

# Changes in food intake from 2005 to 2010 by a cohort of black rural and urban African men and women in the North West Province of South Africa: the PURE-NWP-SA study

Edelweiss Wentzel-Viljoen<sup>1,\*</sup>, Ria Laubscher<sup>2</sup> and Hester H Vorster<sup>1</sup>

<sup>1</sup>Centre of Excellence for Nutrition, Faculty of Health Sciences, North-West University, P/Bag X6003, Potchefstroom, South Africa; <sup>2</sup>South African Medical Research Council, Biostatistics Unit, Tygerberg, South Africa

Submitted 25 October 2017; Final revision received 12 June 2018; Accepted 2 July 2018; First published online 28 August 2018

## Abstract

**Objective:** We have shown that nutrient intakes of rural and urban black Africans in the North West Province (NWP) of South Africa (SA) followed the typical nutrition transition pattern upon urbanization and modernization. The current study aimed to examine and report on the changes in food intakes from 2005 to 2010 in rural and urban black South Africans participating in the PURE-NWP-SA study.

**Design/Setting/Subjects:** The PURE-NWP-SA study recruited 2010 volunteers aged 35–70 years in 2005, from which detailed food intakes, measured with a validated quantified FFQ, for 1858 participants were available. In 2010, food intakes of a cohort of 1154 of these participants were measured.

**Results:** Median energy intake increased in men and women in both rural and urban areas from 2005 to 2010. Changes in food intake were interpreted keeping these changes in energy intake and the contribution of foods and food groups to total energy intake in mind. No ‘new’ foods were eaten in 2010, but more participants consumed certain foods and products in 2010 than in 2005. Beneficial changes were increased intakes of vegetables, fruit and milk in most groups. The contribution of cooked staple porridges and bread made from fortified maize and bread flour decreased and therefore also did their contribution to micronutrient intakes.

**Conclusions:** By promoting and supporting observed beneficial changes such as increased intakes of milk, vegetables and fruit by appropriate policies and educational interventions, it should be possible to steer the nutrition transition in this population into a positive direction.

**Keywords**  
South Africa  
Black African men and women  
Nutrition transition  
Food intake  
Food groups  
South African food-based  
dietary guidelines

The global nutrition transition is often defined as the changes in nutrient consumption that occur when developing populations modernize and urbanize because of economic development and other social and lifestyle changes, leading to changes in the availability and affordability and thus exposure to new foods and products, including more processed and ‘takeaway’ foods<sup>(1,2)</sup>. The resultant changes in nutrient intakes are seen to be part of the epidemiological (health) transition, contributing to an increased risk of non-communicable diseases (NCD)<sup>(1,2)</sup>. South Africa (SA), a low-middle-income country, is in the midst of a health transition characterized by a burden of communicable and non-communicable diseases as well as perinatal, maternal and injury-related disorders<sup>(3)</sup>. There are sharp increases in overweight, obesity, hypertension, diabetes and CVD in South African populations without substantial improvements of undernutrition in children<sup>(3–5)</sup>. The South African Medical Research

Council<sup>(6)</sup> showed that both under- and overnutrition are risk factors for disability-adjusted life years and mortality in the South African population. This confirms previous research<sup>(2)</sup> that NCD emerged in sub-Saharan Africa at a faster rate and at a lower economic level than in industrialized countries in the past, before the battle against undernutrition has been won, leading to the phenomenon of a double burden of consequences of the coexistence of under- and overnutrition<sup>(2)</sup>.

We have previously illustrated that the diet followed by black South Africans in rural areas of the North West Province (NWP) does not meet micronutrient requirements<sup>(7–11)</sup> and that both rural and urban black populations increased their added sugar intake, especially as sucrose-sweetened beverages, from 2005 to 2010<sup>(12)</sup>. In an effort to address the micronutrient deficiencies in the South African population, the Department of Health (Directorate Nutrition) instituted a mandatory micronutrient fortification of

\*Corresponding author. Email edelweiss.wentzel-viljoen@nwu.ac.za

the staples, maize meal and bread flour, in 2003<sup>(13)</sup> that came into effect in 2004. Data on food intake *per se* of sub-populations in SA are scarce and a need has been identified to collect and publish food intake data of South Africans<sup>(14)</sup>.

To promote and strengthen the observed beneficial nutrition transition changes in micronutrient intakes of the PURE-NWP-SA participants with urbanization and modernization<sup>(11)</sup>, and at the same time to prevent adverse changes in macronutrient intakes, it is necessary to know which foods were responsible for the reported changes in nutrient intakes<sup>(11)</sup>. Knowledge of these changes in food intake can then be applied in appropriate education programmes using the South African food-based dietary guidelines (SAFBDG)<sup>(15)</sup> to promote optimal nutrition from diets that are adequate regarding micronutrients and at the same time protective against overnutrition and risk of NCD regarding the macronutrients. The purpose of the present paper is therefore to examine and report on the changes in food intakes from 2005 to 2010 in rural and urban black South Africans participating in the Prospective Urban and Rural Epidemiological (PURE-NWP-SA) study.

## Methods

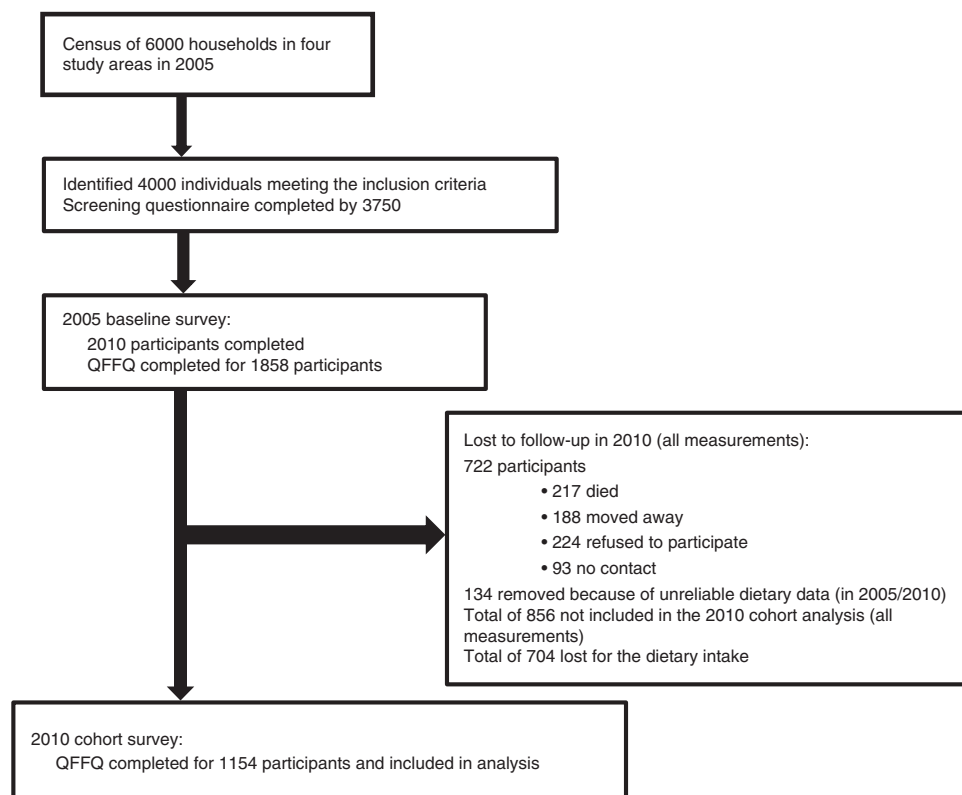
### ***The PURE-NWP-SA study: participants and design***

The participants were volunteers participating in the PURE-NWP-SA study. The PURE study is an international

prospective cohort study tracking changing lifestyles, risk factors and chronic disease in urban and rural areas of seventeen countries in transition<sup>(16,17)</sup>. One of the South African legs of the PURE study is being conducted in a rural and an urban area of the NWP. The baseline study was conducted in 2005 and the first follow-up in 2010. The study design of the PURE-NWP-SA study has been described elsewhere<sup>(12,17,18)</sup>. Briefly, participants were recruited from four different sites (two in the rural area, two in the urban area) in the NWP of SA. The study was explained to the individuals and after voluntary and informed consent was obtained the questionnaires were completed. A total of 2010 participants were tested (about 500 in each community) in 2005, of which dietary data were available for 1858 participants. In the 5-year follow-up survey conducted in 2010, 1233 participants were included. Figure 1 provides a summary of the recruitment and follow-up procedures (adapted from Vorster *et al.*<sup>(12)</sup>).

### ***Measurements: questionnaires***

Standardized structured demographic, socio-economic, lifestyle and physical activity questionnaires of the international PURE study were used<sup>(16)</sup>. These questionnaires were adapted for the South African study where necessary. Sixteen volunteer fieldworkers were recruited from the communities where the study was executed and intensively trained to complete the questionnaires at the



**Fig. 1** Participant recruitment and follow-up from years 2005 to 2010 (adapted from Vorster *et al.*<sup>(12)</sup>). QFFQ, quantified FFQ

study sites or participants' homes. The quantified FFQ (QFFQ) used to collect dietary intake data has been described elsewhere<sup>(11)</sup>. Briefly, a previously validated, culture-sensitive QFFQ was used to obtain dietary intakes covering the previous month<sup>(19–22)</sup>. Suitable tools, including a food-portion photograph book<sup>(23)</sup> specifically developed and tested for this population, were used to quantify amounts and frequencies of foods eaten. The validation of the QFFQ included a comparison of intake results obtained with the questionnaire and with 7 d weighed records in a sample from the same communities participating in this study<sup>(20)</sup>. The food intake divided into seven food groups (milk; meat; fruit; vegetables; maize meal; bread; added sugar), as measured by the QFFQ and the 7 d weighed records, indicated that the QFFQ was valid also for these food groups<sup>(20)</sup>. The quantities of foods reported were converted to weights using standard tables<sup>(24)</sup>. When coding the QFFQ, mixed dishes, not available in the South African food composition tables<sup>(25)</sup>, were split into single ingredients according to recipes collected from the participants or 'standard', unpublished recipes obtained from the local communities, especially for traditional dishes such as Potchefstroom cookies, *chakalaka* (a salad of tinned beans, peppers and tomato) and *ting* (a fermented maize and/or sorghum porridge).

### Food intake: approaches in presenting the data

Food intakes were categorized first into twelve food groups; Table 1 shows examples of the foods in each group, as well as the relevant SAFBDG<sup>(15,26–34)</sup>. Table 1 indicates that, generally, the first seven food groups may be regarded as the 'healthier' food groups with positive messages for consumption in the SAFBDG, while the last five groups may be regarded as the 'less healthy' choices with recommendations in the SAFBDG to limit intake or to use sparingly. In some food groups, both 'healthier' and 'less healthy choices' are possible (e.g. freshly cooked lean meat, chicken or fish in recommended quantities as the 'healthier choice' *v.* highly processed meats in larger-than-recommended quantities as the 'unhealthy choice'). The twelve food groups in Table 1 are therefore based on the SAFBDG which aim to lead to optimum or adequate nutrition, while protecting against the development of risk factors of NCD.

Tables 2 and 3 show median intakes of energy and foods in each of the twelve food groups for men and women in rural and urban areas in both 2005 and 2010. Further groupings of individual food intakes or food group intakes (combinations of foods in grams) are shown in Tables 4 and 5 for those participants (men and women separately) who consumed these particular foods (by at least 5% of the participants in any group). For example,

**Table 1** The content of the twelve food groups

Food group	Example of foods	Relevant SAFBDG
1 Cooked porridge	Maize meal, <i>maltabella</i> (sorghum porridge) and oat porridge	'Make starchy foods part of most meals': a food-based dietary guideline for South Africa <sup>(26)</sup>
2 Starchy grains	Breakfast cereals, bread, <i>vetkoek</i> (deep-fried bread-type dough), <i>samp</i> (crushed maize), maize rice, wheat rice, rice, macaroni and pasta, starchy vegetables (potato, sweet potato, <i>mealies</i> (corn-on-the-cob))	'Make starchy foods part of most meals': a food-based dietary guideline for South Africa <sup>(26)</sup>
3 Vegetables	All fresh and cooked vegetables like carrots, tomato, onion, beetroot, butternut pumpkin	'Eat plenty of vegetables and fruit every day': a food-based dietary guideline for South Africa <sup>(27)</sup> Recommended daily intake for vegetables and fruit: 400 g (5 × 80 g)
4 Fruit	Fresh fruit and fruit juices like apple, banana, grapes	'Eat plenty of vegetables and fruit every day': a food-based dietary guideline for South Africa <sup>(27)</sup> Recommended daily intake for vegetables and fruit: 400 g (5 × 80 g)
5 Legumes	Legume and legume products such as tinned baked beans	'Eat dry beans, split peas, lentils and soya regularly': a food-based dietary guideline for South Africa <sup>(28)</sup>
6 Nuts and seeds	All nuts and seeds such as peanuts	No specific dietary guideline
7 Milk	All milk and milk products such as <i>maas</i> (thick sour milk, often eaten with crumbly maize porridge), yoghurt, cheese	'Have milk, maas or yoghurt every day': a food-based dietary guideline for South Africa <sup>(29)</sup>
8 Animal protein foods	All meat, chicken, fish, and egg and products	'Fish, chicken, lean meat and eggs can be eaten daily': a food-based dietary guideline for South Africa <sup>(30)</sup>
9 Fats and oils	All fats and oils and products (including ice cream)	The importance of the quality or type of fat in the diet: a food-based dietary guideline for South Africa <sup>(31)</sup>
10 Added sugar containing foods	Sugar, syrups, sweets and refined products with sugar added (sweet cookies, cakes, biscuits)	Sugar and health: a food-based dietary guideline for South Africa <sup>(32)</sup>
11 Savoury snacks	Savoury snacks, dishes, sauces, seasoning and products	'Use salt and foods high in salt sparingly': a food-based dietary guideline for South Africa <sup>(33)</sup>
12 Alcohol	Alcoholic drinks like homemade beer, commercial beer	'If you drink alcohol, drink sensibly'. Is this guideline still appropriate? <sup>(34)</sup>

SAFBDG, South African food-based dietary guideline.

**Table 2** Daily energy intake, energy distribution of macronutrients and intakes of twelve selected food groups of male participants according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural men (n 186)					Urban men (n 202)				
	2005		2010		P value*	2005		2010		P value*
	Median	P25–P75	Median	P25–P75		Median	P25–P75	Median	P25–P75	
Energy intake (MJ)	6.9	5.6–8.8	9.7	6.95–13.8	<0.001	9.9	7.2–12.6	13.7	10.5–17.9	<0.001
% of TE from protein	10.6	9.8–11.6	11.3	9.5–13.5	0.005	12.5	11.6–13.5	12.7	11.3–14.3	0.483
% of TE from total fat	17.8	13.6–23.1	21.5	15.7–28.9	<0.001	24.9	21.6–29.4	26.3	22.1–31.3	0.329
% of TE from total carbohydrate	63.8	58.1–69.7	59.5	51.6–66.5	<0.001	56.1	52.0–60.6	54.3	48.4–59.7	0.011
Cooked porridge (e.g. maize meal, oats) and maize-based drinks (g)	700.0	500.0–1000.0	621.4	350.0–928.6	0.0649	539.3	357.1–857.1	678.6	392.9–1150.0	0.0014
Starchy grains (cereals, bread, <i>vetkoek</i> ), starchy vegetables (potato, sweet potato, corn) (g)	192.1	115.0–276.4	231.7	120.3–348.2	0.002	240.6	160.6–326.4	335.3	230.8–483.1	<0.001
Fresh vegetables (g)	40.1	24.1–58.6	39.4	14.6–86.5	0.0271	70.9	48.4–103.6	87.8	49.5–141.7	<0.001
Fresh fruit and fruit juices (g)	15.4	0.0–28.6	56.1	16.9–142.9	<0.001	65.0	25.0–128.6	152.4	66.9–265.7	<0.001
Legumes and legume products (g)	0.0	0.0–5.7	9.1	0.0–33.3	<0.001	2.1	0.0–20.9	18.6	1.1–48.6	<0.001
Nuts and seeds (g)	0	0	0	0		1.4	0.0–5.7	0.0	0.0–5.7	0.6659
Milk and milk products (g)	7.5	0.0–71.4	109.6	21.4–222.9	<0.001	102.9	54.6–184.3	181.5	88.6–301.1	<0.001
All meat, chicken, fish, and egg products (g)	47.8	28.3–73.6	97.2	49.4–162.5	<0.001	131.1	90.4–191.0	190.5	127.1–302.4	<0.001
All fats and oils and products (including ice cream) (g)	9.4	4.7–14.7	16.1	4.4–30.1	<0.001	19.5	12.9–30.1	23.7	9.0–46.5	0.0186
Sugar, syrups, sweets and refined products with sugar added (sweet cookies, cakes, biscuits) (g)	25.0	15.3–49.9	102.1	37.1–210.0	<0.001	85.0	45.6–148.7	141.4	68.3–272.6	<0.001
Savoury snacks, dishes, sauces, seasoning and products (g)	0	0	3.3	0.0–15.0	<0.001	11.7	0.9–31.4	24.5	6.9–57.4	<0.001
Alcoholic drinks (g)	143.6	0.0–1428.6	14.4	0.0–707.1	<0.001	362.5	0.0–1071.4	211.6	0.0–857.1	0.1135

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*P value from Wilcoxon signed-rank test for significance of differences between 2005 and 2010 for men.

sunflower oil intake is reported as a single food item, while all yellow vegetables and all green leafy vegetables are grouped together. Faber *et al.* identified options and methods available to group foods together for analysis purposes<sup>(35)</sup>. We therefore followed a combination of a food group and an FBDG approach while keeping foods with a low contribution to micronutrient intake (e.g. added sugar) separate. The SAFBDG describe milk intake as a separate guideline and hence our decision to keep it separate from animal protein intake<sup>(29)</sup>. The sequence of the food items is based on the percentage of consumers among the rural men/women in 2005. In addition, foods (or food groups) that are known to be associated with either a positive or negative health outcome were kept separate to facilitate statistical analysis in future. Tables 6–9 show

the contribution of specific foods or food groups to total energy intake.

### Statistical analyses

As previously reported, participants with energy intakes of  $\geq 30\,000$  or  $\leq 3000$  kJ/d were excluded<sup>(11,12)</sup>. The statistical software package Stata version 14 was used for the analysis. Since the food intake data were skewed, results are reported as median and 25th–75th percentile. Wilcoxon's signed-rank test was used to test for changes in food intakes based on the twelve food groups between 2005 and 2010 for each of the four groups (by gender and study site). To test for significant changes for the individual food items (as it was not always the same individuals who

**Table 3** Daily energy intake, energy distribution of macronutrients and intakes of twelve selected food groups of female participants according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural women (n 411)					Urban women (n 355)				
	2005		2010		P value*	2005		2010		P value*
	Median	P25–P75	Median	P25–P75		Median	P25–P75	Median	P25–P75	
Energy intake (MJ)	6.2	5.0–7.6	9.1	6.9–12.8	<0.001	9.0	6.5–11.6	11.7	8.9–14.9	<0.001
% of TE from protein	10.9	9.9–12.0	11.1	9.6–12.9	0.326	12.5	11.3–13.5	12.5	11.1–14.3	0.025
% of TE from total fat	20.3	15.6–24.5	22.9	17.7–30.0	<0.001	28.4	23.7–31.9	27.7	22.8–32.3	0.335
% of TE from total carbohydrate	66.7	61.3–71.9	61.7	53.8–67.7	<0.001	55.7	51.1–60.2	54.1	49.5–59.8	0.039
Cooked porridge (e.g. maize meal, oats) and maize-based drinks (g)	700.0	500.0–928.6	650.0	400.0–942.9	0.3063	448.1	324.9–714.3	507.1	303.6–781.4	0.0756
Starchy grains (cereals, bread, <i>vetkoek</i> ), starchy vegetables (potato, sweet potato, corn) (g)	176.7	115.7–260.0	235.6	145.2–358.6	<0.001	230.0	152.1–316.7	333.3	218.0–451.4	<0.001
Fresh vegetables (g)	46.4	31.8–61.7	58.1	25.8–103.6	<0.001	75.6	54.6–112.0	105.5	66.1–170.3	<0.001
Fresh fruit and fruit juices (g)	22.4	8.4–43.6	58.6	19.3–153.6	<0.001	75.7	30.0–142.9	164.3	94.3–297.6	<0.001
Legumes and legume products (g)	0.0	0.0–11.4	12.9	0.0–40.0	<0.001	10.0	0.0–28.9	21.4	7.1–46.4	<0.001
Nuts and seeds (g)	0	0	0.0	0.0–1.1	0.0636	0.0	0.0–5.0	0.0	0.0–4.6	0.0333
Milk and milk products (g)	8.0	0.0–60.0	111.4	16.6–221.4	<0.001	124.0	63.4–219.3	170.0	77.9–254.0	<0.001
All meat, chicken, fish, and egg and products (g)	45.1	26.3–72.6	77.6	37.1–138.6	<0.001	119.6	83.4–177.3	173.9	102.3–247.2	<0.001
All fats and oils and products (including ice cream) (g)	9.1	4.9–15.9	18.1	7.1–37.1	<0.001	23.7	13.9–41.4	23.1	10.4–45.7	0.4678
Sugar, syrups, sweets and refined products with sugar added (sweet cookies, cakes, biscuits) (g)	32.7	14.3–72.4	101.4	40.9–196.0	<0.001	99.4	64.1–163.4	164.4	66.0–305.1	<0.001
Savoury snacks, dishes, sauces, seasoning and products (g)	0.0	0.0–3.3	7.2	0.6–22.9	<0.001	17.4	4.0–41.1	26.2	9.3–53.5	<0.001
Alcoholic drinks (g)	0	0	0	0	0.0035	0.0	0.0–428.6	0.0	0.0–214.3	0.0377

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*P value from Wilcoxon signed-rank test for significance of differences between 2005 and 2010 for women.

consumed a food item in 2005 and 2010) is a challenge. We used quartile regression (median specifically) to test whether there was a change in the gram intake of a food from 2005 to 2010, between rural and urban, for men and women separately. These are shown in Fig. 2 for the individual food groups consumed by at least 90% of the participants and contributing at least 10% to total energy intake (for both genders and in 2005 and 2010), namely: (i) cooked porridge (e.g. maize meal, *maltabella*, oats); (ii) *samp*, maize rice, wheat rice, rice, macaroni and spaghetti; (iii) sugar, white and brown; and (iv) bread, rolls, *vetkoek*.

We previously reported the baseline mean characteristics in 2005 of the cohort and of those participants lost to follow-up<sup>(11)</sup>, as shown in Table 10. As mentioned, food intakes (grams per day) are reported in Tables 2 to 5. Table 11 presents the percentage of consumers meeting the recommended intakes for fruit and vegetables and milk and milk products in 2005 and 2010 based on the SAFBDG<sup>(27,29)</sup>.

## Results

### *Comparison of the cohort with those lost from the study*

Dietary intake data of 1858 participants were measured in 2005. Table 10 shows the characteristics (in 2005) of the 1154 cohort participants who could be followed up in 2010 compared with the baseline characteristics of the 856 participants (of the total original recruited group of 2010 participants in 2005) lost to follow-up. The latter were slightly (but significantly) younger, with lower BMI, HDL-cholesterol and total energy intake. The percentage of men in the group lost to follow-up was also significantly higher.

### *Comparison of food intakes in 2005 and 2010*

The top rows of Tables 2 to 5 give the energy distribution of total energy intake between protein, fat and carbohydrate. These data illustrate the slight but significant

**Table 4** Daily energy intake, energy distribution of macronutrients and food intakes of male consumers according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural men (n 186)						Urban men (n 202)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Energy intake (MJ)	–	6.9	5.6–8.8	–	9.7	6.95–13.8	–	9.9	7.2–12.6	–	13.7	10.5–17.9
% of TE from protein	–	10.6	9.8–11.6	–	11.3	9.5–13.5	–	12.5	11.6–13.5	–	12.7	11.3–14.3
% of TE from total fat	–	17.8	13.6–23.1	–	21.5	15.7–28.9	–	24.9	21.6–29.4	–	26.3	22.1–31.3
% of TE from total carbohydrate	–	63.8	58.1–69.7	–	59.5	51.6–66.5	–	56.1	52.0–60.6	–	54.3	48.4–59.7
Cooked porridge (e.g. maize meal, oats) (g)	99.5	700.0	500.0–1000.0	100.0	550.0	287.6–900.0	100.0	532.1	357.1–857.1	99.5	571.4	317.8–1007.5
Sunflower oil (g)	96.8	5.3	2.9–8.1	94.1	2.6	1.0–6.1	100.0	9.4	6.1–12.4	97.5	3.6	1.9–6.1
Samp, maize rice, wheat rice, rice, macaroni, spaghetti (g)	96.2	85.7	46.4–142.9	96.8	69.0	33.6–120.3	95.5	71.4	35.7–108.9	97.0	75.0	41.6–129.9
Sugar, white and brown (g)	95.7	21.9	12.6–30.6	97.3	33.9	16.3–66.0	98.5	25.1	13.7–45.7	97.5	34.4	17.3–60.0
Bread, rolls, <i>vetkoek</i> (g)	94.6	80.0	41.8–131.4	98.4	74.3	40.0–135.7	97.0	114.3	68.6–171.1	97.0	122.9	63.6–195.0
Chicken, turkey, goose, duck, cooked, including Kentucky (g)	94.6	12.9	7.1–25.8	95.2	19.3	10.1–35.7	98.0	38.2	21.6–58.0	96.5	62.1	33.0–91.3
Yellow and red vegetables (e.g. red peppers, carrots, pumpkin, beetroot) (g)	91.9	14.3	8.6–22.1	88.2	15.8	5.9–38.2	91.6	25.0	13.6–38.6	93.6	26.4	15.8–45.2
Coffee and tea (g)	88.7	300.0	300.0–300.0	95.2	600.0	300.0–900.0	97.5	220.0	157.1–321.4	96.0	352.9	214.3–600.0
Other cooked vegetables (e.g. parsnips, green beans, peas) (g)	88.2	4.0	2.1–7.4	86.0	6.9	2.1–14.1	99.5	10.7	6.9–16.1	98.0	19.4	9.2–35.9
Green vegetables (e.g. spinach, cabbage, coleslaw, broccoli) (g)	87.6	17.1	8.6–25.7	86.6	10.5	4.2–25.7	98.0	16.0	9.3–27.3	89.1	17.8	8.6–33.0
Tomato, cooked and raw (g)	79.0	4.9	3.4–8.0	75.8	4.3	1.7–13.5	98.0	12.4	7.4–21.1	94.1	11.8	5.8–22.1
Canned fish (e.g. pilchards, sardines, tuna) (g)	71.0	6.0	4.1–12.0	54.8	4.3	1.6–11.4	68.8	8.9	4.4–17.7	58.9	6.0	3.0–17.7
White-flesh fruit (e.g. apples, bananas, pears) (g)	66.1	22.9	13.4–33.6	83.9	48.6	19.3–124.5	83.2	45.7	23.9–86.4	93.6	114.3	55.7–190.0
Starchy vegetables (e.g. potato, sweet potato, <i>mealies</i> ) (g)	61.3	13.7	8.6–24.9	81.2	26.4	9.5–65.4	96.0	28.6	12.1–50.0	95.0	37.9	20.7–76.0
Beef, cooked + meatballs (g)	57.0	11.6	5.0–14.3	71.5	12.9	6.4–25.7	82.2	26.3	14.3–43.6	78.7	28.6	11.4–48.4
Beer, commercial and homemade (g)	55.9	1171.4	285.7–2821.4	51.1	678.6	171.4–1285.7	69.3	670.0	321.4–1392.9	61.9	535.7	285.7–1321.4
Non-dairy creamer, milk blend (g)	51.1	6.0	4.0–8.0	44.1	12.0	6.0–18.9	14.9	4.3	2.9–8.6	19.3	8.6	4.3–18.0
Milk, full-fat (g)	50.0	52.1	35.7–140	79.0	120.0	51.4–253.6	89.6	97.7	60.0–157.1	88.6	184.3	87.9–260.0
Eggs (g)	47.8	14.9	11.1–29.7	62.4	28.6	14.3–60.7	77.7	22.3	14.9–44.0	86.6	29.8	20.9–59.4
Organ meats (e.g. liver, kidney, tripe, offal, heart, giblets, lung, tongue, etc.) (g)	44.1	11.4	5.7–17.1	60.2	12.9	4.9–25.7	78.2	17.1	8.6–28.6	80.7	21.5	8.8–44.3
Meat products (e.g. <i>boerewors</i> , <i>biltong</i> , ham, corned meat, viennas, frankfurter, salami, patties) (g)	26.3	7.7	3.9–10.6	61.8	8.6	4.3–25.7	93.1	15.4	9.3–29.7	89.6	21.4	10.0–41.4
Carbonated cold drinks (g)	26.3	37.4	25.0–71.4	57.5	50.0	16.0–115.1	60.4	50.0	32.1–64.3	57.9	64.3	35.7–142.9
Hard margarine (brick) (g)	26.3	1.4	0.7–3.1	44.1	8.6	2.9–17.9	61.9	4.7	2.9–7.1	66.8	5.4	2.9–10.2
Starchy vegetables (e.g. potato, sweet potato, <i>mealies</i> ) with fat added (e.g. potato chips) (g)	22.0	17.1	8.6–17.9	72.0	33.6	10.0–64.3	34.2	13.4	8.6–23.6	83.7	52.9	25.7–107.1
Beans, cooked (e.g. haricot, sugar beans, canned baked beans) (g)	21.5	14.1	7.4–23.7	59.7	14.9	7.7–33.6	39.1	8.6	2.9–20.0	66.8	14.3	6.4–35.7
Orange/yellow/green coloured flesh fruit (e.g. mango) (g)	15.6	17.1	6.4–34.3	29.6	37.1	8.3–100.0	63.9	25.7	14.6–61.4	55.0	54.0	22.9–114.3
Nuts and seeds (mainly peanuts) (g)	14.5	11.4	5.7–22.9	24.2	6.3	3.7–15.0	54.5	5.7	3.1–10.0	43.1	10.0	5.0–20.0
Other savoury liquids (gravy, packet soups, sauces, etc.) (g)	14.5	5.7	3.4–10.3	32.3	8.6	3.8–27.6	31.2	8.6	5.3–17.1	43.1	17.1	7.6–30.0
Jam, syrup, honey, sugar-based sweets (no fat) (g)	12.4	2.0	1.0–4.0	38.2	4.0	1.4–10.0	55.4	3.8	2.8–8.6	66.3	11.1	5.0–25.0
<i>Mahewe</i> (non-alcoholic drink) (g)	11.3	100.0	71.4–350.0	20.4	31.3	17.9–71.4	33.2	71.4	35.7–71.4	47.5	71.4	35.7–142.9
Venison, goat, rabbit, cooked (g)	9.1	8.6	3.1–14.3	30.1	17.1	8.6–44.2	8.9	6.5	3.6–12.9	8.4	5.4	2.1–23.1
Soyabean products (e.g. Toppers) (g)	8.6	11.4	5.7–15.4	37.1	1.9	0.7–6.3	25.7	12.1	8.6–24.3	43.6	7.4	1.8–20.3
<i>Atchar</i> (g)	5.9	2.9	1.4–7.0	7.0	0.9	0.4–3.6	47.5	6.2	1.4–17.1	32.2	2.4	1.3–17.3

Table 4 Continued

	Rural men (n 186)						Urban men (n 202)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Salad dressings, mayonnaise, sandwich spread (g)	4.3	2.3	1.0–4.2	29.0	7.6	2.1–14.0	45.0	4.3	2.9–10.3	42.6	8.8	4.3–32.6
Tomato sauce (g)	3.8	16.0	7.1–32.9	34.4	2.9	1.4–7.9	53.5	4.3	2.9–8.6	58.4	5.6	2.9–12.9
Mutton, cooked (g)	3.8	3.1	2.1–9.7	28.5	8.6	4.3–21.4	18.8	11.5	3.6–15.7	36.6	8.6	4.3–21.4
Raw salads (g)	3.8	2.1	1.0–8.6	7.5	3.5	1.5–7.0	34.2	8.6	4.3–12.9	33.2	8.6	4.0–17.1
Maas/sour milk (g)	3.8	51.4	8.6–180.0	11.3	86.6	51.4–171.4	25.7	30.0	16.9–57.1	37.1	28.6	0.4–57.1
Mixed dishes like bean soup, biryani (g)	3.8	32.1	26.7–89.1	4.3	11.3	6.5–44.3	22.8	15.0	10.0–22.9	12.9	28.6	10.7–44.6
Soft margarine (tub) (g)	2.2	1.2	0.6–1.4	4.8	3.2	1.4–5.7	7.4	5.0	2.9–10.0	24.3	1.4	0.4–7.0
Squash, cold drink (g)	1.6	85.7	64.3–96.4	27.4	42.9	16.1–142.9	27.2	35.7	16.0–71.4	35.6	71.4	33.9–185.7
Sweet cookies, biscuits, rusks (g)	1.6	5.7	5.7–14.3	14.5	2.1	1.1–8.6	32.7	5.7	2.1–19.3	27.7	11.4	4.9–24.3
Low-calorie cold drinks (carbonated & ready-to-mix types) (g)	1.6	42.9	21.4–220.0	2.7	100.0	96.4–178.6	11.9	60.7	32.1–95.4	26.2	128.6	50.0–214.3
Dairy-fruit mix (g)	1.6	32.1	16.0–150.0	3.2	21.0	16.1–500.0	20.3	35.7	28.6–57.1	8.4	35.7	25.7–128.6
Fruit juice (all types) (g)	1.6	32.1	32.1–71.4	1.1	82.1	21.4–142.9	13.9	42.9	10.6–85.7	15.3	32.1	12.6–71.4
Savoury snacks (e.g. potato crisps, nikkaks, etc.) (g)	1.1	5.3	3.4–7.1	9.7	2.9	0.9–13.7	31.7	7.3	3.4–10.9	48.0	6.9	3.3–10.3
Peanut butter (g)	1.1	1.1	0.7–1.4	11.3	4.3	0.7–11.4	29.7	2.9	1.4–4.6	31.2	4.3	1.4–5.7
Medium-fat fish, cooked (g)	1.1	3.9	1.7–6.0	0.5	2.9	2.9–2.9	27.2	5.7	4.3–11.4	11.4	4.7	2.9–8.6
Beef, stewed with potato and/or vegetables (g)	1.1	15.7	15.7–15.7	9.1	15.7	7.9–31.4	0.5	31.4	31.4–31.4	22.8	22.9	8.6–47.1
Fudge, toffee, caramel (g)	1.1	4.3	3.6–5.0	1.1	15.2	4.3–26.1	22.3	1.4	0.7–3.6	8.4	2.9	0.9–7.1
Horse, donkey, cooked (g)	1.1	20.6	7.7–33.4	9.7	19.3	5.9–29.0	0.0	0	0	1.0	4.3	0.7–7.9
Milk products, made with full-fat milk (e.g. custard, beverages, <i>melkkos</i> , etc.) (g)	0.5	3.6	3.6–3.6	11.3	1.4	0.9–3.6	23.8	2.9	1.7–7.0	39.6	3.6	1.4–7.1
Baked sweet foods (e.g. cake, pudding, tart, muffins, scones) (g)	0.5	5.7	5.7–5.7	17.2	6.1	3.1–22.9	12.9	5.1	2.9–13.3	31.7	10.7	4.6–22.8
Chocolate and chocolate-based sweets (g)	0.5	2.6	2.6–2.6	8.6	3.7	2.1–20.0	18.8	1.6	0.6–3.9	21.8	4.2	1.6–8.6
Dried fruit (g)	0.5	1.0	1.0–1.0	8.6	4.6	2.8–13.2	9.9	1.4	0.9–5.0	20.8	12.5	5.4–25.7
Cheese, Cheddar (g)	0.5	1.4	1.4–1.4	0.0	0	0	24.3	1.4	1.1–2.9	11.4	1.4	1.0–3.1
Pork, cooked (g)	0.5	3.1	3.1–3.1	5.9	12.9	7.1–21.4	0.5	42.9	42.9–42.9	6.9	16.1	5.4–25.7
Savoury dishes (e.g. macaroni cheese, savoury tart, pizza, samosa, spaghetti bolognese, pies) (g)	0.0	0	0	3.2	4.6	2.9–8.6	29.7	17.1	5.0–35.6	25.2	10.0	5.0–31.3
Ice cream, all types (g)	0.0	0	0	2.7	8.0	5.4–8.0	19.8	8.6	3.4–28.6	30.2	10.7	5.4–27.9
Low-fat fish, cooked (g)	0.0	0	0	2.7	2.9	2.1–5.7	0.5	9.3	9.3–9.3	43.6	9.3	4.7–18.6
Canned fruit/dried stewed with sugar (g)	0.0	0	0	1.6	15.7	3.6–107.1	19.8	10.7	4.6–18.6	23.8	10.1	6.8–21.4
Red-flesh fruit (e.g. pomegranate) (g)	0.0	0	0	17.7	14.3	7.6–34.3	1.5	7.9	4.3–94.3	20.8	17.1	6.1–31.4
Spirits (e.g. gin, brandy, whiskey, etc.) (g)	0.0	0	0	7.5	2.8	1.1–5.4	3.0	4.4	1.7–6.4	12.9	9.9	4.3–28.6
Yoghurt, drinking, low-fat (g)	0.0	0	0	2.7	6.3	5.4–17.9	5.9	14.3	7.9–25.9	13.9	19.3	7.2–39.3
Breakfast cereals (e.g. corn flakes) (g)	0.0	0	0	1.6	8.3	1.9–10.7	8.9	14.3	5.4–21.4	11.9	16.1	4.6–50.0
Yoghurt, fruit, low-fat (g)	0.0	0	0	2.2	6.7	5.4–39.7	10.9	26.8	12.4–50.0	8.4	21.4	7.1–71.4
Animal fat (e.g. beef, mutton, chicken) (g)	0.0	0	0	2.2	1.3	0.7–4.4	0.0	0	0	12.9	2.5	1.0–7.0
Yoghurt, low-fat, plain (g)	0.0	0	0	0.5	10.7	10.7–10.7	5.9	17.9	14.3–28.6	4.5	10.7	9.0–25.7
Fish products (e.g. fish cakes, fingers, casserole, salad) (g)	0.0	0	0	1.1	6.4	4.3–8.6	7.9	3.6	1.8–11.8	1.0	52.9	20.0–85.7

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*Percentage of consumers.

**Table 5** Daily energy intake, energy distribution of macronutrients and food intakes of female consumers according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural women (n 411)						Urban women (n 355)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Energy intake (MJ)	–	6.2	5.0–7.6	–	9.1	6.9–12.8	–	9.0	6.5–11.6	–	11.7	8.9–14.9
% of TE from protein	–	10.9	9.9–12.0	–	11.1	9.6–12.9	–	12.5	11.3–13.5	–	12.5	11.1–14.3
% of TE from total fat	–	20.3	15.6–24.5	–	22.9	17.7–30.0	–	28.4	23.7–31.9	–	27.7	22.8–32.3
% of TE from total carbohydrate	–	66.7	61.3–71.9	–	61.7	53.8–67.7	–	55.7	51.1–60.2	–	54.1	49.5–59.8
Cooked porridge (e.g. maize meal, <i>maltabella</i> , oats) (g)	100.0	700.0	500.0–850.0	100.0	600.0	314.3–900.0	99.4	405.3	294.6–700.0	100.0	431.1	250.0–675.0
<i>Samp</i> , maize rice, wheat rice, rice, macaroni, spaghetti (g)	98.8	83.4	44.6–125.0	98.1	71.4	40.3–125.0	97.2	71.4	40.1–125.7	98.9	79.7	47.1–140.3
Sunflower oil (g)	97.8	5.1	2.6–8.6	95.6	3.0	1.4–6.0	99.2	9.1	5.9–12.1	97.7	3.7	2.0–6.4
Sugar, white and brown (g)	97.3	19.0	12.0–30.6	96.6	33.3	14.4–63.0	99.7	24.6	13.9–41.6	98.3	30.7	14.1–56.2
Green vegetables (e.g. spinach, cabbage, coleslaw, broccoli) (g)	95.9	17.1	9.3–26.4	87.8	15.8	6.6–28.2	98.9	18.7	11.4–28.6	94.6	19.6	9.0–36.2
Bread, rolls, <i>vetkoek</i> (g)	95.6	71.4	42.9–114.3	96.4	67.4	33.9–129.6	98.0	97.5	59.1–153.9	97.7	94.3	51.4–161.4
Chicken, turkey, goose, duck, cooked, including Kentucky (g)	94.2	14.7	7.7–25.7	94.6	20.9	9.3–41.9	96.9	31.9	18.6–46.4	97.7	45.4	26.9–78.3
Yellow and red vegetables (e.g. red peppers, carrots, pumpkin, beetroot) (g)	93.4	19.3	11.4–25.3	92.9	22.4	8.5–47.6	94.9	27.0	17.9–44.4	98.0	32.1	19.7–57.5
Other cooked vegetables (e.g. parsnips, green beans, green peas) (g)	92.2	4.3	2.1–7.4	91.5	7.0	3.0–18.1	98.0	9.7	5.1–16.4	98.0	24.0	12.0–44.7
Coffee and tea (g)	91.7	300.0	300.0–428.6	93.2	600.0	300.0–880.0	95.5	257.1	171.4–440.0	94.6	440.0	227.9–660.0
Tomato, cooked and raw (g)	88.1	5.1	3.4–9.1	84.4	4.8	1.9–10.6	98.0	11.6	6.9–21.4	92.7	12.2	5.2–23.5
White-flesh fruit (e.g. apples, bananas, pears) (g)	77.6	25.1	15.4–43.6	88.3	55.0	22.9–127.1	84.2	65.0	31.4–92.9	96.6	100.0	60.0–181.0
Starchy vegetables (e.g. potato, sweet potato, <i>mealies</i> ) (g)	71.0	11.4	6.9–21.4	88.3	25.0	10.0–60.7	97.7	23.6	11.0–52.6	95.5	44.3	20.0–80.6
Canned fish (e.g. pilchards in tomato sauce, sardines, tuna) (g)	69.3	6.0	3.0–12.0	51.3	4.3	1.6–12.0	63.9	6.3	3.0–13.3	50.7	6.0	3.0–16.6
Beef, cooked + meatballs (g)	59.4	9.6	3.4–14.3	58.4	10.7	5.4–25.0	85.9	24.3	14.3–40.1	73.5	22.7	11.1–51.4
Milk, full-fat (g)	49.4	53.6	28.6–120	75.2	140.7	60.0–235.7	90.1	100.0	62.1–164.3	87.6	139.3	72.9–220.0
Non-dairy creamer, milk blend (g)	48.7	6.0	4.0–10.4	49.9	9.0	4.7–24.0	17.2	5.1	2.0–12.0	14.1	9.6	4.3–22.9
Organ meats (e.g. liver, kidney, tripe, offal, heart, giblets, lung, tongue, etc.) (g)	47.4	8.9	5.7–17.1	62.0	8.6	4.3–20.0	80.3	17.1	8.6–27.4	76.9	23.1	10.7–44.4
Eggs (g)	45.5	14.9	10.7–29.7	58.2	16.7	7.1–42.9	70.4	22.3	14.9–36.9	79.7	28.6	14.3–44.0
Carbonated cold drinks (g)	37.0	37.4	25.0–61.6	63.0	26.9	12.6–96.4	65.1	42.9	32.1–71.4	51.3	71.4	37.6–150.0
Beans, cooked (e.g. haricot, sugar beans, canned baked beans) (g)	34.8	11.9	6.0–20.0	61.6	19.1	8.3–42.9	48.2	5.7	2.9–11.9	78.9	16.4	6.5–32.6
Meat products (e.g. <i>boerewors</i> , <i>biltong</i> , ham, corned meat, viennas, frankfurter, salami, patties) (g)	30.4	7.7	3.9–10.6	68.9	8.6	4.3–22.9	92.4	16.3	9.6–27.9	85.9	20.0	9.0–42.9
Starchy vegetables (e.g. potato, sweet potato, <i>mealies</i> ) with fat added (e.g. potato chips) (g)	24.8	17.1	8.9–26.7	77.1	34.3	12.9–68.6	38.6	16.0	8.6–22.9	89.6	48.6	20.4–87.0
Beer, commercial and homemade (g)	24.3	496.4	125.0–1985.7	23.1	142.9	60.0–500.0	42.5	571.4	214.3–1050.0	37.5	400.0	142.9–857.1
Hard margarine (brick) (g)	22.6	2.4	0.7–4.3	53.0	5.4	2.1–12.9	73.5	5.0	2.9–8.6	64.5	5.5	1.8–10.0
Jam, syrup, honey, sugar-based sweets (no fat) (g)	20.4	1.4	1.0–4.1	50.9	5.0	2.1–14.0	67.6	4.3	2.6–8.8	75.8	13.3	5.0–29.4
Other savoury liquids (gravy, packet soups, sauces, etc.) (g)	18.0	5.7	3.4–10.3	39.7	12.9	4.3–35.7	35.8	8.6	4.3–17.1	38.0	13.6	5.7–25.7
Orange/yellow/green coloured flesh fruit (e.g. mango) (g)	17.5	12.9	6.4–25.7	28.2	31.4	15.0–94.3	62.0	31.4	15.7–71.8	53.0	67.9	32.5–164.3
Nuts and seeds (g)	17.5	5.7	2.9–11.4	25.3	5.0	2.6–10.0	48.5	5.0	2.9–10.0	37.7	5.0	2.6–11.4
<i>Mahewu</i> (non-alcoholic drink) (g)	16.8	71.4	53.6–350.0	23.4	53.6	17.9–142.9	36.1	57.1	21.4–142.9	31.5	71.4	33.6–142.9
Soyabean products (g)	13.4	11.4	7.9–17.1	43.1	2.6	0.9–7.5	33.5	12.1	5.7–24.3	45.9	5.7	2.6–17.1
<i>Atchar</i> (g)	12.4	7.0	3.6–14.3	10.5	1.1	0.6–4.7	57.2	7.1	2.1–15.0	40.0	2.3	1.1–7.1



Table 5 Continued

	Rural women (n 411)						Urban women (n 355)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Venison, goat, rabbit, cooked (g)	8.5	6.4	3.6–9.7	22.1	8.6	4.0–30.4	5.4	5.3	3.6–7.9	3.7	5.4	3.3–8.6
Tomato sauce (g)	7.8	8.0	4.1–17.9	43.6	2.9	1.4–10.0	54.6	3.9	2.9–7.1	57.7	7.1	2.9–14.3
Squash, cold drink (g)	7.8	64.3	35.7–117.9	37.0	46.4	17.9–150.0	40.6	35.7	25.4–65.7	35.8	87.6	42.9–214.3
Mutton, cooked (g)	6.1	9.7	4.9–14.3	32.6	6.4	3.3–15.4	22.3	9.7	3.6–14.3	24.5	7.7	3.3–21.4
Salad dressings, mayonnaise, sandwich spread (g)	5.6	4.3	3.1–7.9	48.7	6.0	2.0–18.6	62.8	5.0	2.9–13.6	56.6	5.7	2.1–16
Dairy–fruit mix (g)	3.6	37.4	32.1–102.9	3.9	23.2	13.4–42.9	29.3	32.1	20.4–57.1	11.3	47.4	28.6–160.7
Sweet cookies, biscuits, rusks (g)	3.4	3.1	2.9–5.3	20.2	4.3	1.4–14.3	52.4	6.9	2.9–13.9	36.3	10.7	5.4–25.7
Savoury snacks (e.g. potato crisps, niknaks, etc.) (g)	2.9	6.1	4.3–21.8	22.4	2.6	1.1–6.9	50.7	6.9	3.4–12.0	59.7	6.9	3.3–12.0
Raw salads (g)	2.9	8.6	2.1–8.6	11.4	4.4	2.3–9.7	44.5	8.6	4.3–17.1	43.7	8.6	3.3–18.0
Mixed dishes like bean soup, biryani (g)	2.9	20.0	10.4–43.7	3.6	9.7	2.1–25.7	31.8	16.4	8.6–31.4	14.4	10.7	7.1–25.7
Peanut butter (g)	2.7	1.4	0.7–2.9	11.7	2.9	1.4–4.3	49.0	2.9	1.4–5.0	38.6	2.9	1.4–5.0
Fruit juice (all types) (g)	2.2	31.4	22.9–35.7	4.4	25.0	11.6–37.6	14.6	32.1	17.9–57.1	18.9	71.4	21.4–150.0
Soft margarine (tub) (g)	1.7	1.4	0.7–2.9	9.0	6.4	2.9–14.9	13.8	5.0	2.9–9.0	36.1	2.3	0.8–7.3
Low-calorie cold drinks (carbonated and ready-to-mix types) (g)	1.7	35.7	16.0–64.3	4.9	60.7	19.6–100.0	20.3	39.6	29.1–71.4	24.5	71.4	35.7–128.6
Beef, stewed with potato and/or vegetables (g)	1.7	15.7	7.9–31.4	14.1	11.9	4.0–32.9	2.0	18.3	7.9–31.4	26.2	17.1	7.9–47.1
Maas/sour milk (g)	1.5	123.2	16.0–180.0	10.5	77.1	21.4–166.1	33.5	31.4	17.9–71.4	41.1	19.4	0.7–44.7
Baked sweet foods (e.g. cake, pudding, tart, muffins, scones) (g)	1.2	20.0	15.0–25.0	20.7	8.6	5.0–21.4	25.9	4.6	2.7–9.2	39.2	11.9	4.3–27.1
Chocolate and chocolate-based sweets (g)	1.2	2.1	0.7–6.3	16.3	3.6	1.3–7.1	28.7	2.0	1.0–4.6	30.7	5.0	2.4–8.6
Milk products, made with full-fat milk (e.g. custard, beverages, <i>melkkos</i> , etc.) (g)	0.7	3.6	3.6–8.9	14.1	3.2	1.1–4.7	40.6	3.0	1.4–6.9	49.3	4.6	2.9–12.9
Fudge, toffee, caramel (g)	0.7	2.1	0.7–2.9	0.2	3.3	3.3–3.3	33.8	2.1	1.4–3.6	11.0	4.3	1.4–10.7
Yoghurt, drinking, low-fat (g)	0.7	17.9	3.6–42.9	2.9	17.9	7.6–28.6	14.4	25.0	12.4–50.0	18.6	25.0	14.3–35.7
Milk, low-fat/2% (g)	0.7	60.0	35.0–60.0	1.2	20.0	4.3–90.0	2.8	60.7	8.6–100.0	5.6	90.7	64.3–227.1
Dried fruit (g)	0.5	21.9	8.1–35.7	8.8	6.1	4.6–22.4	17.5	2.9	1.0–5.6	20.3	10.7	3.7–25.3
Cheese, Cheddar (g)	0.5	1.9	1.4–2.4	0.5	7.1	1.4–12.9	30.7	1.4	1.1–2.9	15.8	2.1	0.7–4.3
Savoury dishes (e.g. macaroni cheese, savoury tart, pizza, samosa, spaghetti bolognese, pies) (g)	0.2	53.6	53.6–53.6	5.6	6.4	5.0–12.9	38.6	11.7	5.9–24.3	31.5	19.3	5.0–34.9
Medium-fat fish, cooked (g)	0.2	2.9	2.9–2.9	0.2	34.3	34.3–34.3	28.7	5.7	4.6–11.4	6.8	12.7	4.7–20.7
Ice cream, all types (g)	0.0	0	0	7.1	5.4	2.9–14.3	28.5	10.7	3.6–21.4	41.4	15.4	5.4–21.9
Canned fruit/dried stewed with sugar (g)	0.0	0	0	5.1	7.9	5.4–19.6	29.6	12.9	7.4–20.3	28.7	10.0	7.9–20.0
Low-fat fish, cooked (g)	0.0	0	0	6.3	4.3	2.9–8.6	1.4	4.7	2.9–11.4	43.1	11.4	4.7–18.6
Breakfast cereals (e.g. cornflakes) (g)	0.0	0	0	4.6	32.1	5.4–50.0	16.3	8.6	5.0–14.3	27.3	10.7	5.7–25.7
Red-flesh fruit (e.g. pomegranate) (g)	0.0	0	0	11.9	15.7	7.1–36.4	0.8	62.9	11.4–171.4	24.8	24.3	8.6–62.9
Yoghurt, fruit, low-fat (g)	0.0	0	0	6.8	11.8	5.4–30.4	13.2	25.0	6.3–50.0	14.6	21.4	7.1–32.9

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*Percentage of consumers.

**Table 6** Percentage contribution of twelve food groups to total energy intake for the male participants according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural men ( <i>n</i> 186)						Urban men ( <i>n</i> 202)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Cooked porridge (e.g. maize meal, oats) and maize-based drinks (% of TE)	99	35.9	24.5–47.8	100	30.0	16.5–45.9	100	26.3	19.1–35.7	100	23.3	13.2–34.3
Starchy grains (cereals, bread, <i>vetkoek</i> ), starchy vegetables (potato, sweet potato, corn) (% of TE)	99	21.7	14.7–33.6	100	19.7	11.4–27.4	100	21.1	13.6–28.1	100	20.1	15.4–26.6
Fresh vegetables (% of TE)	99	1.3	0.6–2.1	98	0.9	0.4–2.0	100	1.5	1.0–2.2	100	1.6	0.9–2.6
Fresh fruit and fruit juices	69	1.0	0.5–1.8	87	2.4	0.9–5.0	86	2.1	1.1–3.9	96	3.6	1.8–6.4
Legumes and legume products (% of TE)	29	1.1	0.6–2.5	70	1.0	0.5–2.4	53	0.8	0.4–1.7	79	1.1	0.4–1.9
Nuts and seeds (% of TE)	15	3.3	1.7–6.8	24	2.0	0.9–3.6	54	1.4	0.9–2.3	43	1.6	0.8–3.6
Milk and milk products (% of TE)	52	2.3	1.3–5.9	84	3.8	1.6–6.2	91	3.3	2.1–5.6	94	3.9	2.2–5.8
All meat, chicken, fish, and egg and products (% of TE)	99	6.0	3.7–8.9	100	9.7	5.1–14.8	100	13.3	9.7–17.6	100	14.0	10.1–18.7
All fats and oils and products (including ice cream) (% of TE)	99	4.0	2.1–6.2	97	4.2	1.9–8.1	100	6.3	4.4–8.4	100	4.2	2.3–7.5
Sugar, syrups, sweets and refined products with sugar added (sweet cookies, cakes, biscuits) (% of TE)	96	5.9	3.4–8.3	99	9.1	4.9–15.0	99	7.1	4.7–10.0	100	8.6	4.6–13.5
Savoury snacks, dishes, sauces, seasoning and products (% of TE)	23	0.3	0.1–1.1	62	0.5	0.1–1.1	78	1.7	0.4–4.5	87	1.9	0.8–4.1
Alcoholic drinks (% of TE)	56	22.7	6.4–41.8	53	9.4	2.9–18.9	70	11.5	5.2–17.4	64	5.8	2.4–15.9

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*Percentage of consumers.

**Table 7** Percentage contribution of twelve food groups to total energy intake for the female participants according to rural/urban residence in 2005 and 2010; PURE-NWP-SA study

	Rural women ( <i>n</i> 411)						Urban women ( <i>n</i> 355)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Cooked porridge (e.g. maize meal, oats) and maize-based drinks (% of TE)	100	40.0	29.1–53.5	100	32.4	19.9–47.3	99	23.4	15.6–32.6	100	18.4	9.8–28.9
Starchy grains (cereals, bread, <i>vetkoek</i> ), starchy vegetables (potato, sweet potato, corn) (% of TE)	100	24.8	16.4–31.9	100	19.4	13.3–28.4	100	21.6	15.9–28.0	100	21.3	15.7–28.3
Fresh vegetables (% of TE)	100	1.7	1.1–2.5	98	1.5	0.8–3.0	100	1.8	1.3–2.5	100	2.3	1.4–3.4
Fresh fruit and fruit juices (% of TE)	78	1.4	0.8–2.3	90	2.4	1.0–4.9	86	2.8	1.6–4.7	97	4.6	2.6–8.1
Legumes and legume products (% of TE)	42	1.2	0.7–2.1	74	1.4	0.5–2.6	66	0.9	0.5–1.7	88	1.0	0.5–2.1
Nuts and seeds (% of TE)	18	2.5	1.3–4.4	25	1.3	0.6–2.7	48	1.4	0.8–2.5	38	1.3	0.7–2.5
Milk and milk products (% of TE)	52	2.6	1.4–4.8	82	4.3	1.8–7.4	95	4.3	2.4–7.0	97	4.0	2.4–6.3
All meat, chicken, fish, and egg and products (% of TE)	100	6.6	3.9–10.0	99	7.6	0.0–13.1	100	13.8	10.1–17.2	100	13.8	9.4–19
All fats and oils and products (including ice cream) (% of TE)	99	4.7	2.7–7.3	99	5.2	2.7–10.0	100	7.9	5.7–10.5	100	5.0	3.0–8.6
Sugar, syrups, sweets and refined products with sugar added (sweet cookies, cakes, biscuits) (% of TE)	99	6.6	3.7–10.4	99	9.2	4.7–16.2	100	9.1	6.3–12.7	100	10.5	6.3–17.0
Savoury snacks, dishes, sauces, seasoning and products (% of TE)	30	0.6	0.1–2.1	75	0.6	0.2–1.3	88	2.8	0.9–5.5	93	2.4	1.1–4.8
Alcoholic drinks (% of TE)	25	9.4	3.0–31.3	23	2.6	0.9–8.2	44	9.0	4.1–15.9	40	4.6	1.2–9.9

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*Percentage of consumers.

**Table 8** Percentage contribution to total energy intake of individual food groups eaten by at least 25% of male participants AND contributing at least 5% to total energy in 2005 or 2010 according to rural/urban residence; PURE-NWP-SA study

	Rural men (n 186)						Urban men (n 202)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Cooked porridge (e.g. maize meal, <i>maltabella</i> , oats) (% of TE)	99.5	35.09	24.51–47.23	100.0	29.46	16.43–45.82	100.0	26.28	18.80–35.39	99.5	22.88	12.85–33.51
<i>Samp</i> , maize rice, wheat rice, rice, macaroni, spaghetti (% of TE)	96.2	6.72	3.88–9.11	96.8	3.39	1.74–5.55	95.5	3.47	2.22–5.55	97.0	2.55	1.49–4.35
Sugar, white and brown (% of TE)	95.7	5.12	2.93–7.85	97.3	5.79	3.69–10.68	98.5	4.47	2.58–7.15	97.5	4.24	2.15–7.91
Bread, rolls, <i>vetkoek</i> (% of TE)	94.6	15.32	8.07–24.83	98.4	8.69	4.79–17.19	97.0	14.61	8.58–21.47	97.0	9.78	5.91–15.90
Beer, commercial and homemade (% of TE)	55.9	22.71	6.35–41.79	51.1	9.79	3.10–18.90	69.3	11.67	5.41–17.63	61.9	5.97	2.58–15.88

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

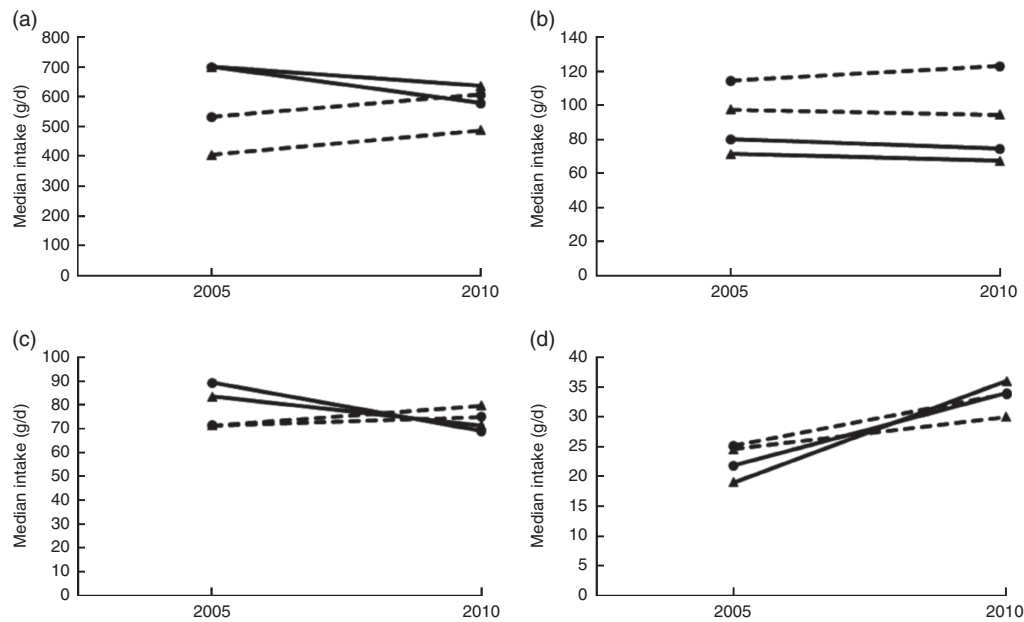
\*Percentage of consumers.

**Table 9** Percentage contribution to total energy intake of individual food groups eaten by at least 25% of female participants AND contributing at least 5% to total energy in 2005 or 2010 according to rural/urban residence; PURE-NWP-SA study

	Rural women (n 411)						Urban women (n 355)					
	2005			2010			2005			2010		
	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75	%*	Median	P25–P75
Cooked porridge (e.g. maize meal, <i>maltabella</i> , oats) (% of TE)	100.0	38.73	8.22–53.17	100.0	32.04	19.17–47.31	99.4	23.19	15.06–31.74	100.0	18.06	9.36–28.34
<i>Samp</i> , maize rice, wheat rice, rice, macaroni, spaghetti (% of TE)	98.8	6.78	4.29–9.85	98.1	3.96	2.04–5.95	97.2	4.35	2.53–7.25	98.9	3.35	2.05–5.2
Sugar, white and brown (% of TE)	97.3	5.61	3.09–8.97	96.6	6.13	2.6–11.84	99.8	4.94	3.07–7.53	98.3	4.37	2.06–8.18
Bread, rolls, <i>vetkoek</i> (% of TE)	95.6	14.68	8.81–21.48	96.4	8.57	4.31–14.71	98.0	12.83	8.61–19.98	97.7	9.43	5.6–15.07
Beer, commercial and homemade (% of TE)	24.3	10.18	3.03–31.63	23.1	2.57	0.89–8.61	42.5	9.16	4.32–16.26	37.5	4.61	1.34–9.87
<i>Maas</i> /sour milk (% of TE)	1.5	6.91	1.08–10.98	10.5	2.68	0.45–3.94	33.5	0.99	0.51–1.91	41.1	0.42	0.02–1.16

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile; TE, total energy.

\*Percentage of consumers.



**Fig. 2** Changes in the median intakes of four food groups over time (2005 to 2010) by men and women in the PURE-NWP-SA study: (a) cooked porridge; (b) bread and *vetkoek*; (c) *samp*, maize and rice; (d) white and brown sugar (—●—, rural men; -●-, urban men; —▲—, rural women; -▲-, urban women). PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa

**Table 10** Baseline characteristics in 2005 of participants followed up from 2005 to 2010 (the cohort) compared with subjects lost to follow-up; PURE-NWP-SA study

Variable	Baseline data in 2005 of subjects followed up in 2010			Baseline data in 2005 of subjects lost to follow-up in 2010			P value*
	n	Mean	SD	n	Mean	SD	
Age (years)	1154	50.8	10.3	856	48.6	10.4	< 0.001
Sex (male; %)	1154	33.6		856	41.8		< 0.001
Locality (rural; %)	1154	51.7		856	47.8		0.080
Education attainment (no formal education; %)	1154	36.0		856	32.1		0.073
HIV positive (%)	1154	17.1		856	22.2		0.004
BMI (kg/m <sup>2</sup> )	1154	25.1	7.0	853	24.1	7.0	< 0.001
Waist circumference (cm)	1147	80.3	12.8	843	79.0	13.3	0.007
HDL-cholesterol (mmol/l)	1087	1.54	0.61	805	1.48	0.66	0.006
Energy intake (MJ/d)							
Median	1154	7.4		796	6.9		0.003
P25–P75		5.6–10.1			4.7–9.8		

PURE-NWP-SA, Prospective Urban and Rural Epidemiology in the North West Province of South Africa; P25, 25th percentile; P75, 75th percentile.

\*P value for significant differences between subjects followed up in 2010 and those lost to follow-up ( $\chi^2$  test for categorical variables; Wilcoxon's signed-rank test for continuous variables).

increases in energy from protein and fat and decrease in energy from carbohydrate of all groups over time.

Tables 2 and 3 show that in this 5-year period from 2005 to 2010, rural and urban men and women decreased the contribution of cooked porridge and other starchy staples to total energy intake: for example, rural men and women had a median intake of cooked porridge of 700 g/d in 2005 and decreased their intake to 621 and 650 g/d, respectively, in 2010. The corresponding figures for urban participants increased: urban women consumed 448 g/d in 2005 and 507 g/d in 2010, while urban men consumed 539 g/d in 2005 and 679 g/d in 2010. Given that energy

intake of urban women increased from 9.0 to 11.7 MJ/d and that of urban men from 9.9 to 13.7 MJ/d (Tables 2 and 3), this explains the decreased energy contribution of cooked porridge to total energy intake from 36 to 30% in rural men, and from 26 to 23% in urban men, from 2005 to 2010 (Table 6). The corresponding figures were a decrease from 40 to 32% in rural women and from 23 to 18% in urban women over this 5-year period (Table 7). However, cooked porridge remained the staple with almost all participants consuming it on a daily basis, as shown in Tables 2 to 5. Furthermore, Tables 4 and 5 also emphasize the decrease in consumption of the other starchy staple

food group, which includes bread and *vetkoek* (a deep-fried 'bun' made from fortified wheat flour), and especially the smaller contribution these foods made to total energy intake from 2005 to 2010, despite increased energy intakes over this time. The changes were from 22 to 20% in rural men; from 21 to 20% in urban men; from 25 to 19% in rural women; and from 22 to 21% in urban women (Tables 6 and 7). Therefore, although in both rural and urban participants the actual daily gram intake of starchy foods increased, the percentage contribution of staple foods to total energy intake decreased.

In addition, the change (2005 to 2010) in the gram intake (median) of cooked porridge was different between rural and urban areas for both men and women (men,  $P=0.017$ ; women,  $P<0.001$ ). In 2005, both men and women in rural areas consumed larger quantities of cooked porridge than their urban counterparts, while in 2010 it reversed (Fig. 2). For the *samp*, maize rice, etc. group, the change (2005 to 2010) in median intake was different between rural and urban areas (men,  $P=0.012$ ; women,  $P=0.005$ ). In 2005, both men and women in rural areas consumed more than their urban counterparts, while in 2010 it reversed. The median intake in 2005 and 2010 of bread and *vetkoek* was similar, but both men and women in urban areas consumed significantly more than their rural counterparts (men, 34 g,  $P=0.001$ ; women, 26 g,  $P<0.001$ ).

Median vegetable, fruit, fruit juices and legume intakes increased in rural and urban men and women (Tables 2 and 3). However, total amounts consumed were relatively small. For example, median intake of fresh vegetables by rural women in 2010 was only 58 g/d and in urban women 106 g/d.

Median consumption of milk and milk products by rural men increased from 8 to 110 g/d and from 103 to 182 g/d in urban men. The increases in rural women were from 8 to 111 g/d and in urban women from 124 to 170 g/d (Tables 2 and 3).

Foods containing added sugar increased from 25 to 102 g/d in rural men from 2005 to 2010, and from 85 to 141 g/d in urban men over this period (Table 2). In women, the corresponding figures were from 33 to 101 g/d and from 99 to 164 g/d (Table 3). Tables 6 and 7 show that in all groups (except urban women) these figures represent less than 10% of total energy from added sugar in sugar-containing foods such as baked products, syrups and sweets. These figures could be misleading as this food group includes products like cake that is not only added sugar *per se*. However, in Tables 4 and 5, white and brown sugar consumption *per se* are shown (only the sugar added to tea, coffee, porridges, cold drinks, cake, etc.). This added sugar in the diet increased in all groups from 2005 to 2010, being consumed by more than 90% of all participants in 2005 and 2010. The median intake of sugar increased significantly by 12 g/d for men in rural and urban areas between 2005 and 2010 ( $P<0.001$ ). For women the change (2005 to 2010) in the median gram

intake was different between rural and urban areas ( $P=0.001$ ). In 2005, women in rural areas consumed less than their urban counterparts, while in 2010 it reversed (Fig. 2). The percentage of consumers in rural areas (men and women) of sugar-added carbonated cold drinks increased dramatically over time.

The intake of foods from animals (excluding milk and milk products) increased significantly from 2005 to 2010: from 48 to 97 g/d in rural men, and from 131 to 191 g/d in urban men (Table 2). In women, the corresponding figures were 45 to 78 g/d for rural women and 120 to 174 g/d for urban women (Table 3). However, Tables 4 and 5 show that of all the animal foods eaten, chicken was the most popular. More participants ate chicken than any other 'meat' in 2005 and this continued in 2010. Tables 4 and 5 also show that the changes in rural and urban men and women were essentially the same. Large increases were observed in the percentage of participants consuming processed meat over time in the rural men and women, while the percentage of consumers decreased for the urban groups. However, the quantities remained relatively small with the highest median intake of 21 g/d (urban men in 2010).

From the above it becomes clear that the additional dietary energy in 2010 was provided by both 'healthier' and less 'healthier' food choices. Table 3, for example, shows that the 'healthier' food choices of women in 2010 were increased intakes of fresh vegetables, fresh fruit and juices, and legumes and legume products. The less 'healthier' choices were an increased consumption of more products containing sugar and savoury snacks and dishes. In men (Table 4), as in women (Table 5), marked increases in added sugar (sugar added to porridge or coffee and tea) were seen. A beneficial change seen in men (but not in women) was an increased intake of fresh, full-fat milk (Tables 4 and 5).

Another important observation from Tables 2 to 5 is that although the vegetable and fruit intakes in both men and women increased from 2005 to 2010, the total amounts of foods in these groups were relatively modest. For example, in 2010 rural women consumed a median of ~58 g each of vegetables and fruit daily, while the urban women consumed 106 and 164 g of vegetables and fruit daily, respectively. This is still less than the recommendation of at least 400 g/d given in the SAFBDG<sup>(27)</sup>.

The foods most often consumed included cooked porridge, sunflower oil, starchy grains, sugar, bread, coffee and tea, and some form of vegetables. The only animal protein food consumed by all groups as part of the 'top ten' consumed foods was chicken (either home-prepared or bought as fried chicken). Fruit was not part of the 'top ten' consumed foods for men, but white-flesh fruit (apples, bananas, pears) were for the urban women in 2005 and 2010 and the rural women in 2010.

Tables 6 and 7 show the percentage contribution to total energy intake of the twelve food groups. Cooked porridge



group of researchers and fieldworkers measured intakes in 2005 and 2010.

A major strength of the study is the prospective cohort design, although the period of only 5 years may be regarded as a limitation. However, our publication on nutrient intakes<sup>(11)</sup> indicated significant differences in intakes during this 5-year period.

### ***The context of nutrient changes in evaluation of changes in food intake***

It has been mentioned that we found that the changes in energy and nutrient intakes of these rural and urban women and men from 2005 to 2010 followed the changes described for the nutrition transition in other parts of the world<sup>(1,11,12)</sup>. It is, however, important for developing policies and programmes for specific populations to steer the nutrition transition in a beneficial direction, to know which foods were responsible for positive changes, so that they may be targeted in interventions. Positive changes would be those that improve nutritional status (in this population particularly addressing micronutrient deficiencies), without increasing risk of overweight, obesity and therefore NCD. Briefly, taking the changes in intakes of women as an example, we showed<sup>(11)</sup> that in 2005 rural women had a median energy intake of 6.2 MJ/d compared with 9.0 MJ/d of urban women, a difference of 45%. In 2010 this cohort of rural women increased their energy intake to 9.1 MJ/d and the urban women to 11.7 MJ/d, increases of 47 and 30%, respectively. So, the rural women had an energy intake in 2010 similar to that of the urban women in 2005. Similarly, rural men increased their energy intake from a median of 6.9 MJ/d in 2005 to 9.7 MJ/d in 2010 and urban men from 9.9 to 13.7 MJ/d in the corresponding years (Table 2 and 3).

The changes in distribution of energy between the macronutrients gives a background for evaluating food contributions to changing energy intakes. Urban women had slightly more of their energy as total protein than rural women. Both urban and rural women ingested more of their energy as animal protein sources in 2005, and both rural and urban women decreased plant protein intake from a median of 7.5 and 6.1% of total energy in 2005 to 6.3 and 5.5%, respectively, in 2010. The changes in total fat intake are intriguing. In 2005, rural and urban women had respective median intakes of 20.3 and 28.4% of total energy as fat. In 2010, rural women had a median intake of 22.9% and urban women 27.7%. It seems as if the urban women already reached a plateau in 2005, while rural women had only a slight increase in total energy as fat. The differences and changes in saturated and polyunsaturated fats largely mirrored differences and changes of the animal *v.* plant protein intakes<sup>(11)</sup>.

It seems therefore that the percentage of energy as carbohydrate may reflect the biggest change in the

distribution of energy. In 2005, rural women had 66.7% of their energy as carbohydrate and urban women 55.7%. In 2010 this changed to 61.7 and 54.1%, respectively. Again, it seems that while the rural women decreased the total percentage of energy contributed by carbohydrate over the 5 years, the urban women may have reached a plateau or 'steady state' already in 2005. However, the percentage of energy provided by added sugar increased in both the rural and urban women, from 6.4 to 8.9% and from 8.2 to 9.0%, respectively, from 2005 to 2010. Thus, although total carbohydrate energy decreased, energy from added sugar increased.

The changes observed in rural and urban men largely mirrored what was seen in women, although energy from total fat was even lower in the men<sup>(11)</sup>. Rural men had a median energy intake from fat in 2005 of 17.8% and of 21.5% in 2010, while urban men increased their median energy intake from fat from 24.9 to 26.3%. These values are well below the value of 30% of energy from fat recommended in the SAFBDG<sup>(31)</sup> and leaves room for increased energy intake from foods rich in  $\alpha$ -linoleic and *n*-3 fatty acids such as plant oils (e.g. sunflower or olive oil) or fish.

### ***Beneficial and detrimental changes in food intake***

The results of the analysis of changes in foods eaten clearly showed some beneficial effects over the 5 years (more vegetables and fruit, more milk and milk products, more fish and more foods from animal sources), which will all contribute to improved micronutrient intakes. Unfortunately, these changes were small and did not allow the majority of participants to reach recommended intakes of vegetables, fruit, and milk and milk products. Furthermore, some detrimental changes were observed, especially an increase in added sugar intake, mainly in the form of sugar-sweetened beverages, increased consumption of beer by women and increased intakes of processed meat, savoury snacks and hard margarine (and therefore a higher saturated fat intake), illustrating an emergence of processed foods in the diet, which is of concern. We have previously shown that the increased intakes of added sugar and sucrose-sweetened beverages have a detrimental effect on several risk factors for NCD<sup>(12)</sup> in this specific population. Furthermore, a study from Sweden showed that a sucrose intake of more than 15% of energy is associated with an increased risk of a coronary event<sup>(36)</sup>. Processed meat consumption has been linked to an increased risk of certain types of cancer<sup>(37–40)</sup>. Hard margarines contribute to saturated fat intake and are potential sources of *trans*-fatty acids with known detrimental effects on risk of CVD<sup>(31)</sup>. More and more global dietary and food recommendations mention the need for home-prepared meals from fresh ingredients because of the high energy content of processed foods and links to obesity<sup>(41)</sup>.

### *Diet variety*

There was no evidence of 'new' foods eaten in 2010 and the 'top ten' consumed foods remained unchanged from 2005 to 2010. (Note: participants were always requested to report foods eaten that were not part of the QFFQ.) However, some products were consumed by a larger percentage of participants in 2010 than in 2005. For example, white-flesh fruit was eaten by 77.6% of rural women in 2005 and by 88.3% of them in 2010. Similarly, more men consumed products such as milk, eggs, organ meats, processed meats, hard margarine and cooked starchy vegetables with added fat in 2010 than in 2005.

### *Dietary staples*

The decreased intake of cooked maize porridge and bread may be of concern because of the mandatory fortification of maize meal and bread flour<sup>(13)</sup> to provide micronutrients. However, the data show that porridges are replaced to a certain extent by micronutrient-rich foods such as vegetables, fruit, milk and animal-origin foods. These trends should be encouraged to increase the total amounts of these foods eaten.

### *Added sugar*

The increased intakes of products containing added sugar by all groups is a real concern that should be addressed. The South African Government is in a process of instituting taxation of sugar-sweetened beverages in an attempt to address the growing public health problem of obesity<sup>(42,43)</sup>. Although this tax was introduced on 1 April 2018, it is not certain if it will be an effective mechanism to address obesity in the South African population.

## **Conclusions**

It is concluded that from 2005 to 2010, as part of the nutrition transition, rural and urban men and women in the NWP of SA changed dietary choices that resulted in improved diets, but also in some instances included more products that may increase risks of NCD. These changes were probably based on what were available and affordable to both rural and urban communities. The opening of a large food retail store in the rural community could have contributed to the availability and affordability of less healthy foods. This population needs to be informed on the potential effects of these potential negative dietary changes while encouraging current good practices like the consumption of whole grains, fruit and vegetables, chicken meat and canned fish. It is suggested that nutrition education interventions could assist the adult and adolescent populations in this province to choose their foods eaten based on knowledge of the beneficial and detrimental effects of certain foods and food products. Although this is the first prospective study

in SA on a large cohort, the results should be interpreted with caution and not generalized for all the different ethnic groups.

## **Acknowledgements**

*Acknowledgements:* The authors acknowledge the contribution of the late Professor Annamarie Kruger to the PURE South Africa study. They thank all supporting staff and participants in the PURE study; in particular, from PURE South Africa, the PURE-NWP-SA research team, fieldworkers and office staff in the Africa Unit for Transdisciplinary Health Research and the Centre of Excellence for Nutrition, Faculty of Health Sciences, North-West University, Potchefstroom, South Africa; and from PURE International, S. Yusuf and the PURE project office staff at the Population Health Research Institute, Hamilton Health Sciences and McMaster University, Ontario, Canada. *Financial support:* This work was supported by the South Africa Netherlands Research Program on Alternatives in Development; the South African National Research Foundation (GUN numbers 2069139 and FA200604070 0010); North-West University; the Population Health Research Institute, McMaster University, Canada; and the South African Medical Research Council. Funders were not involved in any aspect of the design, implementation, analysis, or interpretation and written account of the study. *Conflict of interest:* The authors declare that they have no competing interests. *Authorship:* E.W.-V. and H.H.V. were responsible for the conception and design, analysis and interpretation of the data and wrote the manuscript. R.L. was responsible for the statistical analysis of the data, made contributions to the interpretation of the data and critically revised the manuscript for important intellectual content. *Ethics of human subject participation:* The Ethics Committee of the North-West University approved the study (04M10 and NWU-0016-10-A1). The study complied with all applicable requirements of international regulations, including the Helsinki Declaration of 1975 (as revised in 2008). Permission for the study was also obtained from the North-West Provincial Department of Health, local government authorities, and tribal chiefs in the rural areas. Volunteers gave written informed consent. The participants were transported to and from the study sites in both the urban and rural areas. They received lunch on site after blood sampling was completed. The study is registered at ClinicalTrials.gov (ID: NCT03225586; <http://www.clinicaltrials.gov>).

## **References**

1. Hawkes C (2007) WHO Commission on Social Determinants of Health. Globalization, Food and Nutrition Transitions. Globalization and Health Knowledge Network: Research Papers. [http://www.who.int/social\\_determinants/resources/gkn\\_hawkes.pdf](http://www.who.int/social_determinants/resources/gkn_hawkes.pdf) (accessed July 2018).



2. Vorster HH, Kruger A & Margetts BM (2011) The nutrition transition in Africa: can it be steered into a more positive direction? *Nutrients* **3**, 429–441.
3. Mayosi BM, Flisher AJ, Lalloo UG *et al.* (2009) The burden of non-communicable diseases in South Africa. *Lancet* **374**, 934–947.
4. Nojilana B, Bradshaw D, Pillay-van Wyk V *et al.* (2016) Persistent burden from non-communicable diseases in South Africa needs strong action. *S Afr Med J* **106**, 436–437.
5. Shisana O, Labadarios D, Rehle T *et al.* (2013) *South African National Health and Nutrition Examination Survey (SANHANES-1)*, pp. 135–144. Cape Town: HSRC Press.
6. Norman R, Bradshaw D, Schneider M *et al.* (2007) A comparative risk assessment for South Africa in 2000: towards promoting health and preventing disease. *S Afr Med J* **97**, 637–641.
7. Vorster H, Venter C, Kruger H *et al.* (2000) The impact of urbanization on physical, physiological and mental health of Africans in the North West Province of South Africa: the THUSA study. *S Afr J Sci* **96**, 505–514.
8. MacIntyre U, Kruger H, Venter C *et al.* (2002) Dietary intakes of an African population in different stages of transition in the North West Province, South Africa: the THUSA study. *Nutr Res* **22**, 239–256.
9. Serfontein N, Venter C, Kruger A *et al.* (2010) Alcohol intake and micronutrient density in a population in transition: the Transition and Health during Urbanisation in South Africa (THUSA) study. *S Afr J Clin Nutr* **23**, 22–28.
10. MacIntyre U, Venter C, Kruger A *et al.* (2012) Measuring micronutrient intakes at different levels of sugar consumption in a population in transition: the Transition and Health during Urbanisation in South Africa (THUSA) study. *S Afr J Clin Nutr* **25**, 122–130.
11. Wentzel-Viljoen E, Lee S, Laubscher R *et al.* (2018) Accelerated nutrition transition in the North West Province of South Africa: results from the Prospective Urban and Rural Epidemiology (PURE-NWP-SA) cohort study, 2005 to 2010. *Public Health Nutr*. Published online: 8 May 2018. doi: 10.1017/S1368980018001118.
12. Vorster HH, Kruger A, Wentzel-Viljoen E *et al.* (2014) Added sugar intake in South Africa: findings from the Adult Prospective Urban and Rural Epidemiology cohort study. *Am J Clin Nutr* **99**, 1479–1486.
13. South African Department of Health (2003) *Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972). Regulations Relating to the Fortification of Certain Foodstuffs*. Pretoria: Government Gazette, Republic of South Africa; available at <https://extranet.who.int/nutrition/gina/en/node/17871>.
14. Van Heerden IV & Schonfeldt HC (2011) The lack of food intake data and the consequences thereof: invited review. *S Afr J Clin Nutr* **24**, 10–18.
15. Vorster HH, Badham J & Venter C (2013) An introduction to the revised food-based dietary guidelines for South Africa. *S Afr J Clin Nutr* **26**, Suppl, S5–S12.
16. Corsi DJ, Subramanian S, Chow CK *et al.* (2013) Prospective Urban Rural Epidemiology (PURE) study: baseline characteristics of the household sample and comparative analyses with national data in 17 countries. *Am Heart J* **166**, 636–646.e4.
17. Schutte AE, Schutte R, Huisman HW *et al.* (2012) Are behavioural risk factors to be blamed for the conversion from optimal blood pressure to hypertensive status in black South Africans? A 5-year prospective study. *Int J Epidemiol* **41**, 1114–1123.
18. Sotunde O, Kruger H, Wright HH *et al.* (2015) Lean mass appears to be more strongly associated with bone health than fat mass in urban black South African women. *J Nutr Health Aging* **19**, 628–636.
19. MacIntyre U, Venter C & Vorster H (2001) A culture-sensitive quantitative food frequency questionnaire used in an African population: 1. Development and reproducibility. *Public Health Nutr* **4**, 53–62.
20. MacIntyre U, Venter C, Vorster H *et al.* (2001) A combination of statistical methods for the analysis of the relative validation data of the quantitative food frequency questionnaire used in the THUSA study. *Public Health Nutr* **4**, 45–51.
21. Wentzel-Viljoen E, Laubscher R & Kruger A (2011) Using different approaches to assess the reproducibility of a culturally sensitive quantified food frequency questionnaire. *S Afr J Clin Nutr* **24**, 143–148.
22. MacIntyre U, Venter C & Vorster H (2001) A culture-sensitive quantitative food frequency questionnaire used in an African population: 2. Relative validation by 7-day weighed records and biomarkers. *Public Health Nutr* **4**, 63–71.
23. Venter C, MacIntyre U & Vorster H (2000) The development and testing of a food portion photograph book for use in an African population. *J Hum Nutr Diet* **13**, 205–218.
24. Langenhoven M, Conradie P, Wolmarans P *et al.* (1991) *MRC Food Quantities Manual*. Cape Town: South African Medical Research Council.
25. Wolmarans P, Danster N, Dalton A *et al.* (2010) *Condensed Food Composition Tables for South Africa*. Cape Town: South African Medical Research Council.
26. Vorster HH (2013) 'Make starchy foods part of most meals': a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl, S28–S35.
27. Naudé CE (2013) 'Eat plenty of vegetables and fruit every day': a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl, S46–S56.
28. Venter CS, Ochse R & Swart R (2013) 'Eat dry beans, split peas, lentils and soya regularly': a food-based dietary guideline. *S Afr J Clin Nutr* **26**, Suppl, S36–S45.
29. Vorster HH, Wentzel-Viljoen E & Vermaak M (2013) 'Have milk, maas or yoghurt every day': a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl., S57–S65.
30. Schonfeldt HC & Hall N (2013) 'Fish, chicken, lean meat and eggs can be eaten daily': a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl., S66–S76.
31. Smuts CM & Wolmarans P (2013) The importance of the quality or type of fat in the diet: a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl., S87–S99.
32. Temple NJ & Steyn NP (2013) Sugar and health: a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl, S100–S104.
33. Wentzel-Viljoen E, Steyn K, Ketterer E *et al.* (2013) 'Use salt and foods high in salt sparingly': a food-based dietary guideline for South Africa. *S Afr J Clin Nutr* **26**, Suppl., S105–S113.
34. Jacobs I & Steyn NP (2013) 'If you drink alcohol, drink sensibly.' Is this guideline still appropriate? *S Afr J Clin Nutr* **26**, Suppl., 114–S119.
35. Faber M, Wenhold FA, MacIntyre UE *et al.* (2013) Presentation and interpretation of food intake data: factors affecting comparability across studies. *Nutrition* **29**, 1286–1292.
36. Warfa K, Drake I, Wallström P *et al.* (2016) Association between sucrose intake and acute coronary event risk and effect modification by lifestyle factors: Malmö Diet and Cancer Cohort Study. *Br J Nutr* **116**, 1611–1620.
37. Lippi G, Mattiuzzi C & Cervellin G (2016) Meat consumption and cancer risk: a critical review of published meta-analyses. *Crit Rev Oncol Hematol* **97**, 1–14.
38. Beaney AJ, Banim PJ, Luben R *et al.* (2017) Higher meat intake is positively associated with higher risk of developing

- pancreatic cancer in an age-dependent manner and are modified by plasma antioxidants: a prospective cohort study (EPIC-Norfolk) using data from food diaries. *Pancreas* **46**, 672–678.
39. Crippa A, Larsson SC, Discacciati A *et al.* (2018) Red and processed meat consumption and risk of bladder cancer: a dose–response meta-analysis of epidemiological studies. *Eur J Nutr* **57**, 689–701.
  40. Stepien M, Chajes V & Romieu I (2016) The role of diet in cancer: the epidemiologic link. *Salud Publica Mex* **58**, 261–273.
  41. Monteiro CA, Levy RB, Claro RM *et al.* (2010) Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public Health Nutr* **14**, 5–13.
  42. Tugendhaft A, Manyema M, Veerman LJ *et al.* (2016) Cost of inaction on sugar-sweetened beverage consumption: implications for obesity in South Africa. *Public Health Nutr* **19**, 2296–2304.
  43. Manyema M, Veerman LJ, Chola L *et al.* (2014) The potential impact of a 20% tax on sugar-sweetened beverages on obesity in South African adults: a mathematical model. *PLoS One* **9**, e105287.