ABSTRACT

This study describes the independent association between nutritional risk and death in older adults diagnosed with cognitive impairment. Canadian Study of Health and Aging participants who completed a clinical exam and were diagnosed with cognitive impairment and had complete data for regression analyses were included (n=735). Nutritional risk was defined as the presence of at least one abnormal nutrition indicator identified during the clinical exam (history of weight loss, abnormal serum albumin, poor appetite, body mass index < 20). Other covariates believed to influence mortality were modelled with nutritional risk using logistic regression. There were 373 deaths during the five-year follow-up period in this sample. Nutritional risk was found to independently increase the likelihood of death (OR=1.6, 95% CI 1.1, 2.2) in these older adults suffering from cognitive impairment. Further work is required to determine if interventions can improve nutritional status and quality of life of these older adults.

ABRÉGÉ

Cette étude décrit l'association indépendante entre le risque nutritionnel et la mort chez des personnes âgées souffrant de déficience intellectuelle. On a inclus les participants (n = 735) à l'Étude sur la santé et la vieillissement au Canada qui avaient passé un examen physique, à qui on avait donné un diagnostique de déficience intellectuelle et pour lesquels on disposait de données complètes pour les analyses de régression. Le risque nutritionnel a été défini comme l'identification de la présence d'au moins un indicateur de nutrition anormale (antécédents de perte de poids, sérum-albumine anormale, manque d'appétit, indice de masse corporelle < 20) au cours de l'examen médical. À l'aide d'une analyse de régression logistique, on a modélisé les autres co-variables dont on pense qu'elles influencent la mortalité avec le risque nutritionnel. Dans cet échantillon, il y a eu 373 décès au cours des cinq ans de la période de suivi. On a constaté que le risque nutritionnel augmentait la probabilité de décès de façon indépendante (RR = 1,6, 95 % IC 1,1, 2,2) chez ces personnes âgées souffrant de déficience intellectuelle. D'autres études sont nécessaires pour déterminer si des interventions permettraient d'améliorer l'état nutritif et la qualité de vie de ces personnes.

Do Nutrition Indicators Predict Death in Elderly Canadians with Cognitive Impairment?

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It is estimated that the prevalence of dementia in Canada will increase from approximately 350,000 in 1999 to over 500,000 in 2014.[1] Approximately two thirds of dementia seen in the older adult is believed to be Alzheimer's disease (AD).[1] Dementia occurs more frequently with increasing age, and as the very old (85 years of age and older) is one of the fastest growing population subgroups, the prevalence and sequelae of dementia are anticipated to have a significant impact on caregiving and health service utilization.[2] Dementia is usually progressive resulting in behavioural problems, caregiver stress, and institutionalization.[3,4] Interventions that can delay the onset and progression of this disease even modestly will have a major impact on public health.[2]

The older adult population has been recognized as a group "at nutritional risk". Many of the physiological changes that occur with age can lead to poor nutritional states: poor chewing ability, functional dependency for shopping, cooking and eating food, decreased absorption of food and nutrients and decreased muscle mass which can lead to restrictive eating to maintain body weight.[5,6] Several adverse health events have been linked to poor nutritional states and weight loss in the older adult; there is an increased risk for hospitalization, infection, falls and mortality.[7-10]

There are specific nutritional concerns for older adults with dementia: they may lose the ability to eat independently and recognize food, they have decreased olfactory and taste sensations and may lose the ability to safely swallow food.[4,11-13] These sequelae put older adults who suffer from dementia at increased risk for nutritional problems; weight loss is a frequent occurrence in AD.[14-16] However, longitudinal reports of the effects of nutritional status on health outcomes of seniors who suffer from dementia are rare.[14,17] One of the challenges has been the measurement and control of confounders, such as disease severity, that can alter the effect nutritional status has on health outcomes and progression of dementia.[7,18,19] These analyses of the data from the Canadian Study of Health and Aging test the hypothesis that nutritional risk (as defined by the presence of at least one abnormal indicator of nutritional status) is independently associated with death in those diagnosed with cognitive loss, when disease severity and other covariates are considered.

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METHODS

The Canadian Study of Health and Aging is a national survey of Canadians 65 years of age and older, involving 18 study centres in 10 provinces. The first phase of the study, CSHA-1, was conducted between February 1991 and May 1992. The sample was representatively drawn from urban and surrounding rural areas in each of the provinces; 9,008 seniors living in the community and 1,255 living in institutions were included.[1] The community sample was selected from computerized records of the provincial health care plans in nine provinces, and from provincial enumeration records in Ontario. The sampling frame was stratified by age group, and the oldest seniors (75-84 and 85+

years) were oversampled. Institutions were randomly sampled from a comprehensive list; within chosen institutions, residents over the age of 65 were eligible for random selection.[1]

A screening questionnaire was used to determine cognitive status in the community sample. This interviewer-administered questionnaire included demographic data, assessment of independence in activities of daily living, the Modified Mini Mental State Exam (3MS) to screen for dementia[20] and health questions.[21] Community participants who screened positive for cognitive impairment and a reference sample who screened negative were invited to complete an extensive clinical assessment. The compliance rate was 73.1% for clinical examination among those that screened positive. All residents of institutions were included in the clinical assessment. The respondents who underwent the clinical examination, were diagnosed with some level of cognitive impairment, and had complete data for the regression (n=735) were included in the analyses presented.

The clinical exam involved trained nurses, physicians and neuropsychologists.[22] During each individual clinic visit, trained nurses completed height and weight measurements and collected basic evaluation data such as date of birth, marital status and other demographic information, medication usage, and vital signs. Those respondents who had a 3MS score of 50 or more completed a neuropsychological evaluation and a clinical history. Those with a score less than or equal to 49 completed only a clinical history.[23]

The clinical history included behavioural symptoms (e.g., paranoid features), an assessment of instrumental (IADL) and basic activities of daily living (ADL), memory difficulties, history of trauma that could influence cognition, assessment of depressive symptoms, and other physical complaints. The Older Americans Resource Inventory[24] and CAMDEX[25] were used to collect detailed information on function. A complete physical examination including a number of biochemical tests were also done. This information was used to develop a diagnostic consensus as to the presence, severity, and type of dementia.[26]

Although nutritional status was not specifically assessed during the clinical evaluation, there were several parameters available that are used to determine nutritional status. These included serum albumin, body mass index (BMI), self-reported weight change (> 3 kg in 6 months), physician-diagnosed weight change, and self-reported poor appetite. Serum albumin was classified as normal (> 35 g/L), abnormal (< 35 g/L but > 31 g/L) and significantly abnormal (< 31 g/L) by the clinician. If a clinic subject had any *one* of these factors (albumin abnormal or significantly abnormal; BMI < 20, etc.), they were classified for this analysis as "at nutritional risk". Serum albumin was not required in the panel of biochemical tests and was completed in only 63% of the clinic sample. The other indicators of nutritional status were completed on almost all participants.

Only those clinical participants who were diagnosed with cognitive impairment were included in this analysis, as it was anticipated that those factors associated with the occurrence of death in cognitively normal seniors might be different from those who were cognitively impaired. Covariates considered in this analysis were abstracted from the clinical examination data and screening questionnaire from CSHA-1. The literature on mortality in dementia guided the selection of covariates. Full models included demographics (e.g., age, marital status, gender, living alone, education level), type and severity of dementia, smoking status depression, presence of a mobility impairment, difficulty in instrumental (IADL) or basic activities of daily living (ADL), presence of difficult behaviours, hearing and visual impairments, comorbidity, and fall history.

Derived variables for these analyses included education, presence/severity of dementia, comorbidity (based on number of different drugs taken), IADLIMP (whether the respondent had difficulty driving, going out of the house, or cooking), and ADLIMP (whether the respondent had difficulty dressing, grooming, bathing or toileting). Similarly, if any of the respondents experienced wandering, apathy, violence, urinary or fecal incontinence, hallucinations, delusions, confusion or episodes of agitation, they were classified as having at least one difficult behaviour (DIFFBEH).

CSHA-2 involved the follow-up of the original subjects five years later, with the mandate of determining incidence of dementia, risk factors for AD and vascular dementia, and mortality rates, institutionalization and frailty of CSHA-1 participants.[22] Only 268 of 10,263 subjects from

TABLE I
Descriptive Statistics of Participants with Cognitive Impairment, CSHA-1 (n=735)

Variable	%
Demographic Variables	
Women	58.0
Widowed	51.0
Never married	8.2
Married	38.0
Live alone	35.8
Had at least one child	78.9
Living in an institution	64.5
Nutrition Variables	
Nutritional risk (any one of: low BMI, serum albumin, weight change, poor appetite)	41.0
Body mass index < 20	17.9
Loss of appetite	9.8
Perceived weight loss	12.2
Physician-diagnosed weight change	7.8
Serum albumin (abnormal or significantly abnormal)†	11.6
Health	
Perceived health status Not too good to very poor	46.6
Hearing inadequate	3.8
Vision inadequate	7.1
Fall history	28.1
Depression	8.0
ADL/IADL Impairments	
Mobility impairment	34.0
Any ADL impairment (ADLIMP)	18.3
Difficulty bathing	16.2
Difficulty grooming	7.9
Difficulty toileting	6.2
Difficulty dressing	9.6
Any IADL impairment (IADLIMP)	23.6
Difficulty going out alone	15.3
Difficulty cooking	10.4
Difficulty driving	7.5
Behaviours	
Wanders	2.9
Urinary incontinence	18.8
Fecal incontinence	3.4
Violent episodes	1.0
Episodes of agitation/emotional outbursts	6.1
Hallucinations	3.7
Confusion	6.1
Delusions	3.9

† Based on 275 clinic participants

TABLE II
Bivariate Analysis: Variables Associated with Nutritional Risk (n=735)

Variable	χ^2 Value	Direction of Association
Gender (male)	40.3**	-
Age Group	47.9**	+
Marital Status	29.5**	n/a
Education Level	48.8**	n/a
Current Smoking Status	7.8**	-
Institutionalization	109.4**	+
Mild Dementia	9.3**	-
Moderate Dementia	0.85	
Severe Dementia	86.8**	+
Depression	110.4**	+
Hearing Impairment	24.4**	-
Vision Impairment	56.3**	+
Mobility Impairment	189.3**	+
IADL Impairment	33.6**	+
ADL Impairment	182.1**	+
Presence of Difficult Behaviours (e.g., wandering, delusions, etc.)	115.5	+
More than 6 Medications	49.1**	+
History of Falls	33.8**	+
Poor Perceived Health Status	36.8	-

Statistically significant at $p < 0.01$, * $p < 0.01$, ** $p < 0.001$, ***$p < 0.0001$
n/a indicates direction of association not applicable as categories for cross-tabs are not ordinal

TABLE III
Bivariate Analysis: Variables Associated with Mortality (n=735)

Variable	χ^2/F Value	Direction of Association
Nutritional Risk	12.7 **	+
Gender (male)	6.9**	+
Age	297.9***	+
Marital Status	2.2 (n.s.)	
Education Level	0.44 (n.s.)	
Institutionalization	437.2**	+
3MS	477.3***	- †
Final Diagnosis	25.6**	+
Severity of Cognitive Impairment	33.8**	+
Depression	3.7 (n.s.)	
Hearing Impairment	20.9**	+
Vision Impairment	5.8 (n.s.)	
Mobility Impairment	29.7**	+
IADL Impairment	4.5 (n.s.)	
ADL Impairment	55.9**	+
Presence of Difficult Behaviours (e.g., wandering, delusions, etc.)	10.7**	+
More than 6 Medications	4.7 (n.s.)	
History of Falls	2.5 (n.s.)	
Poor Perceived Health Status	8.7**	

Statistically significant at $p<0.01$, * $p<0.01$, ** $p<0.001$, ***$p<0.0001$
† Lower 3MS scores indicate more severe dementia

CSHA-1 were lost to follow-up at CSHA-2. Incidence of death of CSHA-1 participants was obtained from the Office of the Registrar General in each province. The total number of deaths for the sample used in these analyses was 373.

As risk of mortality in any group is greatly influenced by gender and age, a basic regression model including only these variables was first developed. To determine if nutritional risk had any independent association with mortality when age and gender were accounted for, a second basic model was developed. This second basic model indicated that nutritional risk was independently associated with mortality. The next step was to determine if nutritional risk was "explained away" by the inclusion of other covariates believed to be associated with the outcome. A full model was developed using the method of Kleinbaum,[27] which allows for the greatest control of confounding of the exposure-outcome relationship. Interaction between nutritional risk status and demographic, cognitive and comorbidity covariates was assessed. These interaction terms were not significant predictors of the outcomes and were dropped from the analysis. Institutionalization and dementia diagnosis were not included because of collinearity.

SAS (version 6.12) was used to complete all analyses. Descriptive and bivariate relationships were explored with the use of frequency and univariate procedures, chi-square, and one-way analysis of variance. Logistic regression using a maximum likelihood procedure was used to model the relationship between nutritional risk and occurrence of death in cognitively impaired community-living seniors. Comparison of the full model odds ratio and parameter estimate for the nutritional risk variable to subsequent models as described,[27] was the method chosen to determine the final fully adjusted model. Wald's Chi-Square Test and Hosmer and Lemeshow's Goodness-of-Fit Test were also completed.

RESULTS

Of the 735 participants included in this sample, 42% were male and the average age was 81 years (S.D. 6.6 years). Over half of the subjects had cognitive loss with no diagnosed dementia (55.8%); 21.5% had mild dementia, 20.6% had moderate dementia and 2.1% had severe dementia. Classification on severity of cognitive loss/dementia was based on the diagnosis of dementia (Alzheimer's type, vascular dementia, "other") and a subjective rating by physicians on the severity of the dementia.

The average clinical 3MS score for these cognitively impaired participants was 68.3 (minimum 7, maximum 98; S.D. 14.6), where lower scores indicate greater cognitive impairment. Nutritional risk was considered present if one or more nutrition indicators were abnormal; 41% of these participants were considered to be at nutritional risk, although only 13.6% were identified to have two or more nutrition indicators. The average BMI was 24.3, with 17.9% having a BMI less than 20. As serum albumin was an optional test, only 275 had these data of which 11.6% had abnormal values. Almost 10% complained of a loss of appetite and 12.2% described weight loss. As found in practice, all of these nutrition indicators were positively

and significantly ($p < 0.001$) associated with each other (data not shown). Descriptive statistics for categorical covariates used in the regression model are presented in Table I. Table II presents the associations between nutritional risk status and covariates. Being female, older, institutionalized, more severely demented, depressed, vision-impaired, having decreased mobility and other functional impairments, having difficult behaviours, a history of comorbidity (taking more than six medications) and a history of falls were significantly associated with nutritional risk. Being a current smoker, having a hearing impairment and poor perceived health were also significantly, but negatively associated with nutritional risk; participants with these behaviours/problems were less likely to be at nutritional risk.

Several significant associations ($p < 0.01$) were found between many of the covariates and mortality (Table III). Nutritional risk (presence of at least one abnormal indicator) was positively associated with mortality in bivariate analysis ($\chi^2 = 12.7$ $p < 0.001$) indicating that "at risk" participants were more likely to die during the follow-up period than those who were considered not to be at nutritional risk. As expected, several covariates such as marital status and gender were associated ($\chi^2 = 344.1$ $p < 0.001$). Women were more likely to be widowed or never married than men, more women lived alone ($\chi^2 = 45.8$ $p < 0.001$) and, on average, women were three years older than men ($F=80.9$ $p < 0.001$).

The two basic models derived included the association of gender and age and gender, age and nutritional risk with mortality. Nutritional risk was a significant independent predictor of mortality in this second basic model (OR = 2.3, 95% CI 1.9, 2.6). Age and gender parameter estimates and odd's ratios changed minimally with the addition of nutritional risk, indicating their importance in increasing the likelihood of death. Nutritional risk was a significant predictor of mortality in full (OR = 1.7) and the final reduced model (OR = 1.6) (Table IV). These results indicate that nutritional risk, gender, age, mobility impairment, ADL impairment, moderate and severe dementia and comorbidity are independently associated with an increased likelihood of death in cognitively impaired seniors. The chi-square for covariates was 156.4 ($p = 0.0001$) and the Goodness-of-fit statistic equaled 15.2 ($p = 0.06$).

TABLE IV
Final Model for Risk of Mortality in CSHA Participants with Cognitive Impairment (n=735)

Variable	Beta	Odds Ratio	95% CI Odds Ratio
Gender (male=1)	0.87	2.4	1.7, 3.3
Age	0.08	1.08	1.06, 1.1
Nutritional Risk	0.45	1.6	1.1, 2.2
Mobility Impairment	0.42	1.5	1.1, 2.2
IADL Impairment	-0.27	0.8	0.48, 1.1
ADL Impairment	1.05	2.9	1.8, 4.9
Mild Dementia (cognitive impairment without dementia was reference)	0.07	1.1	0.71, 1.6
Moderate Dementia	0.64	1.9	1.2, 3.2
Severe Dementia	1.6	4.8	1.2, 19.5
Hearing Impairment	0.23	1.3	0.86, 1.8
Poor Perceived Health†	0.26	1.3	0.88, 1.8
Comorbidity (reference <3 drugs) (3-5 drugs)	0.38	1.5	1.0, 2.2
Comorbidity (6+ drugs)	0.53	1.7	1.1, 2.7

† Includes "not too good", "poor" and "very poor" self-perceived health status

DISCUSSION

As most dementias are progressive and have adverse health outcomes, delaying the onset and progression of these diseases could have significant health care consequences.[2,28] Nutritional status is a characteristic that can be modified by various interventions, even in dementing illnesses.[7] However, one of the limitations of prior research is understanding the impact of nutritional risk on outcomes while considering covariates known to increase risk. This analysis determined the independent association of risk of malnutrition with death in cognitively impaired participants of the CSHA-1.

One of the primary limitations of this data collection was categorization of nutritional risk in this study. Unlike in the study by White et al.,[17] change in nutritional status or weight was not assessed during the follow-up period of CSHA. As well, the determination of nutritional risk was crudely categorized based on the presence or absence of nutritional parameters. Nutritional risk and status are difficult to measure with simple tools,[29] thus any individual parameter will not sufficiently identify those with impaired nutritional states. Therefore, it is plausible that some CSHA-1 participants who had poor nutritional states were not identified by using the five nutritional indicators collected during the clinical exam. A second limitation was the missing data present in the original data set; 1993 CSHA-1 participants completed the clinic exam and were diagnosed with some level of cognitive impairment. However, due to missing data for the regression analyses, this sample was decreased to 735 reported on at this time. This sample may not be representative of the entire cognitively impaired group studied in the CSHA; the sample used in this analysis had more males (42% vs. 34.4%) and more living in an institution (64.5% vs. 53.1%) than the entire data set. As well, only 73.1% of the screened sample who tested positive for some cognitive impairment completed the clinical exam. This rate is comparable to those achieved elsewhere,[30] but may influence generalizability.

Nutritional risk was significantly and independently associated with mortality in this CSHA analysis, with an odds ratio of 1.6; nutritional risk increases the likelihood that death will occur during a five-year follow-up of demented seniors. Others have found a relationship between weight loss and mortality in those with probable AD, whereas weight gain was associated with a decreased risk for mortality.[17] Further work is required to determine if this extension of survival is accompanied by maintenance of quality of life and absence of morbidity. There has been some indication that weight maintenance in dementia may delay the progression of cognitive decline.[17] This evidence supports interventions to improve nutritional status

and weight maintenance in those with AD. Previous work suggests that quality of life in the form of decreased morbidity is also maintained with improved nutritional states.[7]

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