ABSTRACT

This study determined the independent association of 24 risk factors with dietary intake in community-living seniors. The study sample was 5,073 seniors for whom complete data were available from the 1990 Ontario Health Survey. Risk factors were items completed on an interviewer-administered health questionnaire. Diet Score, Mean Adequacy Ratio and energy were the diet outcomes derived from a self-administered food frequency questionnaire. The independent association of risk factors with these diet outcomes was assessed with multiple linear regression analyses. Factors that were consistently and positively associated with diet outcomes included: education, income, social support, perceived health status, belief in the nutrition/health link, dependence in walking and vision. Factors that were consistently and negatively associated with diet outcomes included: chewing status, dentition, hearing, level of happiness and body mass index. These results provide a basis for the development of a screening tool for the identification of "at risk" subgroups of seniors.

ABRÉGÉ

Cette étude visait à déterminer l'association indépendante de 24 facteurs de risque avec l'apport alimentaire chez des personnes âgées vivant en communauté. L'étude a porté sur un échantillon de 5 073 aînés dont l'ensemble des données provenait de l'Enquête sur la santé en Ontario de 1990. Les facteurs de risque étaient les éléments figurant sur un questionnaire administré par un interviewer. Les résultats diététiques, soit la note diététique, le rapport moyen de suffisance et l'apport énergétique, ont été obtenus à partir d'un questionnaire auto-administré sur la fréquence de consommation des aliments. L'association indépendante des facteurs de risque avec ces résultats diététiques a été évaluée à l'aide de multiples analyses par régression linéaire. Les facteurs qui sont apparus régulièrement et positivement associés aux résultats diététiques comprenaient : le niveau d'éducation, le niveau de revenu, le soutien social, la perception de l'état de santé, la conviction de l'existence d'un lien entre la nutrition et l'état de santé, l'autonomie de déplacement et la vision. Les facteurs qui sont apparus régulièrement et négativement associés aux résultats diététiques comprenaient : l'état de la mastication, la dentition, l'ouïe, le degré de bonheur et l'indice de masse corporelle. Ces résultats jettent les bases de la mise au point d'un outil de dépistage pour identifier les sous-groupes de personnes âgées «à risque».

Predictors of Dietary Intake in Ontario Seniors

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Recent estimates indicate that seniors, defined as those over the age of 65, will constitute 23.2% of Canadian society by the year 2036.^{1,2} Seniors frequently have significant chronic health problems and lifestyle factors (i.e., inability to drive) that may interfere with adequate dietary intake and compromise nutritional status. Malnutrition is estimated to be present in 5% of community-living seniors,^{3,4} however, inappropriate dietary intake that can lead to malnutrition is more common.^{5,6} In the United States, screening identified poor nutrient intakes in as many as 50%^{7,8} of seniors evaluated. As a result, routine nutrition screening of seniors is a priority in the U.S. There is no screening initiative in Canada at this time. Poor dietary intake and specifically nutritional status have been linked to morbidity, institutionalization and mortality in seniors.^{9,10} The early identification and treatment of poor dietary intake may prevent or delay these outcomes.

As an initial step in the development of a screening tool appropriate for community-living Canadian seniors, studies need to be conducted on the predictors of dietary intake in this population. Much of the international research that has been completed¹¹⁻¹³ may not apply to a Canadian population due to differences in social programs. The little Canadian research that is available has not consistently assessed the

independent effect of risk factors.¹⁴⁻¹⁶ The purpose of this study was to determine the independent association of a series of potentially important risk factors on dietary intake in a large probability sample of Ontario seniors.

METHODS

The Ontario Health Survey (OHS) was conducted in 1990 by the Ontario Ministry of Health.^{17,18} The OHS is one of the few Canadian studies that measured a broad spectrum of health-related variables as well as food intake. The first part of the survey was an interviewer-administered questionnaire completed by one member of each household, resulting in a sample of over 60,000 (85% response rate).¹⁸ The second part of this survey included an 84-item, validated, self-administered Food Frequency Questionnaire (FFQ).¹⁹ The FFQ was completed by almost 50,000 people (77% response rate).²⁰ Complete data from both sections of the questionnaire were available from 5,073 seniors (72% response rate).

Diet quality outcomes

No single method of evaluation of nutrient intake is entirely adequate.²¹ Thus, three very different measures were selected: the Mean Adequacy Ratio (MAR) based on individual nutrients, the Diet Score based on food groups, and total energy intake. The first two measures were composite scores described by Guthrie and Scheer.²² The MAR is based on the comparison of intakes of selected diet components (i.e., iron, calcium, vitamin A, vitamin C, thiamin, riboflavin, niacin, energy and protein) compared with age- and gender-specific Recommended Nutrient Intakes.²³

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TABLE I
Proportion of Seniors in the Ontario Health Survey with Various Risk Factors

Variable/Risk Factor	Proportion of Sample with Risk Factor (%)
Born in Canada	66
Women	60
Live in rural area	15
Completed primary school	70
Completed high school	43
Lived in subsidized housing	20
Low income	31
Married or common-law	62
Live with spouse	50
Live alone	28
Don't drive a vehicle	36
Walking difficulties	12
Difficulties with basic self-care	6
Take two or fewer medications	74
Poor vision	2
Poor hearing	5
Difficulties chewing	25
Use dentures or have no teeth	39
Perceive health to be good/excellent	65
Happy/somewhat happy most of the time	93
Good memory	70
Good thinking ability	85
Smoke	15
Drink alcohol once per month	47
Body mass index less than 20	9
Body mass index greater than 27	26

Note: Appendix indicates coding scheme for univariate and multivariable analyses.

MAR ranges from 0 to 1.0, where 1.0 indicates the likelihood that intake of all nutrients included meet or exceed the requirements of each individual.²² Diet Score²² is based on food groups with points assigned for the number of portions consumed *each day* from each of the four food groups. The scoring was modified to correspond to the most recent Canadian recommendations²⁴ with a maximum score of 20. The scores were: 2 per serving of "milk & milk products" and "meat & alternates" (i.e., nuts, legumes, fish), with a maximum score of 4 for each group and 1 per serving of "vegetables & fruit" and "grain products" with a maximum of 5 for each group. In addition, 2 points were awarded if the participant consumed foods from each of the food groups each day, even in amounts less than recommended.

Measurement of potential risk factors

Based on previous research, 24 variables were selected as possible risk factors for poor dietary intake in seniors.¹⁵ Data were self-reported and none of the responses

TABLE II
Significant Univariate Associations Between Dietary Outcomes and Risk Factors in Ontario Health Survey Senior Participants

Covariate	Diet Score	MAR	Energy
Sex (male)	36.7†** (+)	---	151.8** (+)
Age‡	13.5* (-)	---	---
IADL¶ limitation	43.0** (-)	7.8* (-)	20.9** (-)
ADL§ limitation	4.3* (+)	---	---
Not driving	41.4** (-)	---	36.7** (-)
Urban strata	---	---	7.5* (+)
Married	6.4* (+)	---	5.4* (+)
No. house residents‡	10.7* (-)	17.1* (-)	---
Education level	64.9** (+)	21.3** (+)	---
Income level	28.7** (+)	21.4** (+)	---
Smoke	42.4** (-)	10.4* (-)	---
Drink 1/month	7.7* (+)	4.8* (+)	7.7* (+)
Hearing	---	---	6.3* (-)
Dentition	35.2 (+)	15.4** (+)	---
Chewing status	21.1** (+)	4.8* (+)	3.2* (+)
Body mass index‡	5.1* (+)	4.9* (+)	---
Depression	18.1** (-)	15.1** (-)	2.6* (+)
Loneliness	26.0** (-)	14.7** (-)	3.2* (+)
Happiness	18.3** (+)	---	---
Perceived health	6.9** (+)	6.8** (+)	---
Ability to think	7.4* (+)	9.0* (+)	---
Social support‡	13.2* (+)	16.2** (+)	---
Nutrition/health link	---	5.4* (+)	---

† Table cells include the F value for the variable based on ANOVA or simple linear regression and the direction of this association (+/-)

** p < 0.001; * p < 0.05; --- not significant

‡ indicates a continuous variable; the rest are categorical

¶ Instrumental activities of daily living (grocery shopping, banking, driving a car)

§ Basic activities of daily living (bathing, walking, feeding oneself).

APPENDIX 1

The continuous variable "number of health problems" was used to describe health status. Poor or fair (0) "perceived health status" was compared with good or excellent (1); difficulty (0) or lack of difficulty (1) in seeing and hearing; difficulty (0) or lack of difficulty (1) with the ability to think and remember; and happy most of the time (1) as compared with happy infrequently (0) were also used. The number of medications consumed on a regular basis (≥ 2 vs. 3 or more); current smoking (yes or no); alcohol consumption (less than once per month vs at least once per month) and vitamin use (yes=1, no=0) were dichotomized. Specific functional limitations addressed on the questionnaire included: walking dependence (i.e., uses a cane, walker or wheelchair), "not driving a vehicle for 12 months", and getting help with general instrumental (IADL) or basic (ADL) activities of daily living. Instrumental activities include driving, grocery shopping and banking, whereas ADL activities include bathing, dressing and feeding oneself. Dependence (1) was compared to independence (0). Respondents who felt that diet could be changed to improve their health were coded 1 as compared with those who did not believe this (0). Body mass index (BMI) was calculated from self-reported body weight and height and was a continuous variable. Chewing and dental status variables were derived by the OHS working group.¹⁸ Social support was assessed with several questions and an index (SSINDEX4) was derived by the OHS working group on the support provided to seniors.¹⁸ Living arrangement was dichotomized into those who live alone (0) and those who do not (1), regardless of the relationship. Married seniors (1) were compared to all single seniors (0) whether widowed, never married or divorced. The low income derived by the OHS working group was defined by poverty lines and income cut-offs developed by Statistics Canada (1990) ("moderate" and "high" (1) vs. "low" (0)). Education was dichotomized into those with primary school or less (0) and those with more than a primary school education (1).

were confirmed with medical reports or demonstration of abilities. Health, psychosocial, demographic and functional variables were selected as potential predictors of dietary intake in these seniors (See Appendix 1). Most variables were dichotomized for analyses.

Data management and statistical analyses

The statistical package SAS version 6.09 running under SunOS (Unix) was used. Analyses were adjusted for analytic weights

and design effect.^{18,25} Weighted descriptive analyses included one-way analysis of variance and simple linear regression to assess the significance of associations between covariates and diet quality. Weighted multiple linear regression using mixed stepwise selection was carried out for the MAR, Diet Score and energy outcomes and was stratified by sex. Results include point estimates and 95% confidence intervals for the standardized regression coefficients based on this analysis.

TABLE IIIa
Independent Associations Between Dietary Outcomes and Factors Obtained
by Multivariable Analysis, OHS Men

Predictor Variable	Men		
	Diet Score R ² =5.4%	MAR R ² =3.5%	Energy R ² =2.6%
Income	0.59 (0.26, 0.92)	0.009 (0.001, 0.017)	---
Social support	0.017 (0.08, 0.26)	0.004 (0.002, 0.006)	---
Education level	0.49 (0.18, 0.8)	0.01 (0.003, 0.02)	---
Perceived health status	0.55 (0.14, 0.96)	---	---
Nutrition/health link	0.49 (0.18, 0.8)	0.008 (0, 0.16)	308 (-58, 674)
Chew	-1.1 (-1.7, -0.45)	-0.016 (-0.03, 0)	-723 (-1450, 4)
Dentate	---	-0.01 (-0.002, -0.02)	-717 (-1097, -337)
Happy	-0.64 (-1.23, -0.05)	-0.015 (-0.03, 0.001)	-1569 (-2242, -896)
Hearing	-0.59 (-1.18, 0)	-0.01 (-0.02, 0)	-619 (-1342, 104)
No. health problems	---	0.001 (-0.001, 0.003)	---
No. medications	0.64 (0.29, 0.99)	---	---
Smoking	---	---	644 (157, 1132)
BMI	---	-0.0002 (-0.0004, 0)	---
Think clearly	---	0.01 (0, 0.02)	---
Walking dependence	---	---	---
No longer drive	---	---	-602 (-1111, -93)
IADL dependence	---	---	818 (76, 1560)

Note: Standardized regression coefficients and 95% Confidence Intervals (CI) are presented for three diet outcomes stratified by sex. CI that span zero indicate lack of significance. Model adjusted R square values are provided.

RESULTS

The proportion of seniors with various risk factors is outlined in Table I and provides a descriptive summary of this sample. The average age of respondents was 72.7 years (range 65-98) and they identified on average 2.4 health problems (range 0-8). One-way analysis of variance (ANOVA) and simple linear regression were utilized to determine significant univariate associations between the outcome variables and potential risk factors. F test values and the direction of the association are provided in Table II.

The average Mean Adequacy Ratios for men (0.962) and women (0.965) were close to 1.0 indicating adequate intakes of energy, protein and seven micronutrients. Mean intakes for individual nutrients were on average greater than the RNI,²³ although 22% of respondents did not con-

sume the recommended amount for protein and 30% of men and 42% of women did not meet the base recommendation for energy.²³ The mean Diet Score was quite good at 16.1 but approximately 30% of seniors had Diet Scores less than 15 (maximum Diet Score was 20). Almost 70% of women did not consume five servings of "grain products" or two servings of "meat & alternates" in a day. Sixty percent of men did not consume the recommended amount of "grain products" and more than 50% of both sexes did not consume five "vegetables & fruits" on a daily basis.

Multiple linear regression analyses

Tables IIIa and IIIb present the results from the sex-stratified regression analyses. Variables that were associated with more than one diet outcome are more likely to be true risk factors and are discussed below.

Men: Consistent predictors of better diet quality were: adequate incomes, higher levels of social support, higher levels of education, better perceived health and belief in the nutrition/health link. Strong and significant risk factors for poorer diet quality across more than one diet outcome were: chewing and dental status, hearing and being happy. Men who reported having difficulties chewing, having their own teeth rather than dentures, having self-perceived good hearing or being happy most of the time had poorer diet quality.

Women: Levels of education and income were significantly and positively associated with Diet and MAR scores. Dependence in walking and excellent or good perceived health status were significantly and positively associated with all outcomes. Adequate vision was significantly associated with higher Diet Scores and energy, whereas adequate hearing was negatively associated with Diet Score and energy intake although significance was only found for the latter outcome. Higher BMI values were negatively associated with Diet and MAR scores, implying poor diet quality in obese individuals. Opposing associations were found for dental status; women with their own teeth had higher MAR scores but lower energy intake as compared to women with dentures. All other significant associations were found for only one outcome variable.

DISCUSSION

Many risk factors or predictors of diet quality were identified in this study. Income and education were consistent predictors of better diet quality in men and women in the present study, as with previous work in Canada.^{26,27} Income has been suggested to be the single most important non-biologic factor that influences health and nutrition in seniors.²⁸ Poor income may result in difficulty obtaining a wide variety of food or more expensive items.

Age, marital status and living arrangement were not associated with diet quality. Multivariable analyses in large samples have found no independent effect of age²⁹ on diet. Marital status and living situation may indicate greater household income, thus the minimal independent effect of

these variables may be accounted for by the strong association between income and diet quality in the final models or the stratification by gender.

Being happy most of the time was negatively associated with diet quality across all three outcomes for men. This association is not intuitive. Unfortunately, no previous reports have looked at a similar risk factor in a multivariable analysis. More social support for seniors was associated with higher Diet Scores in both sexes and higher MAR scores in men. In previous work, better diets have been found in seniors who receive support as compared to those who do not.¹⁵

Seniors frequently perceive their health to be good despite a high frequency of chronic health problems.³⁰ Good perceived health status was significantly and consistently associated with better diet quality in the present study, and is consistent with previous reports.^{12,15,29} Few studies have modeled smoking in relation to diet in a multivariable manner in seniors. Smokers have been found to have a lower consumption of plant foods.^{31,32} Opposing effects were seen in men and women in the present study; women smokers had poorer Diet Scores whereas male smokers had higher energy intake, as compared to their nonsmoking counterparts. Higher levels of dietary energy do not necessarily indicate better diet quality but may only indicate a higher fat intake.³³

The association between BMI and diet quality seems to suggest that obese individuals, especially obese women, have poorer diet quality than seniors with a BMI in the healthy range. Obese respondents are suspected of underestimating dietary intake with current diet assessment methods,²² but this association may also reflect decreased intake to promote weight loss. Davis et al.³⁴ found a similar relationship between BMI and dietary intake in seniors. It was interesting to find an association in men between the belief that a change in diet could improve one's health and diet quality, but not find this association in women. Perhaps senior men are more proactive than women about implementing health strategies, or perhaps there was little variation in this variable for women. Certainly, previous work has

TABLE IIIb
Independent Associations Between Dietary Outcomes and Factors Obtained by Multivariable Analysis, OHS Women

Predictor Variable	Women		
	Diet Score R ² =6.8%	MAR R ² =6.2%	Energy R ² =1.4%
Income	0.37 (0.02, 0.72)	0.009 (0.003, 0.015)	---
Social support	0.1 (0, 0.2)	---	86.8 (-1.7, 175.3)
Education level	0.61 (0.24, 0.98)	0.009 (0.003, 0.015)	---
Perceived health status	0.90 (0.49, 1.31)	0.02 (0.012, 0.028)	581 (233, 929)
Chew	-1.08 (-1.64, -0.5)	---	---
Dentate	---	0.006 (0, 0.012)	-290 (-576, -4)
Happy	---	0.001 (-0.009, 0.01)	---
Hearing	-0.56 (-1.3, 0.18)	---	-724 (-1347, -102)
Vision	1.47 (0.31, 2.61)	---	1105 (99, 2112)
No. health problems	0.13 (0.05, 0.21)	---	---
No. medications	---	---	-133 (-418, 192)
Smoking	-0.84 (-1.31, -0.37)	---	---
BMI	-0.005 (-0.009, -0.001)	-0.0003 (-0.0004, -0.0002)	---
Think clearly	---	0.01 (0.002, 0.018)	---
Walking dependence	0.53 (0.02, 1.04)	0.01 (0.004, 0.02)	483 (55.6, 909)
No longer drive	-0.24 (-0.57, 0.09)	---	-452 (-735, -170)
IADL dependence	-0.87 (-1.44, -0.3)	---	---
Age	0.03 (0.01, 0.05)	---	4.9 (-17.9, 27.7)
Marital status	0.34 (0.01, 0.67)	----	---

Note: Standardized regression coefficients and 95% Confidence Intervals (CI) are presented for three diet outcomes stratified by sex. CI that span zero indicate lack of significance. Model adjusted R square values are provided.

identified positive associations between nutrition attitudes and diet quality in both sexes.³⁵

This analysis suggests that those with dentures or those who have difficulty chewing have poorer diets. Poor chewing ability has been linked to decreased energy and protein intake³⁶ and fruit and vegetable intake.³⁷ Good vision in women appears to be associated with better diet quality. Seniors who have visual difficulties may be reluctant to leave their homes to do grocery shopping or eat with others. Previous work has identified similar associations.¹⁵ Good hearing was negatively associated with diet quality across more than one outcome for both sexes. This consistent effect is unlikely to be artificial and may suggest that seniors who are quite deaf

receive formal and informal supports that promote adequate diets.

Functional limitations appear to have their greatest influence on the dietary quality of women. Difficulties with higher functional activities such as driving appear to be associated with poorer diet quality in women. Lack of a significant or an opposing association for instrumental activities of daily living (IADL) in men may indicate that functionally limited men have more social supports that promote adequate diets due to gender differences in marital status and living situation. Dependence in walking was associated with better diet quality in women. Seniors who live independently in the community despite walking difficulties may receive a significant amount of informal and formal support, since walking

ability seems to be a marker of a need for services.³⁸ "Not having a disability" has been found to be significantly associated with better diets²⁹ in previous work.

This analysis provides new insights into independent risk factors for diet quality in seniors. Many risk factors were crudely measured in this population survey, as was dietary intake. Further work should investigate some of the unexpected results as well as those risk factors newly identified in this sample. One specific area that should be investigated further, is the extent of activity limitation and its effects on diet quality in seniors. Valid assessments of risk factors and of dietary intake are required, preferably in a senior cohort, so that longitudinal changes in dietary intake and nutritional status can be examined. Finally, this analysis provides the basis for further work in the development of a "nutritional risk" screening tool, for use in the Canadian senior population.

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