FOOD SERVICES IN LONG-TERM CARE HOMES ARE ASSOCIATED WITH RESIDENTS' FOOD INTAKE

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Abstract: *Background:* Food and nutrient intake of Canadian long-term care residents is commonly inadequate. Factors influencing resident food intake and nutritional quality of menus are numerous and those related to food service are often poorly investigated. *Objective:* To: a) describe food service characteristics of diverse Canadian long-term care homes, b) determine if there are provincial differences in these characteristics, c) determine the association between these characteristics and food intake of residents, and d) determine the association between these characteristics and the nutritional quality of the menus. *Design:* A cross-sectional study. *Setting:* Thirty-two long-term care homes in four Canadian provinces (Alberta, Manitoba, New Brunswick and Ontario). *Participants:* 639 residents. *Measurements:* Food service operations were reported by home administrators using a standardized questionnaire and summarized by province for analysis. Resident food intake was assessed by weighing and observing intake over three non-consecutive days including one weekend day. Absolute mean energy and protein intake per resident was used in analyses, as well as the nutritional quality of the diet (iMAR). Menus (regular and pureed) were analyzed for nutrient content and compared to the Dietary Reference Intakes to determine the menu Mean Adequacy Ratio (mMAR), a score that summarizes the nutrient quality. *Results:* Daily energy and protein intake as well as iMAR were not significantly different across provinces. The timing of the biggest meal of the day, the proportion of commercially prepared food and the mMAR score were the only food service variables significantly different between provinces. Homes who reviewed their menus in the past six months (72%), was positively associated with participant's energy (β=23.0; p=0.02) and protein intake (β=3.1; p=0.03). Food production system was associated with pureed menu mMAR score (F=5.46; p=0.01). Supper as the biggest meal of the day (67.7 %), was negatively associated with participants' protein intake (β=-16.73; p=0.02) while the pureed menu mMAR score was positively associated with the iMAR score (β=0.61; p=0.01). *Conclusion:* To promote sufficient intake, effort is needed to ensure menus meet dietary requirements. Most homes provided the largest meal of the day in the evening and this practice appears to lead to lower protein intake. Relatively few food service variables analysed were associated with resident intake, suggesting that others factors (i.e., resident attributes, mealtime environment, etc.) should also be considered.

Key words: older adults, long-term care home, food service, food intake.

Introduction

To date, numerous studies have examined risk of malnutrition among older adults living in long-term care (LTC) homes (1-5). According to the Public Health Agency of Canada, the prevalence of malnutrition is up to 60% among people living in LTC, mainly because of the precarious health of this population (6). This high prevalence of malnutrition among LTC residents (20-77%) has been confirmed by several Canadian studies (1-5). Malnutrition can be influenced by various factors related to the aging process itself (8), medical conditions, psychological and social status (8, 9), but also different institutional factors that can impact the nutritional care of LTC residents (2, 10). Abbott et al. (2013) described institutional factors that could improve food intake, specifically those related to mealtime interventions, in a systematic review. Studies were categorized by intervention type as follows: food improvement (e.g., food fortification, addition of flavor), staff training (e.g., nutrition education for nursing staff, feeding skills training programs), eating assistance (e.g., intervention to improve food intake), dining environment (e.g., improving ambiance, presentation of foods), and food service (e.g., smaller meals, liberalization of diets) (11).

Although food intake is a common topic in LTC research, only a few studies have examined the link between residents' food intake and food service factors (12-14). Furthermore, these studies typically only focused on a few aspects of food service, such as the food distribution system. Other LTC food service practices that could impact food intake of residents, such as food production systems, require further investigation. Food production is typically categorized into either traditional or non-traditional systems. Traditional food production is similar to home-style meal preparation, where meals are prepared and cooked on-site every day and delivered immediately to residents, while non-traditional production consists of bulk foods pre-prepared and cooked in advance and then chilled or frozen and finally reheated when needed. This

type of meal can also be prepared off-site in another facility and then transported to the home as required (15, 16). Food distribution systems are generally divided into two categories: centralized and decentralized, although some LTC homes have both systems. In a centralized system, all food distribution occurs from one central kitchen and then meals (food trays or plates) are distributed to residents on trays or plates either in one large dining room attached to the central kitchen or to residents' rooms (17). A decentralized food distribution system typically consists of a central kitchen or a distribution facility where food is prepared and then transported in bulk to one or more receiving kitchens (i.e., kitchenettes, serveries) attached to a dining room where food is held in steam tables and then plated and served to residents (2, 12, 14, 16). Some finishing off of cooking may also happen in these kitchenettes. Buffet-style dining is another system that has been studied in previous research. Meals are served on the table in large portions and then distributed to residents according to their preferences (13, 18). Other food service related factors such as, raw food cost (i.e., food budget), menu quality, menu cycle length, meals and snack choices, menu planning and revision, and food availability (i.e., if residents have access to food outside of mealtime or if they can have food in their rooms), may also influence food intake (2, 13, 15, 16).

As relatively little research has investigated the association of different determinants of food services on food intake of residents in LTC, this study will: a) describe food service characteristics in a diverse sample of LTC homes from four provinces in Canada, b) determine if there are provincial differences in these characteristics, c) determine if these food service characteristics are associated with residents' food intake (amount and quality) and, d) determine if these characteristics are associated with the nutritional quality of the menus provided.

Methods

Recruitment and data collection

This analysis is part of the Making the Most of Mealtimes (M3) study, which was a cross-sectional, multi-site study that collected data in 32 LTC homes from four Canadian provinces: Alberta (AB), Manitoba (MB), New Brunswick (NB) and Ontario (ON). The main objective of the M3 study was to identify factors associated with food and fluid intake of LTC residents. Within each home, data were collected from one to four randomly selected care units. A total of 640 residents were assessed in 82 dining rooms; however, at the end of data collection, one participant withdrew from the study, reducing the total sample to 639 participants (19).

LTC homes were geographically close to the research centre (i.e., university) in each province. Homes that had been in operation for at least six months with a minimum of 50 residents, assuming that less than half would meet the eligibility criteria, were recruited. Homes were also purposively

sampled to have key characteristics (e.g., profit status, unique populations such as Asian). Nursing home administrators were initially contacted and a solicitation letter with the project summary was sent to them. When the administrator and home management agreed to participate in the study, resident participants from the home were recruited. To be eligible to participate in this study, residents had to be either English or French speaking, aged 65 years and over, living in the LTC home for more than a month, requiring at least two hours of assistance with activities of daily living, medically stable (i.e., no acute care hospitalization in previous month), not on a tube feed, not considered palliative and either they or their alternate decision maker (ADM) could provide consent. When residents or their ADM accepted to be contacted by the research team, they were further informed about the study requirements by the research coordinator and were provided an information letter with a written consent form to be signed.

Residents' characteristics and food intake

Specific resident information, such as age, sex, medical diagnosis, cognitive status, prescription drug use, monthly body weight, and therapeutic diets, were gathered from health and medical records by each provincial M3 research coordinator. Food intake for each participating resident was recorded using both observation and weighing methods by two trained research assistants. Nine meals per participant (i.e., three breakfasts, three lunches and three suppers) over three non-consecutive days, including a weekend day, were observed. Consumption of side dishes and liquids was estimated, while main plate items were weighed before and after consumption, all of which were recorded using a standardized form. Food and beverages consumed outside meals were reported by direct observation, where possible, or by asking care staff, families or residents about types and amounts consumed. Use of vitamin supplements or oral nutritional supplements on the days of data collection was also included in the assessment of dietary intake; the latter was included in the food-only assessment of nutrient intake.

Menu and diet quality

Nutritional analysis of foods consumed by each participant was completed using every home's recipes. The first week of the menu cycle was also analyzed to determine nutrient quality of the menu; first choice for regular and pureed menus were analyzed. ESHA Food Processor, Version 10.14.1, 2014 was used in all provinces. Food intake for residents was adjusted for intra-individual variation (20). Diet quality was assessed by comparing resident's food intake to the Dietary Reference Intake recommendations using the Recommended Dietary Allowance (RDA) (21). An individual mean adequacy ratio (iMAR) for each participant was calculated using the nutrient adequacy ratio (NAR). A NAR is a ratio of intake of a given nutrient relative to the RDA for that nutrient. NAR was equivalent to the percentage of the corresponding RDA

Table 1
Resident's descriptive characteristics by province (N=639)

	All Provinces	Alberta	Manitoba	New Brunswick	Ontario
N	**639**	**160**	**159**	**160**	**160**
Sex, Men, n (%)	199 (31.1)	58 (36.2)	50 (31.4)	48 (30.0)	43 (26.9)
Age, mean (SD)	86.8 (7.83)	87.6 (7.82)	86.5 (7.95)	85.7 (8.38)	87.3 (7.04)
MNA-SF Score, n (%)*					
Increased Risk of Malnutrition	343 (53.8)	85 (53.5)	82 (51.6)	87 (54.4)	89 (55.6)
Normal Nutritional Status	295 (46.2)	74 (46.5)	77 (48.4)	73 (45.6)	71 (44.4)
Diet Texture, n (%)†					
Regular	338 (52.9)	63 (39.4){	94 (59.1)#	76 (47.5){	105 (65.6)#
Soft	91 (14.2)	47 (29.4)	22 (13.8)	17 (10.6)	5 (3.13)
Minced/Moist	139 (21.8)	29 (18.1)	35 (22.0)	42 (26.2)	33 (20.6)
Pureed	68 (10.6)	19 (11.9)	7 (4.4)	25 (15.6)	17 (10.6)
Liquidized	3 (0.5)	2 (1.2)	1 (0.6)	0 (0.0)	0 (0.0)
Number of Diagnoses, mean (SD)	5.4 (2.03)	6.2 (2.12){	5.6 (1.90){#	4.5 (1.80)**	5.2 (1.92)#
Any Dementia diagnosed, n (%)	416 (65.0)	93 (58.1){	95 (59.4){	108 (67.5){#	120 (75.0)#
Number of Drugs prescribed, mean (SD)	7.5 (7.00)	7.4 (3.34){	6.5 (2.98){	9.5 (3.55)#	6.5 (2.98){
Number of vitamin/ mineral Supplements prescribed, mean (SD) ‡	1.5 (1.21)	1.7 (1.37){	1.6 (1.19){	1.0 (0.96)#	1.7 (1.14){
Any Oral Nutritional supplements prescribed, n (%)	196 (30.7)	60 (37.5)	52 (32.7)	42 (26.2)	42 (26.2)
Adjusted Daily Energy Intake, kcal, mean (SD)	1553.51 (294.54)	1563.94 (332.38)	1513.73 (264.97)	1537.62 (293.54)	1598.43 (278.68)
Adjusted Daily Protein Intake, g, mean (SD)	57.43 (13.05)	57.43 (13.79)	56.48 (12.09)	56.81 (12.65)	59.00 (13.55)
Individual MAR score (iMAR), mean (SD)	0.79 (0.09)	0.79 (0.09)	0.78 (0.09)	0.79 (0.09)	0.80 (0.08)

* Risk of malnutrition as per MNA-SF screening tool; 0-11= increased risk of malnutrition, 12-14 = normal nutritional status; n=638; † Texture based on the International Dysphagia Diet Standardized Initiative (IDDSI) guidelines; ‡ Data were transformed for statistical analysis, to fulfill assumptions of ANOVA; § Missing data, n=637; Missing data; n=632; {, #, ** Values with different symbols are significantly different at p<0.01; superscripts for diet texture refer to all levels of texture and not only regular texture; Abbreviations: BMI = body mass index; SD= standard deviation; MNA-SF= Mini Nutritional Assessment-Short Form

for each nutrient consumed, to a maximum value of 1, which would indicate that the RDA for the participant's age and sex had been met. NARs were calculated for seventeen nutrients (calcium, copper, folate, iron, magnesium, phosphorus, selenium, vitamin A, vitamin B1, vitamin B2, vitamin B3, vitamin B6, vitamin B12, vitamin C, vitamin D, vitamin E α-tocopherol, zinc) (22). The iMAR provides a single score that indicates a resident's intake (i.e., food and oral nutritional supplement only, does not take into account vitamin or mineral pills) relative to the RDA overall by summing the individual nutrient NAR and dividing by the number of nutrients assessed. Similarly, menus were analyzed for these 17 nutrients for regular and pureed offerings (mMAR). The amount of the nutrient provided on the menu was compared to the RDA for that specific nutrient using the RDA for males 70+ years of age. The mMAR provides a single score that indicates how well the menu offered met the RDA for this population.

Food service characteristics

At the beginning of data collection in each home, a questionnaire on the characteristics of the facility was given to the administrators. Completion of the form was shared with appropriate personnel such as food service managers, dietitians and directors of care. They were required to complete this questionnaire before the end of data collection in their home (i.e., within four to six weeks). This questionnaire included questions related to administration of the home (e.g., for-profit or not-for-profit status, part of a chain, year home opened, level of care, number of beds available and occupied, staffing level), specialized services (e.g., therapeutic specialists availability, nutritional support resources availability, therapeutic diet options, weight measurements), and food service operations (e.g., menu planning and revision, food production and distribution). The latter section of this questionnaire was used for this analysis to address the research questions.

Statistical analysis

Characteristics of the food services, homes and residents were summarized using descriptive statistics. These characteristics were compared using ANOVA and chi-square tests to assess for differences across provinces. Linear regression analyses of food services variables with outcome

Table 2
Characteristics of home's food service by province (N=32)

	All Provinces	Alberta	Manitoba	New Brunswick	Ontario
Menu cycle length, weeks, mean (SD)	3.8 (0.88)	3.8 (0.46)	3.6 (0.92)	4.2 (1.28)	3.8 (0.71)
Menu reviewed in past 6 months, yes, n (%)	23 (71.9)	4 (50.0)	6 (75.0)	6 (75.0)	7 (87.5)
Raw food cost/resident/day, mean (SD)*	7.70 (1.21)	7.45 (0.69)	7.84 (1.14)	7.20 (0.67)	8.48 (1.98)
Food production system, n (%)					
Traditional production	22 (68.8)	5 (62.5)	4 (50.0)	5 (62.5)	8 (100.0)
Non-traditional (Pre-prepared and rethermed)	4 (12.5)	0 (0.0)	2 (25.0)	3 (37.5)	0 (0.0)
Both systems used	6 (18.8)	3 (37.5)	2 (25.0)	0 (0.0)	0 (0.0)
Food available outside of mealtime, n (%)	31 (96.9)	8 (100.0)	8 (100.0)	7 (87.5)	8 (100.0)
Food delivery system, n (%)					
Decentralized	20 (62.5)	5 (62.5)	6 (75.0)	2 (25.0)	7 (87.5)
Centralized	5 (15.6)	0 (0.0)	2 (25.0)	3 (37.5)	0 (0.0)
Both systems used	7 (21.9)	3 (37.5)	0 (0.0)	3 (37.5)	1 (12.5)
Supper is biggest meal of day, n (%)†	21 (67.7)	8 (100.0) ‡	6 (85.7) ‡	1 (12.5) §	6 (75.0) ‡
Proportion of commercially prepared food, mean (SD)	23.8 (24.51)	17.5 (22.26) ‡ §	46.3 (29.61) ‡	20.3 (18.02) ‡ §	13.8 (11.57) §
Menu MAR Scores					
Regular Menu	0.86 (0.07)	0.84 (0.06)	0.90 (0.05)	0.81 (0.08)	0.89 (0.02)
Pureed Menu	0.79 (0.15)	0.76 (0.15) ‡ §	0.85 (0.10) ‡ §	0.67 (0.18) §	0.89 (0.04) ‡

* n=27; 2 homes in MB, 1 home in NB and 2 homes in ON were not able to report raw food cost; † n=31; one home in MB missing response; ‡, §, Values with different symbols are significantly different at p<0.01; Note: Between-province differences were tested for each variable of interest.

variables (i.e., resident energy and protein intake, iMAR and mMAR) were performed using SAS® 9.4 statistical software (SAS Institute Inc., Cary, North Carolina). Models were adjusted for residents' age, sex and three levels of nesting (resident within dining room, within home, within province). Analysis was set at a significance of p<0.01 when comparing homes' food service characteristics between provinces and at p<0.05 when determining the association between food services variables and residents food intake and diet quality, due to the exploratory nature of this analysis.

Ethics approval

The M3 research project received approval from research ethics boards from the University of Waterloo (ORE#20056), University of Alberta (Pro00050002), University of Manitoba (J2014:139), and Université de Moncton (1415-022). Some individual LTC homes also required ethics approval from local/regional research ethics committees.

Results

Resident descriptive characteristics by province are presented in Table 1. More than two-thirds of participants were women with an average age of 87 years old. Risk of malnutrition, according to the Mini Nutritional Assessment-Short Form (MNA-SF), was similar across the provinces with

ON having the greatest proportion of residents at risk (55.6%) and MB the lowest risk (51.6%). As for diet texture, there was a significant difference between provinces, with MB (59.1%) and ON (65.6%) having the highest percentage of participants on regular texture diets, compared to NB (47.5%) and AB (39.4%) (p<0.01). There were significant differences among provinces for the total number of diagnoses, dementia diagnoses, number of prescribed drugs and participants being prescribed vitamin and mineral supplements. Average adjusted energy and protein intake per day, as well as iMAR scores were not significantly different among provinces; ON had the highest energy (mean [M]= 1633±387 kcal/day) and protein (M= 60±19 g/day) intake and iMAR score (M= 0.80 ±0.08), while MB had the lowest energy (M= 1506±388 kcal/day) and protein (M= 57±17 g/day) intake and iMAR score (M= 0.78±0.09).

Food service descriptive characteristics are presented in Table 2. Most food service characteristics were not significantly different across Canada. Traditional food production systems were the most frequently used across Canada (n=22 of 32). All participating ON homes were using this system, compared to only half of participating MB homes. Two MB and three NB homes were using a non-traditional (pre-prepared) system only, while some homes opted for both traditional and pre-prepared production methods (two in MB and three in AB). As for food delivery systems, decentralized was the most commonly used system for AB (five of eight

Table 3
Linear regression analysis of food service variables with resident food intake (n=632)*

	Energy		Protein		iMAR	
	Parameter Estimate	p-value	Parameter Estimate	p-value	Parameter Estimate	p-value
Menu cycle length, weeks	136.12	0.71	-2.09	0.68	0.06	0.14
Menu reviewed in past 6 months	23.0	0.02	3.1	0.03	-0.01	0.06
Raw food cost/resident/day †	177.82	0.76	-34.94	0.15	-0.02	0.46
Food production system		0.56		0.81		0.33
Traditional production	‡	---	‡	---	‡	---
Pre-prepared and rethermed (bulk or individual)	-288.44	---	-10.01	---	-0.10	---
Both systems used	-475.41	---	-15.76	---	-0.19	---
Food available outside of mealtime	75.65	0.85	4.32	0.81	0.02	0.53
Food delivery system		0.22		0.42		0.46
Decentralized	‡	---	‡	---	‡	---
Centralized	-298.93	---	-9.37	---	-0.13	---
Both systems used	-188.95	---	-12.21	---	-0.11	---
Supper is biggest meal of day §	86.00	0.81	-16.73	0.02	-0.01	0.15
Proportion of food commercially prepared	3.39	0.85	-0.67	0.79	-0.00	0.82
Regular Menu MAR score	3453.36	0.67	52.98	0.23	1.46	0.12
Pureed Menu MAR score	1432.41	0.44	21.98	0.09	0.61	0.01

* n=632, food services data were not available for seven residents; data were adjusted for intra individual variation as well as three levels of nesting, age and gender; † Missing data n=534; ‡ Referent category; § Missing data n=612

homes), MB (six of eight homes) and ON (seven of eight homes), while NB had only two of their participating homes using this system. Out of the four provinces, only two MB homes and three NB homes used a centralized system. Similar to the production system, some food services used both food delivery systems in the same home, one home in ON and three homes in each NB and AB.

Supper was the biggest meal of the day for the majority of participating homes in AB, ON and MB, however only one home in NB indicated supper was their biggest meal. The difference between NB (12.5 %) and the others three provinces was statistically significant (P<0.01). Although there was some variation between provinces for the proportion of commercially prepared food, only ON (13.8 %) and MB (46.3 %) differed significantly (P=0.02). The mean MAR score for the menu (mMAR) for all provinces was 0.86±0.07 for the regular texture menu and 0.79±0.15 for the pureed texture menu. NB had the lowest average regular texture score (M= 0.81±0.08) and the highest average regular texture score was found in MB (M= 0.90±0.05), but this difference was not significant. A significant difference was found between provinces for the pureed texture MAR score, with NB having the lowest score (M= 0.67±0.18) while the highest average pureed texture score was in ON (M= 0.89±0.04) (P<0.01).

The association between food service characteristics and residents' food intake is shown in Table 3. Resident energy (β=23.0; P=0.02) and protein (β=3.1; P=0.03) intake were significantly higher in homes that did a menu revision in the past six months. However, resident total protein intake was significantly lower when a home provided the largest meal of the day at supper (evening meal) (β=-16.73; P=0.02). Furthermore, the mMAR score for the pureed texture menu was positively associated with the iMAR score for residents consuming this texture (β=0.61; P=0.01). This means that residents who consumed a pureed diet and had better diet quality (more likely to meet their nutritional needs) were more likely to live in a home that offered a higher nutritional quality pureed menu. However, this association was only significant for the pureed menu and not for the regular texture menu.

An analysis of the association of food service variables with the mMAR score is presented in Table 4. None of the food service variables were significantly associated with the regular texture mMAR score. Yet, one food service variable (type of food production system) was significantly associated with the pureed mMAR score (F=5.46; P=0.01). Lower mMAR score for pureed texture was found in LTC homes with either a non-traditional system (pre-prepared and rethermed) (β=-0.06) or those using both systems in the same home (β=-0.18) compared to the homes using a traditional food production system only.

Table 4

Linear regression analysis of food service variables with menu Mean Adequacy Ratio (mMAR) score for regular and pureed menus as outcomes, adjusted for province (N=32)

	mMAR - Regular		mMAR – Pureed	
	Parameter Estimate	**p-value**	**Parameter Estimate**	**p-value**
Menu cycle length, weeks	0.01	0.69	0.04	0.16
Menu reviewed in past 6 months	-0.00	0.87	-0.01	0.79
Raw food cost/resident/day*	-0.01	0.41	-0.01	0.83
Food production system		0.14		0.01
Traditional	†		†	
Non-traditional (pre-prepared and rethermed)	-0.06		-0.06	
Both systems used	-0.03		-0.18	
Food available outside of mealtime ‡	--	--	--	--
Food delivery system		0.09		0.34
Decentralized	†		†	
Centralized	0.05		0.06	
Both systems used	-0.03		-0.06	
Supper is biggest meal of day §	0.01	0.75	0.02	0.78
Proportion of food commercially prepared	0.00	0.60	0.00	0.28

* Missing data, n=27; † Referent category; ‡ Could not compute; only one home without food available outside of mealtime; § Missing data n=31

Discussion

Similar to other research studies, LTC residents in our study were at high risk for malnutrition (1-4, 7). As for the iMAR and mMAR score, results show that the average diet quality (0.79±0.09) and average menu quality (0.86±0.07) for regular texture menus could be improved. With the exception of ON, pureed menus had a lower mMAR score than the regular menus, meaning that pureed menus are typically of lower nutritional quality than the regular menu.

Some food service variables were similar (i.e., menu cycle length and availability of foods outside of mealtimes), while others varied among provinces. Average menu cycle length (3.8 weeks) was shorter than that found in a previous study where 90% of menu cycles were four weeks or longer (15). Even though our results found that only one home (NB) did not provide food outside of mealtimes and that it did not have any association with resident's diet or menu quality, food accessibility is a key component in LTC homes; food and fluids offered between meals provide a significant contribution to resident's energy intake (23). Another LTC study comparing traditional food service with a restaurant-style food service (24) showed that food accessibility (i.e., what, when and with whom the resident ate) was associated with residents' living arrangements and social organization (i.e., the facility itself). They also found that residents eating in a restaurant-style food service had more variety and choice over their food as well as more choice over when and with whom they will eat (24).

Although restaurant food delivery models were not part of the current study, variables such as frequent menu revisions, which were the norm in this Canadian sample, are practices that support choice and preferences, especially if residents are involved in menu planning. In this analysis, frequent revision of the menu was positively associated with energy and protein intake.

Food budget allocation varied by province, but these differences were not statistically significant and were not associated with residents' diet quality (iMAR) nor the menu quality (mMAR). A recent German study found that a higher daily food budget was associated with lower malnutrition risk in residents. Furthermore, a lower food budget was associated with a higher risk of a body mass index (BMI) <20 kg/m2 (10). In this analysis, iMAR and mMAR were below 1.0 suggesting that improvements in menus can be made. Although menu quality is influenced by budget and a base level to meet the RDA for nutrients needs to be determined, this analysis also suggests that increased raw food budget alone may not be sufficient to promote a nutritionally adequate diet and attention to menu planning, sufficient staffing to prepare quality food and nutrient dense recipes are also required. The limited variation in food budget and mMAR (especially the regular menu) and iMAR may also explain the lack of association across provinces.

The biggest meal of the day was significantly different between NB (biggest meal offered at lunch) and other provinces (biggest meal offered at supper). Having the largest

meal at supper was negatively associated with protein intake, but not with residents' diet quality (iMAR) or the menu quality (mMAR). In a New Zealand observational study, investigators did not measure food intake, but gathered data on the food service environment among 50 aged-care homes (15). They found that only eight homes served their biggest meal in the evening. It appears that cultural differences may explain choice of the largest meal of the day in LTC. Given that time of day may be a key component of food intake, consideration should be made to adjusting the largest meal to breakfast or noon. In fact, evidence has shown that focus on food should be made at breakfast where residents, especially those living with dementia, are more stimulated, have less behavioral difficulties (i.e., confusion, aggressiveness, anxiety, etc.) and have their peak energy consumption (25). Considering that almost two-thirds of our residents had some form of dementia and that supper was the biggest meal of the day for many homes, we should consider adjusting this mealtime delivery practice not only for homes with dementia units, but for all LTC homes.

In this study, the majority of homes had a traditional food production system. This is consistent with prior work in New Zealand where most homes used a traditional system (46 of 50 homes) (15). However, our results differ from their study in regard to food delivery systems. Most homes in our study had a decentralized delivery system, while Chisholm et al. (2011) found that more than half of homes in their study used a centralized delivery system (15). From results of other similar studies (12, 14), we had expected a significant association of food production and delivery system with residents' overall diet quality as well. However, only food production system type was associated with pureed menu quality in this study; those that did not have traditional system had lower quality pureed menus. Shatenstein & Ferland (2000) evaluated nutritional consequences of changing from a centralized to a decentralized food delivery system in a Canadian LTC home with dementia residents. After the change to the decentralized food delivery system, daily energy intake rose from 1555 calories to 1924 calories and daily protein intake increased by 9 grams (14). Similarly, Desai et al. (2007) compared two different food delivery systems in a LTC home that was changing from a traditional to a bulk delivery system. They measured energy intake of residents with cognitive impairment in the old (tray) delivery system and the new (bulk) delivery system and found that residents receiving from the bulk system had higher daily energy intake, especially at the evening meal. This was mainly associated with higher carbohydrate intake (12). Compared with the current study, these differences could be attributed to the experimental nature of these studies and the application of a new food delivery system that offered choice for participants. In our analysis, the association between traditional food production and higher pureed food intake quality suggests that a traditional system may provide more opportunities for variety and nutrient density with on-site food preparation. Commercially prepared pureed food can vary in

nutritional and sensory properties and this analysis supports in-house production as a best practice (26). A prior analysis of menus from this study also suggests that in-house production promotes nutrient density through the use of quality recipes and standardized portions (27).

Although prior studies did not explicitly consider food intake, some did examine food service variables and their association with other related outcome variables such as residents' risk of malnutrition (2), body weight (28), quality of life (29) or food satisfaction (28). Carrier et al. (2007) found that malnutrition risk in LTC homes can be associated with some food service factors (i.e., difficulty manipulating dishes, lids or food packaging, food delivery system, overall food satisfaction, longer menu cycle and use of porcelain dishes) (2). In another study, a multi-level resident-centered delivery system was implemented in LTC homes called Eat Right (28). Researchers measured resident satisfaction, body weight, food intake and nutritional status before and after the system was implemented. Resident satisfaction with the meal service significantly increased post intervention. They also found an increase in body weight and serum pre-albumin, although total food intake did not improve (28). Finally, an observational study compared two LTC homes food delivery systems: 1) pre-plated by staff, and 2) family-style, where food is placed at the center of the dining table or plated and served individually. They observed that residents eating in a family-style environment had more independence and choices than residents eating from a pre-plated service. Family-style dining also offered more opportunity to interact, which promoted a higher level of well-being for residents (29). These studies demonstrate the importance of food service factors to food intake and well-being of residents.

Study limitations

Even though M3 was a large-scale study in the LTC field, with more than 500 participants with data collected in many areas related to resident's food intake, having eight research assistants gathering data across four provinces might have led to systematic bias in data collection. Although substantial training was provided in-person with on-going training via teleconference to promote consistency. Furthermore, the home survey was completed by a variety of home managers who might not have had the knowledge or access to data required to answer all questions accurately as various domains related to the homes were covered. For example, raw food cost was especially challenging as some homes did not have a specific budget line that could be readily reported.

Conclusion

The current study did find a few provincial differences, especially between characteristics that had a direct link with meals (e.g., biggest meal of the day, proportion of commercially prepared food and menu MAR scores). We

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expected more associations between food service variables and residents' food intake; lack of difference may have been due to the few differences in practices. However, multiple factors other than food service aspects, such as resident characteristics and mealtime environment are also associated with resident's dietary intake (30). All of those variables, including food service, should be taken into account globally since they all have an impact on residents' living in LTC homes. Future studies related to LTC and food service should also focus on outcomes such as anthropometric data (e.g., weight and BMI), malnutrition, resident's satisfaction and resident's quality of life in addition to food intake.

Conflict of Interest: None to declare.

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