss, and Mini Nutritional Assessment score (145). Findings were consistent with this study with respect to the association between BMI and energy and protein intake and significant differences were found. Lack of statistical significance in the current study may be a result of, the majority of pureed consumers being within the normal weight category.

Of the six studies that investigated consumption of MTDs among residents living in LTC, three of the studies compared energy and protein intake to requirements (38,79,96), with only one study also examining micronutrients and comparing intake to requirements (96). We believe the estimates of intake and comparison to requirements in the M3 study to be an advancement to existing research. The median energy (1466.66 calories, SD= 376.13) and protein (57.49 grams, SD= 19.66) intakes found in this study are within the broad range demonstrated in this previous literature. The average energy intake across prior studies ranged from 908 calories to 1786 calories, meanwhile the mean protein intake ranged from 40 grams to 78 grams (38,43,46,79,96,145). The wide range illustrated across studies could be related to the various countries and settings they were conducted in (38,43,79,96,145), with only one study being Canadian (46). Some of the studies sampled participants from only a few LTC homes (e.g., one to four facilities) (38,46,79,96,145), combined all MTDs together for analysis (e.g., bite-sized, chopped, soft, minced, pureed) (38,79,145), or used either a one day weighed intake or visual estimates to measure dietary intake (38,43,96,145). Thus, this current analysis provides a stronger basis to our understanding of the consumption of food by residents prescribed a pureed diet. However, it is notable that there is a range of intake with our study with the only modifiable covariate being number of staff assisting the resident at a meal.

Protein intake was generally adequate in this sample with more than 10% but less than 25% not consuming adequate amounts, using a standardized requirement of 0.8 g protein per kilogram of body weight (102). Some suggest as high as 93% of participants consumed inadequate amounts of protein (38), while others found protein intake for persons requiring a MTD to meet recommendations (79,96). Differences in samples (e.g. elderly wards at one hospital); (38), how diet was assessed as well as regional differences in menu planning. The median dietary fibre intake of 10.70 grams (SD= 3.73) per day is consistent with a previous study reporting low consumption of dietary fibre among institutionalized older adults (43).

Micronutrients examined in this study that were consumed below the recommendations are consistent with some of the findings from the only study that has previously examined micronutrient intake of older adults living in LTC consuming pureed food (96). Consistent with this work, calcium, vitamin D, folate, and vitamin B6 were estimated to be consumed at inadequate amounts (96). However, the current study found additional micronutrients that were estimated to be consumed at inadequate amounts: vitamin E, riboflavin, and vitamin B12 (96). There were also several micronutrients that were examined in this study but not in the previous work, specifically: vitamin A, niacin, copper, magnesium, phosphorus, selenium, vitamin K, pantothenic acid, manganese, and sodium. All of these nutrients were consumed at inadequate amounts with only niacin having an estimated low prevalence of inadequacy (<5%) in the current study. The discrepancies between this study and the previous one could be explained by different DRIs used in each study. The prior study which was conducted in 1995 used the Recommended Dietary Allowance (RDA) values from 1989 for women over the age of 51 years (96). This study used the updated EAR or AI values for women over the age of 70 years to compare the median intake of nutrients and used the EAR cut-point method, while adjusting for the usual intake distribution of the sample. This is a more accurate method for determining the estimated prevalence of inadequacy for nutrients (71,102,157). Moreover, the earlier study was conducted in only one LTC home in the United States using a sample of 20 female residents consuming a pureed diet and a visual estimated method was used to assess food intake. The M3 study which compared intake of 51 female participants consuming a pureed diet from across 32 LTC homes in four provinces provides the current best estimates with respect to adequacy of dietary intake for this highly vulnerable resident group. In line with other literature assessing the micronutrient intake of older adults consuming primarily regular texture diets, participants consistently consumed many of the same micronutrient intakes in low amounts (158–160).

Looking at the findings from this study and across the existing literature on dietary assessment of older adults, the observations illustrate that relatively high proportions of this population are consuming inadequate amounts of numerous micronutrients (96,158,159,161). Inadequate or low intake of nutrients may have significant implications for both nutritional and function status, especially among institutionalized older adults with co-morbidities, eating difficulties, dysphagia, cognitive impairment and are consuming a low quality pureed diet (i.e. nutrient density, palatableness) (18,19,26,27,33,34). Improving the nutrient density of MTFs through "super-menus" is just one way to support older adults in meeting their respective DRIs (85,100,107,144). For example, substitution and/or addition of food items and ingredients that contain more nutrients, such as red peppers instead of green ones or adding dairy products during cooking methods, in order to increase consumption of both macronutrients and micronutrients (85,100,107,144). Key nutrients to focus on include vitamin B6, vitamin D, vitamin E, folate, calcium, magnesium since prevalence of inadequacy was high (> 50%), as well as fibre, vitamin K, and potassium since they were below the AI. Examples of ingredients and foods, which contain these key nutrients are salmon, chickpeas, milk, cheese, almonds, sunflower seeds, beans, spinach, sweet potatoes, kale, and lentils (162,163).

However, supplementation or fortification of macronutrients and micronutrients may be warranted in this population to prevent malnutrition, frailty, and nutrient deficiency if DRIs cannot be met solely through dietary sources (21,85,88,142,143). In the M3 study, supplementation (both oral nutritional and micronutrient) were prescribed to the majority of female residents consuming pureed diets; 58.82% (n= 30) were on oral nutritional supplementation and 62.75% (n= 32) were on micronutrient supplementation. Although, the objective of this study was to examine dietary intake only, the prevalence of inadequate intake for nutrients may have included micronutrient supplementation, as oral nutritional supplementation contents were analyzed as well.

4.4.2 Exploratory characteristics of residents associated with consuming pureed diets

The M3 study also provided the opportunity to explore factors associated with energy and protein intake among residents consuming a pureed texture living in LTC. This is the first analysis that has attempted to explain factors that are associated with intake *within* persons consuming only this texture. As noted in Figure 1 and 2, intake of energy and protein was variable and understanding if this variability can be modified is important for future intervention work. Prior work has identified covariates associated with intake when comparing pureed to other textures and significant covariates tend to be factors highly associated with consuming this texture, such as dementia status (43) and requiring eating assistance (43,79). When adjusted for age and gender, only average number of staff assisting with a meal was independently associated with both energy and protein intake. As the number of staff increased during mealtimes the amount of energy and protein intake per kilogram of body weight decreased. The results from another study with pureed consumers that examined covariates of food intake were contrary with what this study found. Nowson and colleagues examined eating ability and feeding assistance level and found no differences in daily dietary intake between those with and without an eating impairment, and also self-eating ability had no effect on nutrient intake (43). However, they did not assess type and number of specific eating challenges. Person-centred care and the quality of assistance could also explain this discrepancy between the studies (164).

Individuals on MTDs in LTC are likely to have a decreased ability to self-feed and need eating assistance from staff members during mealtimes (73,164). In this study almost 80% (n= 52) required some or frequent eating assistance. Previous research on eating challenges and person-centred care during assistance could further explain our findings. Eating difficulties during mealtimes can impact food intake if adequate assistance is not provided from staff (83,84). This study found that

Ed-FED and "other eating challenges" scores were significantly associated with number of staff assisting; and more specifically the proportion of residents that sometimes or often required close supervision, physical help while eating, received close supervision with eating, and received verbal prompting to eat was associated with number of staff assisting. Further, there was a trend to longer average duration of mealtimes for residents that had two staff assisting during mealtimes compared to one or no staff assisting them, although findings were not significant. Prior work suggested longer mealtimes for residents receiving assisting from two staff (84,164). Staying with the resident during the entire care period increases food intake by promoting consistency in care. Other confounding factors could also be contributing to the relationship between the number of staff assisting during mealtimes and energy and protein intake, which were not assessed in this study. For example, staff's attitude towards eating assistance, supports in place to promote quality eating assistance, or time constraints of staff could also influence intake (164,165). The low R^2 values from the multiple linear regression analyses indicate that only 13% of the variation in energy intake was explained by the resident level variables and 18% for protein intake; both values are low and do not explain much of the variation for intake. Further, the lack of association with demographic, health and functional variables suggests that residents consuming pureed diets are relatively homogenous. Specifically, almost all consumers had dementia, were female, were above the median age, and were prescribed supplementation; this could be a potential reason for finding only one resident level variable independently associated with energy and protein intake. Future work should consider other factors that may be associated with eating assistance to better understand variation in intake. There is the potential that home level covariates (e.g., proportion of commercial versus in-house production of MTFs, person directed care, and raw food cost), which are known to impact energy and protein intake (Chapter 3: Quality of the Regular and Modified Texture Menus as Planned in Long Term Care, Tables 5 and 6) are also relevant and should be considered in future work.

4.4.3 Strengths and limitations

Due to the design of the study, which is cross-sectional in nature, causality with respect to resident characteristics that truly lead to low intake cannot be inferred. Yet, this is the first study that has attempted to determine factors associated with intake in this most vulnerable group of residents. A limitation of this study was that the sample size of male participants consuming a pureed diet was too small to estimate "usual" intakes using the nutrient adjustment procedure. Also, nutrients with an AI value could not be assessed for inadequacy and it could only be assumed that the group had a low prevalence of inadequate intake if the median nutrient value was at the AI value or above. Even nutrients with an EAR value are only estimates and the true prevalence of inadequacy is unknown. The World Health Organization and ESPEN have recommended standards for BMI categories (< 18.5 kg/m^2; 18.5 kg/m^2 - 24.9 kg/m^2; ≥ 25.0 kg/m^2), which were used in this study. However, literature has suggested different cut points for older adults over the age of 65; for example, a BMI of < 20.0 kg/m^2 may be considered underweight (166). If these suggested cut points were used instead then this would not only change the proportion of residents in each category but also the average intake of energy, carbohydrate, protein and fibre across the BMI categories. Another limitation is the set sample size of 67 participants consuming a pureed diet since this study is a secondary data analysis of the M3 study. Although this is a robust sample in that it was randomly selected from 32 homes and provides better estimates than prior work with respect to prevalence and estimation of intake, the sample was not purposely selected to address this research question. Due to the small sample size available, only resident-level variables were assessed to identify potential factors independently associated of their energy and protein intake within pureed consumers. Additionally, as only one to two residents per LTC home consuming a pureed diet were included in the analysis from across the 32 homes, analysis of home-level characteristics was considered inappropriate. Similarly, interaction effects could not be examined because of the small sample size.

As compared to previous studies, this study contains several strengths. To date this is the largest sample size used to estimate nutrient inadequacies among consumers of a pureed diet; a total of 51 female residents from 32 LTC homes across four provinces from the M3 study were included. The nutrient intake was adjusted for within participant variation using a valid procedure proposed by the National Research Council for estimating “usual” intakes (102,157), making the findings more accurate. To further increase the precision of results, three days of weighed food intake was recorded for each resident, which included three meals per day and snacks. Additionally, this is the first and only Canadian study to comprehensively examine resident characteristics impacting energy and protein intake of individuals consuming a pureed diet as previous research has only studied a few factors across textures. Finally, energy and protein intakes were used as standardized measures in this study by adjusting for the body weight of residents as these intakes are highly correlated with the individual’s size.

4.5 Conclusion

Research regarding the nutrient adequacy of pureed food consumption and the factors that are associated with this intake is needed because existing research is limited and dated, especially in the Canadian LTC context. These findings can advocate for an improved nutrient density of pureed food and help pinpoint factors that are impacting this intake among the LTC population consuming this diet texture. This study showed that inadequate nutrient intake exists within this group for several nutrients, and specifically of concern are vitamin B6, vitamin D, vitamin E, vitamin K, folate, calcium, magnesium, potassium, and fibre. The number of staff assisting at mealtimes was the only independently associated variable of food intake; as the number increased the energy and protein intake for a resident decreased. This suggests that the quality of eating assistance plays a more important role when delivering this care during mealtimes than the number of staff assisting, which has implications for care and future interventions in LTC. This study serves as a basis for future research as more large scale studies should be conducted that include both male and female participants across different diet textures, considering regular and modified texture foods and not only pureed textures. Moreover, research should also investigate home and unit level variables that are associated with food intake across diet textures to comprehensively understand what other key factors are contributing to this intake.

Table 12. Characteristics of residents consuming a pureed diet by gender (n= 67).

Variables	Descriptive Statistics			t-value/ χ^2 value	P-value
	All residents (n= 67)	Females (n= 51; 76.12%)	Males (n= 16; 23.88%)		
Age (years), mean (SD)	87.12 (7.58)	87.92 (7.81)	84.56 (6.32)	-1.56	0.12
Number of diagnoses, mean (SD)	4.97 (2.14)	5.21 (2.18)	4.19 (1.83)	-1.70	0.09
Dysphagia risk, % (n)					
Yes	73.13 (49)	68.63 (35)	87.50 (14)	2.21	0.14
No	26.87 (18)	31.37 (16)	12.50 (2)		
Dementia diagnosis, % (n)					
Yes	86.57 (58)	84.31 (43)	93.75 (15)	0.93	0.33
No	13.43 (9)	15.69 (8)	6.25 (1)		
Number of drugs, mean (SD)	6.25 (2.97)	6.33 (2.92)	6.00 (3.18)	-0.39	0.70
Oral nutritional supplementation, % (n)					
Yes	56.72 (38)	58.82 (30)	50.00 (8)	0.39	0.53
No	43.28 (29)	41.18 (21)	50.00 (8)		
Micronutrient supplementation, % (n)					
Yes	61.19 (41)	62.75 (32)	56.25 (9)	0.22	0.64
No	38.81 (26)	37.25 (19)	43.75 (7)		

Descriptive statistics were used to compute means for continuous variables and frequencies for the categorical variables. Used Student t-test for continuous variables and t-values are presented for numerical data. Chi-Square tests were used for categorical variables and χ^2 values are presented for categorical data. Numerical and ordinal data are mean (standard deviation). Categorical and a data are % (n).
Abbreviations: SD= standard deviation.

Table 13. Energy, macronutrient, and fibre intakes by body mass index for female residents consuming a pureed diet (n= 51).

	BMI Category		
Nutrient	**Underweight (< 18.5 kg/m²) (n= 11)**	**Normal Weight (18.5 kg/m² - 24.9 kg/m²) (n= 30)**	**Overweight (≥ 25.0 kg/m²) (n= 10)**
Energy (kcal)	1377.69 ± 128.13	1490.58 ± 77.58	1682.13 ± 134.38
Energy (kcal per kg body weight)	33.21 ± 2.55	28.23 ± 1.54	24.33 ± 2.67
Carbohydrate (g)	196.73 ± 18.37	213.54 ± 11.12	246.14 ± 19.27
Protein (g)	56.67 ± 6.81	58.36 ± 4.12	62.80 ± 7.14
Protein (g per kg body weight)	1.36 ± 0.13	1.10 ± 0.08	0.91 ± 0.14
Dietary Fibre (g)	11.14 ± 1.52	11.23 ± 0.92	13.78 ± 1.60

Abbreviations: kcal= kilocalorie; kg= kilogram; g= gram.
Values are least squares mean ± standard error.
No significant differences found between the three BMI categories for energy, nutrient, and fibre intakes ($p<0.05$).

Table 14. Estimated usual intake percentile distribution for nutrients with EAR* values for female residents consuming a pureed diet (n= 51).

Nutrient	**EAR***	**Intake Percentiles**								**Prevalence of Inadequacy**
		5th	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**99th**	
Carbohydrate (g)	100	109.91	148.74	189.34	216.24	251.27	277.17	289.98	306.52	<5%
Protein (g/kg)	0.66	0.51	0.62	0.87	1.06	1.27	1.66	1.83	2.07	>10% but <25%
Vitamin A (RAE)	500	349.60	403.58	498.01	593.01	658.36	732.30	793.77	870.46	>25% but <50%
Thiamin (mg)	0.90	0.76	0.84	0.96	1.02	1.10	1.16	1.17	1.29	>25% but <50%
Riboflavin (mg)	0.90	0.89	1.09	1.22	1.54	1.69	1.94	2.05	2.42	>5% but <10%
Niacin (NE-mg)	11	11.28	12.07	15.55	18.41	20.74	22.83	24.30	26.22	<5%
Vitamin B6 (mg)	1.3	0.57	0.78	0.94	1.05	1.35	1.56	1.71	1.76	**>50% but <75%**
Vitamin B12 (mcg)	2.0	1.04	1.53	2.49	3.56	4.69	5.48	6.06	8.30	>10% but <25%
Vitamin C (mg)	60	79.86	93.12	105.24	136.19	162.50	194.34	218.97	248.98	<5%
Vitamin D (mcg)	10	2.00	2.91	3.55	5.15	6.56	8.00	9.37	11.25	**>95% but <99%**
Vitamin E (mg)	12	3.91	4.19	4.43	4.88	5.30	5.80	6.03	6.39	**>99%**
Folate-DFE (mcg)	320	45.75	68.84	115.01	147.05	185.35	216.96	246.74	268.60	**>99%**
Calcium (mg)	1000	359.00	428.10	528.50	687.39	898.08	1001.88	1221.52	1394.89	**>75% but <90%**
Copper (mg)	0.7	0.41	0.49	0.70	0.87	0.98	1.18	1.25	1.42	25%
Iron (mg)	5	3.63	4.65	6.65	9.40	11.01	12.66	14.33	15.65	>10% but <25%
Magnesium (mg)	265	99.31	114.08	169.52	211.15	272.56	311.47	339.43	377.91	**>50% but <75%**
Phosphorus (mg)	580	445.38	593.33	753.09	987.71	1244.10	1434.74	1632.59	1810.51	>5% but <10%
Selenium (mcg)	45	15.69	20.13	33.30	52.35	71.17	94.02	105.02	114.30	>25% but <50%
Zinc (mg)	6.8	3.13	3.51	5.73	7.24	9.99	11.42	12.46	13.28	>25% but <50%

*EAR = Estimated Average Requirement.

Abbreviations: RAE= Retinol Activity Equivalent; NE= Niacin Equivalent; DFE= Dietary Folate Equivalent; g= gram; mg= milligram; mcg= microgram.

Male participants were excluded in this analysis because the sample size (n= 16) was insufficient for the nutrient adjustment procedure.

Table 15. Estimated usual intake percentile distribution for dietary fibre and nutrients with AI* values for female residents consuming a pureed diet (n= 51).

Nutrient	AI*	Intake Percentiles								Assessment Comments
		5th	10th	25th	50th	75th	90th	95th	99th	
Dietary Fibre (g)	21	6.06	7.00	8.86	10.70	12.95	17.09	17.70	18.37	**Median intake is below the AI; 99% of participants consumed < AI**
Vitamin K (mcg)	90	15.65	18.60	35.67	41.63	58.14	82.00	110.60	125.93	**Median intake is below the AI**
Pantothenic acid (mg)	5	2.27	2.39	3.34	4.46	5.61	6.59	7.27	11.00	Median intake is at the AI
Manganese (mg)	1.8	0.50	0.91	1.23	1.83	2.51	3.15	3.39	3.98	Median intake is at the AI
Potassium (mg)	4700	1230.11	1591.40	1862.14	2174.59	2709.20	2986.92	3150.78	3487.92	**Median intake is below the AI; 99% of participants consumed < AI**
Sodium (mg)	1200	997.86	1270.26	1489.25	1775.94	2199.16	2499.13	2896.25	3268.00	Median intake is above the AI

*AI= Adequate Intake.
Abbreviations: g= gram; mg= milligram; mcg= microgram.
Male participants were excluded in this analysis because the sample size (n= 16) was insufficient for the nutrient adjustment procedure.

Table 16. Descriptive statistics and bivariate analysis with selected resident-level variables associated with energy (kcal/kg body weight) and protein (g/kg body weight) consumption for a pureed diet (n= 66*).

Variables	Descriptive Statistics	Total (n)	Energy Intake			Protein Intake		
			kcal / kg mean (SD)	Parameter Estimate	P-value	g / kg mean (SD)	Parameter Estimate	P-value
Age (years), mean (SD)	87.12 (7.64)	66*	28.81 (8.56)	0.08	0.55	1.15 (0.45)	-0.001	0.90
Gender[a], % (n)								
Male	22.73 (15)	66	29.76 (7.99)	1.22	0.63	1.23 (0.43)	0.12	0.39
Female	77.27 (51)		28.54 (8.77)			1.12 (0.46)		
Number of diagnoses, mean (SD)	5.02 (2.12)	66	28.81 (8.56)	-0.23	0.64	1.15 (0.45)	-0.03	0.33
Dysphagia risk[b], % (n)								
Yes	72.73 (48)	66	28.80 (8.67)	-0.05	0.98	1.12 (0.45)	-0.08	0.55
No	27.27 (18)		28.85 (8.50)			1.20 (0.45)		
Dementia diagnosis[b], % (n)								
Yes	87.88 (58)	66	29.15 (8.26)	2.74	0.40	1.17 (0.44)	0.20	0.25
No	12.12 (8)		26.41 (10.79)			0.97 (0.50)		
Number of drugs, mean (SD)	6.20 (2.95)	66	28.81 (8.56)	0.13	0.72	1.15 (0.45)	0.02	0.39
Oral nutritional supplementation[b], % (n)								
Yes	57.58 (38)	66	29.70 (8.92)	2.08	0.33	1.18 (0.45)	0.09	0.42
No	42.42 (28)		27.62 (8.04)			1.09 (0.45)		
Micronutrient supplementation[b], % (n)								
Yes	62.12 (41)	66	28.57 (8.02)	-0.66	0.77	1.13 (0.45)	-0.03	0.78
No	37.88 (25)		29.22 (9.53)			1.17 (0.46)		
Family routinely brings food in for resident[b], % (n)								
Yes	13.64 (9)	66	27.11 (10.75)	-1.97	0.52	1.09 (0.54)	-0.07	0.69
No	86.36 (57)		29.08 (8.24)			1.15 (0.44)		
interRAI LTCF scales Cognitive Performance Scale[c], % (n)								
≥5	74.24 (49)	66	28.33 (7.51)	-0.87	0.71	1.10 (0.40)	-0.22	0.42
3-4	18.18 (12)		30.62 (10.61)	-2.28		1.24 (0.51)	-0.14	
≤2	7.58 (5)		29.21 (13.83)	--		1.32 (0.74)	--	
Total mean (SD) [median]	5.00 (1.38) [6.00]	66	28.81 (8.56)	-0.94	0.22	1.15 (0.45)	-0.08	0.05
Activities of Daily Living Scale, mean (SD) [median]	24.23 (5.04) [27.00]	66	28.81 (8.56)	-0.49	0.02	1.15 (0.45)	-0.03	0.002
MNA-SF score, mean (SD)	8.50 (2.36)	66	28.81 (8.56)	-0.35	0.44	1.15 (0.45)	-0.0002	0.99
Ed-FED, mean (SD)	15.19 (2.43)	66	28.81 (8.56)	-0.85	0.05	1.15 (0.45)	-0.06	0.01
Other eating challenges, mean (SD)	12.14 (1.49)	66	28.81 (8.56)	-0.69	0.34	1.15 (0.45)	-0.04	0.32
All eating challenges (Ed-FED + others], mean (SD)	27.33 (3.50)	66	28.81 (8.56)	-0.53	0.08	1.15 (0.45)	-0.03	0.04
Relational Behaviour Scale, mean (SD)	16.49 (3.68)	47	28.81 (8.56)	0.40	0.17	1.15 (0.45)	0.02	0.28

Oral health rating[d], % (n)								
Affects consumption	62.75 (32)	51	29.20 (10.30)	0.60	0.83	1.16 (0.52)	0.04	0.79
Does not affect consumption	37.25 (19)		28.60 (8.07)			1.12 (0.43)		
Average length of meal (minutes), mean (SD)	35.86 (14.38)	66	28.81 (8.56)	-0.01	0.88	1.15 (0.45)	-0.002	0.66
Total eating assistance (as per RBS)[b], % (n)								
Yes	71.21 (47)	66	27.16 (7.30)	-5.76	0.01	1.06 (0.37)	-0.29	0.02
No	28.79 (19)		32.92 (10.17)			1.35 (0.56)		
Physical assistance required during mealtimes[e] (as per Ed-FED) % (n)								
Often	63.64 (42)	66	26.82 (7.65)	-6.02	0.04	1.05 (0.39)	-0.38	0.02
Sometimes	15.15 (10)		31.56 (5.19)	-4.74		1.13 (0.34)	-0.08	
Never	21.21 (14)		32.84 (11.27)	--		1.43 (0.59)	--	
Number of staff assisting at mealtimes, median (IQR)	1.00 (0.00) range: 0-2	66	28.81 (8.56)	-6.73	0.004	1.15 (0.45)	-0.43	0.0004

Descriptive and bivariate statistics based on linear regression for energy and protein intake per kg of body weight since it is a continuous variable. Numerical and ordinal data are mean (standard deviation). Categorical and ordinal data are % (n). Abbreviations: kcal= kilocalorie; g= gram; SD= standard deviation; IQR= interquartile range; MNA-SF= Mini Nutritional Assessment Short Form; Ed-FED= Edinburgh Feeding Evaluation in Dementia Questionnaire; RBS= Relational Behaviour Scale.

*Total number of residents consuming a pureed diet is 67 from the total M3 sample of 639 residents, however one resident had a missing body weight thus the total number of residents used for this analysis is 66. Relational Behaviour Scale only completed in residents who required total eating assistance. Oral health exam not completed for some residents due to inability to access their oral cavity for the exam.

[a]Reference category= female.

[b]Reference category= No.

[c]Reference category= ≤ 2.

[d]Reference category= oral health does not affect consumption.

[e]Reference category= never.

Table 17. Multivariable linear regression analysis of resident-level variables independently associated with energy intake (kcal/kg body weight) adjusted for age and gender.

Model 1: adjusted for age and gender Dependent variable: Energy intake (kcal) per kg				
Covariates	**β**	**SE**	**t-value**	**P-value**
Intercept	31.54	12.69	2.49	0.02
Age	0.04	0.14	0.30	0.76
Gender[a]	-0.37	2.55	-0.14	0.89
Number of staff assisting during mealtimes	-6.74	2.38	-2.84	0.01

Used multivariable linear regression. Initial full model: energy (kcal) intake per kg body weight= Cognitive Performance Scale + Activities of Daily Living Scale + Ed-FED + Relational Behaviour Scale + physical assistance + number of staff assisting + age + gender.
Abbreviations: kcal= kilocalorie; β= parameter estimate; SE= standard error.
N= 66. Model F-value= 2.95 (p= 0.04, df= 3). Model R-square= 0.13. Model adjusted R-square= 0.08.
[a]Reference category= female.

Table 18. Multivariable linear regression analysis of resident-level variables independently associated with protein intake (grams/kg body weight) adjusted for age and gender.

Model 1: adjusted for age and gender Dependent variable: Protein intake (g) per kg				
Covariates	**β**	**SE**	**t-value**	**P-value**
Intercept	1.84	0.64	2.86	0.01
Age	-0.003	0.01	-0.48	0.63
Gender[a]	-0.01	0.13	-0.06	0.95
Number of staff assisting during mealtimes	-0.43	0.12	-3.59	0.001

Used multivariable linear regression. Initial Full model: protein (g) intake per kg body weight= Cognitive Performance Scale + Activities of Daily Living scale + Ed-FED + Relational Behaviour Scale + physical assistance + number of staff assisting + age + gender.
Abbreviations: g= gram; β=parameter estimate; SE= standard error.
N= 66. Model F-value= 4.60 (p= 0.01, df= 3). Model R-square= 0.18. Model adjusted R-square= 0.14.
[a]Reference category= female.

Table 19. Eating challenges associated with number of staff assisting during mealtimes (n= 66).

Variables	**Number of staff assisting during mealtimes**					
	0 (n= 9)	**1 (n= 52)**	**2 (n= 5)**	**Total (n)**	**F-value/ χ^2 value**	**P-value**
Ed-FED, mean (SD)	11.74 (0.98)	15.82 (2.12)	14.87 (2.14)	66	15.84	<0.0001
Does the resident require close supervision while feeding/eating? % (n)						
Sometimes/Often	22.22 (2)	96.15 (50)	100.00 (5)	66	36.46	<0.0001
Never	77.78 (7)	3.85 (2)	0 (0)			
Does the resident require physical help with feeding/eating? % (n)						
Sometimes/Often	11.11 (1)	88.46 (46)	100.00 (5)	66	28.92	<0.0001
Never	88.89 (8)	11.54 (6)	0 (0)			
Does the resident tend to leave food on the plate at the end of the meal? % (n)						
Sometimes/Often	55.56 (5)	57.69 (30)	80.00 (4)	66	0.99	0.61
Never	44.44 (4)	42.31 (22)	20.00 (1)			
Does the resident ever refuse to eat? % (n)						
Sometimes/Often	0 (00	17.31 (9)	20.00 (1)	66	1.89	0.39
Never	100.00 (9)	82.69 (43)	80.00 (4)			
Does the resident turn his head away while being fed? % (n)						
Sometimes/Often	0 (0)	11.54 (6)	20.00 (1)	66	1.58	0.45
Never	100.00 (9)	88.46 (46)	80.00 (4)			
Other eating challenges, mean (SD)	10.56 (0.88)	12.41 (1.45)	12.20 (1.15)	66	7.02	0.002
Does the resident receive close supervision with feeding/eating? % (n)						
Sometimes/Often	22.22 (2)	94.23 (49)	100.00 (5)	66	31.91	<0.0001
Never	77.78 (7)	5.77 (3)	0 (0)			
Does the resident receive verbal prompting to eat? % (n)						
Sometimes/Often	0 (0)	61.54 (32)	60.00 (3)	66	11.77	0.003
Never	100.00 (9)	38.46 (20)	40.00 (2)			
Does the resident lack energy to eat? % (n)						
Sometimes/Often	11.11 (1)	30.77 (16)	80.00 (4)	66	1.64	0.44
Never	88.89 (8)	69.23 (36)	20.00 (1)			
Average length of meal (minutes), mean (SD)	38.33 (14.62)	34.33 (14.40)	47.42 (8.66)	66	2.11	0.13

Used ANOVA for continuous variables. Chi-Square tests were used for categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). F-values are presented for numerical data. χ^2 values are presented for categorical data. Abbreviations: SD= standard deviation.

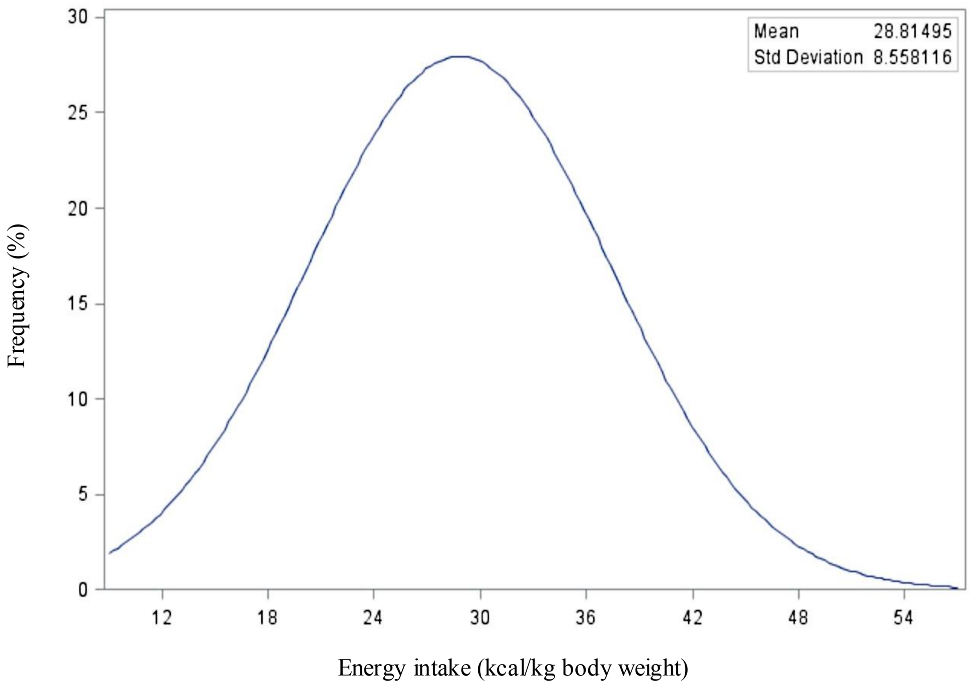

Figure 1. Distribution of energy intake (kcal/kg body weight) of residents consuming a pureed diet (n= 66).

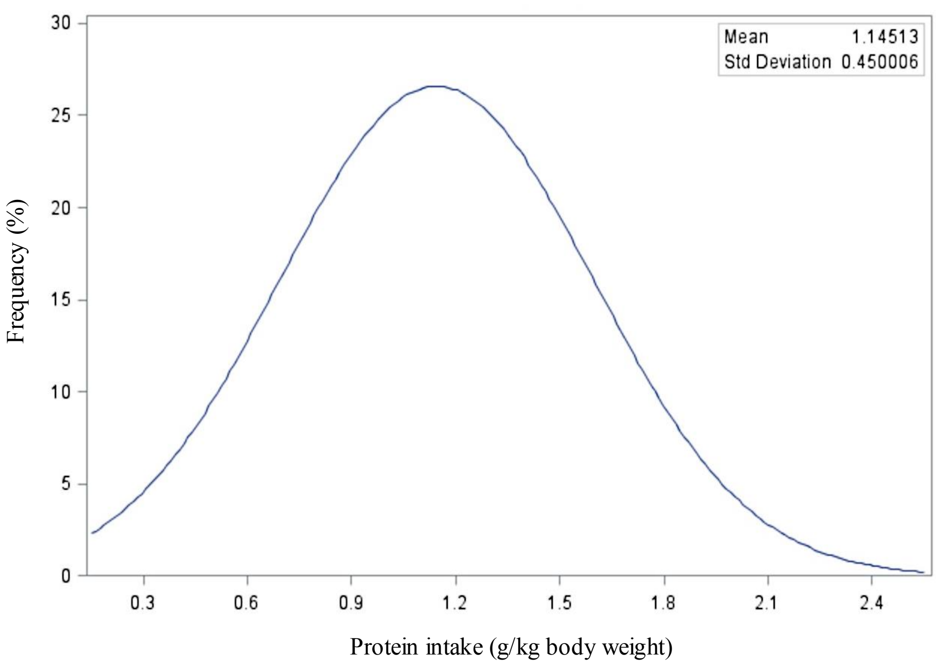

Figure 2. Distribution of protein intake (g/kg body weight) of residents consuming a pureed diet (n= 66).

Chapter 5
Malnutrition and Modified Texture Food in Long Term Care

5.1 Introduction

Malnutrition among older adults living in long term care (LTC) is a rising concern since it can have many negative outcomes including impaired: cognition, functional capacity, psychological well-being, and quality of life (23,27,33,34,72,109). Malnutrition can also increase the risk of depression, infections, falls, mortality, morbidity, and result in an hospital admission and a longer length of stay (23,27,33,34,72,109). Malnutrition is defined as an inadequacy or imbalance in energy and/or nutrients to meet the body's functional needs (61,167); this includes protein-energy malnutrition which can directly result from an inadequate intake of food, utilization of nutrients and/or indirectly from a chronic condition (19,61,167–169). According to the European Society of Clinical Nutrition and Metabolism (ESPEN), those at risk of malnutrition should be identified through the usage of validated screening tools such as the Mini Nutritional Assessment and completed by trained healthcare professionals (61). Due to health care costs that are associated with malnutrition, and with a rapid increase in older adults who are potentially malnourished in LTC, there is a crucial need to identify how malnutrition in this segment of the population can be prevented to reduce healthcare costs and promote quality of life (169,170).

Malnutrition is complex, as many factors synergistically play a role, but it is also preventable and reversible, yet, many processes of aging make it challenging to maintain and improve nutritional status among older adults (114). A large proportion of older adults living in LTC are at risk of malnutrition or are malnourished with estimates ranging from 40% - 80% of older adults in Canadian and US facilities (11,27,33,109,110); this variation is believed to be due to how malnutrition is defined and measured (39). This increased risk may be attributed to loss of lean body mass (i.e. reduced metabolic and energy requirements), oral health problems (i.e. reduced food intake), and diminished sense of taste and smell (i.e. poor appetite), medication use, and chronic conditions, as well as factors associated with the LTC institution itself (27). Poor food intake is considered the primary cause of malnutrition as the average consumption of food offered in LTC is about 50% (18,28).

Eating difficulties and the inability to feed one-self are direct causes that can lead to malnutrition. Eating difficulties include: tooth loss, fatigue, chronic conditions, and physical and/or cognitive impairments (19,27,36,51). These causes are embedded in the Making the Most of

Mealtimes (M3) concept created by Keller and colleagues, who have conceptualized three categories of factors that can determine the food and fluid intake of LTC residents which then impacts their risk of malnutrition; these domains include mealtime experience, meal access, and meal quality (11). Levels of influences on these domains are resident, staff, LTC home, and regional government characteristics (11). Several resident-level conditions have been demonstrated to be associated with malnutrition including dementia, stroke, multiple sclerosis, Parkinson's disease, and amyotrophic lateral sclerosis (19,25–27,33,34). These conditions are commonly associated with dysphagia and prescription of modified texture diets (19,25–27,33,34). Studies have reported up to 40% prevalence rate of dysphagia among older adults living in LTC (41,171).

Staff-level influences associated with malnutrition include the quality and amount of time provided for eating assistance by staff and volunteers, and attitudes of staff towards modified texture food (MTF) (19,25–27,33,34). Further, the LTC facility itself can impact the risk of malnutrition for residents, in that the dining room environment and food production methods can influence food intake (11,80). Regional governments control food budget allocation, which determines the quality of food provided (i.e. nutrient density) and this can influence the risk of malnutrition if less nutritious food is offered (11,18,19). Other key covariates of malnutrition include age, oral nutritional supplementation, micronutrient supplementation, sensory appeal of offered food and additional food provided by family and friends (19,25–27,33,34).

Modified texture foods, especially pureed food, are associated with a high prevalence of under-nutrition and weight loss among older adults in LTC but there is limited research evidence (11,20–27). Reasons for this association could be the quality of the food provided (i.e. nutrient density, palatableness), the amount and type of eating assistance provided, chronic conditions, or medication use that is also associated with dysphagia (18,19,26,27). Research to date considering MTF as a potential cause of under-nutrition has been limited in sample size and diversity (18,25,28,97,172,173), as well as the lack of measurement of a variety of covariates that could confound this association (19,25,28,109,172,174,175). Further, existing literature around diets and malnutrition of older adults in LTC has only examined the prescription of diets, such as low sodium or diabetic, as a indicator of malnutrition (19). There is a need for research to determine indicators of nutritional status in this population at risk as a means of developing tailored interventions that appropriately target modifiable factors contributing to malnutrition.

To address these research gaps, this study will attempt to answer the following research question: Is the prescription of a modified texture diet (MTD) as compared to a regular texture diet independently associated with the Mini Nutritional Assessment (MNA-SF) score in residents of LTC homes included in the M3 study when diverse relevant covariates are considered? This study will also aim to answer the following sub-question: (a) Is the prescription of a pureed diet as compared to a regular texture diet independently associated with the MNA-SF score in residents of LTC homes included in the M3 study when diverse relevant covariates are considered?

5.2 Methodology

5.2.1 Sample and participants

The M3 study, a cross-sectional multi-site project across Canada, was designed to determine the associations between inadequate food and fluid intake among residents living in LTC and the multi-level influences and multi-factorial causes of this intake (52). The comprehensive data collection included gathering data at the provincial, home, unit, staff, and resident levels to ascertain the determinants of meal access, meal quality and the mealtime experience of residents, hypothesized to impact their food and fluid intake (11,52). The ultimate goal of the M3 study was to improve food and fluid intake among residents and thus nutritional status by informing future intervention studies (11,52).

A total of 32 LTC homes were recruited across four different provinces (8 homes per province) in Canada: Alberta (AB), Manitoba (MB), Ontario (ON), and New Brunswick (NB) (52). Eligibility criteria for LTC homes included the following: 1) in operation for at least six months; and 2) having a minimum of 50 residents who met the resident eligibility criteria, which will be described below (52). For-profit and not-for profit homes were recruited and diversity in the sample was also attempted by including homes where a high proportion of individuals were from cultural minorities, independent operators and large corporations, rural or urban settings and faith-based homes (52). Within each LTC home, one to three units with residents that met the eligibility criteria were randomly selected and participants were then randomly sampled from the unit or units for participation (52). If it existed within the home, a behavioural or dementia unit was selected (52).

The eligibility criteria for residents were the following: 1) resided in the randomly chosen units; 2) were over the age of 65 years; 3) required a minimum of two hours per day of nursing care for activities of daily living; 4) resided in the LTC home for a least one month; and 5) either they or their decision maker provided informed consent for participation in the study (52). The exclusion criteria were as follows: 1) resided in the LTC home for less than a month; 2) were medically unstable (i.e. recent hospitalization); 3) were a short term admission; 4) required tube feeding; 5) residents who were not eating because they were on end of life care; 6) did not routinely eat in the dining room; 7) had advanced orders excluding them from any research; or 8) they or their decision makers were unable to understand English, French and in the case of Ontario, Cantonese (52).

Based on inclusion and exclusion criteria, 20 residents from each home (n= 32 homes, 8 homes per province) were recruited, for a total sample of 639 participants (one participant withdrew consent) included into the study for data collection (52). For the sub-question analysis conducted, only residents consuming regular texture food and pureed food were analyzed (n= 405).

5.2.2 Data collection and measures

The MNA-SF was completed for each participant by a trained project coordinator skilled in nutritional assessment (one per province) (52). The four provincial coordinators were comprehensively trained in person on all procedures and each coordinator trained two research assistants (n= 8, 2 per province) on the collection of mealtime observation data including food intake (52). The tool gathers information on changes in food intake, mobility, BMI, weight change, and dementia and depression diagnoses; the latter three aspects were obtained from a participants' health record. To complete the MNA-SF the trained research staff observed the participant and discussed their care needs with staff. The MNA-SF identifies nutrition risk and provides a score from 0 to 14, where a score of ≥ 12 indicates satisfactory nutritional status and a score of ≤ 11 implies a risk of malnutrition (63,64). The MNA-SF score was used in a numerical manner for the analysis. This tool is commonly used to screen for malnutrition among LTC populations and is validated to identify risk of or malnutrition itself (19,63,64).

The prescribed diet texture for each participant and various resident characteristics were gathered from their health records or collected using standardized procedures by the project coordinators (52). The International Dysphagia Diet Standardization Initiative (IDDSI) framework was used to streamline and categorize the prescribed diet texture labels for all residents (n= 639) as a total of 67 different labels were used by the 32 homes in this study. Specifically, five different levels of the IDDSI continuum were used in the analysis to categorize the texture labels; level three refers to a liquidized diet, level four refers to a pureed diet, level five refers to a minced and moist diet, level six refers to a soft and bite-sized diet, and level seven refers to a regular texture diet (49). Coding rules were created a priori to address this categorization. Where the prescribed texture as described from the resident chart was consistent with IDDSI terminology (e.g. soft; pureed) categorization was made. For other home labels not consistent with IDDSI terms, categorization was based on IDDSI descriptions and attempting to categorize the prescribed diet in the most logical or similar level (e.g. 'ground' was coded as minced or level 5; 'diced' was coded as soft and bite-sized or level 6). Where participants were prescribed more than one texture (e.g. minced/pureed) then the observed texture from the Food Intake Forms was used, and categorization based on either the texture for two of the three meals per observation day or the majority of food as consumed (e.g. first course is minced, main course is pureed, and dessert is pureed then resident would be considered a level four or pureed diet). Where the frequency of observed texture labels was equal, then the lower grade of texture was used in the analysis to ensure that lower levels of MTD were not underreported.

Prior literature was used to theoretically identify covariates to be modeled. Covariates collected from the health records of participants and used in the analysis included: age, gender, length of admission (months), total number and type of major diagnoses using the InterRAI diagnostic checklist (dementia), supplementation (oral nutritional, micronutrient; Yes/No), total number of drugs, and if family routinely brings in food for resident (Yes/No) (52). The interRAI LTCF assessment provided further information on resident characteristics, and a relevant aspect included in this analysis was the cognitive performance scale (CPS) (CPS ≤2 or 3+, where 0 represents intact cognition and 6 represents very severe impairment) (52,70). To ensure accuracy and currency, the items on interRAI LTCF assessment required for these scales was completed by the research staff by interviewing home staff familiar with the current care of the resident (52).

Assessment of residents at risk of dysphagia was based on a composite measure (52). All residents currently prescribed thickened fluids were categorized as at 'dysphagia risk' (52). For those residents who could comply with a risk evaluation using the Screening Tool for Acute Neurological Dysphagia (STAND) assessment (i.e. water and applesauce swallowing test) (52,62) and demonstrated challenges, they were classified as at risk. Finally, a subset of individuals who could not comply with the STAND assessment, but demonstrated 'sometimes' or 'often' coughing and/or choking during two of the three days of meal observations, but were not already on thickened fluids were also categorized as 'at risk' for dysphagia (52). The oral health and dentition of participants was determined from the Oral Health Examination, where a dental hygienist completed a standardized oral assessment based on 13 items with sub-questions, each item pertained to a specific aspect of oral health observed (52,65). A summary item completed the assessment, which was a subjective rating by the hygienist based on their standardized assessment; using a rating from 1 to 5, the hygienist rated their perception that the oral health status could influence food intake of the participant (1=

not/unlikely influenced; 5= food intake significantly impacted by oral health) (52). This single item provides a practical variable for categorizing participants' oral health status. This item was further categorized into two groups (0, 1 vs. 2+) for the analysis with consultation from a member of the M3 team who is an oral health expert (52).

Further, the two research assistants in each of the four provinces who observed food intake for three non-consecutive days, including a weekend day, also completed other mealtime observations (52). For one meal per day, they completed a more detailed assessment which included the standard and valid Edinburgh Feeding Evaluation in Dementia Questionnaire (Ed-FED) that assesses eating and feeding issues in older adults with dementia (52,66). They also recorded other observed eating behaviours (i.e. chewing problems, lack of energy) using an ordinal scale (1= not applicable or never; 2= sometimes; 3= often) (66–69) and scores for these nine additional questions were summed and termed here as Other Eating Challenges (52). Additionally, the single question on Ed-FED (i.e. Does the resident require physical help with feeding/eating?) was left categorized as three groups for the analysis (0= no physical assistance required; 1= sometimes physical assistance is required; and 2= often physical assistance is required to eat during mealtimes). The average length of a meal per participant in minutes was also used in the analysis and determined from the average recorded for up to nine meals observed (52). The number of staff providing eating assistance to each resident during mealtimes was recorded by the research assistants and the median number for up to nine meals observed was used in this analysis (52). Information regarding the quality of eating assistance provided to the resident was gathered from the Relational Behaviour Scale (RBS), also completed by two research assistants per province at one meal per day over three days (i.e. including a weekend day) for each resident that required full eating assistance (155). The RBS contains three questions each scored from one to seven (1= low intensity of relational care and 7= high intensity of care) (155), and the total score for each meal was averaged for up to three meals and used in the analysis.

Lastly, care staff across the 32 LTC homes completed the valid and reliable Person-Directed Care (PDC) questionnaire, which collects information on staff's knowledge regarding residents' preferences, values, choices, and care issues (176,177). This variable was expressed as an average summary score for staff where a higher score indicates better person-centred care (52). A site survey was completed by each LTC home, which captures key aspects of menu planning and food production (e.g., proportion of commercial food use, raw food cost), and other pertinent services in the home (52). This survey was typically completed by the director of food services and other key personnel in the home (e.g., food service supervisor, dietitian) (52). Variables used in this analysis included: the proportion of commercial versus in-house production of regular and modified texture food and raw food cost. These variables were used in this analysis as home level covariates, which could potentially indicate factors independently associated with malnutrition among residents in the M3 study.

5.2.3 Data analysis

A secondary data analysis was performed. Data was analyzed using Statistical Analysis System software for Windows (Version 9.4). A hierarchical multiple linear regression analysis, accounting for clustering within province, home, and unit, was performed to assess the association of the MNA-SF score with the prescription of a modified texture diet as compared to a regular texture diet while adjusting for relevant covariates. First, hierarchical multi-level regression analyses were conducted to assess the relationship between the outcome variable and the independent variable of interest. These models contained indicator variables for province, random effect variables for home and unit, and independent variables under consideration. All relevant covariates, including resident, staff, and home level variables, that had a p-value <0.20 were added to the initial full model, with MNA-SF score as the outcome variable. Backwards elimination was used to develop the final model. Variables within the model that contributed the least based on their R square value were manually deleted from the model at each step until at least all variables in the model had a p-value of <0.05 and were based on the smallest decreases in the model sum of squares value as non-significant variables were removed. This method was repeated until results in the final model from which no variable could be eliminated without adversely affecting the R square value. Then prescribed diet texture, as an independent variable, was added to the reduced model to determine if prescription of a modified texture diet compared to a regular texture diet was independently associated with the MNA-SF score while controlling for influential covariates. Interactions between Ed-FED and CPS, and also Ed-FED and prescribed texture (i.e. MTD, pureed) in the final model were tested. Further, multicollinearity was assessed by inspection of the correlation matrix to detect high correlations (R square values) among independent variables. Pearson correlations between independent variables were all less than 0.45 (>0.60-0.70 is a sign that multicollinearity exists). A second regression analysis using the same steps was used to compare consumption of a pureed diet as compared to a regular texture diet while accounting for clustering and adjusting for relevant covariates. For this specific analysis, hierarchical multiple linear regression analyses were conducted with and without home level variables because of the unequal sample sizes between those prescribed a pureed diet and a regular texture diet. Due to the small sample size of residents prescribed a pureed diet, leaving approximately two residents per LTC home, the regression analysis *without* home level variables was selected as the final model as it was unjustified to conduct higher order analyses for this sample.

Covariates in both of the analyses included: prescribed diet texture, age, gender, length of admission in months, total number of major diagnoses, dementia diagnosis, dysphagia risk, number of drugs, supplementation (i.e. oral nutritional and micronutrient intake), if family routinely brings food in per participant, CPS score, average Ed-FED score per participant, Other Eating Challenges score per participant, eating assistance level, average of RBS score, oral health rating, average length of meal, average staff PDC score per participant, proportion of commercially outsourced food, and raw food cost.

5.3 Results

5.3.1 Examining characteristics and MNA-SF score among residents prescribed a modified and a regular texture diet

Table 20 illustrates resident characteristics of the M3 sample prescribed a modified and a regular texture diet. The average MNA-SF score for the sample was 10.64 (SD= 2.53). A total of 47.18% (n= 301) were prescribed a modified texture diet and the average MNA-SF score was lower for the modified texture group compared to the regular texture group (MTD: MNA-SF= 9.81, standard deviation (SD)= 2.68; regular: MNA-SF= 11.37, SD= 2.13). The mean age of the sample was 86.81 years (SD= 7.80). Female participants made up majority of the sample (68.97%, n= 440) and the MNA-SF score was lower on average for the female residents (female: MNA-SF= 10.52, SD= 2.57; male: MNA-SF= 10.89, SD= 2.42). The average number of diagnoses was 5.41 (SD= 2.02), with 65.20% (n= 416) of participants having a dementia diagnosis and over half (55.77%, n=353) having a CPS score of three or more which indicated cognitive impairment; MNA-SF scores were lower among those having a diagnosis of dementia and a higher CPS score (Table 20). The average number of drugs residents were taking was 7.50 (SD= 3.45), and 30.72% (n= 196) were on oral nutritional supplementation and 76.65% (n= 489) were taking micronutrient supplementation. Participants consuming oral nutritional supplementation had a lower MNA-SF score than those who did not, however residents taking micronutrient supplementations had a higher MNA-SF score (Table 20). Lastly, 59.09% (n= 377) of residents had a risk dysphagia and 76.78% (n= 486) did not require physical assistance during mealtimes; MNA-SF scores on average were lower among those with a dysphagia risk and individuals requiring physical assistance during mealtimes (Table 20).

Results from the hierarchical multiple linear regression analysis illustrating variables independently associated with MNA-SF score for residents prescribed a MTD, while accounting for clustering (i.e., province, home, and unit) and adjusting for age and gender are presented in Table 22. It was found that oral nutritional supplementation, CPS score, Ed-FED score, and oral health rating while adjusted for age and gender explained a significant amount of the variance in the MNA-SF score ($F(85, 475)= 5.59$, $p<0.0001$, $R^2= 0.50$). Being prescribed a modified texture diet was not independently associated with MNA-SF score for residents when adjusted for these relevant covariates ($\beta= -0.23$, standard error (SE)= 0.20, $t(475)= -1.16$, $p= 0.25$). MNA-SF score was significantly associated with age in this sample of residents, but not associated with gender (age: $\beta= -0.03$, SE= 0.01, $t(475)= -2.11$, $p= 0.04$; gender: $\beta= -0.20$, SE= 0.20, $t(475)= -0.98$, $p= 0.33$). All covariate associations were negative, meaning that presence of these characteristics increased the likelihood of a resident being at nutritional risk. Interaction effects tested between CPS and Ed-FED scores were not significant, as well as the interaction effect between prescription of a modified texture diet and Ed-FED score.

5.3.2 Examining characteristics and MNA-SF score among residents prescribed a pureed diet and a regular texture diet

Table 23 illustrates resident characteristics of the M3 sample prescribed a pureed and a regular texture diet. Similar associations with MNA-SF were found in this reduced sample with only pureed and regular textures (Table 24), as when all modified textures were compared to a regular texture (Table 21). The average MNA-SF score for the sample was 10.88 (SD= 2.41). A total of 16.79% (n= 68) were prescribed a pureed diet and the average MNA-SF score was lower for the pureed group compared to the regular texture group (pureed: MNA-SF= 8.41, standard deviation (SD)= 2.25; regular: MNA-SF= 11.37, SD= 2.13).

Results from the hierarchical multiple linear regression analysis illustrating variables independently associated with MNA-SF score for residents prescribed a pureed diet, while accounting for clustering (i.e., province, home, and unit) and adjusting for age and gender are presented in Table 25. As with the modified texture diet comparison (Table 22), a significant regression equation was found using the backward elimination method, it was found that oral nutritional supplementation, CPS score, Ed-FED score, and oral health rating while adjusted for age and gender, explained a significant amount of the variance in the MNA-SF score ($F(84, 279)= 3.84$, $p<0.0001$, $R^2= 0.54$; Table 25). However, this regression analysis also identified that being prescribed a pureed diet was independently associated with MNA-SF score for residents when adjusted for relevant covariates ($\beta= -0.89$, standard error (SE)= 0.40, $t(279)= -2.23$, $p= 0.03$). Being on a pureed diet, independent of other relevant covariates, increased the risk of malnutrition in these residents. MNA-SF score is not independently associated with age or gender in this sample of residents (age: $\beta= -0.02$, SE= 0.02, $t(279)= -1.52$, $p=0.13$; gender: $\beta= -0.19$, SE= 0.26, $t(279)= -0.71$, $p= 0.48$). Oral nutritional supplementation, CPS score, Ed-FED score, and oral health rating were independently associated with MNA-SF score; again these associations were negative indicating that presence of the risk factor was associated with increased malnutrition. Interaction effects tested between CPS and Ed-FED scores were not significant, as well as the interaction effect between prescription of a modified texture diet and Ed-FED score.

5.4 Discussion

5.4.1 Characteristics and malnutrition among resident in long term care

Our findings suggest that the MNA-SF score of residents in LTC homes of the M3 study is not significantly associated with the prescription of a MTD when relevant covariates were considered, however MNA-SF score was significantly associated with the prescription of a pureed diet in this sample. Studies have not examined MTDs as a potential cause of malnutrition (18,19,25,28,172–175,178); prior research is limited to acute care settings, other diet prescriptions (e.g., lactose), and older adults in LTC from other countries, therefore factors associated with malnutrition are not clearly understood in the Canadian LTC context (19,25,28,172,174,175,178). To our knowledge, this is the first multi-site and multi-regional study to examine MTDs in LTC as a potential factor of malnutrition while relevant covariates were considered. This analysis suggests that independent of nutritional supplementation, cognition, oral health, and eating dependence and challenges, prescription a pureed diet is associated with malnutrition. Existing literature has suggested that pureed food contains lower amounts of energy and protein compared to regular texture and other modified textures (e.g., chopped, minced) (18,19,26,27). A probable explanation for this finding could be the quality of the food provided such as low nutrient density or unappealing palatableness and presentation which could lead to a decrease in food intake among this population (18,22,26,27,43). Less nutritious modified texture foods, especially pureed food, has been associated with malnutrition risk and weight loss among older adults in LTC (11,20–25,27). Therefore, interventions that improve the nutrient density of pureed diets should be implemented in LTC, such as energy and protein dense menus, fortification of vitamins/minerals, or “super-menus” (85,100,107,144). However, this study does not have a temporal fix on the relationship between a pureed diet and malnutrition because of the cross-sectional design. It is unknown if malnourished individuals in LTC are more likely to get a pureed diet to support their nutrition or vice versa, as mentioned previous where if persons on a pureed diet become malnourished. Whichever way the association between a pureed diet and malnutrition exists, it is important for staff in LTC to be aware of residents consuming pureed foods and to pay close attention or intervene to not further exacerbate their risk of malnutrition. Other studies have investigated diet prescriptions to manage specific disease states (e.g. diabetic, renal, low salt), and found no significant associations with malnutrition; therefore these diets may be beneficial for individuals (19,174). Furthermore, age was significantly associated with MNA-SF score in this study, but only when all modified textures were compared to the regular texture diet; pureed diet use is positively associated with age and thus likely mediated the effect in this model. This finding is confirmed by other studies, where some have found an association between age and malnutrition but not for gender (19,174,175,178). Therefore, gender is not associated with risk of or malnutrition itself, and it can occur in older adults regardless of their gender (19,174,175,178).

In our study, four major factors were found to be independently associated with risk of or malnutrition they were: being on oral nutritional supplementation, a CPS score of three or more, a higher Ed-FED score, and an oral health rating that affects food consumption. These four causes were consistent across both diet texture models (Table 22 and 25). In both models there was a relatively high R^2 value indicating that these resident level variables explained a good portion of the variance in MNA-SF score. No home level factors were included in final models.

The significant association between risk of or malnutrition itself and oral nutritional supplementation has been cited in previous research (19,174). The finding is logical and not surprising, as residents are typically put on this form of supplementation to prevent or reduce malnutrition risk and/or reverse malnutrition itself (37,109,172). This was supported by the findings from the M3 study, where residents on oral nutritional supplementation had a lower MNA-SF score on average compared to residents who were not taking supplementation. In contrast, a study by Suominen and colleagues found that nutritional supplementation was not independently associated with malnutrition; however this was likely due to the very low proportion of nutritional supplementation (4%) used by the residents studied (175). Oral nutritional supplementation is high in energy and protein, and it is balanced in micronutrients, which offers individuals in LTC homes a nutritional intervention to support overall health and quality of life (90,179–181). Prior research on the use of oral nutritional supplements has shown to improve energy and protein intake, body weight and thus nutritional status for older adults in LTC, and also decrease the potential for negative outcomes to occur such as: depression, sarcopenia, infections, falls, and mortality (89,90,179,181).

This study also found a significant association between risk of or malnutrition itself and CPS score, which has been found in prior studies as well (19,174,175). More specifically it was found that moderate to severe cognitive impairment was independently associated with a lower score on the MNA-SF. Other studies have measured cognitive status with the Mini Mental State Exam or presence of a diagnosis of dementia, and results are similar (19,175). Institutionalized older adults with cognitive impairments such as dementia tend to have lower energy and protein intake, weight loss, and risk of malnutrition (89,181), however this complex relationship and the pathway is not clear. Research has pinpointed many factors that contribute to this complicated relationship. A decrease in dietary intake, or metabolic changes (e.g., hypothyroidism) in those with dementia, or behavioural issues related to dementia such as increased energy expenditure due to wandering, could solely lead to weight loss and malnutrition or a combination of all factors (28,109,179,181). Research has also indicated that the dining environment can play a role in this complex relationship between cognitive impairment and malnutrition. The mealtime experience can have an impact on food intake for residents with dementia, for example distractions (e.g., glare on floor, no table setting contrast, background noise) in the dining room during mealtimes can decrease intake and promote malnutrition (81,182,183). Moreover, the combination of resident and dining room factors could further exacerbate malnutrition, and this has been noted in the existing literature (81,174,182,183). More research is needed to determine which factors contribute to these associations and how they can be potentially influenced. These home level variables were not included in this analysis, and further work should how environmental factors influence eating behaviour.

Furthermore, the significant association between risk of or malnutrition itself and Ed-FED score is in line with other research assessing eating challenges and behaviours (19,174). The M3 study found that residents with higher scores on the Ed-FED assessment had a lower MNA-SF score, which indicated that when more eating challenges were present, they were more at risk of malnutrition. The research conducted by Verbrugghe and colleagues demonstrated that the number of problems (e.g., food manipulation on plate, food transportation to mouth, sitting position, alertness, appetite) with food consumption were positively associated with malnutrition (19). This finding is not surprising since eating difficulties, the inability to feed one-self, and dementia are causes that can lead to malnutrition and are commonly associated with dysphagia and prescription of MTDs (11,19,25–27,33,34). Again, this complex relationship is not clear in terms of which component or combination of components contribute to the nutritional status of older adults.

The significant association between risk of or malnutrition itself and an oral health rating affecting consumption of food was found in this study, and has also been examined previously (19). It is important to have good oral health such as proper fitting dentures, no toothaches or jaw pain, in order to promote food intake and minimize the potential for malnutrition (89,184). This study found that residents had a lower MNA-SF score when their oral health was rated to have an effect on food intake. However, the study by Verbrugghe and colleagues found that malnutrition was not significantly associated with deglutition (19). The assessment tools used and what was being measured could explain the difference in findings. Verbrugghe et al used the Minimal Eating Observation Form-Version II to determine mastication problems related to food intake and the deglutition element included the ability to chew, manipulation of food in mouth, and swallowing (19). Whereas, the M3 study used the Oral Health Examination conducted by an expert to determine the impact of oral health on food consumption. Further, in this study the risk of dysphagia was not independently associated with malnutrition risk or malnutrition itself, potentially to the high frequency of dysphagia risk; therefore mastication ability may be a better indicator of malnutrition than swallowing impairment (19,89,174). This explanation could be related to residents receiving the appropriate modified texture to improve food intake and thus reducing the risk of malnutrition, therefore interventions around food texture should not only focus on dysphagia risk but also on individuals who have oral health issues (e.g., reduced chewing ability) that could influence their food intake (26,32,41,50). Screening these individuals in LTC for oral health issues should be emphasized and providing suitable interventions (e.g., a soft or minced diet for persons with impaired chewing abilities) may benefit their food intake and nutritional status.

5.4.2 Strengths and limitations

Due to the design of the study, which is cross-sectional in nature, causality cannot be inferred with respect to risk factors that if present result in malnutrition. Rather, associations between risk factors and malnutrition were determined. Despite this limitation, these findings can be used as a basis for design of future intervention research. A limitation of this study was the use of the MNA-SF to examine nutrition risk in the M3 sample. The MNA-SF can be used in community dwelling older adults with confidence, however the full MNA may be more appropriate assessment to administer to older adults living in LTC (57,63). The MNA-SF is still a valid screening tool, and it has not only retained its validity but also its accuracy of the full MNA (57,63). Other indicators of malnutrition could have been used to further validate the results of this study, such as BMI, weight loss, fat free mass (61). Another limitation was the small sample size of those prescribed a pureed diet compared to the larger sample size of those prescribed a regular texture diet. This meant that there were approximately two residents per LTC home and thus home-level covariates were questionable for inclusion in modeling. However, this was a secondary data analysis so the sample number was set, plus the results were comparable to for both MTDs and pureed diets, as well as across other studies.

This study also contains several strengths. To date this is the largest sample size used to assess the relationship between the MNA-SF score of residents and prescription of a MTD and pureed diet while relevant covariates were considered. Additionally, this is the first and only Canadian study to investigate if diet texture is independently associated with malnutrition while considering other relevant covariates. The inclusion of several regions and homes provides greater confidence in the generalizability of findings than prior work. Lastly, this is the first and only study to also account for clusters of the province and home for residents within the same LTC facility, which ensured that factors to be found in final models were truly present and not due to potential cluster effects.

5.5 Conclusion

Malnutrition is prevalent among residents living in LTC facilities, with many factors contributing to this issue. The findings from this study have suggested that the MNA-SF score is not significantly associated with the prescription of a MTD when relevant covariates were considered, however MNA-SF score was significantly and independently associated with the prescription of a pureed diet. Several covariates were independently associated with the MNA-SF score and they included taking oral nutritional supplementation, having cognitive impairment, eating challenges, and poor oral health that could affect food consumption. Oral nutritional supplements do not appear to be sufficient to address all of the malnutrition identified in this sample. Interventions focused on oral health and improving environmental and eating assistance may also improve the nutritional status of residents with dementia. This analysis also demonstrates that the pureed diets themselves require further attention with respect to improving nutrient density and sensory appeal to support food intake and prevent malnutrition. It is important to implement multifactorial interventions to reduce the prevalence of malnutrition in LTC, which may then influence other negative outcomes including cost not only to the healthcare system such as hospitalization, but also to the individual such their health and quality of life.

Table 20. Resident characteristics of the M3 sample prescribed a modified and a regular texture diet (n= 638).

Variables	Descriptive Statistics	MNA-SF Score mean (SD)
Age (years), mean (SD)	86.81 (7.80)	10.64 (2.53)
Gender, % (n)		
Male	31.03 (198)	10.89 (2.42)
Female	68.97 (440)	10.52 (2.57)
Number of residents on prescribed diet texture, % (n)		
Regular Diet	52.82 (337[a])	11.37 (2.13)
Modified Texture Diet[b]	47.18 (301)	9.81 (2.68)
Length of admission (months), mean (SD) [median]	27.79 (27.16) [20.00]	10.64 (2.53)
Number of diagnoses, mean (SD)	5.41 (2.02)	10.64 (2.53)
Dementia diagnosis, % (n)		
Yes	65.20 (416)	10.27 (2.60)
No	34.80 (222)	11.32 (2.23)
Dysphagia risk, % (n)		
Yes	59.09 (377)	10.54 (2.50)
No	40.91 (261)	10.77 (2.56)
Number of drugs, mean (SD)	7.50 (3.45)	10.64 (2.53)
Oral nutritional supplementation, % (n)		
Yes	30.72 (196)	9.05 (2.77)
No	69.28 (442)	11.34 (2.06)
Micronutrient supplementation, % (n)		
Yes	76.65 (489)	10.84 (2.37)
No	23.35 (149)	9.96 (2.86)
interRAI LTCF scales, CPS, % (n)*		
≤2	44.23 (280)	11.81 (1.95)
≥3	55.77 (353)	9.72 (2.53)
Physical assistance required during mealtimes, % (n)*		
Often	11.85 (75)	8.24 (2.31)
Sometimes	11.37 (72)	9.33 (2.92)
Never	76.78 (486)	11.21 (2.19)

Descriptive statistics were used to compute means for continuous variables and frequencies for the categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). Abbreviations: SD= standard deviation. Total n= 638, where * n= 633.

[a]Total number of residents prescribed a regular texture diet is 338 from the total M3 sample of 639 residents, however one resident prescribed a regular texture diet had a missing MNA-SF total score thus the total number of residents prescribed a regular texture used for this analysis is 337.

[b]Modified texture= soft and bite-sized; minced and moist; pureed; or liquidized.

Table 21. Descriptive statistics and bivariate analysis showing variables associated with malnutrition (MNA-SF score) for residents prescribed a modified and a regular texture diet (n= 638).

Variables	Descriptive Statistics	MNA-SF Score mean (SD)	F-value	Parameter Estimate	P-value
Province	4	--	3.03	--	0.93
Home (province)	32	--	2.31	--	0.01
Unit (province home)	72	--	1.61	--	0.008
Number of residents on prescribed diet texture[c], % (n)					
Regular Diet	52.82 (337[a])	11.37 (2.13)	57.93	-1.58	<0.0001
Modified Texture Diet[b]	47.18 (301)	9.81 (2.68)			
Age (years), mean (SD)	86.81 (7.80)	10.64 (2.53)	12.08	-0.05	0.0005
Gender[d], % (n)					
Male	31.03 (198)	10.89 (2.42)	0.35	-0.14	0.55
Female	68.97 (440)	10.52 (2.57)			
Length of admission (months), mean (SD) [median]	27.79 (27.16) [20.00]	10.64 (2.53)	11.30	-0.01	0.0008
Number of diagnoses, mean (SD)	5.41 (2.02)	10.64 (2.53)	0.29	0.03	0.59
Dementia diagnosis[e], % (n)					
Yes	65.20 (416)	10.27 (2.60)	12.23	-0.82	0.0005
No	34.80 (222)	11.32 (2.23)			
Dysphagia risk[e], % (n)					
Yes	59.09 (377)	10.54 (2.50)	3.22	-0.41	0.07
No	40.91 (261)	10.77 (2.56)			
Number of drugs, mean (SD)	7.50 (3.45)	10.64 (2.53)	15.08	0.13	0.0001
Oral nutritional supplementation[e], % (n)					
Yes	30.72 (196)	9.05 (2.77)	123.28	-2.33	<0.0001
No	69.28 (442)	11.34 (2.06)			
Micronutrient supplementation[e], % (n)					
Yes	76.65 (489)	10.84 (2.37)	11.30	0.86	0.0008
No	23.35 (149)	9.96 (2.86)			
Family routinely brings food in for resident[e], % (n)[1]					
Yes	35.38 (225)	11.15 (2.37)	8.42	0.67	0.004
No	64.62 (411)	10.35 (2.57)			
interRAI LTCF scales, mean (SD)[2] Cognitive performance scale[f], % (n)					
≤2	44.23 (280)	11.81 (1.95)	87.78	-2.10	<0.0001
≥3	55.77 (353)	9.72 (2.53)			
Mean (SD) [median]	2.87 (1.78) [3.00]	10.64 (2.53)	180.32	-0.79	<0.0001
EDFED, mean (SD)[2]	12.37 (2.25)	10.64 (2.53)	180.81	-0.60	<0.0001
Other Eating Challenges, mean (SD)[2]	10.64 (1.65)	10.64 (2.53)	107.87	-0.67	<0.0001
All eating challenges (Ed-FED + others], mean (SD)[2]	23.01 (3.68)	10.64 (2.53)	174.85	-0.37	<0.0001
Relational Behaviour Scale, mean (SD)[3]	16.49 (3.32)	10.64 (2.53)	0.03	-0.02	0.86
Oral health rating[g], % (n)[4]					
Affects consumption	49.47 (280)	10.41 (2.67)	15.56	-0.92	<0.0001
Does not affect consumption	50.53 (286)	11.19 (2.19)			

Average length of meal (minutes), mean (SD)[1]	40.18 (13.05)	10.64 (2.53)	11.39	-0.04	0.0008
Physical assistance required during mealtimes[h], % (n)[2]					
Often	11.85 (75)	8.24 (2.31)	47.62	-2.90	<0.0001
Sometimes	11.37 (72)	9.33 (2.92)		-1.14	
Never	76.78 (486)	11.21 (2.19)			
Person directed care (summary score out of 100), mean (SD)	61.54 (5.50)	10.64 (2.53)	0.17	0.09	0.68
Proportion (%) of commercially outsourced food, mean (SD)	24.41 (23.81)	10.64 (2.53)	0.00	0.02	0.96
Raw food cost, mean (SD)[5]	7.70 (1.19)	10.64 (2.53)	2.87	1.04	0.10

Used hierarchical multiple linear regression to assess bivariate relationships, model: MNA-SF total score= variable + Province + Site(Province) + Unit(Province Site). Numerical and ordinal data are mean (standard deviation). Categorical and ordinal data are % (n). Abbreviations: SD= standard deviation.

[a]Total number of residents prescribed a regular texture diet is 338 from the total M3 sample of 639 residents, however one resident prescribed a regular texture diet had a missing MNA-SF total score thus the total number of residents prescribed a regular texture used for this analysis is 337. Total n= 638, where [1]n= 636, [2]n= 633, [3]n= 99, [4]n= 566, [5]n= 538.

[b]Modified texture= soft and bite-sized; minced and moist; pureed; or liquidized.

[c]Reference category= regular texture diet.

[d]Reference category= female.

[e]Reference category= no.

[f]Reference category= ≤2.

[g]Reference category= oral health does not affect consumption.

[h]Reference category= never.

Table 22. Hierarchical multivariate linear regression analysis of malnutrition risk and use of any modified texture diet.

Model 1: adjusted for age and gender Dependent variable: MNA-SF score				
Covariates	**β**	**SE**	**t-value**	**P-value**
Intercept	15.17	1.47	10.3	<0.0001
Prescribed modified texture diet[a]	-0.23	0.20	-1.16	0.25
Age	-0.03	0.01	-2.11	0.04
Gender[b]	-0.20	0.21	-0.98	0.33
Oral nutritional supplementation[b]	-1.52	0.21	-7.12	<0.0001
Cognitive performance scale score[d]	-1.07	0.22	-4.83	<0.0001
Ed-FED score	-0.32	0.05	-6.31	<0.0001
Oral health rating[e]	-0.41	0.20	-2.09	0.04

Abbreviations: β= standardized beta parameter estimate; SE= standard error.

N= 561. Model F-value= 5.59 (p= <0.0001, df= 85). Model R-square= 0.50.

[a]Reference category= regular texture diet.

[b]Reference category= female.

[c]Reference category= no.

[d]Reference category= ≤2.

[e]Reference category= oral health does not affect consumption.

Table 23. Resident characteristics of the M3 sample prescribed a pureed and a regular texture diet (n= 405).

Variables	Descriptive Statistics	MNA-SF Score mean (SD)
Age (years), mean (SD)	86.64 (7.85)	10.88 (2.41)
Gender, % (n)		
Female	70.62 (286)	10.76 (2.50)
Male	29.38 (119)	11.17 (2.16)
Number of residents on prescribed diet texture, % (n)		
Regular Diet	83.21 (337[a])	11.37 (2.13)
Pureed Diet	16.79 (68)	8.41 (2.25)
Length of admission (months), mean (SD) [median]	25.22 (25.07) [18.00]	10.88 (2.41)
Number of diagnoses, mean (SD)	5.31 (2.04)	10.88 (2.41)
Dementia diagnosis, % (n)		
Yes	64.94 (263)	10.55 (2.47)
No	35.06 (142)	11.48 (2.18)
Dysphagia risk, % (n)		
Yes	54.81 (222)	10.67 (2.37)
No	45.19 (183)	11.13 (2.45)
Number of drugs, mean (SD)	7.50 (3.51)	10.88 (2.41)
Oral nutritional supplementation, % (n)		
Yes	24.44 (99)	9.12 (2.70)
No	75.56 (306)	11.44 (2.01)
Micronutrient supplementation, % (n)		
Yes	79.51 (322)	11.02 (2.34)
No	20.49 (83)	10.31 (2.60)
interRAI LTCF scales, CPS, % (n)		
≤2	48.64 (197)	11.93 (1.93)
≥3	51.36 (208)	9.88 (2.41)
Physical assistance required during mealtimes, % (n)*		
Often	12.44 (50)	8.34 (2.02)
Sometimes	10.20 (41)	9.71 (2.27)
Never	77.36 (311)	11.44 (2.17)

Descriptive statistics was used to compute means for continuous variables and frequencies for the categorical variables. Numerical and ordinal data are mean (standard deviation) and median where appropriate. Categorical and ordinal data are % (n). Abbreviations: SD= standard deviation.

[a]Total number of residents prescribed a regular texture diet is 338 from the total M3 sample of 639 residents, however one resident prescribed a regular texture diet had a missing MNA-SF total score thus the total number of residents prescribed a regular texture used for this analysis is 337. Total n= 405, where * n= 402.

Table 24. Descriptive statistics and bivariate analysis showing variables associated with malnutrition (MNA-SF score) for residents prescribed a pureed and a regular texture diet (n= 405).

Variables	Descriptive Statistics	MNA-SF Score mean (SD)	F-value	Parameter Estimate	P-value
Province	4	--	0.79	--	0.50
Home (province)	32	--	1.10	--	0.34
Unit (province home)	72	--	1.05	--	0.38
Number of residents on prescribed diet texture[b], % (n)					
Regular Diet	83.21 (337[a])	11.37 (2.13)	59.34	-2.69	<0.0001
Pureed Diet	16.79 (68)	8.41 (2.25)			
Age (years), mean (SD)	86.64 (7.85)	10.88 (2.41)	3.86	-0.03	0.05
Gender[c], % (n)					
Male	29.38 (119)	11.17 (2.16)	0.06	-0.08	0.81
Female	70.62 (286)	10.76 (2.50)			
Length of admission (months), mean (SD) [median]	25.22 (25.07) [18.00]	10.88 (2.41)	6.39	-0.01	0.01
Number of diagnoses, mean (SD)	5.31 (2.04)	10.88 (2.41)	0.03	-0.01	0.86
Dementia diagnosis[d], % (n)					
Yes	64.94 (263)	10.55 (2.47)	6.41	-0.74	0.01
No	35.06 (142)	11.48 (2.18)			
Dysphagia risk[d], % (n)					
Yes	54.81 (222)	10.67 (2.37)	3.63	-0.54	0.06
No	45.19 (183)	11.13 (2.45)			
Number of drugs, mean (SD)	7.50 (3.51)	10.88 (2.41)	6.19	0.10	0.01
Oral nutritional supplementation[d], % (n)					
Yes	24.44 (99)	9.12 (2.70)	59.70	-2.29	<0.0001
No	75.56 (306)	11.44 (2.01)			
Micronutrient supplementation[d], % (n)					
Yes	79.51 (322)	11.02 (2.34)	2.22	0.51	0.14
No	20.49 (83)	10.31 (2.60)			
Family routinely brings food in for resident[d], % (n)[1]					
Yes	36.97 (149)	11.52 (2.01)	7.87	0.81	0.005
No	63.03 (254)	10.50 (2.55)			
interRAI LTCF scales, mean (SD)[2] Cognitive performance scale[e], % (n)					
≤2	48.64 (197)	11.93 (1.93)	49.31	-2.01	<0.0001
≥3	51.36 (208)	9.88 (2.41)			
Mean (SD) [median]	2.73 (1.78) [3.00]	10.88 (2.41)	107.78	-0.77	<0.0001
EDFED, mean (SD)[2]	12.26 (2.20)	10.88 (2.41)	120.79	-0.63	<0.0001
Other Eating Challenges, mean (SD)[2]	10.47 (1.58)	10.88 (2.41)	65.76	-0.70	<0.0001
All eating challenges (Ed-FED + others], mean (SD)[2]	22.73 (3.58)	10.88 (2.41)	112.75	-0.38	<0.0001
Relational Behaviour Scale, mean (SD)[4]	16.65 (3.45)	10.88 (2.41)	0.07	-0.04	0.79
Oral health rating[f], % (n)[4]					
Affects consumption	46.58 (170)	10.54 (2.60)	15.45	-1.17	0.0001
Does not affect consumption	53.42 (195)	11.38 (2.07)			

Average length of meal (minutes), mean (SD)[1]	39.44 (12.34)	10.88 (2.41)	4.94	-0.03	0.03
Physical assistance required during mealtimes[g], % (n)[2]					
Often	12.44 (50)	8.34 (2.02)	28.10	-2.90	<0.0001
Sometimes	10.20 (41)	9.71 (2.27)		-1.13	
Never	77.36 (311)	11.44 (2.17)			
Person direction care (average score out of 5), mean (SD)	3.18 (0.29)	10.88 (2.41)	0.20	0.18	0.66
Person direction care (summary score out of 100), mean (SD)	62.01 (5.58)	10.88 (2.41)	0.23	0.01	0.63
Proportion (%) of commercially outsourced food, mean (SD)	24.64 (23.05)	10.88 (2.41)	1.20	0.02	0.28
Raw food cost, mean (SD)[5]	7.80 (1.28)	10.88 (2.41)	8.66	1.04	0.008

Used hierarchical multiple linear regression to assess bivariate relationships, model: MNA-SF total score= variable + Province + Site(Province) + Unit(Province Site). Numerical and ordinal data are mean (standard deviation). Categorical and ordinal data are % (n). Abbreviations: SD= standard deviation.

[a]Total number of residents prescribed a regular texture diet is 338 from the total M3 sample of 639 residents, however one resident prescribed a regular texture diet had a missing MNA-SF total score thus the total number of residents prescribed a regular texture used for this analysis is 337. Total n= 405, where [1]n= 403, [2]n= 402, [3]n= 66, [4]n= 365, [5]n= 328.

[b]Reference category= regular texture diet.

[c]Reference category= female.

[d]Reference category= no.

[e]Reference category= ≤2.

[f]Reference category= oral health does not affect consumption.

[g]Reference category= never.

Table 25. Hierarchical multivariate linear regression analysis of malnutrition risk and use of pureed texture diet.

Model 2: adjusted for age and gender Dependent variable: MNA-SF score				
Covariates	**β**	**SE**	**t-value**	**P-value**
Intercept	13.93	1.96	7.11	<0.0001
Prescribed pureed texture[a]	-0.89	0.40	-2.23	0.03
Age	-0.02	0.01	-1.52	0.13
Gender[b]	-0.19	0.26	-0.71	0.48
Oral nutritional supplementation[c]	-1.51	0.29	-5.23	<0.0001
Cognitive performance scale[d]	-0.85	0.29	-2.94	0.004
Ed-FED score	-0.34	0.08	-4.49	<0.0001
Oral health rating[e]	-0.56	0.26	-2.20	0.03

Abbreviations: β= standardized beta parameter estimate; SE= standard error.

N= 364. Model F-value= 3.84 (p= <0.0001, df= 84). Model R-square= 0.54.

[a]Reference category= regular texture diet.

[b]Reference category= female.

[c]Reference category= no.

[d]Reference category= ≤2.

[e]Reference category= oral health does not affect consumption.

Chapter 6
Discussion

6.1 Key findings

This secondary data analysis of Making the Most of Mealtimes (M3) prevalence study has addressed various research gaps in the existing literature. The key findings from Chapter 2: *Prevalence of Modified Texture Diet (MTD) use in Long Term Care (LTC)*, were that the prevalence of prescribed MTDs was high and significantly different across provinces in Canada. Modified texture (i.e., pureed, minced and moist, and soft and bite-sized) diets were prescribed to about 47% of residents in the M3 sample, with the most common MTD being minced and moist. There was significant variation in the proportion of prescribed MTDs across the four provinces for each texture category, with Alberta and New Brunswick having the highest proportions of modified textures. The resident characteristics that were found to be associated with the prescription of a MTD included: longer length of admission, risk of dysphagia, dementia diagnosis, lower number of oral agents/drugs used (e.g., vitamin/mineral supplementation + drugs), decreased number of vitamins/minerals, prescription of oral nutritional supplementation, lower body weight, higher weight loss in the past three months, lower body mass index, decreased calf circumference, lower Mini Nutritional Assessment short-form (MNA-SF) score (i.e., increased risk for malnutrition), requirement of physical assistance for eating, higher Edinburgh Feeding Evaluation in Dementia Questionnaire (ED-FED) score (i.e., more eating challenges), oral health status affecting food consumption, and higher cognitive performance scale (CPS) and activities of daily living long form scale (ADL-LFS) score indicating greater cognitive deficits and need for supports with daily activities.

The key findings from Chapter 3: *Quality of the Regular and Modified Texture Menus as Planned in LTC,* were that pureed menus tended to offer a lower amount for many nutrients as compared to the regular menu when looking at the average across provinces. It was also evident that there was variability in the quality of menu planning across provinces and LTC homes in the M3 sample. Findings suggest there were significant province and diet texture interactions for energy, protein, carbohydrates, fibre, and 11 of 22 micronutrients analyzed, with New Brunswick and Alberta having lower nutrient content for both menus as compared to Ontario and Manitoba. Within each province, similar trends were observed; some homes had significantly lower nutrient content for pureed diets, while others did not. Specifically in Ontario, there were fewer differences in micronutrients between pureed and regular textures, with some micronutrients actually higher in the pureed menu. Furthermore, fibre and nine micronutrients were below DRI recommendations for both menus across the provinces, with variation existing across the sites within each province where some had more or less nutrients meeting the specific DRI recommendations. There were home characteristics that were found to be associated with energy and protein provision from the regular and pureed texture menus; for-profit homes provided significantly higher amounts when compared to non-profit homes across both textures; homes that had more beds provided more energy for the regular texture menu; menu cycles of six weeks in length provided significantly lower protein and energy intake than three, four, and five week menu cycles for both regular and pureed menus; a menu revision of more than 18 months provided significantly lower amounts of energy and protein across both textures, with a menu revision of 6−12 months providing significantly higher amounts of energy for only the pureed texture; homes that had higher funding for raw food provided more energy for the pureed texture; and homes that had a higher proportion of commercial food product use provided more energy for the regular texture.

The key findings from Chapter 4: *Consumption of Modified Texture Food in LTC* were that inadequate nutrient intake existed for residents consuming a pureed diet for several nutrients, and specifically of concern were vitamin B6, vitamin D, vitamin E, vitamin K, folate, calcium, magnesium, potassium, and fibre. The findings also suggested that energy, carbohydrate, protein, and dietary fibre did not statistically significantly vary by body size. The number of staff assisting at mealtimes was the only significant predictor of food intake within this group. Specifically, as the number of staff increased during mealtimes the amount of energy and protein intake per kilogram of body weight decreased for residents consuming a pureed texture.

Lastly, the key findings from Chapter 5: *Malnutrition and Modified Texture Food in LTC,* were that a prescribed MTD, and more specifically a pureed diet, was independently associated with a risk of/malnutrition among residents living in LTC facilities. Four covariates while adjusting for age and gender were also found to be independently associated with risk of/malnutrition across both diet textures and they were: being on oral nutritional supplementation, a CPS score of three or more (e.g., severe cognitive impairment), a higher Ed-FED score (e.g. more eating challenges), and an oral health rating that affects food consumption. Age and gender were not independently associated with MNA-SF score; except age for prescription of MTDs only.

6.2 Key messages

Modified texture foods, especially pureed food, are associated with a high prevalence of under-nutrition and weight loss among older adults in LTC (11,20–27), and this study found that the prevalence of pureed diets was between 4% to 16% across the provinces in the M3 study with a national average of about 11%. It was also found that individuals prescribed a pureed texture were highly vulnerable residents, due to many resident characteristics that were found to be associated with prescription of a pureed diet. A very large proportion of these residents had a dementia diagnosis (~87%) and more cognitive impairment, as well as more impairment in their activities of daily living. Moreover, these individuals had a significantly lower body weight, more weight loss over a three-month period, and lower body mass index. Lastly, a higher percentage of residents on a pureed diet required physical assistance during mealtimes (~80%) and had poor oral health that affects food consumption (~60%), and more eating challenges. All of these factors can play a role in the development of malnutrition or can further exacerbate individuals that already are malnourished; this study confirmed that residents on a pureed diet were at higher risk of malnutrition as detected by a lower MNA-SF score (mean= 8.41, SD= 2.25).

This secondary data analysis also found that a pureed diet was independently associated with risk of or malnutrition among residents living in LTC facilities, along with four other factors. The four factors previously mentioned were also significantly associated with prescription of a pureed diet as identified in the first study. In addition to being prescribed a pureed diet, which increases the risk of malnutrition, these resident characteristics further exacerbate this risk. Therefore, to reduce the risk of malnutrition in this segment of the population, interventions targeting these four factors should be implemented into LTC practice now that more information is known about this specific population. Residents on oral nutritional supplementation are likely already malnourished and this is an intervention to mitigate poor food intake; however staff training could focus on increasing their awareness of these individuals at risk and paying more attention to their food intake and weight loss to try to reduce their risk of being malnourished. Moreover, interventions that specifically support staff to provide quality assistance to the most vulnerable with significant cognitive impairment and eating challenges could be developed and evaluated to determine if they can reduce the risk of malnutrition in this population (84,139,185). Previous work has indicated that quality eating assistance improves body weight and supports food intake of older adults in LTC (84,139,185). This finding from study four (Chapter 5) coincides with the finding from study three (Chapter 4) that having more persons involved in assisting was associated with poor intake when on a pureed diet. As these individuals also had more eating challenges, it is hypothesized that various staff try to intervene with limited success. These associations could also suggest that these residents are near the end of life and interventions may not be effective. Lastly, ensuring proper oral health such as providing properly fitted dentures and treating cavities so food consumption is not impacted could also reduce the risk of malnutrition (174,186). There is little research around the oral health of older adults in LTC, but studies have suggested that poor oral health is a concern in this population (22,174,186).

This is the first known study that had demonstrated the effects of the diet alone on malnutrition while controlling for eating challenges, oral health, dementia, age and gender and demonstrates that the diet prescription itself also contributed to malnutrition in this sample. As planned menus were found to provide variability in nutrients across the provinces and LTC homes in the M3 sample, and pureed menus tended to offer a lower amount for many nutrients as compared to the regular menu when looking at the average across provinces, menu planning and the diet itself is also an area that needs to be addressed. Planned menus for the pureed texture offered an average of about 1800 calories across all the provinces and when compared to the average intake of about 1588 calories for residents consuming a pureed diet across the entire M3 sample, the average consumption found in this study was about 88% of offered. This new finding is substantially higher than what previous research has suggested, where the estimated average consumption was about 50% of food offered in LTC (18,28). Reasons for this higher consumption could be related to residents receiving the appropriate texture, delivery of person-centred care during eating assistance, pleasant mealtime experiences, and/or more palatable pureed food. This new finding suggests intake may be better than previously thought, yet there are still improvements to be made. If residents are being provided food that does not meet DRIs then they are already at risk of not consuming an adequate amount of nutrients to meet their daily requirements. Vitamin B6, vitamin D, vitamin E, vitamin K, folate, calcium, magnesium, potassium, and fibre had the potential to be inadequate for 50% or more of residents consuming a pureed diet in the M3 sample. When looking across the four provinces at planned menus, many of the same nutrients were being provided at levels below their respective DRI making it impossible for residents to consume adequate amounts of those nutrients from only dietary sources and without supplementation (e.g., oral nutrition or micronutrient). The only exception was zinc where it was provided below the RDA but prevalence of inadequacy was not as high; inadequate intake for this nutrient was estimated between 25%-50% of the sample. Among the four provinces, vitamin D, calcium, and potassium from the pureed menu were provided at higher levels when compared to the regular texture menu, demonstrating that targeted menu planning to address key nutrients is a plausible strategy to mitigate risk of inadequate consumption; however, values for both textures were still below the DRI. Unfortunately, as noted by the consumption data, this was not sufficient to meet the DRI for these nutrients in these consumers as either they continued to not meet the DRI when planned, and/or consumption was insufficient. With a low intake of nutrients among pureed consumers, these residents are at an increased risk of malnutrition as noted in study four (Chapter 5). Further strategies to provide nutrient dense foods through strategic menu planning are needed, as is dissemination to promote improved practice. For example, requiring all homes to complete a comprehensive nutrient analysis for their planned menu is one strategy that could be mandated by government funders. For some nutrients (e.g. vitamin D) supplementation is likely a necessary strategy.

The home level variables that were associated with energy and protein provision in the planned menu for the pureed texture menus across the 32 LTC homes could not be analyzed to identify potential factors associated with actual consumption by residents due to the small sample size of pureed consumers. However, these site level characteristics can play an important role for individuals consuming a pureed diet and analysis by content of planned menus identified some interesting associations. For-profit homes were providing significantly higher amounts of energy and protein when compared to non-profit homes. These facilities may potentially be providing more food or more nutrient dense products which suggests that possibly more investment is being put into menu planning. Menu length, frequency of revision and amount of money provided by food appear to be successful mechanisms for promoting more nutrient dense menus. Further identification of strategies used by homes to promote nutrient density is an area for future research.

In addition to lower quality pureed food offered in LTC, staff practices around eating assistance are associated with low intake of nutrients since many residents on a pureed diet have eating challenges and are dependent on others for help during mealtimes. This study found that having more persons involved in assisting is associated with poor intake when on a pureed diet; more specifically, the number of staff assisting during mealtimes was independently associated with energy and protein intake; as the number of staff increased during mealtimes the amount of energy and protein intake per kilogram of body weight decreased. Only one resident level variable was independently associated with energy and protein intake and this could be related to the lack of variability in the sample of residents consuming pureed diets as almost all consumers had dementia, were female, older in age, and prescribed supplementation. The lack of association with demographic, health and functional variables suggests this sample was homogenous. Further, Ed-FED and "other eating challenges" scores were significantly associated with number of staff assisting, suggesting that the most vulnerable with significant eating challenges are more likely to have poor intake. Previous research has suggested that eating difficulties during mealtimes can impact food intake if adequate assistance is not provided from staff (83,84). Therefore it is not only important to implement interventions that target both staff providing eating assistance and residents requiring the assistance, but also ensuring that staff have advanced skills to address the significant eating challenges seen in those requiring pureed food, and at the end stages of their dementing illness. For example, training staff around person-centered care practices such as staying with the resident during the entire care period to promote consistency in care would be one way to increase food intake as well as specialized techniques to support independent feeding for as long as possible.

Malnutrition is a complex issue among older adults in LTC, as suggested by this work. There are many factors at different levels (e.g., resident, staff, home) that interrelate with one another to increase the risk of malnutrition within this population. The descriptive analysis identified that pureed consumers are highly vulnerable, with more cognitive and physical deficits, oral health issues, and eating dependence and challenges; these same characteristics were also found to be associated with malnutrition risk. These individual characteristics are associated with staff level factors such as the number of persons assisting individuals with eating challenges, which plays a role in their food intake. Further, this study found that residents on pureed diets had low consumption of nutrients, which could be related to their eating challenges and the number of staff that assisted them, but also potentially due to the low quality of pureed food offered by menus in that home. All of the factors described above, pureed food consumption, eating challenges, oral health, and low intake of nutrients, can be intertwined within one another and lead to an increased risk of malnutrition for individuals. This complex relationship could be different for each individual and lead to a varying degree of malnutrition. However, this relationship is not clear or cannot be established as causal due to the cross sectional nature of the data used in this study. Nonetheless, resident, staff, and home level factors are still important to consider for intervention work, which all seem to be associated with the risk of malnutrition risk in older adults in LTC.

This thesis work, a secondary data analysis of M3 Project, has substantially contributed to the existing literature around older adults and modified texture diets in LTC, as this field of research is limited, especially in the Canadian LTC context. Prior research on the prevalence of MTDs and characteristics associated with this diet prescription, planned menus in LTC for MTDs, consumption of MTDs and factors associated with this intake, and association between MTDs and malnutrition has been limited in sample size, diversity, and measurement of resident and home levels characteristics associated with MTDs. This research has addressed some of the research gaps as discussed previously and has indicated that tailored and multifactorial interventions are needed to appropriately address factors contributing to either low food consumption, malnutrition, or low quality menus. Therefore, this research could inform future work and interventions, but improved practices to support intake can also be recommended based on this current research. Specifically, adopting policies around menu length (< 5 weeks), frequent menu revisions (e.g., annual) to promote energy and protein dense menus, or implementing programs around oral hygiene to promote food consumption appear warranted based on these findings.

6.3 Future research and implications for LTC practice

Future research should focus on assessing prescribed textures using the IDDSI framework to confirm home descriptors and ensure accuracy of prevalence when the IDDSI framework is fully implemented in Canada and is adopted by LTC homes across this country. Awareness should be placed on the standardization of recipes for regular and pureed textures to promote consistency in nutrient content across LTC homes and regions but also on deliberate menu planning to reduce the risk of malnutrition in this population. For consumption of pureed food and comparison to DRIs, this study serves as a basis for future research that should include both male and female participants across different diet textures, considering regular and modified texture foods and not only pureed textures. Moreover, research should also investigate home and unit level variables that are associated with food intake across diet textures to comprehensively understand what other key factors are contributing to this intake. Also, studies with a longitudinal design should be conducted to be able to predict factors of malnutrition risk and in order to determine causal relationships between these factors. Due to the design of the M3 study, which is cross-sectional in nature, causality could not be inferred. Regardless, this research was a much-needed important step towards future research rather than a limitation because of the lack of comprehensive research conducted LTC in general, and Canada specifically. The cross-sectional design allowed for comparisons of many variables of interest and to determine associations between inadequate food and fluid intake and the multi-level influences and multi-factorial causes of this intake in the LTC population. Lastly, future work should implement multifaceted interventions that target the three domains (i.e., mealtime experience, meal access, and meal quality) conceptualized by Keller and colleagues (11), to better capture factors at all levels (e.g., resident, staff, home) that are associated with malnutrition risk and promote an individualized intervention to account for the variation existing among residents living in LTC.

6.4 Conclusions

In conclusion, the prevalence of prescribed MTDs was high and significantly different across provinces in Canada, with a number of residents characteristics associated with a prescribed MTD. There was variability in menu planning across provinces and LTC homes in the M3 sample, plus pureed menus tended to offer a lower amount for many nutrients as compared to the regular menu with some exceptions (e.g., vitamin D, calcium). Among residents consuming a pureed diet, inadequate nutrient intake existed for several nutrients, and specifically of concern were vitamin B6, vitamin D, vitamin E, vitamin K, folate, calcium, magnesium, potassium, and fibre. The number of staff assisting at mealtimes was the only significant predictor of food intake within this group. Lastly, prescribed diet texture, more specifically a pureed diet, was independently associated with risk of or malnutrition among residents living in LTC facilities. This secondary data analysis of M3 prevalence study has addressed various research gaps in the existing literature and has substantially contributed to the limited literature around older adults and modified texture diets in LTC. This research could inform future interventions and change practices in LTC, however more research needed in this area to further validate findings and test interventions.

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