Applied nutritional investigation

# Predictors of food variety and dietary diversity among older persons in Botswana

Thomas Clausen, MD[a,*], Karen E. Charlton, MPhil, MSc, SRD[b], Kesitegile S. M. Gobotswang, PhD[c], Gerd Holmboe-Ottesen, PhD[a]

[a] *Department of General Practice and Community Medicine, Faculty of Medicine, University of Oslo, Oslo, Norway*
[b] *Chronic Diseases of Lifestyle Unit, Medical Research Council, Tygerberg, South Africa*
[c] *Department of Home Economics, University of Botswana, Gaborone, Botswana*

Manuscript received June 18, 2004; accepted July 25, 2004.

**Abstract**

**Objective:** We investigated whether food variety and diversity are associated with physical and cognitive functioning in older adults in Botswana and designed a simple set of screening questions that predict food variety in this population.

**Methods:** Data were collected (1998) as a national household survey of 1085 subjects 60 y and older. A food variety score, based on a food frequency checklist, was calculated by summing the frequency of weekly intakes of 16 food items (0 to 66). A dietary diversity score was calculated as the number of food groups consumed weekly (0 to 5). A representative subsample ($n = 393$) was randomly selected for the clinical component of the survey, and measurements on dependency and cognitive function were conducted.

**Results:** Low food variety was found: 35.2%, 59.3%, and 22.4% of subjects consumed no dairy products, fruits, and vegetables, respectively. A higher food variety score was associated with urban residence, ownership of cattle, higher education, and more frequent meals, and these indicators were used to construct a nutritional risk indicator. Higher food variety score was associated with better self-reported health and better cognitive function. Similarly, a higher score on the nutritional risk indicator screening tool was associated with desirable health outcomes.

**Conclusion:** A limited number of foods is consumed, leading to an overall pattern of poor food variety. Higher food variety was associated with improved physical and cognitive functions. A screening tool that predicts food variety in this population has been developed and is recommended to be incorporated at a primary care level to identify older adults most at risk of a poor quality diet. 

*Keywords:* Elderly; Food variety; Dietary diversity; Nutritional status; Botswana; Screening instrument

## Introduction

Eating a variety of foods is recommended in virtually all national food-based dietary guidelines and in global dietary guidelines [1]. There has been a move away from characterizing dietary patterns according to intake of individual nutrients to a concept of overall diet quality [2]. Food variety is usually quantified by the number of different food items [3], whereas dietary diversity is usually quantified by the number of food groups (e.g., grains, meat, fruits, dairy products, and vegetables) [4] consumed over a certain period. Dietary diversity and food variety are generally considered to be measurements of diet quality, but there are no standard definitions for either of these terms. Various indices have been developed in an attempt to monitor a population's adherence to recommended "healthy eating" dietary guidelines. Examples from the United States are the Healthy Eating Index [5] and the Diet Quality Index [6], and a Chinese diet quality index has been designed [7]. Such diet

The project was funded by the Norwegian Council of Universities/Centre for International University Cooperation (NUFU). The first author's doctoral grant was funded through the Norwegian Research Council.

* Corresponding author. Tel.: +47-22-85-0550; fax: +47-22-85-0590.
*E-mail address:* thomas.clausen@medisin.uio.no (T. Clausen).

quality indices generally include aspects of food variety but are complex to calculate, rely on quantified measurements of habitual nutrient and food intake, and require personnel with expertise in nutritional science to analyze the data.

High food variety is regarded to be necessary for an adequate nutrient intake, to lessen the chances of deficient or excessive intake of single nutrients, and to diminish exposure to food contaminants [8,9]. Adequacy of nutrient intake has been positively associated with the number of different foods consumed [3,8,10–16]. In addition, dietary diversity has been found to be inversely associated with age-adjusted mortality rate [4]. In developing countries, positive associations have been reported between dietary diversity or food variety and anthropometric measurements in children [11,15,17]. A rationale for emphasizing dietary diversity and food variety in poor populations in the developing world relates to the problem of multiple nutrient deficiencies, due to a reliance on starchy staples, and diets that often include little or no animal products and few fresh fruits and vegetables [18].

Globally, older persons are typically at nutritional risk. Older persons in developing countries are at particular nutritional risk as a result of a lifetime of poverty and deprivation, poor access to health care, and a diet that has often been inadequate in quantity and quality [19]. Important determinants of poor nutritional status in older adults in the African context include inadequate household food security, war and famine, and the indirect effect of infection with the human immunodeficiency virus and the acquired immunodeficiency syndrome. However, poor nutrition is not confined to developing countries, even in high income countries such as Canada; older persons commonly have an inadequate dietary variety [20].

Optimal nutrition promotes functional health status and mental well-being in older persons, and dietary diversity and variety promote enjoyment and satisfaction with the diet [21] and adequate intakes of nutrients [22]. A 5-y longitudinal study conducted in Japanese elderly associated greater dietary variety at baseline with a decreased risk of higher-level functional decline in community-dwelling subjects [23].

To date, no attempt has been made to assess food variety as a measurement of diet quality in older populations in African countries. The present study investigated whether food variety is associated with physical and cognitive functioning in older persons in an "upper middle-income" country in sub-Saharan Africa, i.e., Botswana. A second objective was to develop a simple set of screening questions that could predict food variety, without the need for detailed dietary assessment methods.

## Materials and methods

### *Sampling and subjects*

In 1998, a nationally representative household survey of 1085 inhabitants 60 y and older was conducted in Botswana, which has a population of 1.6 million [24]. The sample was drawn in accordance with the population distribution in 1991 [24,25] and aimed to represent 1% of the target population in this age category.

A multiple-stage cluster sampling technique was used. The required number of elderly respondents from each selected locality (village or urban center) was calculated in terms of the proportionate distribution of the sampled localities according to the 1991 census. The sampling frame comprised all eligible older persons residing in each of the selected localities. Thereafter, a random selection of the required number of respondents in the locality was performed. Twenty-three questionnaires had to be excluded due to missing data, leaving 1062 respondents.

In the clinical component of the household survey (referred to as the medical survey), more detailed information pertaining to functional and cognitive dependencies, anthropometric status, and other health indicators was collected by one of the authors (T.C.) and a local nurse in a random subsample of subjects who were stratified by age and sex. The clinical examinations took place during home visits and comprised a standardized examination of 60 to 90 min in duration. The medical survey was planned to cover 50% ($n = 543$), as a subsample, of the household survey sample, but a response rate of 72% yielded 393 subjects. Twenty-one of these respondents were excluded from data analysis due to incomplete data from the household survey ($n = 372$). The non-responders did not differ significantly from the responders with regard to age, sex, or area of residence (data not shown).

### *Ethics*

Informed consent was obtained from each participant before interviewing, and examinations and the project was approved by the national ethical committee in Botswana.

### *Measurements*

Trained interviewers administered questionnaires in the subjects' homes. Age was obtained from the national identity card or other official identity papers, if available. Information on marital status was dichotomized as single (never married, divorced or separated, or widowed) or married.

Education was classified according to a yes or no response to the question, "Have you ever attended school?" irrespective of the number of years of schooling. Ownership of cattle was classified dichotomously according to a yes or no response.

A composite socioeconomic status (SES) index was developed from available data in the medical survey subsample by combining responses to 11 dichotomous indicators of wealth: material of house walls, material of house floor, water facilities, toilet facilities, power source, ownership of cattle, ownership of small stock, access to arable land, ownership of house, ownership of other residential property, and educational level. The index was used to demonstrate relative differences in SES (high, medium, or low) in this population. Data on ownership of cattle and educational level were used separately as indicators of SES for the total household sample.

### *Dietary intake patterns*

#### *Food frequency checklist*

From the household survey, dietary data were collected from an unquantified food frequency checklist that included 21 different types of food and beverage items. Frequency responses included the following options: daily, three to six times per week, one to two times per week, monthly, seldom, and never. The specific food items included in the checklist were selected on the basis of information obtained from a qualitative dietary assessment on 440 households in a village not far from the capital, Gaborone. This assessment formed part of a study on food security [26,27] in which the participants were asked to name all foods and drinks they had consumed during the previous 24 h. A draft food list was prepared from the data obtained, discussed in consultation with Botswana nutritionists, and then adjusted to accommodate the most common foods eaten nationwide. In the present study, of the 21 foods included in the food frequency questionnaire, 16 commonly consumed items (excluding alcohol items, sweets, and soft drinks) were combined into five food groups based on those used in the U.S. Healthy Eating Index [5]: grains (staples such as maize and sorghum, bread, rice, pasta, etc.), fruits (including juices), vegetables, dairy products (milk), and meat (including meat, fish, and chicken). Alcohol and confectionery items were excluded from the five food groups because our indices were based on the U.S. Healthy Eating Index, which does not include these items.

#### *Food variety score (FVS)*

Due to a lack of data on food portions consumed by the subjects, our scoring system was based on frequency of intake: 7, everyday; 4, three to six times a week; 1, once or twice weekly; and 0, less than once a week.

A FVS was calculated by summing the frequency scores (0 to 7) of the 16 selected foods (scores 0 to 112; the maximum score acquired by any of the subjects in the survey was 66). As a result of our scoring (based on frequency), only food items consumed at least once weekly contributed to the FVS.

#### *Dietary diversity score (DDS)*

A DDS was calculated as the number of food groups (total = 5; grains, meat, vegetables, fruits, and dairy) consumed during a week. Each food group was counted only once, resulting in a possible score of 0 to 5.

#### *24-h recall*

To further understand usual food intake and meal patterns, subjects (medical sample only) were asked open-ended questions (24-h recall) to provide a summary of foods typically consumed at each mealtime the day before the examination. These data were compared with the food frequency data as a crude way to assess its content validity.

### *Anthropometric measurements and physical and cognitive functions (medical survey)*

Standing height was measured to the nearest 0.5 cm with a stadiometer. Weight was measured with a calibrated, portable bathroom scale to the nearest 500 g with the subject barefoot and in light clothing.

Body mass index was calculated as weight (kilograms) divided by height squared (square meters) and classified into the categories defined by the World Health Organization [28]. All anthropometric measurements were performed by a trained nurse.

As a measure of functional dependence, the ability to perform activities of daily living (ADL) was assessed with an adapted version of the six-item questionnaire by Katz and Stroud [29]. Five of the six items in the questionnaire were included in the present study: dressing/undressing, bathing/washing, use of toilet, getting in/out of bed, and continence. The possible range of scores for the additive index was 0 (most dependent) to 10 (least dependent). The instrumental ADL (IADL) assessment scale [30], which establishes the level at which an elderly individual performs the more sophisticated tasks of everyday life (e.g., taking a bus or taxi, taking medicine, cooking, doing light housework, doing heavy housework/yardwork) was administered. Possible scores ranged from 0 (most dependent) to 10 (least dependent). ADL and IADL scores are used as continuous variables and categorical variables ("able to perform all functions independently" and "unable or in need of help with one or more of the five functions").

Cognitive function was determined with an adapted version of the Mini-Mental State Examination [31,32]. Due to general low educational background levels and high illiteracy rates, the item that requires drawing a geometrical figure and items that required writing or reading skills were removed (leaving a maximum score of 26 versus the maximum score of 30 for the original Mini-Mental State Examination). Subjects were categorized according to the following groups: no cognitive impairment (>16 of 26) or possible cognitive impairment (0 to 15 of 26), considered to be a conservative estimate of the prevalence of possible cognitive impairment. Responses to the three-word memory test (part of the Mini-Mental State Examination) were also analyzed separately.

The chair rise test was performed to assess lower body strength. Subjects were required to rise from a seated to a standing position, with hands placed across the chest. Subjects were instructed to rise and sit down again, five times, as fast as possible, as described by Guralnik et al. [33]; the time taken was recorded in seconds. Subjects were categorized according to those who managed five repetitive chair rises within 30 s, those who were unable to perform chair rises at all, or those who did not complete the test within the allocated period.

### *Biochemical measurements (medical survey only)*

Venous blood samples were processed with a portable Minilab PC (Bayer, West Haven, CT, USA) to assess hemoglobin concentrations. Anemia was defined as hemoglobin concentrations less than 13 g/dL for men and 12 g/dL for women [34].

### *Statistical analyses and development of food variety screening instrument*

Data were analyzed with SPSS 11.0 for Windows (SPSS, Inc., Chicago, IL, USA). Variables are presented as descriptive statistics. Differences between groups for categorical variables were tested with Pearson's chi-square tests. For continuous variables, differences between groups were analyzed with an independent *t* test (for two groups) or analysis of variance test (for three or more groups).

Because the FVS created in the present study is a novel index that has not previously been validated, associations between the FVS and sociodemographic factors obtained in the household survey (i.e., age, sex, marital status, ownership of cattle, educational level, area of residence, and number of meals per day) and indicators of nutritional and health status obtained in the medical subsample (i.e., body mass index, hemoglobin concentration, ADL, IADL, SES index, cognitive function, chair rise test, etc.) were investigated with bivariate analyses.

To further explore associations between the continuous variable FVS and selected sociodemographic variables, linear regression modeling was performed, and results are presented as regression coefficients with 95% confidence intervals.

The variables that contributed significantly to explain the FVS, based on stepwise selection and exclusion (criteria: probability of F to include ≤0.05 and probability of F to exclude ≥0.1), were included in a composite, short nutrition risk indicator (NRI) screening instrument.

Correlation between the screening tool score and the FVS and DDS was assessed according to the presumption that a low score is predictive of poor food intake variety and poor dietary diversity (choice of foods from the five food groups). Scores obtained on the instrument were compared with proxies for nutritional status, which was measured with the body mass index, hemoglobin concentrations, and with measurements of well-being and dependency (self-perceived health status and functional ability) across the three categories of scores by using a chi-square test.

Table 1
Sociodemographic characteristics of an elderly population in Botswana

| | %Household sample ($n$ = 1062) | %Medical subsample ($n$ = 372) |
|---|---|---|
| Sex | | |
| Female | 51.9 | 49.2 |
| Male | 48.1 | 50.8 |
| Age (y) | | |
| 60–69 | 49.7 | 44.9 |
| 70–79 | 27.4 | 30.1 |
| ≥80 | 22.9 | 25.0 |
| Area of residence | | |
| Urban | 25.0 | 25.3 |
| Rural | 75.0 | 74.7 |
| Marital status | | |
| Married | 50.8 | 53.7 |
| Single/widowed | 49.2 | 46.3 |
| Education | | |
| Attended school | 46.8 | 44.9 |
| No schooling | 53.2 | 55.1 |
| Ownership of cattle | | |
| Own cattle | 32.7 | 32.3 |
| No cattle | 67.3 | 67.7 |
| Pension | | |
| Receive pension | 70.9 | 72.9 |
| No pension | 29.1 | 27.1 |
| Socioeconomic status score | | |
| High | | 24.7 |
| Medium | | 48.4 |
| Low | | 26.9 |
| Household composition | | |
| Living alone | 7.0 | 8.1 |
| Grandchildren in household | 65.8 | 65.0 |
| No grandchildren in household | 34.2 | 35.0 |
| No. of people in household* | 6.4 ± 3.9 | 7.7 ± 11.4 |

* Mean ± standard deviation.

## Results

### *Characteristics of the study population*

The mean age ± standard deviation of the household study population was 72.2 ± 9.3 y, with a median age of 70 y (range 60 to 109 y). The median number of people in a household was six (range 1 to 30). Characteristics of the study population for the total sample ($n$ = 1062) and the medical subsample ($n$ = 372) are presented in Table 1. No significant differences were found between the household sample and the medical subsample for any of the selected sociodemographic variables as assessed by chi-square test. Most elderly subjects lived in rural areas. Female respondents were widowed or single significantly more often (71.5%) than were male respondents (25.3%). More than 50% of the study population had never attended school.

Seventy-one percent of subjects received an old age pension (Table I). The contribution of each indicator (i.e., 11 variables) used to construct the composite SES score in the medical survey subsample ($n$ = 372) was investigated.

Table 2
Food intake pattern of selected food items: intake of food item once weekly or more often, presented separately for the household survey sample and the medical sample

| Food or beverage item | Household sample ($n$ = 1062) | Medical subsample ($n$ = 372) |
|---|---|---|
| Tea | 92.1% | 94.0% |
| Sorghum meal | 89.4% | 90.8% |
| Maize meal | 76.4% | 80.2% |
| Bread | 72.2% | 71.5% |
| Green leaves | 65.4% | 68.3% |
| Milk | 64.6% | 66.4% |
| Other vegetables* | 62.2% | 64.1% |
| Meat | 55.6% | 56.6% |
| Rice | 55.1% | 51.1% |
| Soft drinks | 33.8% | 32.1% |
| Fruits† | 31.0% | 31.5% |
| Chicken | 26.6% | 25.5% |
| Pumpkin | 19.6% | 18.5% |
| Sweets | 18.2% | 16.5% |
| Fruit juice | 14.2% | 13.8% |
| Fish | 12.0% | 11.8% |
| Alcoholic drinks‡ | 22.5% | 22.3% |

* Other vegetables may include potato, carrot, tomato, onion, cabbage, etc.

† Fruits are a combination of melon, watermelon, wild fruits, other fruits.

‡ Alcoholic drinks are a combination of canned beer and local sorghum-based beers.

The variables of ownership of cattle and education contributed significantly to the SES score, with ownership of cattle having the strongest correlation ($r = 0.57$, $P < 0.001$). These two variables together explained 42% of the variance in the final SES score.

### *Typical dietary pattern and food intake*

Subjects more commonly ate only one or two meals (55%), rather than three or more meals (45%) per day. The 24-h recall (non-quantified medical survey sample) data showed that breakfast typically consisted of tea with milk and sugar alone or combined with sorghum meal porridge. Other daily meals typically consisted of sorghum or maize meal porridge alone or with vegetables or meat often mixed as a stew. Eggs, beans, and liver were listed by only 3, 6, and 3 of the 372 subjects, respectively, confirming that these food items were not commonly consumed in this population (these items were not included in the food frequency questionnaire).

Table 2 presents the frequencies of weekly intake of the listed foods and drinks from the food item list in decreasing order of consumption. Food intake patterns of the medical survey subsample did not differ from the nationally representative household sample. As supported by the 24-h recall data, tea and sorghum porridge were the two items consumed by most older adults. Alcohol was consumed by 22.5% of the sample on a weekly basis, and soft drinks were consumed weekly by 33% of subjects.

Table 3
Weekly frequency of intake of food items from each of the five food groups (16 individual foods listed according to food groups)*

| Reported frequency of intake per group/wk | Mean | SD | Range of scores |
|---|---|---|---|
| Food groups† | | | |
| Grains (bread, sorghum, maize, rice) | 13.1 | 5.5 | 0–28 |
| Vegetables (green leaves, pumpkin, other vegetables) | 3.5 | 3.8 | 0–21 |
| Protein/Meat (meat, chicken, fish) | 2.4 | 3.2 | 0–21 |
| Dairy (milk) | 2.3 | 2.6 | 0–7 |
| Fruits (melon, watermelon, wild fruits, other fruits, fruit juices) | 1.7 | 2.6 | 0–35 |
| FVS‡ | 23.0 | 10.4 | 0–112 |
| DDS§ | 3.5 | 1.2 | 0–5 |

DDS, dietary diversity score; FVS, food variety score; SD, standard deviation.

* Household sample ($n$ = 1062)

† All 16 individual food items used to calculate the FVS are listed according to food group.

‡ Defined as the sum of the weekly frequency score of each of the 16 individual foods included in the five food groups. All 16 individual food items used to calculate the FVS are listed according to food group. Maximum FVS and fruit score acquired by any subject in the survey were 66 and 23, respectively.

§ Defined as the sum of food groups (0–5) from which foods are chosen in a week. If more than one food from the same food group is taken, they only count as one. Example of scoring for FVS, based on data from food frequency questionnaire (16 food items); sorghum meal porridge, daily = 7; rice, 3–6 times per week = 4; meat, 3–6 times per week = 4; green leaves, 3–6 times per week = 4; milk, once or twice weekly = 1; and all other food items in list, less than weekly = 0. Sum for FVS = 7+4+4+4+1 = 20. Using the same example to calculate the DDS would produce a DDS of 4 (1 point per food group; grains, meat, vegetables, and dairy).

### *Food variety score*

In Table 3, most of the foods listed in Table 2 have been combined into the five food groups included in the U.S. Food Guide Pyramid and categorized as in the U.S. Healthy Eating Index [5]. The staples/grains subgroup makes up the bulk of food items consumed per week. Only 2% of subjects reported that they did not consume any items from this food group weekly. Mean scores for the fruit and dairy groups were low, indicating that these foods were consumed, on average, only about twice a week. In addition, 35.2% of subjects did not consume any items from the dairy food group on a weekly basis. Vegetable intake was also low, consumed only about three to four times per week. Moreover, 59.3% and 22.4% of subjects did not consume any of the listed fruits and vegetables, respectively, weekly, and 14.5% consumed neither fruits nor vegetables weekly. Intake of protein-rich foods such as meats and fish was inadequate (consumed only about twice a week); 38.3% did not consume any of these foods weekly.

The weekly DDS was 3.5 ± 1.2 (median score = 4). Further, 55% of the sample consumed foods from four or five of the five food groups on a weekly basis, and the remaining 45% consumed items from between one and three food groups weekly. Six percent of subjects consumed foods from only the grains group, and 13.2% had grains combined with vegetables or with meat. There was a positive association between DDS and FVS ($r = 0.61$, $P < 0.01$)

The FVS is shown according to selected sociodemographic variables, functional status, and cognitive status in Table 4. Self-report of good health and ability to function well was significantly associated with a higher FVS, as was normal cognitive function measured by the Mini-Mental State Examination. Ability to manage all five ADL and IADL items was associated (non-significantly) with a higher FVS compared with those who needed assistance with one or more of the required activities. All sociodemographic variables (sex, age, area of residence, marital status, educational level, ownership of cattle, and number of meals per day) showed bivariate, significant associations with the FVS.

These sociodemographic variables were included in a multivariate regression model (Table 5). In the final linear regression model, area of residence, ownership of cattle, educational level, and number of daily meals were significant variables, explaining 15% ($R^2$) of the total variance in the FVS.

On the basis of linear regression modeling, the four dichotomous variables that contributed significantly to explain the regression model, in addition to age (dichotomous ≤80 y), were used to create a new composite NRI. Although age was not shown to contribute significantly to the multivariate model, we chose to keep age in our score because it is generally accepted to be an important determinant of food intake in elderly populations.

### *Composite index of five questions (NRI) predicting poor food variety*

Items included in the NRI screening tool to assess food variety are shown in the Appendix. Responses to the variables were dichotomous, and a score of 0 was assigned if the risk factor was present and a score of 1 was assigned if the factor was absent (possible total score = 0 to 5). The score on the screening tool was 2.28 ± 1.2. A positive association was found between the NRI screening score and the FVS ($r = 0.32$, $P < 0.001$) and the DDS ($r = 0.26$, $P < 0.001$; Table 6).

Poor nutritional status, measured by using the proxies of a low body mass index (<18.5 kg/m$^2$) or presence of anemia, was found to be more common in subjects who scored low (i.e., 0 to 1) on the screening index than in those who score high. Poor physical and cognitive functioning levels also showed significant associations with low screening scores (Table 6). In addition, self-reported health status differed significantly across the three screening index score categories (Table 6).

Table 4
FVS according to characteristics of the study population‡

| | Mean FVS | SD | *P* | % Total |
|---|---|---|---|---|
| Sex | | | | |
| Female | 22.41 | 10.3 | 0.030* | 52 |
| Male | 23.78 | 10.4 | | 48 |
| Age (y) | | | | |
| 60–69 | 24.24 | 10.5 | 0.001* | 50 |
| 70–79 | 23.08 | 11.0 | | 27 |
| ≥80 | 20.71 | 8.6 | | 23 |
| Area of residence | | | | |
| Urban | 28.58 | 10.2 | 0.001* | 25 |
| Rural | 21.21 | 9.7 | | 75 |
| Marital status | | | | |
| Married | 24.04 | 10.5 | 0.002* | 51 |
| Single/widowed | 22.08 | 10.1 | | 49 |
| Education | | | | |
| Attended school | 25.11 | 11.1 | 0.001* | 47 |
| No school | 21.28 | 9.3 | | 53 |
| Ownership of cattle | | | | |
| Own cattle | 24.33 | 10.1 | 0.005* | 33 |
| No cattle | 22.43 | 10.5 | | 67 |
| No. of meals per day | | | | |
| 1–2 | 21.28 | 9.5 | 0.001* | 55 |
| 3–4 | 25.31 | 10.9 | | 45 |
| Self-reported health | | | 0.004* | |
| Good | 25.26 | 10.1 | | 23 |
| Average | 23.02 | 10.4 | | 62 |
| Poor | 21.84 | 10.3 | | 15 |
| Self-reported overall ability to function | | | 0.001* | |
| Good | 24.83 | 12.0 | | 20 |
| Decreased | 23.18 | 10.1 | | 60 |
| Dependent | 21.13 | 9.2 | | 20 |
| BMI (kg/m$^2$)† | | | 0.38 | |
| <18.5 | 22.31 | 11.7 | | 17.5 |
| 18.5–29.9 | 22.50 | 10.3 | | 65 |
| ≥30 | 24.48 | 10.8 | | 17.5 |
| Anemia† | | | 0.18 | |
| Normal | 23.10 | 10.6 | | 88 |
| Anemia (13 men/12 women) | 20.92 | 11.1 | | 12 |
| ADL† | | | 0.44 | |
| Able all 5 | 23.07 | 10.3 | | 77 |
| Unable ≥1 of 5 | 22.04 | 11.7 | | 23 |
| IADL† | | | 0.37 | |
| Able all 5 | 23.38 | 10.3 | | 43 |
| Unable ≥1 of 5 | 22.37 | 10.8 | | 57 |
| Chair rise test† | | | 0.96 | |
| Able to complete 5 chair rises | 22.82 | 10.4 | | 79 |
| Unable | 22.76 | 11.7 | | 21 |
| Cognitive function (MMSE)† | | | 0.026* | |
| "Normal" | 23.19 | 10.6 | | 91 |
| Cognitive impairment | 18.97 | 11.0 | | 9 |
| 3-Word memory test† | | | 0.043* | |
| Remember all 3 | 23.85 | 10.1 | | 56 |
| Remember 1–2 | 22.42 | 11.6 | | 24 |
| Remember 0 | 20.29 | 10.6 | | 20 |

ADL, activities of daily living; BMI, body mass index; FVS, food variety score; IADL, instrumental activities of daily living; MMSE, Mini-Mental Status Examination

* $P < 0.05$ for differences in FVS across categories by using independent *t* test (two categories) or analysis of variance (three or more categories).

† $n = 372$ (data from medical subsample).

‡ Household sample ($n = 1062$).

Table 5
Relation between the food variety score (dependent variable) and the selected sociodemographic independent variables assessed by linear regression

| Sociodemographic independent variables* | Beta | 95% CI | *P* |
|---|---|---|---|
| Area of residence | 7.1 | 5.7–8.4 | 0.000 |
| No. of daily meals | 3.2 | 2.0–4.4 | 0.000 |
| Ownership of cattle | 2.3 | 1.1–3.6 | 0.000 |
| Education | 1.9 | 0.7–3.1 | 0.002 |

CI, confidence interval.

* Sex, age, and marital status were excluded from the final model by stepwise exclusion because they did not contribute significantly to explain the final regression model.

## Discussion

This study has provided a profile of food intake patterns and identified dietary patterns characterized by low food variety and dietary diversity in a representative sample of older people from a sub-Saharan African country. Of particular concern are the findings that 59% and 22% of subjects did not consume any of the listed fruits and vegetables, respectively, as often as weekly, and more than 33% of subjects did not consume any items from the dairy food group. Protein-rich animal foods were consumed, on average, only about twice a week. It is not possible to comment on the adequacy of nutrient intake of subjects in the present study due to the dietary assessment methodology used. However, it is noteworthy that the poor micronutrient intake of older black South Africans has been explained by the few portions of foods consumed from the calcium-rich food group and the vitamin C- or carotene-rich vegetable group [35].

Even within this elderly population with such a limited range of dietary patterns, higher FVSs are associated with favorable outcomes of various indicators, namely self-reported health status and self-perceived functional ability of subjects and measurements of cognitive function.

Some methodologic considerations need to be taken into account in the interpretation of the present findings. The FVS used in this study has not previously been validated and is based on responses to 16 items from a non-quantified food frequency list that had a recording period of 1 wk. Important food items may have been omitted. However, data from the open-ended questions (24-h recall) related to subjects' food consumption of the previous day confirmed that no major food item had been omitted from the checklist.

Most instruments designed to measure the overall quality of an individual's diet have adopted a quantitative approach to score the amount of variety in the diet and compliance with specific dietary recommendations such as the U.S. Healthy Eating Index [5].

Our FVS is a composite score of frequency of intake from five food groups; theoretically, a relatively high score could be achieved if many foods from only one or a few food groups are consumed. However, the DDS, which counts food groups only once, demonstrates similar food intake patterns.

Valid dietary intake data in representative elderly populations are largely unavailable in most African countries [19]. The collection of food frequency data, without quantification of food intake, is rapid and can be included in large household surveys. Data handling and analyses are also less time consuming when treating simple FVS or DDS values compared with quantification of nutrient intake. However, the main disadvantage of this approach is the inability to assess adequacy of nutrient intakes for individuals or households. Studies from Mali have demonstrated a consistent positive association between the number of foods (i.e., food variety) and food groups (i.e., dietary diversity) consumed and adequacy of nutrient intake [36–38]. This finding has been confirmed from other studies in developing countries [10–12,15].

Four independent risk factors were identified in the present study to predict a low food variety, namely consuming only one or two meals a day, having no formal education, not owning cattle, and living in a rural area. Our findings are in line with other studies among older adults, in which nutrient intake has been shown to increase with the number of meals eaten daily [39,40].

Being in the lowest SES quartile has been associated with an increased risk of being underweight in this sample (odds ratio = 3.3, 95% confidence interval = 1.3 to 8.2) [41]. The variables ownership of cattle and education contributed significantly to the total SES score and together explained 42% of the variance in the final SES score. Thus, their association with the FVS indicates that SES is an important predictor of dietary quality in this population. Despite Botswana being an upper middle-income country and one of few such relatively "wealthy" African nations, most older persons live without basic facilities such as electricity, piped water, and modern toilet facilities in their homes (data not shown). Older persons in Botswana do not appear to have been part of the rapid wealth increase typically experienced by younger and more economically productive segments of the population. Huge inequalities exist in the distribution of wealth in this country. A universal old-age pension scheme operates in Botswana and all citizens 65 y and older are eligible to receive benefits, and the amount was equivalent to US $20 per month at the time of the survey.

Our findings are consistent with studies from other developing countries that have reported a positive association between SES and dietary diversity in urban and rural Mali [17], Nepal [42], and in a multicountry analysis of data from 10 countries [43]. Similarly, in Mali, dietary diversity is related to indicators of household food security, such as food availability, the variety of agricultural equipment and domestic animals, and vulnerability to food crisis [37]. Parallel to this, positive predictors of diet quality in older

Table 6
Indicators of nutritional status, physical and cognitive function, and self-reported health status, according to three categories of scoring on the nutritional risk index

| Indicator | Nutritional risk index score | | | $P$* |
|---|---|---|---|---|
| | 0–1 | 2–3 | 4–5 | |
| Subjects (%) | 28.0 | 55.1 | 16.9 | |
| Mean FVS (SD) | 19.11 (8.6) | 23.14 (10.0) | 29.79 (10.5) | 0.001 |
| Mean DDS (SD) | 3.13 (1.2) | 3.49 (1.2) | 4.05 (1.0) | 0.001 |
| Self-reported health | | | | 0.001 |
| Good | 10.4 | 15.3 | 23.2 | |
| Average | 50.8 | 66.9 | 61.3 | |
| Poor | 38.8 | 17.8 | 15.5 | |
| Ability to function | | | | 0.001 |
| Good | 8.7 | 21.4 | 31.1 | |
| Decreased | 51.3 | 65.9 | 59.5 | |
| Dependent | 40.0 | 12.7 | 9.4 | |
| BMI (kg/m$^2$)† | | | | 0.003 |
| <18.5 | 24.6 | 16.2 | 8.3 | |
| 18.5–29.9 | 67.5 | 64.0 | 65.0 | |
| ≥30 | 7.9 | 19.8 | 26.7 | |
| ADL score† | | | | 0.001 |
| Able all 5 | 65.5 | 79.1 | 93.3 | |
| Decreased function (1–5) | 34.5 | 20.9 | 6.7 | |
| Mean (range 0–10) | 9.5 (1.0) | 9.6 (1.1) | 9.9 (0.7) | 0.043 |
| IADL† | | | | 0.001 |
| Able all 5 | 27.9 | 45.4 | 60.0 | |
| Decreased function (1–5) | 72.1 | 54.6 | 40.0 | |
| Mean (range 0–10) | 7.3 (2.6) | 8.1 (2.3) | 8.8 (1.9) | 0.001 |
| Chair rise test† | | | | |
| Able to perform 5 chair rises | 72.8 | 80.7 | 85.0 | 0.118 (trend test 0.043) |
| Unable | 27.2 | 19.3 | 15.0 | |
| Anemia† | | | | 0.067 (trend test 0.024) |
| Absent | 82.5 | 86.8 | 95.0 | |
| Present | 17.5 | 13.2 | 5.0 | |
| Cognitive function (MMSE)† | | | | 0.001 |
| "Normal" | 83.3 | 91.8 | 100 | |
| Cognitive impairment | 16.7 | 8.2 | 0 | |
| 3-Word memory test† | | | | 0.001 |
| Remembers all 3 | 37.7 | 59.2 | 81.6 | |
| Remembers 1–2 | 29.8 | 21.9 | 16.7 | |
| Remembers 0 | 32.5 | 18.9 | 1.7 | |

ADL, activities of daily living; BMI, body mass index; DDS, dietary diversity score; FVS, food variety score; IADL, instrumental activities of daily living; MMSE, Mini-Mental Status Examination.

* Chi-square test unless otherwise specified.

† $n$ = 372 (Data from medical sub-sample)

persons in developed nations include income and education [44,45].

In the United States, women ages 21 to 80 y who had higher scores on the Healthy Eating Index were more likely to be older, married, better educated, and to have higher household incomes [46].

Rural residence predicted poorer access to varied dietary intake, similar to data reported from a study of South African elderly households, in which a higher prevalence of food poverty in rural versus urban households was demonstrated [19,47,48].

Based on the identification of four risk factors (in addition to age) for poor food variety, we developed a novel pilot screening instrument (Appendix). The screening tool comprises a simple five-item questionnaire that can be self-administered, is quick to complete, and is thus appropriate for use in a primary health care setting in developing countries. Although the screening tool has been developed in Botswana, it may be generalizable to other developing countries in which most older persons are rural residents and typically rely on cattle farming or other livestock farming. The purpose of the screening tool is to allow early identification of older African people who are at greatest risk for a poor quality diet and who may be in need of dietary interventions. The screening questionnaire was purposefully developed to exclude the need for more detailed assessments, such as blood tests, anthropometric measurements, or dietary assessments, which are time consuming and require resources and professional expertise. It was not the purpose of the present study to validate the screening tool for food variety against robust indicators of adequacy of nutrient intake. However, a degree of construct validity has been demonstrated through the tool's ability to characterize subjects according to differences in self-reported health status, self-perceived level of functional ability, objective measures of physical functioning (ADL and IADL), performance on physical strength tests, being underweight, presence of anemia, and measurements of cognitive functioning and memory. In all cases, a higher score on the screening tool indicated better outcome measures.

## Conclusion

The study findings have identified that older persons in Botswana have a diet that lacks variety. Determinants of food variety, based on the study findings, are number of meals per day, rural residence, and SES. A five-item questionnaire tool was developed to screen for nutritional risk of poor dietary variety and was associated with outcome indicators of health and nutritional status, level of independence in daily living, and physical and cognitive functioning. The rapid screening tool may provide government health, welfare, and agricultural sectors, food relief agencies, and nongovernmental organizations with an effective method of targeting nutrition-related activities toward older persons who are at greatest nutritional risk. However, the challenge of how to promote an increased consumption of a wider variety of foods in elderly African populations, given severe underlying socioeconomic constraints, remain.

## Acknowledgments

The authors thank all participants in the survey; the collaborative partners and the data collection team at the National Institute of Research and Documentation, University of Botswana; Professor Benedicte Ingstad, project coordinator (University of Oslo) and Ingvild Dalen (University of Oslo) for statistical advice on this report.

## References

[1] World Health Organization. Preparation and use of food-based dietary guidelines: report of a joint FAO/WHO consultation. WHO technical report series. Geneva: World Health Organization; 1998.
[2] Coulston AM. The search continues for a tool to evaluate dietary quality. Am J Clin Nutr 2001;74:417.
[3] Bernstein MA, Tucker KL, Ryan ND, O'Neill EF, Clements KM, Nelson ME, et al. Higher dietary variety is associated with better nutritional status in frail elderly people. J Am Diet Assoc 2002;102: 1096–104.
[4] Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr 1993;57:434–40.
[5] Kennedy ET, Ohls F, Carlson S, Fleming K. The healthy eating index: design and applications. J Am Diet Assoc 1995;95:1103–8.
[6] Haines PS, Siega Riz AM, Popkin BM. The Diet Quality Index revised: a measurement instrument for populations. J Am Diet Assoc 1999;99:697–704.
[7] Stookey JD, Wang Y, Ge K, Lin H, Popkin BM. Measuring diet quality in China: the INFH-UNC-CH Diet quality Index. Eur J Clin Nutr 2000;54:811–21.
[8] Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The effects of variety in food choices on dietary quality. J Am Diet Assoc 1987;87:897–902.
[9] Hodgson JM, Hsu-Hage B HH, Wahlquist ML. Food variety as a quantitative description of food intake. Ecol Food Nutr 1994;32:137–48.
[10] Rose D, Meershoek S, Ismael C, McEwan M. Evaluation of a rapid field tool for assessing household diet quality in Mozambique. Food Nutr Bull 2002;23:181–9.
[11] Tarini A, Bakari S, Delisle, H. The overall nutritional quality of the diet is reflected in the growth of Nigerian children (abstract). Sante 1999;9:23–31.
[12] Ogle BM, Hung PH, Tuyet HT. Significance of wild vegetables in micronutrient intakes of women in Vietnam: an analysis of food variety. Asia Pac J Clin Nutr 2001;10:21–30.
[13] Drewnowski A, Ahlstrom Henderson S, Driscoll A, Rolls BJ. The dietary variety score: assessing diet quality in healthy young and older adults. J Am Diet Assoc 1997;97:266–71.
[14] Randall E, Nichaman MZ, Contant CF. Diet diversity and nutrient intake. J Am Diet Assoc 1985;85:830–6.
[15] Onyango A, Koski KG, Tucker KL. Food diversity versus breastfeeding choice in determining anthropometric status in rural Kenyan toddlers. Int J Epidemiol 1998;27:484–9.
[16] Guthrie HA, Scheer JC. Validity of a dietary score for assessing nutrient adequacy. J Am Diet Assoc 1981;78:240–5.
[17] Hatløy A, Hallund J, Diarra MM, Oshaug A. Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). Public Health Nutr 2000;3:57–65.
[18] Ruel MT. Is dietary diversity an indicator of food security or dietary quality? A review of measurement issues and research needs. In: FCND discussion paper. Washington, DC: International Food Policy Research Institute; 2002.
[19] Charlton KE, Rose D. Nutrition among older adults in Africa: the situation at the beginning of the millenium. J Nutr 2001;131:2424S–8.
[20] Shatenstein BNS, Ferland G. Diet quality among older Quebecers as assessed by simple indicators. Can J Diet Pract Res 2003;64(4):174–80.
[21] Drewnowski A, Warren-Mears VA. Does aging change nutrition requirements? J Nutr Health Aging 2001;5(2):70–4.
[22] Marshall TA, Stumbo PJ, Warren JJ, Xie XJ. Inadequate nutrient intakes are common and are associated with low diet variety in rural, community-dwelling elderly. J Nutr 2001;131:2192–6.
[23] Kumagai S, Watanabe S, Shibata H, Amano H, Fujiwara Y, Shinkai S, et al. Effects of dietary variety on declines in high-level functional capacity in elderly people living in a community (abstract). Nippon Koshu Eisei Zasshi 2003;50:1117–24.
[24] 1991 National population and housing census. Gaborone: Central Statistics Office, Republic of Botswana; 1992.
[25] Census: population composition and distribution, stats brief. Gaborone: Central Statistics Office, Republic of Botswana; 1991, p. 1994.
[26] Holmboe-Ottesen G. Nutrition and food security in Letlhakeng village, Kweneng district, Botswana. Interim report. Oslo: University of Oslo/Gaborone: University of Botswana; 1991.
[27] Holmboe-Ottesen G. Nutrition and food security in Letlhakeng village. In: Mugabe M, Gobotswang K, Holmboe-Ottesen G, editors. From food security to nutrition security in Botswana. Gaborone: Lentswe La Lesedi; 1998, p. 100–26.
[28] World Health Organization. Obesity: preventing and managing the global epidemic. Report on a consultative meeting. Geneva: World Health Organization; 1997.

[29] Katz SC, Stroud MW. Functional assessment in geriatrics: a review of progress and directions. J Am Geriatr Soc 1989;37:267–71.
[30] Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 1969;9:179–86.
[31] Tombaugh TN, McIntyre NJ. The Mini-Mental State Examination. A comprehensive review. J Am Geriatr Soc 1992;40:922–35.
[32] Folstein MF, Folstein SE. "Mini-Mental State": A practical method for grading the cognitive state of patients for the clinician. J Psychiatric Res 1975;12:189–98.
[33] Guralnik JM, Ferrucci L, Simonsick EM, Salive ME, Wallace RB. Lower extremity function over the age of 70 years as a predictor of subsequent disability. N Engl J Med 1995;332:556–61.
[34] World Health Organization. Nutritional anaemias: report of a World Health Organization scientific group. Technical report series 405. Geneva: World Health Organization; 1968.
[35] Charlton KE, Bourne LT, Steyn K, Laubscher R. Poor nutritional status in older black South Africans. Asia Pac J Clin Nutr 2001;10:31–8.
[36] Torheim LE, Barikmo I, Parr CL, Hatløy A, Ouattara F, Oshaug A. Validation of food variety as an indicator of diet quality assessed with a food frequency questionnaire for Western Mali. Eur J Clin Nutr 2003;57:1283–91.
[37] Torheim LE, Ouattara F, Diarra MM, Thiam FD, Barikmo I, Hatløy A, Oshaug A. Nutrient adequacy and dietary diversity in rural Mali: associations and determinants. Eur J Clin Nutr 2004;58:594–604.
[38] Hatløy A, Torheim LE, Oshaug A. Food variety—a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. Eur J Clin Nutr 1998;52:891–8.
[39] Lee CJ, Templeton S, Wang C. Meal skipping patterns and nutrient intakes of rural Southern elderly. J Nutr Elder 1996;15:1–14.
[40] Redondo MR, Ortega RM, Zamora MJ, Quintas ME, Lopez-Sobaler AM, Andres P, Gaspar MJ. Influence of the number of meals taken per day on cardiovascular risk factors and the energy and nutrient intakes of a group of elderly people. Int J Vitam Nutr Res 1997;67:176–82.
[41] Clausen T, Charlton KE, Holmboe-Ottesen G, Nutritional status, tobacco use and alcohol consumption of older persons in Botswana. J Nutr Health Aging 2004(in press).
[42] Gittelsohn J, Mookherji S, Pelto GH. Operationalizing household food security in rural Nepal. Food Nutr Bull 1998;19:210–22.
[43] Hoddinott J, Yohannes Y. Dietary diversity as a food security indicator. FCND discussion paper. Washington, DC: International Food Policy Research Institute; 2002.
[44] Keller HH, Ostbye T, Bright-See E. Predictors of dietary intake in Ontario seniors. Can J Public Health 1997;88:305–9.
[45] Shatenstein B, Nadon S, Ferland G. Determinants of diet quality among Quebecers aged 55–74. J Nutr Health Aging 2004;8:83–91.
[46] Hann CS, Rock CL, King I, Drewnowski A. Validation of the Healthy Eating Index with use of plasma biomarkers in a clinical sample of women. Am J Clin Nutr 2001;74:479–86.
[47] Rose D, Charlton KE. Prevalence of household food poverty in South Africa: results from a large nationally representative survey. J Public Health Nutr 2002;5:383–9.
[48] Rose D, Charlton KE. Quantitative indicators from a food expenditure survey can be used to target the food insecure in South Africa. J Nutr 2002;132:3235–42.

## Appendix

Botswana NRI screening tool

| NRI | Low score predicting poor food diversity[#] |
|---|---|
| Age* | |
| ≥80 y | 0 |
| <80 y | 1 |
| Residence[†] | |
| Rural | 0 |
| Urban | 1 |
| Education[‡] | |
| No | 0 |
| Yes | 1 |
| Cattle[§] | |
| No | 0 |
| Yes | 1 |
| Meals daily[‖] | |
| 1–2 | 0 |
| 3–4 | 1 |
| Total score | 0–5 |

NRI, nutritional risk index

* Please state your age (<80 y/≥80 y).

† Area of residence (rural/urban).

‡ Have you ever attended school (yes, including all levels of education or incomplete primary school/no formal education)?

§ Do you own cattle? (yes/no)

‖ How many meals do you usually eat per day (1–2, ≥3)?

# A score of 0 to 1 is indicative of high nutritional risk.