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## PUBLIC HEALTH NUTRITION AND EPIDEMIOLOGY

# Development of a quantitative food frequency questionnaire for use among rural South Africans in KwaZulu-Natal

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dietary assessment, rural, South Africa.

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### Abstract

**Background:** South Africa is experiencing a dietary and lifestyle transition as well as increased rates of noncommunicable chronic diseases. Limited information is available on the diets of rural populations. The present study aimed to characterise the diets of men and women from rural KwaZulu-Natal (KZN) and develop a quantitative food-frequency questionnaire (QFFQ) specific for this population.

**Methods:** A cross-sectional study was carried out by collecting single 24-h dietary recalls from 81 adults and developing a QFFQ in Empangeni, KZN, South Africa.

**Results:** The diet of this population was limited in variety, high in plant-based foods (especially cereals and beans), and low in animal products, vegetables and fruits. Amaize meal staple (*Phutu*) was consumed by over 80% of subjects and accounted for almost 45% of energy intake, as well as making an important contribution to fat and protein intake. Most of the protein consumed by the study population was plant-based protein, with almost 40% being obtained from the consumption of *phutu* and beans. A culturally appropriate QFFQ was developed that includes 71 food and drink items, of which 16 are composite dishes unique to this population.

**Conclusions:** Once validated, this QFFQ can be used to monitor diet-disease associations, evaluate nutritional interventions and investigate dietary changes in this population.

### Introduction

South Africa is a multicultural country of over 50 million people, consisting of Black African, Asian, White and Coloured individuals. Black African peoples make up almost 80% of the total population (Statistics South Africa, 2011) and include a diversity of tribal groups, such as the Zulu, Tswana, Sotho, Pedi, Venda and Ndebele. Over recent decades, populations in South Africa have been undergoing a dietary and lifestyle transition caused by both political changes within the country itself, as well as the broader demographic and socio-economic trends that are happening at a global level related to

increased industrialisation, urbanisation, acculturation, etc. (Kruger *et al.*, 2005). This has resulted in a shift to a less prudent, 'Western' dietary pattern, which is associated with an increased risk of noncommunicable chronic diseases (Popkin 2006). Between 1940 and 1990, fat intake in black people living in urban settings increased from 16% to 26% of total energy, whereas energy from carbohydrate fell from 69% to 62% (Bourne *et al.*, 2002). Results from the Transition, Health and Urbanisation in South Africans (THUSA) study (MacIntyre *et al.*, 2002; Kruger *et al.*, 2005) across five strata of urbanisation (from rural to upper-class urban residential areas) showed that energy from carbohydrate decreased from

67% to 56% and energy from fat increased from 23% to 31% between the lowest and highest strata. In addition, more than half of all subjects, regardless of residence, had intakes of vitamin A, folate, ascorbic acid, calcium, iron and zinc that were less than 67% of the recommended dietary allowance for their sex and age groups, with rural subjects having significantly lower intakes of most micronutrients than urban subjects (Kruger *et al.*, 2005). The introduction of national mandatory fortification of commonly consumed staple foods (maize meal and wheat flour) appears to have had a significant positive impact on overall micronutrient adequacy (Steyn *et al.*, 2008) but, for some groups, especially the poor and among rural populations, consuming a healthy diet remains problematic because of limited access as well as the high cost of healthier food choices (Temple *et al.*, 2011).

There is convincing evidence that high intakes of energy-dense, micronutrient-poor foods increase the risk of obesity and noncommunicable chronic diseases (World Health Organization, 2003). In South Africa, the burden of noncommunicable chronic diseases is increasing in both urban and rural areas, especially in poor people living in urban settings (Mayosi *et al.*, 2009). This burden is expected to increase substantially over coming decades unless concerted prevention and control measures are taken (Abegunde *et al.*, 2007). Because diet is a major potentially modifiable risk factor for noncommunicable chronic disease, accurate assessment of dietary intake in at-risk South African populations is essential.

Dietary intake can be determined by a variety of methods, including 24-h recalls, food frequency questionnaires (FFQs), food diaries and measurement of dietary diversity (Cade *et al.*, 2002; Torheim *et al.* 2004). FFQs have become the primary method of measuring dietary intake in epidemiological studies because of their low cost, ease of administration, low subject burden and the ability to measure mean intakes over an extended period of time in large numbers of subjects (Willett, 1998). Although it is common practice to adapt previously developed FFQs, such as the Block (National Cancer Institute) (Block *et al.*, 1986) and Willett (Harvard) (Willett *et al.* 1987) questionnaires, for different study populations (Tucker *et al.*, 1998), it is well recognised that food availability, accessibility and preferences differ, often substantially, between settings and across different ethnic population groups. Therefore, FFQs need to be developed specifically for each population to produce valid and reliable dietary data (Sharma 2011). The aim of the present study was to characterise the diets of rural South African men and women in KwaZulu-Natal (KZN) by identifying the most commonly consumed foods, as well as other foods that make an important contribution to the diet, with the aim of developing a

quantitative food frequency questionnaire (QFFQ) for use specifically with this population.

## Materials and methods

### Study setting

This cross-sectional study took place in six rural villages in Empangeni, KZN, South Africa. Villages were randomly selected from a map of Empangeni, which is located 160 km north of Durban, the capital of KZN, and is within the local municipality of Umhlatuze.

### Subjects

Men and women ( $n = 81$ ) from the six villages were selected to participate in the present study. Within each village, a fieldworker was asked to select people representing the geographical area and to include people of both sexes and from all age groups (19–79 years). Fieldworkers selected people who lived close to the food stores, as well as those who lived at long distances from stores. The fieldworker was informed of the need for the sample to be representative of the population residing in the villages and was asked not to purposely select relatives and friends. The majority of the villages had a fairly small population with very similar socio-economic status and access to food. Respondents were asked to attend a local centre for the interviews to be undertaken. The study was approved by the University of Alberta Internal Review Board and University of KwaZulu-Natal. Written informed consent was obtained from all participants.

### Data collection

Data collection was conducted by locally-trained field staff in June to December 2011. Training took place at Izulu Orphan Projects (IOP) and included practice interviews on IOP staff. Staff were trained by the principal investigator (SS) and supervised during data collection. The interviews were conducted in local language (Zulu). A pre-established method (Sharma 2011) was followed based on the steps outlined below.

#### *Compilation of a complete and accurate food list*

Subjects were asked to complete one interviewer-administered 24-h recall. Interviews were conducted at the community centres in the villages and systematically sought and recorded information about all foods and drinks consumed during the preceding 24-h period. Data were recorded on dietary assessment forms developed specifically for the present study. An additional list of questions was included to prompt for easily forgotten foods, such as sweets, alcohol and snacks. Questions were also

included on smoking, employment status, use of dietary supplements, existing medical conditions, medication usage, and any special dietary practices that the respondents followed, such as weight-loss or low-fat diets. All subject demographics and general characteristics, including age, employment, smoking status and disease history, were self-reported.

#### *Determination of culturally appropriate portion sizes*

The amount of foods consumed was assessed using familiar household units (e.g. cup, spoon, glass, bowl), standard units (e.g. slices of bread) or three-dimensional models (Nasco International, Fort Atkinson, WI, USA) that had been carefully chosen to best estimate the amount consumed. Each interviewer was given a set of food models, as well as commonly used bowls, cups, glasses and spoons, to use during the interview. To derive weights for the portion sizes that respondents reported consuming in the 24-h recalls, the interviewer weighed portions for all reported foods.

#### *Development of the draft quantitative food frequency questionnaire*

Any food item reported on the 24-h recalls by more than one subject (apart from foods contributing little or no energy value, such as condiments and spices) was included on the draft QFFQ. Foods that did not appear in the 24-h recalls but were considered relevant to rural South Africans, such as seasonal foods, were also added (MacIntyre *et al.* 2002). Additional blank lines were provided under each food group for respondents to list any other foods or drinks that they consumed.

#### *Nutritional composition of mixed dishes*

To calculate the nutritional composition of commonly consumed local composite dishes, weighed recipes were collected as described previously (Sharma, 2011). Briefly, five community volunteers were asked to cook each composite dish under the supervision of a trained investigator. Individual ingredient weights (having allowed for inedible or discarded material) and final cooked weights of each of the five dishes were recorded by the investigator, and an average recipe was calculated for each dish. All food weights were obtained using an electronic kitchen scale (Aquatronic Baker's Dream Scale; Salter Houseware, Ltd, Fairfield, NJ, USA).

#### **Statistical analysis**

Dietary data from the 24-h recalls were coded and analysed using NUTRIBASE, version 9 (Cybersoft Inc., Phoenix, AZ, USA), which calculated energy and nutrient intakes per person. The food composition tables in Nutribase

(United States Department of Agriculture, 2011) were updated to include the weighed recipes for commonly consumed local composite dishes. All analyses were undertaken using SAS, version 9.3 (SAS Institute, Inc., Cary, NC, USA).

## **Results**

### **Subject characteristics**

Eighty-one participants completed a single 24-h recall. Two subjects whose estimated energy intakes were extremely high [ $>20\ 920\ \text{kJ day}^{-1}$  ( $>5000\ \text{kcal day}^{-1}$ )] were excluded, leaving a final sample of 79 (34 men and 45 women). Subject characteristics are shown in Table 1.

**Table 1** Demographic and other information among study participants in rural KwaZulu-Natal

Characteristics	Males ( <i>n</i> = 34), <i>n</i> (%)	Females ( <i>n</i> = 45)
	Mean (SD)	Mean (SD)
Age (years)	44.0 (17.4)	49.6 (15.2)
	<i>n</i> (%)	<i>n</i> (%)
Employment		
Yes	6 (17.6%)	11 (24.4%)
No	9 (26.5%)	13 (28.9%)
No response	19 (55.9%)	21 (46.7%)
Smoke		
Yes	14 (41.2%)	1 (2.2%)
No	7 (20.6%)	38 (84.4%)
No answer	13 (38.2%)	6 (13.3%)
Chewing tobacco		
Yes	1 (2.9%)	3 (6.7%)
No	26 (76.5%)	33 (73.3%)
No answer	7 (20.6%)	9 (20.0%)
Usual amount eaten		
More than usual	1 (2.9%)	1 (2.2%)
Less than usual	5 (14.7%)	5 (11.1%)
Yes	27 (79.4%)	37 (82.2%)
No response	1 (2.9%)	2 (4.4%)
Supplement use		
Yes	1 (2.9%)	6 (13.3%)
No	22 (64.7%)	28 (62.2%)
No response	11 (32.4%)	11 (24.4%)
Conditions reported		
Hypertension (only)	2 (5.9%)	3 (6.7%)
Diabetes (only)	–	1 (2.2%)
HIV	1 (2.9%)	8 (17.8%)
Multiple conditions (>1)*	–	5 (11.1%)
Other	1 (2.9%)	–
No reported conditions	30 (88.2%)	26 (57.0%)
Medications		
Blood pressure	2 (5.9%)	6 (13.3%)
Diabetes	–	5 (11.1%)
Anti-retroviral therapy	1 (2.9%)	6 (13.3%)

\*Diabetes and hypertension.

The mean (SD) age for men and women was 44.0 (17.4) and 49.6 (15.2) years, respectively. Approximately 18% of men and 24% of women reported being in employment, whereas the remainder were either unemployed or gave no answer regarding their employment status. Approximately 41% of men and 2% of women smoked cigarettes, whereas 3% of men and 7% of women chewed tobacco. Approximately 80% of participants reported that their intake on the day recalled was the same as usual and no-one reported being on a special diet. Approximately 3% of men and 13% of women took multivitamin supplements. When asked if they had any serious medical conditions, 6% of men and 7% of women reported hypertension only; 2% of women reported diabetes diagnosis only; 11% of women reported having multiple conditions, mainly diabetes and hypertension; and 3% of men and 18% of women reported HIV-positive status. Some 6% of men and 13% of women reported taking antihypertensive medication; 11% of women reported taking diabetes medication; and 3% of men and 11% of women reported taking anti-retroviral therapy medication for HIV.

### Most commonly reported foods

The 20 most commonly reported foods in the 24-h recalls are shown in Table 2. The top four items were *phutu* (a crumbly maize meal porridge, which is a staple food for this population), brown sugar, tea and beans; these foods were reported by between one-half and over four-fifths of participants. Apart from potatoes, the only vegetables to appear were cabbage, spinach, and onions and tomatoes, which were part of mixed dishes. There were no fruits among the top 20 most reported foods.

### Major food contributors to energy, fat and protein intake

The major foods contributing to energy, fat and protein intake are listed in Table 3. The top five sources of energy were *phutu*, rice, beans, samp and beans, and 'stiff maize meal porridge' (*stifpap*). *Stifpap* is a maize meal porridge with a thicker consistency than *phutu*; however, both are mixtures of refined maize meal, salt and water and *Stifpap* is traditionally consumed for breakfast (Spearing *et al.*, 2012). *Phutu* alone accounted for some 45% of energy intake. Beans provided 14% of dietary fat, whereas other important contributors to fat intake were *phutu*, fried vegetables (cabbage, spinach) and stews (fish, chicken, beef). *Phutu* was also the major contributor to protein intake, accounting for some 28%. Beans provided 12% of dietary protein, followed by chicken stew (9%), samp and beans (7%), and white rice (5%).

**Table 2** Food and drink items most commonly reported by study participants

Food/drink	Description	Number (%) of people reporting that food
Phutu	Maize meal staple, thick porridge made with water and salt	66 (84)
Brown sugar	Store-bought sugar	62 (78)
Tea	Black tea, consumed with milk and sugar	54 (68)
Beans	Sugar/kidney beans fried with tomato and onion	41 (52)
White rice	Boiled white rice	27 (34)
Stifpap	Maize meal thick porridge, made with water and salt	21 (27)
Whole wheat bread	Store-bought brown bread	17 (22)
White bread	Store-bought white bread	16 (20)
Cremora (milk substitute)	Powdered creamer	14 (18)
Roast chicken	Chicken roasted in oven or on fire	14 (18)
Margarine	Store-bought margarine	14 (18)
Cabbage, fried	White cabbage with oil and tomatoes added	13 (16)
Chicken stew	Home-made – chicken with skin fried with onion and tomato	12 (15)
Spinach, fried	Home-made – fried spinach with onions and tomato	12 (15)
Beef stew	Home-made – beef with bone, fried with onion and tomato	10 (13)
Samp and beans	Refined corn boiled with sugar beans, salt added	9 (11)
Cordial drink	Store-bought cordial drink	8 (10)
Potato stew	Home-made – boiled and fried potatoes with onions and tomato	8 (10)
Fish stew	Home-made – canned sardines fried with onion and tomato	7 (9)
Peanut butter	Store-bought peanut butter	7 (9)

### Development of a draft quantitative food frequency questionnaire

A draft QFFQ was developed based on a list of all food items reported by more than one subject from the 24-h recalls. Seasonal foods (particularly fruits and vegetables) that had not been reported were added, including mangoes, guavas and ibhece (yellow melon). Goat, which was not reported by any subject but is a commonly consumed ceremonial food, was also added. The individual food items appearing on the QFFQ are shown in Table 4. There are 71 food and drink items in all, comprising 11



**Table 3** Top 10 food and drink items contributing to energy, fat and protein intake (%)

Energy Foods	% contribution*	Fat Foods	% contribution	Protein Foods	% contribution
Phutu	44.6	Beans	13.6	Phutu	27.6
Rice	8.2	Phutu	11.8	Beans	12.1
Beans	8.1	Fish stew	8.1	Chicken stew	9.0
Samp and beans	4.7	Spinach fried	7.8	Samp and beans	6.9
Stifpap	3.9	Chicken stew	7.7	White rice	5.4
White bread	3.3	Cabbage fried	7.6	Fish stew	5.0
Sugar	2.7	Beef stew	5.7	Chicken drumstick	4.5
Chicken stew	2.6	Milk	5.3	Beef stew	4.4
Fish stew	2.0	Margarine	4.0	White bread	3.5
Milk	1.8	Chicken drumstick	3.4	Milk	3.2
Total	81.9%		75%		81.7%

\*% Contribution of a food to Y-nutrient =  $100 \times (\text{total Y-nutrient from that food} / \text{total Y-nutrient from all foods consumed})$ .

**Table 4** Food and drink items listed on the final quantitative food-frequency questionnaire

Category	Food items
Cereals and cereal products (11)	Porridge (maize meal); pap; bread – white, brown; jeqe (homemade); samp and beans; samp; phutu (maize meal staple); mealies (imbila) roasted and boiled; rice
Meat, fish, poultry (18)	Tinned fish; chicken boiled, fried with tomatoes, stew, soup, curried, with dumplings; beef boiled, fried with tomatoes and onion, stew, soup; goat, boiled, fried, curried, with dumplings; mutton; sausages; polony
Dairy products and eggs (6)	Amasi (cultured milk-traditional); liquid milk in tea; butter; eggs – fried, eggs – boiled; powdered milk in tea
Vegetables (including potatoes) (8)	Green leafy vegetables (including spinach, pumpkin leaves and wild greens (imbuya); cabbage – boiled/fried; carrots; beetroot; gold-dish (canned mixed vegetables); pumpkin/butternut squash; potatoes – fried, boiled or curried; sweet potato
Fruits (9)	Apple/pear; banana; orange/naatjie (mandarin); mangoes; guavas; paw paw; iindoni (wild fruit); grapes; pineapple
Snacks (7)	Sweets; biscuits; cake; crisps – corn-based, potato-based; chocolate; nuts
Drinks (6)	Tea; coffee; concentrated juices; fresh homemade orange/lemon juice; amahewu (traditional drink); soft fizzy drinks
Alcohol (3)	Beer; umqombothi (traditional); isiqatha (moonshine)
Other foods (3)	Indlubu (ground nuts); ibhece (yellow melon); lentils

cereals and cereal products; 18 meats, fish and poultry; six dairy products and eggs; eight vegetables; nine fruits; seven snacks; six non-alcoholic drinks; three alcoholic drinks; and three other foods. Sixteen items are

composite dishes unique to this population. Frequency of consumption on the QFFQ is defined in eight categories ranging from 'never' to '2 or more times a day', and portion sizes are culturally appropriate. The draft QFFQ was pilot-tested in a convenience sample of 15 individuals selected from men and women in rural Empangeni who agreed that it reflected all commonly consumed foods within the study population. Administration of the QFFQ takes an average of 15–20 min.

## Discussion

To combat the rising burden of noncommunicable chronic diseases in South Africa, accurate dietary information is essential not only to examine the association between food and nutrient intake and disease risk factors, but also to inform and evaluate community-based interventions aimed at prevention, and to monitor long-term changes in diet. Because of the cultural, ethnic and geographical differences that exist between peoples within South Africa, it is inappropriate to use a single QFFQ to assess the diets of multiple populations; instead, QFFQs must be developed specifically for each population. In the present study, single 24-h dietary recalls were used to characterise the diets of rural men and women from six villages in Empangeni, KZN, and develop a draft QFFQ for this population. Results from the 24-h recalls (data not shown) revealed that some 70% of dietary energy came from carbohydrates and only 15% was provided by fat. This dietary pattern has been reported previously amongst rural populations in a number of developing countries, including South Africa (Bourne *et al.*, 2002), Kenya (Hansen *et al.*, 2011), Malawi (Nyambose *et al.* 2002) and Cameroon (Mennen *et al.*, 2000). Cereals were the predominant items in the diet, with *phutu* being consumed by over 80% of subjects and accounting for almost 45% of energy intake, as well as making an important

contribution to fat and protein intake. Most of the protein consumed by the study population was plant-based protein, with almost 40% being obtained from the consumption of *phutu* and beans. The limited use of animal products and the more frequent use of dried products such as nondairy creamers and powdered milk may be explained by the fact that most animal products, including dairy products, require refrigerated storage; although some households had electricity, the majority did not, and thus there was no facility to store these products.

Previously, MacIntyre *et al.* (2001a) developed a culturally specific QFFQ to assess the diets of South African men and women in the North West Province. Their instrument included 145 food items and composite dishes and was used to assess the diets of South Africans at different stages of the nutrition transition from rural to urban (MacIntyre *et al.*, 2001b). The instrument developed in the present study, which is targeted at rural South Africans in KZN, has only 71 food and drink items but still captures most kinds of foods commonly eaten by this population. The smaller number of food items in our QFFQ reflects the fact that the diets of rural populations in South Africa tend to have less variety than those of urban groups. Although the diet of adult South Africans, regardless of rural or urban residence, has been described as lacking in variety, those living in rural and informal urban areas are most affected (Labadarios *et al.*, 2011). A key determinant for rural populations lacking a diversity of foods is limited access to supermarkets, which could provide a wider variety of foods.

The most important part of developing a culturally appropriate QFFQ is the compilation of the food list (Sharma, 2011). The omission of important items may lead to an underestimation of nutrient intake, whereas inclusion of irrelevant items unduly increases participant burden (Willet, 1998). Our QFFQ includes all foods reported in the 24-h recalls by two or more respondents, as well as other foods that may not have been reported originally as a result of seasonality. The top 10 foods contributing to energy, fat and protein accounted for 82% of energy and protein intake and 75% of fat intake, which suggests that the food list is both culturally relevant and substantially complete. At the same time, administration of the QFFQ takes only approximately 15–20 min, and so participant burden is not excessive. Obtaining accurate portion size information is also critical because average portion sizes from one population are not always applicable to other populations, particularly other ethnic/racial groups (Sharma 2011). In the present study, food models and common household items such as plates, spoons, bowls and cups were used that were familiar to the population and chosen with their input. Community members were involved in the development of the QFFQ at a

number of levels. This was not just in the selection of appropriate food models and portion sizes, but also in the ordering and grouping of foods, providing local terminology for foods (such as amahewu for traditional drink; ibhece for yellow melon), identifying important but easily forgotten foods (especially seasonal foods) and providing feedback on the questionnaire. Community members were also recruited as staff and trained to administer the 24-h recalls and the draft QFFQ, and the questionnaire was piloted on people from within the community.

## Conclusions

The diet of this population of rural men and women in KZN, South Africa, was limited in variety, high in plant-based foods (especially cereals and beans) and low in animal products, vegetables and fruits. A culturally appropriate QFFQ containing 71 food and drink items was developed. Once validated, this QFFQ can be used to monitor diet–disease associations, evaluate nutritional interventions, and investigate dietary changes in this population arising from the effects of urbanisation and globalisation in South Africa.

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## Conflict of interests, source of funding and authorship

The authors declare that there are no conflicts of interest.

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TS was responsible for manuscript editing. FK carried out data analysis and was responsible for manuscript editing. TLM carried out data collection and was responsible for community liaison. TK was responsible for manuscript editing. SS was responsible for conceiving the study. All authors critically reviewed the manuscript and approved the final version submitted for publication.

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