Geriatric Nursing 39 (2018) 330–335

Contents lists available at ScienceDirect

Geriatric Nursing

journal homepage: www.gnjournal.com

Feature Article

Inadequate fluid intake in long term care residents: prevalence and determinants

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ARTICLE INFO

Article history:
Received 25 July 2017
Received in revised form 5 November 2017
Accepted 13 November 2017
Available online 5 January 2018

Keywords:
Dehydration
Fluid intake
Geriatrics
Long term care
Malnutrition

ABSTRACT

Dehydration is estimated to be present in half of long term care residents, as many do not consume the recommended levels of fluid intake. This study aims to describe fluid intake in long term care residents and identify the factors associated with fluid intake. Data were collected from 622 long term care residents, with a mean age of 86.8 ± 7.8. Total fluid intake was estimated over three non-consecutive days. Potential resident and unit-level variables risk factors for low fluid intake were collected, such as dementia status, activities of daily living, and eating challenges. Average daily fluid intake ranged from 311–2390 mL (1104.1 ± 379.3). Hierarchical regression analysis revealed that fluid intake was negatively associated with increased age, cognitive impairment, eating challenges and increased dining room staffing. Being male and requiring more physical assistance were positively associated with intake. Variables identified to predict intake could help inform strategies and targeted interventions to improve fluid intake.

Contribution of the paper

What is already known about the topic?

- Older adults may not regularly drink enough because of a reduced thirst sensation,[1] fear of incontinence that may lead to intentional fluid restriction,[2] forgetting to drink secondary to cognitive impairment[2] and psychotropic medication use may reduce intention to drink.[3]
- It is recommended that older men drink 3700 mL of fluid per day, and older women consume 2700 mL of fluid per day.[4]

What this paper adds

- The present study provides new insight into the potential reasons for low fluid intake that can lead to dehydration, a form on malnutrition in the institutionalized elderly.
- Based on the current sample, residents in long term care are not consuming the daily recommended amount of fluids. Moreover, the majority of residents are not even consuming 1500 mL of fluids per day.
- This study shows that the factors that are contributing the most to poor fluid intake are: older age, being female, presence of mealtime difficulties and requiring physical assistance at meals. The latter two factors should be the focus of future research interventions.

Introduction

Malnutrition is commonly defined as a state of nutrition in which either over- or under-consumption of energy, macro and micronutrients or their utilization by the body, leads to a change

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0197-4572/$ — see front matter © 2017 Elsevier Inc. All rights reserved.
https://doi.org/10.1016/j.gerinurse.2017.11.004

in body composition and diminished function.[5] Previous research has suggests that approximately 44% of older long term care (LTC) residents are undernourished due to poor food intake, and which is associated with older age, number of eating challenges, pureed/liquidized diet and requiring eating assistance, amongst other variables.[6] Malnutrition could lead to falls, chronic and poor wound healing, hospital admission, disproportionate use of health services and reduced quality of life.[7–11]

A form of malnutrition is dehydration, which refers to insufficient fluid in the body.[12] Dehydration has been conceptualized as various combinatons of intracellular and extracellular fluid depletion,[12,13] and adequate fluid intake is critical for the safe elimination of toxins and waste products, as well as whole-body thermoregulation.[14,15] Insufficient fluid intake can lead to delirium and is a relevant concomitant disorder that can complicate the treatment of many other illnesses, including thrombo-embolic complications, urinary tract or pulmonary infections, kidney stones, hyperthermia, constipation and orthostatic hypotension.[16–19] According to recommendations by the Institute of Medicine (2005),[4] older individuals may not be consuming adequate amounts of fluid; recommendations are 3700 mL and 2700 mL in men and women, respectively. The recommendations also specify that approximately 81% of total water intake should come from beverages, including drinking water, and only 19% of fluids should come from foods.[4] These recommendations for adequate total water intake for older adults were based on self-reported water intake in a young community-dwelling population as part of the NHANES III survey.[4]

According to the National Center for Health Statistics, in 2014 there were 15,600 LTC homes in the United States accommodating approximately 1.4 million older people.[20] Similarly, in 2013 there were an estimated 5,153 nursing homes and 12, 525 residential care homes in the United Kingdom, of which over 90% of residents were 65 years of age or older.[21] Likewise, as of 2015 in Japan, approximately 1.69 million people lived in LTC homes, which was a 40% increase from 2012.[22] These numbers will continue to grow given our rapidly aging population. An international survey of 19 nursing home experts from 8 countries (Australia, Canada, China, Czech Republic, England, France, Italy, the Netherlands, Scotland, and the United States) has cited nutrition as an important research priority.[23] As such, in order to further our knowledge of nutrition in LTC, limit and mitigate the consequences of dehydration, and improve fluid intake in older people, it is critical that we understand the factors associated with and contributing to fluid intake for those residing in LTC.

Older adults are particularly at risk for developing dehydration, as their kidneys are less able to concentrate urine and some medications, such as diuretics, increase fluid excretion.[13] However, the main reason for dehydration in older adults is reduced fluid intake.[24] Older adults may not regularly drink enough because of: a reduced thirst sensation[1]; fear of incontinence that may lead to intentional fluid restriction to avoid needing to get to a toilet or to avoid difficult or painful position changes[2,25]; forgetting to drink secondary to cognitive impairment[2]; decreased access to fluids due which could be exacerbated by poor ambulation[26]; and psychotropic medication.[3] Given that a large proportion of older people who reside in LTC have cognitive impairment, are incontinent of urine and/or have difficulty ambulating,[6] they are also at risk for low fluid intake and becoming dehydrated. Moreover, previous reports have suggested that up to 60% of LTC residents are dehydrated when hospitalized, and end up re-hospitalized due to persistent dehydration.[27] In a recent review, the economic burden of dehydration in older adults was directly associated with increased hospitalizations and use of intensive care units.[28] There are a wide range of interventions and environmental factors that may increase fluid intake and reduce dehydration risk in older people, but the efficacy of many strategies, particularly within the LTC setting, has not been assessed.[29]

In the long term care setting where resident disability in communication, mobility, cognition and eating prevents many from accessing fluid independently,[30] a simple and appropriate approach to assess hydration status is monitoring fluid intake. Previous research studying fluid intake in this setting has only focused on water consumption,[31] used a sample size of less than 50,[30,32] and/or did not include resident-level, unit-level and home-level variables as potential risk factors for low intake.[33] The present study will be the first to look at multiple sources of fluid intake, in a large sample of LTC residents, and consider multiple variables as factors potentially influencing fluid intake. The objectives of this study were to: 1) using a large and diverse sample report the average fluid intake and proportion consuming less than the recommendations; and 2) identify factors associated with fluid intake in LTC residents when adjusting for covariates. Our hypotheses included:

H1: Average fluid intake of participants will be less than 1500 mL /day.
H2: Older participants, those with more eating challenges, those consuming a pureed/liquidized diet, and those requiring eating assistance will consume significantly less fluid than participants without these characteristics.
H3: Participants with greater mobility disability (i.e. poor ambulation) will have significantly lower fluid intake than residents with less mobility disability.
H4: Participants with urinary incontinence will have significantly lower fluid intake than those who are continent.

Materials and methods

The present study is part of the Making the Most of Mealtimes (M3) study, which is a large cross-sectional, multi-site project that took place between 2015 and 2016. The complete protocol is described in detail elsewhere.[34] In brief, 32 Canadian LTC homes participated, and each was purposively selected from four Canadian provinces. Two to three units within each LTC home were randomly selected for recruitment, and a unit specializing in dementia care if available. A total of 82 units participated. Eligible residents: (1) were 65 + years of age; (2) were medically stable (no hospital admission in previous month or palliative); (3) had been in the home for at least one month; (4) ate an oral diet; (5) and typically ate in the dining room. There were 2358 residents living on the recruited units; however, not all residents were eligible. All eligible residents for the selected units within the home were listed in a random number table that was used by trained home staff to determine order for approaching potential participants to see if they were interested in the study. Once 40 eligible residents agreed to hear more about the study, this list was provided to researchers to complete the informed consent process. The first 20 residents or their alternative decision maker who agreed to participate were included for the home. As described in the protocol paper, participants were representative of the units where they lived; age, proportion of males and those requiring alternative decision-makers for consent did not differ between participants and eligible non-participants.[34]

Trained research personnel (4 per province; one research coordinator, two research assistants and one dental hygienist) used consistent methods across all homes to collect data. Three, non-consecutive days (including one weekend day) of weighed and estimated food and fluid intake were collected for each meal and snacks for each participating resident. RAs were typically at the home from before breakfast until after dinner, so most food and fluids throughout the day were tracked by the study team. Plates were

weighed before and after consumption of items on the main plate for each meal, and beverages, side dishes and snacks were estimated. Estimations for beverages and side dishes were based on standard volumes, after accounting the size of the service ware in each home and approximate portion given to each resident. Typically, snacks were items that were standardized (packaged items or a piece of fruit) so these measurements were easily taken. Staff were also consulted in regard to snacks consumed to ensure accurate recording, where observation could not be made. Incidental foods and beverages brought in by friends and family were also tracked during the day. Family members were consulted to track small items brought in for the resident; if family brought in a meal or the resident left the home for a meal, this was marked as a missing meal in order to avoid skewing the data due to concerns about estimating ingredients and portion sizes. Staff were provided with tracking sheets to record any fluid intake that took place when RAs were not present (i.e. during the night). They were instructed to record any intake, including water given with medications or consumed during the night.

Food Processor Nutrition Analysis Software version 10.14.1 (ESHA Research, Salem, OR, USA) was used with recipes from each home's kitchen to estimate nutrients, including fluid intake. Total fluid intake, from both beverages (including oral nutritional supplements) and fluid-like food items (e.g., soups, chowders, stews, etc.), was the dependent variable for this study. Resident variables, such as medications, use of vitamin/mineral supplements, diet prescription, and 6-month weight history, were collected from the health record. Staff were interviewed by research personnel to complete items on the interRAI-LTCF in order to determine scores on the Cognitive Performance Scale.[35] Dysphagia risk was defined as either: a) the resident was prescribed thickened fluids; b) they failed a standardized swallowing screening protocol using applesauce and water[36]; or c) they coughed or choked during mealtime observations. Finally, during one of the three meals observed each day, eating behaviors and interactions between staff and residents were also documented using: the Edinburgh Feeding Questionnaire (Ed-FED-Q),[37] the Relational Behavior Scale for those requiring total eating assistance,[38] and the Mealtime Relational Care Checklist (MRCC).[39]

The Person-Directed Care questionnaire[40] was completed by staff working in the study units in each home (e.g., personal care assistants, clinicians, housekeeping, support staff, etc.) and had contact with the residents in some capacity. Person-centered care practices, physical and social ratings of the mealtime experience, and homelikeness and functionality of the dining rooms (maximum rating 8 for all summary scales where higher scores = better) were assessed using the Mealtime Scan[39] and Dining Environment Audit Protocol.[41] The number of residents and staff in the dining room, excess noise and use of music during meals was noted with the Mealtime Scan on four to six occasions in each dining room. Ethics clearance for the study protocol was provided by the Research Ethics Boards at the Universities of Waterloo, Manitoba, Alberta and Moncton, as well as Toronto Rehabilitation Institute - University Health Network. Informed written consent was obtained from the participating residents (or their proxies) and staff.

Descriptive statistics were used to describe the LTC sample. Variables were selected for inclusion in the analysis based on available data and *a priori* reasoning. Variables hypothesized to be associated with intake (Table 1) were based on the M3 conceptual model, which suggests three domains influencing food and fluid intake in residential settings: 1) meal access (e.g., dysphagia, self-feeding capacity), 2) meal quality (e.g., nutrient density, sensory appeal), and 3) mealtime experience (e.g., ambiance). The model acknowledges that each of these areas can be influenced by resident (e.g., diagnosis of dementia), staff (e.g., number, skill), home (e.g., policy, philosophy of care) and regional factors (e.g., regulation).[42] Each variable included in the present study was summarized using univariate analysis and included in an initial full model for regression analysis. The intraclass correlation values of each of the four levels of

Table 1
Sample description of resident, unit, and home (n = 32) variables.

Variable of interest	Sample Description Mean (SD) / Percentage (n)
Outcome	
3-Day Average Fluid Intake, ml/day	1104.1 (±379.3)
Resident Level Variables (n = 622)	
Age	86.8 (±7.84)
Sex, male	31.7% (197)
Cognitive Performance Scale (InterRAI LTCF)	2.8 (±1.77)
Moderate/Severe Impairment (3+)	55.3% (344)
Risk of Dysphagia	58.8% (366)
Fluid Consistency, thickened	10.3% (64)
Diet Texture (IDDSI Framework)[c]	
Regular	53.5% (333)
Soft	14.0% (87)
Minced/Moist	21.5% (134)
Pureed	10.9% (68)
ONS prescribed	30.4% (189)
Number of Drugs Prescribed	7.5 (±3.47)
Physical Assistance Required at Mealtimes	
Never	77.3% (481)
Sometimes	11.2% (70)
Often	11.4% (71)
Continence (InterRAI LTCF)[a]	
Continent	14.3% (89)
Control with any catheter or ostomy	4.2% (26)
Infrequently incontinent	8.0% (50)
Occasionally incontinent	10.9% (68)
Frequently incontinent	19.6% (122)
Incontinent	42.9% (267)
Ambulation (InterRAI LTCF)[a]	
Independent	27.6% (172)
Independent, set up help only	14.0% (87)
Supervision	11.2% (70)
Limited assistance	12.1% (75)
Extensive assistance	13.2% (82)
Maximal assistance	5.5% (34)
Total dependence	15.8% (98)
Activity did not occur	0.6% (4)
Ed-FED-Q score	12.3 (±2.23)
Other eating challenges score	10.6 (±1.65)
Proportion of negative MRCC events	36.6 (±11.24)
Positive:Negative MRCC Score	2.2 (±1.30)
Unit Level Variables (n = 82)	
Dementia Care Unit	28.8% (179)
Ratio of Residents per Staff in Dining Room[b]	7.7 (±4.38)
Number of Staff in Dining Room	3.4 (±2.25)
Number of Residents in Dining Room	25.2 (±13.90)
Homelikeness Score	4.6 (±1.40)
Functionality Score	5.3 (±1.03)
Physical Score	5.6 (±0.84)
Social Score	5.0 (±0.86)
Person-Centred Score	5.5 (±0.73)
Home Level Variables (n = 32)	
Food/Drink Made Available Outside of Meals and Snacks	97.0% (603)

[a] Continence and Ambulation collapsed into dichotomous variables were also tested in the backwards elimination analysis. Continence: Frequently Incontinent, n = 389 (62.5%), Incontinent Occasional or Less, n = 233 (37.5%); Ambulation: Extensive Assistance Required for Locomotion, n = 218 (35.0%), Less Than Extensive Assistance Required, n = 404 (65.0%).

[b] Missing data, n = 553.

[c] Mappings to the IDDSI framework are assumed (no items were tested using the IDDSI methods).

Abbreviations: Ed-FED = Edinburgh Feeding Evaluation in Dementia questionnaire; IDDSI = International Dysphagia Diet Standardisation Initiative; MRCC = Mealtime Relational Care Checklist; ONS = oral nutritional supplement.

nesting (residents, units, homes and provinces) were calculated to determine the proportion of variance in fluid intake that was accounted for by each nested level prior to inclusion of potential variables. The unexplained variation between homes and units within homes was used to assess variables at the home and unit levels respectively. A backward regression analysis reduced the initial model by one variable at a time, based on the least significant coefficient (i.e., with the greatest p-value), starting with resident-level variables, followed by unit- and then home-level variables. This process continued until all coefficients in the model were significant at $p < 0.05$. Potential interactions between variables were also tested. R^2 values were considered when identifying the most parsimonious model and post-hoc tests were performed to identify outliers, potential collinearity and goodness of fit. All analyses were performed using SAS® 9.4 statistical software (SAS Institute Inc., Cary, North Carolina).

Table 2
Determinants of fluid intake based on multivariate linear regression (n = 622).

Variable	Parameter Estimate	p-value
Resident Level (n = 622)		
Age, years	–6.07	<0.01
Sex, male	118.91	<0.01
Moderate/Severe Cognitive Impairment	–70.00	0.048
Ed-FED-Q score	–61.76	<0.01
Physical assistance required at mealtimes		<0.01
Never/rarely	[a]	
Sometimes	35.49	
Often	226.72	
Unit Level (n = 82)		
Number of Staff in Dining Room	–447.62	0.02

[a] Referent category.
Abbreviations: Ed-FED = Edinburgh Feeding Evaluation in Dementia questionnaire; LTC = long term care.

Results

Data describing the residents, units, and homes in the sample are summarized in Table 1. This was a large and diverse sample of residents from 82 units in 32 long term care homes. Of the 639 residents who were recruited and eligible, 622 had complete data on variables for this analysis and were included in the present study. The mean age of the 622 residents participating in this study was 86.8 ± 7.84 years and 68% were female. Almost a third of residents resided in specialized units for dementia care. The 3-day average fluid intake was 1104.1 ± 379.3 milliliters/day (mL/d), with 1233.4 ± 401.6 mL/d for males and 1044.2 ± 353.3 mL/d for females. Ten percent of residents were prescribed thickened liquids, while 46% consumed modified texture foods (i.e. International Dysphagia Diet Standardization Initiative [IDDSI] levels 3 to 6). Based on the Cognitive Performance Scale scores, 55% of participants had a moderate or severe cognitive impairment (score ≥3), and the average resident was prescribed seven different drugs. Residents were highly vulnerable; 43% were incontinent and 34% required extensive, maximal or total assistance with ambulation. Based on mean score from the Ed-FED questionnaire (where a score greater than 10 is indicative of mealtime difficulties), the mean score for "other eating challenges" (where a score greater than 9 is indicative of eating challenges), and the observation that 23% of residents required physical assistance with eating, the average resident had some difficulties with food/fluid consumption. The mean ratio of residents per staff member in the dining room was 8:1, and residents received more positive than negative interactions based on the Mealtime Relational Care Checklist (ratio 2 ± 1). All dining rooms had moderate ratings for homelikeness and functionality based on the Dining Environment Audit Protocol scale. The physical, social and person-centeredness aspects of the mealtime experience all had moderate scores based on the Mealtime Scan and Dining Environment Audit Protocol. Almost all of the LTC homes involved in the study (97%) had food and/or fluids available outside of meals and snacks.

Based on the intraclass correlation values, resident level differences accounted for 78.6% of variance in fluid intake, 7.4% was explained at the home level, and 14.0% was explained at the unit level. There was no variation between provinces. The final multilevel regression model, summarizing the determinants or variables of fluid intake, had an adjusted R^2 value of 31%; thus the variables in the final model explained 31% of the variance in resident fluid intake (see Table 2).

In the final regression model, only age, sex, cognitive impairment, number of eating difficulties, requiring physical assistance to eat and number of staff in the dining room were found to be associated with fluid intake. This is contrary to our hypotheses that a pureed/liquidized diet, poor ambulation, and urinary incontinence would also be factors significantly associated with fluid intake. For every one-year increase in age, fluid intake declined by 6 mL/d when adjusted for other variables in the model ($p < 0.01$). Males had significantly higher fluid intakes than females by approximately 119 mL/d. Moderate to severe cognitive impairment resulted in a decrease in intake of 70 mL/d ($p < 0.05$). A higher score on the Ed-FED questionnaire, indicating a greater number of eating challenges, was associated with a decrease in fluid intake. For each one-point increase in this score, there was a significant decrease of 62 mL/d in fluid intake. Residents who "often" required physical assistance during meals drank significantly more fluid than those who "never/rarely", or "sometimes" required assistance. Finally, more staff in the dining room was associated with a decrease in fluid intake, and this association was significant.

Discussion

This large, diverse sample of older adults residing in LTC homes across Canada had a mean total fluid intake of 1104.1 mL/day ± 379.3, with both sexes consuming well below the recommended daily adequate intake for total water of 3700 mL and 2700 mL for adult men and women, respectively.[4] Although total fluid intake estimations included all types of beverages, as well as liquid-based food items such as soups, none of the 622 residents in the sample met the recommended adequate daily intake for water. It has been noted that the Institute of Medicine fluid intake recommendations do not necessarily apply to at-risk groups, such as older adults.[13,25] Others have recommended a general guide of 1500 mL/day of beverage intake for sedentary adults.[13,25] Even using this less stringent daily fluid intake recommendation, 85.5% of the participants in the current study did not consume adequate amounts of fluid per day. It should be noted that commonly referenced dietary fluid intake recommendations are problematic. Both U.S. and European fluid intake recommendations are based on median water intake derived from dietary surveys of the population, complete with recall bias limitations associated with survey methods.[25]

A post-hoc analysis was performed to determine if there was any differentiation of reduced fluid consumption by age. The proportion of residents with inadequate fluid intake is significantly higher amongst residents 85 years and older ($X^2(1) = 7.84$, $p < 0.05$), with 88% of residents 85 years and older consuming less than 1500 mL/d, and 80% of those younger than 85 consuming less than 1500 mL/d. This finding is consistent with the results of the multivariate analysis that demonstrated that older age is associated with reduced fluid intake. Other studies also have found low fluid intake among nursing home residents.[30,33,43–45] Reed et al.,[33] found that 51.3% of U.S. nursing home residents with a mean age of 85 consumed less

than 8 ounces (~237 mL) of fluid per meal. In this sample, approximately 37% of the residents had very severe cognitive impairment, while 27% had severe, 25% had moderate, and 12% had mild cognitive impairment. Nursing home residents' average daily consumption of total fluid has been documented to be different depending on region: 2083 mL ± 876.4 in Taiwan (mean age: 75 years; 18% of residents with dementia)[45]; 1632 mL ± 573 in Indiana, U.S. (mean age: 86 years; 63% of residents with moderately to severely impaired cognitive skills)[30]; 897 mL ± 284 in California, U.S. (mean age: 87 years; 71% of residents with severely impaired mental status, 13% with moderately impaired mental status and 16% with mildly impaired to not impaired mental status)[32]; 1147 mL ± 433 in Tennessee, U.S. (mean age: 83 years; 76% with dementia)[44]; and 1002 mL (range: 463–1607) in Canada (mean age: 78 years; 50% severely cognitively impaired).[43] A review of dehydration in institutionalized elderly concluded with a recommendation for further research to identify how much fluid those over 85 years actually need.[13] Given that only 44% of residents in the current study were identified as being malnourished according to the Patient Generated Subjective Global Assessment,[6] one can assume that there are many residents who are considered to be adequately nourished despite their seemingly poor fluid intake.

In terms of determining how to improve fluid intake in the LTC setting, the findings from the multivariate analysis offer direction for future intervention research. While quality of the diet, poor ambulation and urinary incontinence were not factors significantly predicting poor fluid intake, the final multivariate model demonstrated that poor fluid intake was significantly associated with older age, being female, moderate-to-severe cognitive impairment, eating challenges, not receiving physical assistance to eat, and more staff in the dining room. These variables combined accounted for 31% of the variance in fluid intake, indicating that despite the broad range of variables considered in this analysis, there are yet other unassessed variables contributing to the variance in fluid intake. Of the variables that were included in the final multivariate model, many cannot be modified (i.e., age, gender and cognitive impairment); however, the presence of staff in the dining room is modifiable and was significantly associated with reduced fluid intake. Although it seems initially counterintuitive that more staff would be associated with less fluid intake, it is likely that more staff in the dining room was due to increased numbers of residents with disabilities requiring more assistance to eat and drink and/or larger dining rooms with more residents. Reed et al. (2005)[33] found a small association between staffing levels of LTC homes and fluid intake; whereas in another study of LTC residents using dehydration as the outcome measure, staffing levels did were not associated with dehydration.[46] As eating challenges were also a significant covariate, in addition to receiving eating assistance (which supported fluid intake), the final multivariate model suggests that more staff may not solely be the answer to addressing current eating challenges, but that training of staff, and physical and mealtime interventions that mitigate these challenges are needed. For example, staff rushing residents to eat due to meal timing constraints may result in more behavioral expressions and abandoning of the meal. Another study investigating the effect of environment on ability of LTC residents to eat independently, identified the quality of the physical and social environment to be at least as important as the progression of dementia in initiating or delaying the onset of eating disability.[47] The National Nutritional Guidelines for Older People in Finland suggest nutritional interventions for individuals in long term care which include staff socializing with residents to create a calm, family-style mealtime experience.[48]

The identified variables from the multivariate analysis are aligned with a recently published companion article from the same M3 study, which investigated the determinants of inadequate *food* intake.[6] Aspects of meal access, including the presence of eating difficulties and often requiring physical assistance to eat, also figured prominently in the final regression models for energy and protein intake in that study. This suggests that interventions to improve overall intake, including hydration, should focus on the specific eating difficulties of residents, seeing if and how these can be positively altered, and then training staff to optimize physical assistance during mealtimes.

Study limitations

It is important to note that reduced fluid intake is not synonymous with dehydration. It cannot be assumed that low fluid intake is indicative of, or necessarily leads to, dehydration.[12,44] A recent cross-sectional study found that serum osmolality was not associated with meticulously assessed total fluid intake in long term care residents.[44] Hydration status assessment, through biochemical analysis of serum osmolality and/or physical assessments, is required in the context of a prospective longitudinal research design to understand the link between fluid intake and dehydration. Fluid intake was used in the current study as it is more easily assessed than dehydration.

Although it was not feasible to randomly recruit LTC homes to the study, in an effort to optimize the representativeness of the sample, we purposively sampled the LTC homes for maximum variation and randomly recruited residents within each home, which were demonstrated to be representative of eligible residents in the home units included in the study. The limitations of obtaining fluid intake data are well known. For example, the adequate intake values recommended by the Institute of Medicine for Americans and Canadians were based on reported water intake, with associated recall bias.[49] In the current study, food and fluid intake was calculated based on three non-consecutive days of weighed and observed estimates for all meals and most snacks, however there are still limitations to these methods. We may have underestimated fluid intake. Although we observed between-meal intake during the day, some participants would have been able to get their own drinks between meals. Furthermore, the evening snack was always based on staff report and thus less accurate. Further, this analysis only counted fluid as beverages or liquid based foods (e.g. soup) and not the water content of foods. Separate research data collection teams for each of the four provinces may have resulted in measurement bias; we were unable to assess inter-rater reliability across the provinces throughout the year of data collection. We attempted to mitigate this bias with a 2-day orientation to data collection for all of the provincial research coordinators and principal investigators at the beginning of the study. Ours was a cross-sectional study. Future longitudinal studies are indicated to further assess the relevance of factors identified in this study with fluid intake and occurrence of dehydration.

Conclusions

This study reports the average and prevalence of low fluid intake, and the association of total fluid intake with an extensive array of variables at the resident, unit, facility and provincial levels. Approximately 85% of participants consumed less than 1500 mL per day, suggesting that inadequate fluid intake is prevalent in LTC homes. Modifiable determinants of poor fluid intake at the resident-level and the unit-level were identified, including eating assistance and staffing in the dining room. Mobility and urinary incontinence were not associated with poor fluid intake, contrary to our hypotheses. Future research should focus on identifying specific eating difficulties and modifying elements of the mealtime to avoid these difficulties, as well as training staff in the best methods to

provide physical assistance for both food and fluid intake. Targeting the identified determinants of this inadequacy is indicated to improve fluid intake in LTC residents.

Acknowledgement

We thank the research assistants, provincial coordinators, and project managers for their significant contributions to the M3 project. We would also like to express our gratitude to the long term care homes, staff, residents, and families who participated in the M3 study. This study was funded by the Canadian Institutes of Health Research (Grant Number MOP-136888).

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