CHAPTER 4

THE USE OF PREDEFINED DIET QUALITY SCORES IN THE CONTEXT OF CARDIOVASCULAR DISEASE RISK DURING URBANISATION IN THE SOUTH AFRICAN PURE STUDY

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2. Barker DJ, Winter PD, Osmond C *et al*. (1989) Weight in infancy and death from ischaemic heart disease. *Lancet* **ii**, 577–580.

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15. Henderson L, Gregory J, Irving K *et al*. (2004) *National Diet and Nutrition Survey: Adults Aged 19 to 64 Years*. vol. 2: *Energy, Protein, Fat and Carbohydrate Intake*. London: The Stationery Office.

16. International Agency for Research on Cancer (2004) *Cruciferous Vegetables, Isothiocyanates and Indoles. IARC Handbooks of Cancer Prevention* no. 9 [H Vainio and F Bianchini, editors]. Lyon, France: IARC Press.

17. Linder MC (1996) Copper. In *Present Knowledge in Nutrition*, 7th ed., pp. 307–319 [EE Zeigler and LJ Filer Jr, editors]. Washington, DC: ILSI Press.

18. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases*. *Joint WHO/FAO Expert Consultation*. *WHO Technical Report Series* no. 916. Geneva: WHO.

19. Keiding L (1997) *Astma, Allergi og Anden Overfølsomhed i Danmark – Og Udviklingen 1987–199I* (*Asthma, Allergy and Other Hypersensitivities in Denmark, 1987–1991*). Copenhagen, Denmark: Dansk Institut for Klinisk Epidemiologi.

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21. Kramer MS & Kakuma R (2002) *The Optimal Duration of Exclusive Breastfeeding: A Systematic Review*. Rome: WHO; available at http://www.who.int/nut/documents/optimal_duration_of_exc_bfeeding_review_eng.pd

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Nomenclature of vitamins. Most of the names for vitamins and related compounds that are accepted by the Editors are those recommended by the IUNS Committee on Nomenclature. See *Nutrition Abstracts and Reviews* (1978) **48**A, 831–835.

Acceptable name	*Other names**
Vitamin A	
Retinol	Vitamin A1
Retinaldehyde,	retinal Retinene
Retinoic acid (all-*trans* or 13-*cis*)	Vitamin A1 acid
3-Dehydroretinol	Vitamin A2
Vitamin D	
Ergocalciferol, ercalciol	Vitamin D2 calciferol
Cholecalciferol, calciol	Vitamin D3
Vitamin E	
α-, β- and γ-tocopherols plus tocotrienols	
Vitamin K	
Phylloquinone	Vitamin K1

Menaquinone-n (MK-n)†	Vitamin K2
Menadione	Vitamin K3,
	menaquinone, menaphthone
Vitamin B1	
Thiamin	Aneurin(e), thiamine
Vitamin B2	
Riboflavin	Vitamin G, riboflavine, lactoflavin
Niacin	
Nicotinamide	Vitamin PP
Nicotinic acid	
Folic Acid	
Pteroyl(mono)glutamic acid	Folacin, vitamin Bc or M
Vitamin B6	
Pyridoxine	Pyridoxol
Pyridoxal	
Pyridoxamine	
Vitamin B12	
Cyanocobalamin	
Hydroxocobalamin	Vitamin B12*a* or B12*b*
Aquocobalamin	
Methylcobalamin	
Adenosylcobalamin	
Inositol	
Myo-inositol	*Meso*-inositol
Choline	
Pantothenic acid	
Biotin	Vitamin H
Vitamin C	
Ascorbic acid	
Dehydroascorbic acid	

*Including some names that are still in use elsewhere, but are not used by *Public Health Nutrition*.

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Vitamin K. The term **vitamin K** should be used as the generic descriptor for 2-methyl-1,4-naphthoquinone (menaphthone) and all derivatives exhibiting qualitatively the biological activity of phylloquinone (phytylmenaquinone).

Niacin. The term **niacin** should be used as the generic descriptor for pyridine 3-carboxylic acid and derivatives exhibiting qualitatively the biological activity of nicotinamide.

Vitamin B6. The term **vitamin B6** should be used as the generic descriptor for all 2-methylpyridine derivatives exhibiting qualitatively the biological activity of pyridoxine.

Folate. Due to the wide range of C-substituted, unsubstituted, oxidized, reduced and mono- or polyglutamyl side-chain derivatives of pteroylmonoglutamic acid that exist in nature, it is not possible to provide a complete list. Authors are encouraged to use either the generic name or the correct scientific name(s) of the derivative(s), as appropriate for each circumstance.

Vitamin B12. The term **vitamin B12** should be used as the generic descriptor for all corrinoids exhibiting qualitatively the biological activity of cyanocobalamin. The term **corrinoids** should be used as the generic descriptor for all compounds containing the corrin nucleus and thus chemically related to cyanocobalamin. The term **corrinoid** is not synonymous with the term **vitamin B12**.

Vitamin C. The terms **ascorbic acid** and **dehydroascorbic acid** will normally be taken as referring to the naturally-occurring L-forms. If the subject matter includes other optical isomers, authors are encouraged to include the L- or D- prefixes, as appropriate. The same is true for all those vitamins which can exist in both natural and alternative isomeric forms.

Amounts of vitamins and summation. Weight units are acceptable for the amounts of vitamins in foods and diets. For concentrations in biological tissues, SI units should be used; however, the authors may, if they wish, also include other units, such as weights or international units, in parentheses.

See *Metric Units, Conversion Factors and Nomenclature in Nutritional and Food Sciences* (1972) paras 8 and 14–20. London: The Royal Society.

Nomenclature of fatty acids and lipids. In the description of results obtained for the analysis of fatty acids by conventional GLC, the shorthand designation proposed by Farquhar JW, Insull W, Rosen P, Stoffel W & Ahrens EH (*Nutrition Reviews* (1959), **17**, Suppl.) for individual fatty acids should be used in the text, tables and figures. Thus, 18 : 1 should be used to represent a fatty acid with eighteen carbon atoms and one double bond; if the position and configuration of the double bond is unknown. The shorthand designation should also be used in the abstract. If the positions and configurations of the double bonds are known, and these are important to the discussion, then a fatty acid such as linoleic acid may be referred to as *cis*-9,*cis*-12-18 : 2 (positions of double bonds related to the carboxyl carbon atom 1). However, to illustrate the metabolic relationship between different unsaturated fatty acid families, it is sometimes more helpful to number the double bonds in relation to the terminal methyl carbon atom, *n*. The preferred nomenclature is then: 18 : 3*n*-3 and 18 : 3*n*-6 for α-linolenic and γ-linolenic acids respectively; 18 : 2*n*-6 and 20 : 4*n*-6 for linoleic and arachidonic acids respectively and 18 : 1*n*-9 for oleic acid. Positional isomers such as α- and γ-linolenic acid should always be clearly distinguished. It is assumed that the double bonds are methylene-interrupted and are of the *cis*-configuration (see Holman RT in *Progress in the Chemistry of Fats and Other Lipids* (1966) vol. 9, part 1, p. 3. Oxford: Pergamon Press). Groups of fatty acids that have a common chain length but vary in their double bond content or double bond position should be referred to, for example, as C20 fatty acids or C20 PUFA. The

modern nomenclature for glycerol esters should be used, i.e. triacylglycerol, diacylglycerol, monoacylglycerol *not* triglyceride, diglyceride, monoglyceride. The form of fatty acids used in diets should be clearly stated, i.e. whether ethyl esters, natural or refined fats or oils. The composition of the fatty acids in the dietary fat and tissue fats should be stated clearly, expressed as mol/100 mol or g/100 g total fatty acids.

Nomenclature of micro-organisms. The correct name of the organism, conforming with international rules of nomenclature, should be used: if desired, synonyms may be added in parentheses when the name is first mentioned. Names of bacteria should conform to the current Bacteriological Code and the opinions issued by the International Committee on Systematic Bacteriology. Names of algae and fungi must conform to the current International Code of Botanical Nomenclature. Names of protozoa should conform to the current International Code of Zoological Nomenclature.

Nomenclature of plants. For plant species where a common name is used that may not be universally intelligible, the Latin name in italics should follow the first mention of the common name. The cultivar should be given where appropriate.

Other nomenclature, symbols and abbreviations. Authors should consult recent issues of *Public Health Nutrition* for guidance. The IUPAC rules on chemical nomenclature should be followed, and the recommendations of the Nomenclature Committee of IUBMB and the IUPAC-IUBMB Joint Commission on Biochemical Nomenclature and Nomenclature Commission of IUBMB in *Biochemical Nomenclature and Related Documents* (1992), 2nd ed., London: Portland Press (http://www.chem.qmul.ac.uk/iupac/bibliog/white.html). The symbols and abbreviations, other than units, are essentially those listed in *British Standard* 5775 (1979–1982), *Specifications for Quantities, Units and Symbols*, parts 0–13. Day should be abbreviated to d, for example 7 d, except for 'each day', '7th day' and 'day 1'.

Elements and simple chemicals (e.g. Fe and CO2) can be referred to by their chemical symbol (with the exception of arsenic and iodine, which should be written in full) or formula from the first mention in the text; the title, text and table headings, and figure legends can be taken as exceptions,. Well-known abbreviations for chemical substances may be used without explanation, thus: RNA for ribonucleic acid and DNA for deoxyribonucleic acid. Other substances that are mentioned frequently (five or more times) may also be abbreviated, the abbreviation being placed in parentheses at the first mention, thus: lipoprotein lipase (LPL), after that, LPL, and an alphabetical list of abbreviations used should be included. Only accepted abbreviations may be used in the title and text headings. If an author's initials are mentioned in the text, they should be distinguished from other abbreviations by the use of stops, e.g. 'one of us (P. J. H.)…'. For UK counties the official names given in the *Concise Oxford Dictionary* (1995) should be used and for states of the USA two-letter abbreviations should be used, e.g. MA (not Mass.) and IL (not Ill.). Terms such as 'bioavailability' or 'available' may be used providing that the use of the term is adequately defined.

Spectrophotometric terms and symbols are those proposed in *IUPAC Manual of Symbols and Terminology for Physicochemical Quantities and Units* (1979) London: Butterworths. The attention of authors is particularly drawn to the following symbols: m (milli, 10−3), μ (micro, 10−6), n (nano, 10−9) and p (pico, 10−12). Note also that ml (millilitre) should be used instead of cc, μm (micrometre) instead of μ (micron) and μg (microgram) instead of γ.

Numbers. Numerals should be used with units, for example, 10 g, 7 d, 4 years (except when beginning a sentence, thus: 'Four years ago...'); otherwise, words (except when 100 or more), thus: one man, ten ewes, ninety-nine flasks, three times (but with decimal, 2·5 times), 100 patients, 120 cows, 136 samples.

Abbreviations. The following abbreviations are accepted without definition by *Public Health Nutrition:*

ADP (GDP) adenosine (guanosine) 5'-disphosphate

AIDS acquired immune deficiency syndrome

AMP (GMP) adenosine (guanosine) 5'-monophosphate

ANCOVA analysis of covariance

ANOVA analysis of variance

apo apolipoprotein

ATP (GTP) adenosine (guanosine) 5’-triphosphate

AUC area under the curve

BMI body mass index

BMR basal metabolic rate

bp base pair

BSE bovine spongiform encephalopathy

CHD coronary heart disease

CI confidence interval

CJD Creutzfeldt-Jacob disease

CoA and acyl-CoA co-enzyme A and its acyl derivatives

CV coefficient of variation

CVD cardiovascular disease

Df degrees of freedom

DHA docosahexaenoic acid

DM dry matter

DNA deoxyribonucleic acid

dpm disintegrations per minute

EDTA ethylenediaminetetra-acetic acid

ELISA enzyme-linked immunosorbent assay

EPA eicosapentaenoic acid

Expt experiment (for specified experiment, e.g. Expt 1)

FAD flavin-adenine dinucleotide

FAO Food and Agriculture Organization (except when used as an author)

FFQ food-frequency questionnaire

FMN flavin mononucleotide

GC gas chromatography

GLC gas–liquid chromatography

GLUT glucose transporter

GM genetically modified

Hb haemoglobin

HDL high-density lipoprotein

HEPES 4-(2-hydroxyethyl)-1-piperazine-ethanesulfonic acid

HIV human immunodeficiency virus

HPLC high-performance liquid chromatography

Ig immunoglobulin

IHD ischaemic heart disease

IL interleukin

IR infra red

kb kilobases

Km Michaelis constant

LDL low-density lipoprotein

MHC major histocompatibility complex

MRI magnetic resonance imaging

MS mass spectrometry

MUFA monounsaturated fatty acids

NAD+, NADH oxidized and reduced nicotinamide-adenine dinucleotide

NADP+, NADPH oxidized and reduced nicotinamide-adenine dinucleotide phosphate

NEFA non-esterified fatty acids

NF-κB nuclear factor kappa B

NMR nuclear magnetic resonance

NS not significant

NSP non-starch polysaccharide

OR odds ratio

PAGE polyacrylamide gel electrophoresis

PBS phosphate-buffered saline

PCR polymerase chain reaction

PG prostaglandin

PPAR peroxisome proliferator-activated receptor

PUFA polyunsaturated fatty acids

RDA recommended dietary allowance

RER respiratory exchange ratio

RIA radioimmunoassay

RMR resting metabolic rate

RNA, mRNA etc. ribonucleic acid, messenger RNA etc.

rpm revolutions per minute

RT reverse transcriptase

SCFA short-chain fatty acids

SDS sodium dodecyl sulphate

SED standard error of the difference between means

SFA saturated fatty acids

SNP single nucleotide polymorphism

TAG triacylglycerol

TCA trichloroacetic acid

TLC thin-layer chromatography

TNF tumour necrosis factor

UN United Nations (except when used as an author)

UNICEF United Nations International Children's Emergency Fund

UV ultra violet

VLDL very-low-density lipoprotein

VO2 O2 consumption

VO2max maximum O2 consumption

WHO World Health Organization (except when used as an author)

Use of three-letter versions of amino acids in tables: Leu, His, etc.

CTP, UTP, GTP, ITP, as we already use ATP, AMP etc.

Disallowed words and phrases. The following are disallowed by *Public Health Nutrition*:

deuterium or tritium (use 2H and 3H)

c.a. or around (use approximately or about)

canola (use rapeseed)

ether (use diethyl ether)

free fatty acids (use NEFA)

isocalorific/calorie (use isoenergetic/energy)

quantitate (use quantify)

unpublished data or observations (use unpublished results)

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ABSTRACT

Objective: Urbanisation is generally associated with increased CVD risk and accompanying dietary changes. Little is known regarding the association between increased CVD risk and dietary changes using approaches such as diet quality. The relevance of predefined diet quality scores (DQS) in non-Western developing countries has not yet been established.

Design: The association between dietary intakes and CVD risk factors was investigated using two variations of DQS, adapted to the black South African diet. Dietary intake data were collected using a quantitative FFQ. CVD risk was determined by analysing known CVD risk factors.

Setting: Urban and rural areas in North West Province, South Africa

Subjects: Apparently healthy volunteers from the South African PURE study population (n=1710)

Results: CVD risk factors were significantly increased in the urban participants, especially the women. Urban men and women had significantly higher intakes of both macronutrients and micronutrients, with macronutrient intakes well within the recommended CVD guidelines. While micronutrient intakes of the urban groups were generally higher than the rural groups, intakes of selected micronutrients were low in both groups. Both variations of DQS indicated improved diet quality in the urban groups and showed good agreement between the scores although they seem to measure different aspects of diet quality.

Conclusion: The apparent paradox between improved diet quality and increased CVD risk in the urban group can be explained when interpreting the cut-offs used in the scores against the absolute intakes of individual nutrients. Predefined DQS as well as current guidelines for CVD prevention should be interpreted with caution in non-Western developing countries.

INTRODUCTION

In developing countries, the process of urbanisation and the modernisation of lifestyles has marked effects on populations. While still battling infectious diseases, these countries are also facing an increase in non-communicable diseases [(1)]. With urbanisation in low- and middle-income countries there is an increase in socio-economic status, which is usually accompanied by an increase in most risk factors for CVD[(2)]. These risk factors include obesity and increased dietary intake of total fat and saturated fat, as has been observed in the North West province of South Africa in the Transition and Health during Urbanisation of South Africans (THUSA) study[(3)], as well as in other developing countries[(4)]. Among numerous other factors, this increase in CVD risk has been ascribed to a worsening diet in populations as they transition from a rural to an urban lifestyle. Traditionally, in South Africa, the diet was low in fat and sugar and rich in fibre[(5)]. As a consequence of urbanisation, the diet now tends to be richer in animal products, refined grains, fats, salt and sugar as well as lower in fibre[(6)].

Until now, the effect of urbanisation on diet has been investigated by examining mostly the nutrient composition of diets. However, the failure of single-nutrient supplementation to protect against CVD[(7)] and cancers[(8,9)] highlighted the fact that it was important to develop a more holistic view of food intake. Foods are biochemically complex and contain compounds that may interact with each other. By investigating not only nutrients but also foods and dietary quality, the complexity of dietary behaviours and interactions are taken into account. One way of assessing dietary quality is to use theoretically defined dietary patterns that are based on current nutrition knowledge. These theoretical or predefined diet quality scores consist of foods and/or nutrients which are considered to be important to health[(10)].

In a critical review of predefined diet quality scores (DQS), Waijers *et al.* (2007)[(10)] made recommendations regarding the decisions that need to be taken when constructing a DQS. It is advised that a score should contain two macronutrients (fat, carbohydrate or protein) to ensure overall balance. It is also desirable that the score be proportional to intake, rather than using simple cut-off values, or else that a scoring range be designed. To avoid confounding by energy intake, scores should depend on, or be adjusted for, energy intake. Another important issue to be taken

into account is that, because food intake is culturally determined, general dietary habits within the population being studied need to be considered when the score items and their cut-offs are chosen. The score should also be constructed in such a way that an acceptable dietary variety is ensured of obtaining a high score, although variety does not necessarily have to be included as a score item. It is also advisable to select more than one score when evaluating diet quality[11].

Using these criteria, two scores were selected from the numerous available variations of DQS to assess diet quality in this study population. The first is a score developed by Thiele *et al*.[12], which was adapted to the South African diet and renamed the Adapted Thiele Score (see methods section for more details), and the second, the Healthy Diet Indicator (HDI)[13]. The rationale for electing to use these specific variations of DQS over the other known scores is that not only nutrients but also food groups are included, and that diet quality is assessed in relation to known and proven dietary guidelines specifically for the prevention of CVD. It will also be relatively simple to fit South African foods into the food groups used in these scores.

The aim of this study is, therefore, to relate the dietary intakes of the South African Prospective Urban and Rural Epidemiological (PURE) study population (n=2010) using both nutrient intakes and diet quality, to CVD risk associated with urbanisation. The PURE study is a large-scale cohort study that tracks changing lifestyles, risk factors and chronic disease using periodic standardised data collection in urban and rural areas of 17 countries in transition[14].

MATERIALS AND METHODS

This study used baseline data collected over a twelve-week period in 2005 from 2010 randomly selected subjects in the South African arm of the PURE study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human volunteers were approved by the Ethics Committee of the North West University, South Africa (No. 04M10). The subjects signed informed consent before commencement of the study, after the study was explained to them in their home language (Annexure F). All data were treated confidentially and all analysis was performed with coded data. Black South African

men (n=750) and women (n=1260) older than 35 years were recruited from 6000 randomly selected households. From these households, 1006 volunteers were recruited from rural areas (living under tribal law) and 1004 from urban areas (living in informal and formal settlements surrounding cities) in the North West Province of South Africa. Volunteers were included if they were apparently healthy. Exclusion criteria were the use of chronic medication for non-communicable diseases and/or any self-reported illness. For various reasons, dietary intake and anthropometric data could not be collected from some volunteers and these were consequently excluded from the data set, resulting in the total study population of 1710.

Details regarding the collection of socio-economic information, anthropometry measurements, blood collection, blood pressure and physical activity have been reported previously[15-17].

A culturally sensitive quantified food frequency questionnaire (QFFQ) (Annexure E) was completed by trained fieldworkers in the respondents' language of choice. The QFFQ, which demonstrated good reproducibility[18], had been previously developed[19] and validated in this population, using seven-day weighed records and biomarkers[20]. Portion sizes were estimated using food portion photographs[21], appropriate utensils and containers and examples of specific foods. Portion sizes were reported in household measurements and converted to weights using standard tables[22]. The QFFQ was completed for foods eaten over the previous 30 days. The food intake was coded according to the South African Food Composition Database System of the South African Medical Research Council and then used to calculate the nutrient and food group intake[23-25].

Diet quality scores. Table 1 presents the components and cut-off points of the HDI[13] and the Deficiency and Excess Score by Thiele *et al*.[12] which were used in this study. The score by Thiele *et al*. suggested using up to 30 nutrients in a Deficiency Score to identify a preferable diet quality and using six nutrients in an Excess Score to identify a non-preferable diet quality. After assessing the completeness of the relevant micronutrients in the South African Food Composition Database System, 19 nutrients were used for the Deficiency Score in this study, and the suggested six were used for the Excess Score. The estimated average requirements (EAR) or adequate intake (AI) (when EAR are not available) were used

as cut-off points in the score[26-30]. Intake was then calculated as a percentage of the EAR or AI. Intake equal to or higher than the EAR or AI was allocated 100%. The scores were added up, giving a total of 1900 for the Deficiency Score and 600 for the Excess Score. To simplify the interpretation, it was decided to combine the Deficiency and Excess Scores into one score by subtracting the Excess from the Deficiency Score, now called the Adapted Thiele Score. This principle of being 'penalised' for non-preferable dietary intakes is used in most variations of DQS[31-33]. The original HDI score was adapted for this study, firstly, by using the more recent guidelines of the WHO for prevention of CVD[34] for the cut-off points and secondly, by changing the scoring system from a dichotomous variable (1 or 0) to a continuous score in order to provide a more sensitive scoring range, instead of using very strict cut-offs.

An additional modification regarding sodium intake was made because the QFFQ did not specifically evaluate the intake of discretional salt. Charlton *et al*.[35] showed that discretionary salt intake made up 45.5% of total sodium intakes in black South African subjects. The sodium intake of the population was therefore adjusted by adding 46% to the sodium intake. Another modification was made regarding the cut-off point for fat, since the fat intake of this population was quite low, with a mean of 24% of total energy. The cut-off for total fat intake in the Excess Score was lowered from 35% to 30%, so that those with a higher fat intake within the study population would be 'penalised'. The last adjustment made was to remove the contribution of alcohol to total energy intake. The median intake of alcohol was alarmingly high, particularly in the men, as has been previously described[36]. This was diluting the contribution of the macronutrients to energy, particularly in those with a very high alcohol intake.

Statistical analysis. Data were analysed using the SPSS (Statistical Package for Social Sciences, version 20) software package. A p-value ≤ 0.05 was regarded as statistically significant. Normally distributed variables are reported as mean (95% confidence interval), and non-normally distributed data as median [25^{th}–75^{th} percentile]. Mann-Whitney U tests were used for comparisons between two groups. ANOVA, with post-hoc comparisons, was used for comparison between three or more groups. Bland Altman graphs were constructed to assess the agreement between the two variations of DQS.

Table 1 Components of Diet Quality Scores

Nutrient or food group (daily intake)	Age (Years)	Cut-off values Men	Women
Healthy Diet Indicator [13]			
SFA* (g)		<10	<10
PUFA* (g)		6-10	6-10
Protein* (% of TE)		10-15	10-15
Complex carbohydrates* (% of TE)		50-70	50-70
Dietary fibre* (g)		>25	>25
Fruit and vegetables* (g)		>400	>400
Pulses, nuts and seeds* (g)		>30	>30
Mono- and disaccharides* (% of TE)		<10	<10
Cholesterol* (mg)		<300	<300
Deficiency Score [12]			
Protein† (% of TE)		15	15
Carbohydrate† (% of TE)		55	55
Total fibre‡ (g)	<51	38	25
	>51	30	21
Calcium‡ (mg)	19-50	1000	1000
	>51	1200	1200
Magnesium§ (mg)	>31	350	265
Iron § (mg)	31-50	6.0	8.1
	>50	6.0	5.0
Zinc § (mg)	>31	9.4	6.8
Manganese ‡ (mg)	>31	2.3	1.8
Potassium ‡ (mg)	>31	4700	4700
Copper § (µg)	>31	700	700
Vitamin A § (µgRAE)	>31	625	500
Thiamine § (mg)	>31	1.0	0.9
Riboflavin § (mg)	>31	1.1	0.9
Niacin § (mg)	>31	12	11
Vitamin B6 § (mg)	31-50	1.1	1.1
	>51	1.4	1.3
Folate § (µg)	>31	320	320
Vitamin B12 § (µg)	>31	2.0	2.0
Pantothenic acid ‡ (mg)	>31	5.0	5.0
Vitamin C § (mg)	>31	75	60
Excess Score [12]			
Total fat* (% of TE)		30	30
Saturated: unsaturated fatty acid ratio		1:2	1:2
Cholesterol* (mg)		<300	<300
Alcohol‖ (g)		30	15
Added sugar *† (% of TE)		10	10
Sodium ‡ (mg)	31-50	1500	1500
	>51	1300	1300

TE, Total energy (excluding energy from alcohol); RAE:retinol activity equivalent
* Criteria used for cut-off values are WHO guidelines for prevention of chronic disease [34]
† DRIs: Acceptable Macronutrient distribution ranges [30]
‡ Adequate Intake [26-29]
§ Estimated average requirement [26-29]
‖ [46]

RESULTS

Table 2 provides details on the general characteristics of the total study population, as well as for the rural men and women and urban men and women separately. The urban women had significantly higher BMI, waist circumference, triglyceride, C-reactive protein and fasting glucose levels than their rural counterparts. Both systolic and diastolic blood pressures were significantly higher in the urban men and women, compared with the rural groups. The same was seen for the plasminogen activator-inhibitor-1 levels. The rural groups were significantly more active than their urban counterparts. In the rural group, the majority of men and women were uneducated, while in the urban group, the majority had a primary school education. Around 17% of the total group were newly diagnosed HIV positive, with no significant differences between the rural and urban groups.

Table 3 provides the means of the DQS and of the nutrients and foods that were used in the calculation of the DQS for the rural and urban groups. This table shows that the dietary intake of the urban men and women was significantly higher than that of their rural counterparts for all nutrients and foods, except for carbohydrate percentage from energy. Table 3 also provides the percentage difference between the intakes of the urban and rural groups, where urban intakes are expressed as a percentage increase or decrease compared with the rural intake. Fat intake was over 40% and sodium over 100% higher in the urban groups. Intakes of vitamin C, vitamin B12, vitamin A and riboflavin the urban groups were more than double the intakes in rural groups, with calcium intake in urban women being more than twice as high as that seen in rural women.

It is also evident that, although nutrients such as total fat as percentage of energy and cholesterol as well as foods such as fruit and vegetables and pulses, nuts and seeds were significantly higher in the urban than the rural group, they were still below the relevant guidelines. The median percentage energy fat intake in the urban groups, although still below the CVD guideline of 30%, was, however, approaching this level. When looking at Table 4, it is clear that the micronutrient intakes of this population are of concern, as can be seen from the large percentage of both the rural and urban groups that did not meet the EAR/AI. When micronutrients expressed as a percentage of the EAR/AI are compared, it is clear that the urban groups' median

intakes were above 100% for 12 of the 18 micronutrients, while this was not the case for the rural groups (4 only). Despite the higher micronutrient intakes in the urban groups in comparison with the rural groups, micronutrients specifically linked to CVD prevention, such as calcium, potassium and vitamin C, as well as fibre were far below the EAR/AI in both the rural and urban groups.

Both versions of DQS also indicated improved diet quality in the urban group in comparison with the rural groups (Table 3). The HDI indicated a 7% and 5% increase in diet quality in the urban men and women respectively, compared with their rural counterparts. When comparing the Deficiency and Excess Scores which make up the Adapted Thiele Score, it is clear that the rural-urban increases of the Deficiency Score (17% and 17%) were higher than the increases in the Excess Score (0.4% and 2%) for men and women respectively. In order to determine the agreement between the two DQS, each participant's scores were expressed as a percentage of the total score. The scores as percentages of the total were then correlated with each other. The two scores correlated significantly with each other for both the rural ($r = 0.6$; $p < 0.0001$) and the urban ($r = 0.7$; $p < 0.0001$) groups. In order to determine whether the differences between the scores were consistent across the total range of DQS values, Bland Altman plots were constructed (Figure 1). At a percentage of less than 70% of the total possible DQS, the HDI score gave consistently higher scores than the Adapted Thiele Score, while at a percentage of greater than 70%, the Adapted Thiele Score gave consistently higher scores. This explains the agreement between the two scores in the rural group, where the median DQS expressed as a percentage of the total was around 70% (72% for HDI men and women; 72% and 73% for Adapted Thiele Score for men and women), and the disagreement between the two scores in the urban groups with the higher DQS, where the median HDI was 77% and 76% for men and women respectively and 84% for both men and women in the Adapted Thiele Score.

Table 2 Comparison of general characteristics of rural and urban participants

	Total	Men			Women		
		Rural	Urban		Rural	Urban	
	n=1710	n=314	n=328	P--value	n=588	n=480	P--value
Age (Years)	48.0 [41.0 -56.0]	48.0 [41.0 -56.3]	49.0 [42.0-58.0]	0.33	46.0 [40.0-54.0]	48.5 [42.0-58.8]	<0.0001
BMI (kg/m^2)	22.8 [19.3-28.4]	19.7 [18.1-22.3]	20.0 [18.3-22.8]	0.43	24.6 [20.7-30.2]	27.0 [22.2-32.5]	<0.0001
Waist circumference (cm)	77.0 [70.2-87.4]	74.6 [70.1-80.5]	74.4 [70.0-81.4]	0.85	78.2 [69.3-89.1]	82.1 [72.7-92.6]	<0.0001
Total cholesterol (mmol/L)	5.03 (1.33,1.42)	4.72 (1.24,1.45)	4.89 (1.20,1.40)	0.11	5.12 (1.30,1.45)	5.22 (1.33,1.51)	0.23
HDL-cholesterol (mmol/L)	1.42 [1.06-1.89]	1.41 [1.02-1.95]	1.52 [1.13-2.05]	0.06	1.41 [1.09-1.85]	1.36 [1.01-1.78]	0.21
LDL-cholesterol (mmol/L)	3.25 (1.18, 1.26)	2.96 (1.10,1.29)	3.02 (1.09,1.28)	0.56	3.36 (1.17,1.31)	3.46 (1.13,1.28)	0.19
TAG (mmol/L)	1.09 [0.82-1.54]	0.96 [0.75-1.34]	1.00 [0.79-1.46]	0.21	1.10 [0.82-1.49]	1.21 [0.89-1.79]	<0.001
Systolic BP (mmHg)	133 (132,134)	132 (129,135)	138 (135,140)	<0.01	127 (125,129)	137(134,139)	<0.0001
Diastolic BP (mmHg)	87.4 (86.7,88.0)	84.9 (83.2,86.6)	88.0 (86.5,89.6)	<0.01	86.6 (85.4,87.7)	89.5 (88.3,90.8)	<0.001
C-Reactive protein (mg/L)	3.20 [0.93-9.20]	2.70 [0.63-8.04]	2.29 [0.83-7.53]	0.85	3.50 [1.03-9.20]	3.87 [1.43-11.40]	0.04
Fasting glucose, (mmol/L)	4.80 [4.30-5.30]	4.70 [4.40-5.10]	4.80 [4.20-5.40]	0.38	4.80 [4.40-5.20]	4.95 [4.30-5.50]	0.01
PAI-1 (U/ml)	4.27 [1.24-7.99]	1.95 [0.00-4.72]	2.85 [0.18-6.74]	<0.01	4.59 [1.84-7.76]	6.28 [3.25-10.68]	<0.0001
Physical Activity Index, *n=1645*	3.0(2.5-3.2)	3.0(2.6-3.4)	2.7(2.4-3.0)	<0.0001	3.1(2.7-3.4)	2.7(2.5-3.0)	<0.0001
Education	n=1608	n=294	n=311		n=553	n=450	
None	592 (36.8%)	155 (52.7%)	79 (25.4%)	<0.00001	265 (47.9%)	93 (20.7%)	<0.00001
Primary school	668 (41.5%)	92 (31.3%)	150 (48.2%)	<0.00001	169 (30.6%)	257 (57.1%)	<0.00001
Secondary School	336 (20.9%)	43 (14.6%)	78 (25%)	<0.001	118 (21.3%)	97 (21.6%)	0.91
University/College	12 (0.8%)	4 (1.4%)	4 (1.3%)	0.92	1 (0.2%)	3 (0.7%)	0.23
HIV status (Newly diagnosed)	n=1703	n=314	n=327		n=586	n=476	
Positive	290 (17.0%)	56 (17.8%)	49 (15.0%)	0.34	101 (17.2%)	84 (17.7%)	0.83
Negative	1413 (83.0%)	258 (82.2%)	278 (85.0%)	0.34	485 (82.8%)	392 (82.4%)	0.86
Smoking status, %	n=1702	n=313	n=325		n=587	n=477	
Former	69 (4.05%)	21 (6.69%)	24 (7.32%)	0.73	15 (2.55%)	9 (1.89%)	0.44
Current	897 (52.7%)	173 (55.2%)	209 (64.3%)	<0.01	289 (49.2%)	226 (47.4%)	0.56
Never	736 (43.2%)	119 (38.0%)	325 (28.3%)	<0.001	283 (48.1%)	242 (50.7%)	0.42

BP, Blood pressure; PAI-1:Plasminogen activator-inhibitor-1

Normally distributed data reported as: mean (95% CI) and non-parametric data reported as median [25th – 75th percentile].

Table 3 Nutrient intake, food group intake and Diet Quality Scores of rural and urban men and women

	Men			Women		
	Rural n=314	Urban n=328	% difference between R and U‡	Rural n=588	Urban n=480	% difference between R and U‡
NUTRIENTS						
Energy (kJ)	6029 [4765;7757]*	8603 [6516;11288]*	42	5677 [4446;7169]†	7664 [5366;10401]†	35
Protein (%TE)	11.6 [10.4;12.9]*	13.2 [12.0;14.2]*	13	11.1 [10.0;12.3]†	12.9 [11.8;14.1]†	16
Carbohydrate (%TE)	69.9 [64.9;73.9]*	59.9 [56.0;64.2]*	↓14	68.9 [63.5;73.2]†	58.0 [53.6;62.9]†	↓16
Total Fat (%TE)	18.7 [15.0;23.3]*	26.7 [22.8;29.9]*	43	19.9 [15.9;24.6]†	29.1 [24.4;33.0]†	46
SFA (%TE)	3.94 [2.59;5.25]*	6.47 [5.34;7.79]*	64	4.14 [2.90;5.77]†	7.19 [5.92;8.77]†	74
PUFA (%TE)	6.10 [4.24;7.86]*	7.49 [6.14;9.19]*	23	6.61 [4.86;8.52]†	8.17 [6.56;9.71]†	24
Cholesterol (mg)	106 [55.9;153]*	234 [149;331]*	121	95.4 [48.8;151]†	205 [131;310]†	115
Added sugar (%TE)	6.13 [3.51;8.86]*	6.94 [4.63;9.88]*	13	6.76 [3.79;10.4]†	8.38 [6.08;11.1]†	24
Alcohol (g)	2.04 [0.00;28.6]*	11.6 [0.00;26.7]*	469	0.00 [0.00;0.00]†	0.00 [0.00;10.2]†	0
Dietary fibre (g)	18.1 [12.6;24.2]*	24.0 [16.5;33.2]*	33	16.5 [12.5;21.3]†	20.4 [13.3;28.5]	24
Calcium (mg)	213 [139;309]*	369 [277;535]*	73	186 [114;267]†	368 [263;586]†	98
Magnesium (mg)	277 [194;421]*	379 [277;519]*	37	225 [172;299]†	296 [203;402]†	32
Iron (mg)	11.9 [8.7;15.2]*	15.1 [10.8;20.9]*	27	10.6 [8.05;13.4]†	12.3 [8.34;17.5]†	16
Zinc (mg)	8.27 [6.24;10.8]*	11.8 [8.58;16.8]*	43	7.34 [5.62;9.34]†	9.62 [6.74;14.0]†	31
Manganese (mg)	1554 [834;3051]*	2488 [1765;3482]*	60	1158 [667;1829]†	1998 [1359;2913]†	73
Potassium (mg)	1309 [956;1714]*	1988 [1449;2741]*	52	1160 [905;1499]†	1828 [1193;2488]†	58
Sodium (mg)	726 [361;1063]*	1673 [1179;2370]*	130	674 [406;1039]†	1808 [1229;2684]†	168
Copper (µg)	102 [75.5;139]*	139 [103;186]*	36	94.8 [69.6;121]†	126 [85.2;173]†	33
Vitamin A (µgRE)	409 [257;648]*	809 [523;1439]*	98	452 [289;693]†	828 [408;1398]†	83
Thiamine (mg)	1.54 [1.12;2.02]*	1.78 [1.31;2.68]*	16	1.36 [1.04;1.74]†	1.41 [0.98;2.10]†	4
Riboflavin (mg)	0.8 [0.6;1.4]*	1.5 [1.1;2.0]*	88	0.7 [0.5;1.0]†	1.3 [0.9;1.9]†	86
Niacin (mg)	11.3 [8.59;16.3]*	17.2 [13.0;23.2]*	52	9.90 [7.56;12.6]†	14.3 [9.88;20.4]†	44
Vitamin B6 (mg)	1.21 [0.84;1.61]*	1.67 [1.14;2.56]*	38	1.10 [0.84;1.43]†	1.40 [0.89;2.06]†	27
Folate (µg)	359 [228;460]*	438 [304;625]*	57	317 [224;417]†	339 [235;490]†	7
Vitamin B12 (µg)	1.52 [0.82;2.90]*	4.47 [2.45;7.47]*	194	1.54 [0.68;2.93]†	4.00 [2.08;6.74]†	159
Pantothenic acid (mg)	2.70 [1.92;3.63]*	4.65 [3.17;6.22]*	72	2.47 [1.87;3.32]†	4.20 [2.77;5.72]†	70
Vitamin C (mg)	11.2 [6.05;15.5]*	30.7 [17.8;55.4]*	174	11.9 [7.27;17.6]†	32.1 [17.0;53.9]†	170
FOODS						
Fruit & vegetables (g)	58.9 [33.8;83.0]*	129 [81.4;216]*	119	69.3 [43.6;100]†	148 [84.6;231]†	114
Pulses, nuts, seeds (g)	0.0 [0.0;10.0]*	9.6 [0.0;28.6]*	860	0.0 [0.0;11.6]†	11.0 [0.0;29.4]†	900
DIET QUALITY SCORES						
Adapted Thiele	1364 [1172;1504]*	1594 [1448;1662]*	17	1381 [1169;1512]†	1592 [1388;1684]†	15
% of total score	72%	84%		72%	84%	
Deficiency score	1409 [1196;1549]*	1649 [1520;1753]*	17	1413 [1215;1547]†	1657 [1444;1765]†	17
New Excess score	583 [500;600]	595 [541;600]	0.4	553 [495;591]	555 [500;588]	2
HDI	6.46 [5.91;6.89]*	6.94 [6.36;7.44]*	7	6.48 [6.03;6.95]†	6.82 [6.11;7.36]†	5
% of total score	72%	77%		72%	76%	

R: rural; U: Urban; Data reported as median [25th−75th percentile].

* indicates significant difference p<0.01 between rural and urban men and superscript

† indicates significant difference p<0.01 between rural and urban women.

‡% indicates a higher intake from rural to urban except for ↓ at carbohydrates which indicates a lower percentage intake

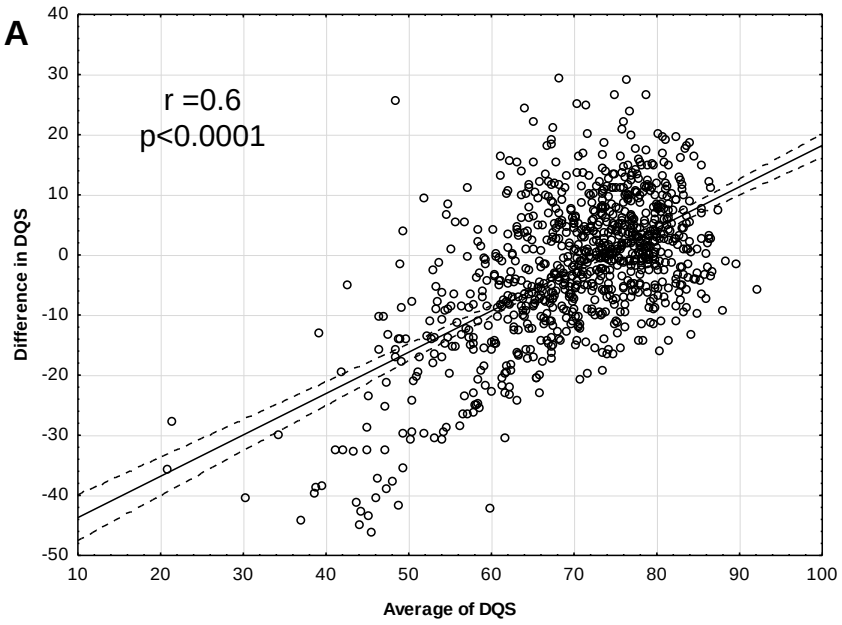
Table 4 Nutrient intake expressed as a percentage of EAR/AI of micronutrients and percentage of population that did not meet the EAR/AI[1]

	MEDIAN [25th;75th percentile] % OF EAR/AI‡				% [n] THAT DID NOT MEET EAR/AI‡				
	RURAL		URBAN			RURAL		URBAN	
	Men n=314	Women n=588	Men n=328	Women n=480	TOTAL	Men n=314	Women n=588	Men n=328	Women n=480
Dietary fibre (g)	52.7 [36.4-71.4]*	70.0[52.9-89.8]†	71.0[46.7-100.0]*	85.7[56.2-123.7]†	77.6 [1327]	95.2 [299]	84.5 [497]	75.0 [246]	59.4 [285]
Calcium (mg)	19.4 [12.4-28.9]*	15.5 [9.5-22.2]†	35.3 [25.5-49.0]*	30.6[21.9-48.8]†	99.0 [1692]	99.0 [311]	100 [588]	96.3 [316]	99.4 [477]
Magnesium (mg)	79.2 [55.5-120]*	70.4 [53.8-93.6]†	108 [79-148]*	92 [63.5-126]†	62.7 [1072]	66.6 [209]	80.1 [471]	40.6 [133]	54.0 [259]
Iron (mg)	198 [144-254]*	154 [109-200]†	252 [180-348]*	185 [125-278]†	14.7 [251]	13.7 [43]	18.0 [106]	7.0 [23]	16.5 [79]
Zinc (mg)	88.0[66.4-114]*	108[82.7-137.3]†	125.6[91.3-178.3]*	141[97.9-206.4]†	39.4 [674]	60.8 [191]	42.9 [252]	31.4 [103]	26.7 [128]
Manganese (mg)	67.6[36.2-133]*	64.3[37.0-102]†	108[76.7-151]*	111[75.4-162]†	58.6 [1002]	67.2 [211]	74.3 [437]	46.0 [151]	42.3 [203]
Potassium (mg)	27.9 [20.3 – 36.5]*	24.7 [19.2-31.9]†	42.3[30.8-58.3]*	38.9 [25.4-52.9]†	99 [1693]	99.7 [313]	99.7 [586]	97.3 [319]	99.0 [475]
Sodium (mg)	30.9[18.1-47.6]*	29.3[17.0-44.9]†	73.2[53.5-107]*	76.2[51.3-112]†	84.6 [1446]	97.1 [305]	98.0 [576]	71.0 [233]	69.2 [332]
Copper (µg)	146[108-199]*	135[99.4-173]†	199[147-265]*	181[122-247]†	18.9 [323]	19.4 [61]	25.2 [148]	11.0 [36]	16.3 [78]
Vitamin A (µg)	81.8[51.5-130]*	72.3[46.2-111]†	162[105-288]*	133[65.4-225]†	49.7 [849]	62.4 [196]	68.2 [401]	23.5 [77]	36.5 [175]
Thiamine (mg)	154[112-202]*	151[115-194]†	178[131-268]*	157[109-234]†	17.5 [299]	20.1 [63]	16.0 [94]	14.0 [46]	20.0 [96]
Riboflavin (mg)	75.4[56-122]*	77.9[57-108]†	132[65.9-181]*	145[96-206]†	50.2 [858]	68.5 [215]	71.1 [418]	26.8 [88]	39.9 [137]
Niacin (mg)	94.5[71.6-136]*	90.0[68.7-114]†	143[108-194]*	130[89-185]†	44.2 [755]	55.1 [173]	61.6 [362]	19.5 [64]	32.5 [156]
Vitamin B6 (mg)	98.1[69-128]*	95.8[69.9-122]†	137[87.6-211]*	117[75.4-179]†	45.5 [778]	50.3 [158]	54.9 [323]	31.1 [102]	40.6 [195]
Folate (µg)	112[71.3-144]*	98.9[69.9-130]†	137[95.1-195]*	106[73.3-153]†	43.2 [738]	42.4 [133]	51.5 [303]	27.1 [89]	44.4 [213]
Vitamin B12 (µg)	76.1[41.1-145]*	77.2[33.8-146]†	223[123-374]*	200[104-337]†	42.5 [727]	61.2 [192]	61.2 [360]	18.9 [62]	23.5 [113]
Pantothenic acid (mg)	54.1[38.5-72.6]*	49.4[37.4-66.3]†	93.0[63.4-125]*	83.9[55.4-114]†	77.5 [1326]	89.5 [281]	93.7 [551]	56.7 [186]	64.2 [308]
Vitamin C (mg)	14.9[8.1-20.7]*	19.8[12.1-29.3]†	41.0[23.7-73.9]*	53.0[28.3-89.8]†	91.9 [1572]	99.7 [313]	98.1 [577]	89.0 [292]	81.0 [389]

* Indicates significant difference p<0.00001 between rural and urban men

† Indicates significant difference p<0.01 between rural and urban women

‡Refer to Table 1 for EAR/AI



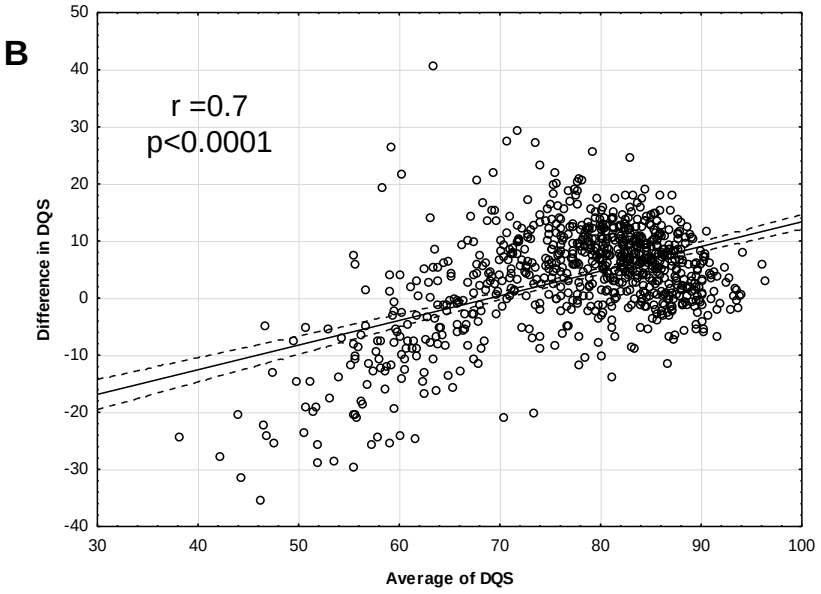


Figure 1 Bland Altman graphs for the rural group (A) and the urban group (B)

DISCUSSION

This is one of only a few studies to investigate the association between increased CVD risk during urbanisation in a developing country and dietary intake by not only considering individual nutrients, but also investigating dietary patterns by means of predefined DQS. It should be kept in mind that DQS have primarily been developed for Western countries and that their relevance for non-Western populations has not yet been confirmed[37]. As can be seen from the increased levels of known CVD risk factors, it is clear that the urban participants, especially urban women, were at an increased risk of CVD in comparison with their rural counterparts. The rural group was, furthermore, less educated than the urban group, and significantly more active. Increasing CVD risk in populations undergoing urbanisation has been described previously, and changing dietary intake is accepted as one of the contributing factors[3,4].

It has been understood that the traditional African rural diet is healthier and protects against CVD in that it is higher in fibre and fruit and vegetables and lower in animal products[5]. As can be seen from Table 3, in this population, however, the urban groups (men and women) had significantly higher intakes of all the macronutrients and micronutrients, except for carbohydrate as percentage energy, which was significantly lower in the urban group. These levels of intakes were markedly higher when looking at the percentage difference in intake between the rural and urban groups. Of particular interest is the total fat as percentage energy intake, which was 40% higher in the urban than in the rural group. Although the median fat intake in the urban groups was still below the CVD guideline of 30%, it was, however, only just below, suggesting that at least 50% of the population was consuming fat at the level of (and higher than) the guideline. Saturated fat, polyunsaturated fatty acids and cholesterol intakes were, however, well within the recommended ranges in both groups. This relatively low fat intake is similar to what has been seen in previous studies (THUSA) in this population[38].

Despite the increased micronutrient intakes in the urban group, intakes for some of the micronutrients were disconcertingly low when compared with the EAR/AI. More than 80% of the population (in both urban and rural groups), for example, did not reach the EAR/AI for dietary fibre, calcium, vitamin C and potassium. Interestingly,

these are also the micronutrients for which some evidence exists for protection against CVD, although most authors agree that dietary advice should not focus on the individual micronutrients but rather on food sources, such as fruit and vegetables[39-42]. In this population, fruit and vegetable intake was less than half the recommended 400g of fruit and vegetables per day, even in the urban group. Fruit and vegetables are good sources of dietary fibre, potassium, folate, antioxidants and minerals such as magnesium[43] and a low intake has been shown to contribute to CVDs such as IHD and ischaemic stroke[44]. On the other hand, for the other micronutrients, the urban group had median intakes above 100% of the EAR/AI. In 2003, the South African Department of Health embarked on a National Food Fortification Programme, resulting in the fortification of staple foods, such as maize meal and bread flour, with vitamin A, thiamine, riboflavin, niacin, pyridoxine, folic acid, iron, and zinc[45]. Therefore, the bread and maize meal porridge that make up the major component of the diet in this population are fortified, probably explaining the higher intakes of these micronutrients.

When comparing dietary intakes of the rural and urban participants using predefined DQS, both scores indicated an improved diet quality in the urban participants. The two scores agreed relatively well, although the HDI gave consistently higher values at low scores (<70% of the total) and the Adapted Thiele Score consistently higher values at high scores (>70% of the total). This could be due to the fact that they are designed to measure different aspects of diet quality, in that HDI measures diet quality according to dietary risk for chronic diseases of lifestyle such as CVD (prudence), while the Adapted Thiele Score additionally measures adequacy, as can be seen from the cut-offs used in each score.

An additional factor that may contribute to the discrepancy between the two scores is that the weights of the constituting factors differ in the two scores. In the Adapted Thiele Score micronutrients contribute to 1700 of the total 1900 (100 points allocated for each nutrient), while in the HDI, micronutrient intakes are reflected in only three of the nine components, i.e. dietary fibre; fruit, vegetables and pulses; and nuts and seeds. Therefore, in the urban group, where more participants had micronutrient intakes higher than the EAR/AI, this improved micronutrient intake will result in a greater improvement in the Adapted Thiele Score, in which micronutrient intakes

represent a larger portion of the score in comparison with the HDI. Regardless of the differences between the two variations of DQS discussed above, however, both scores indicated improved diet quality in the urban group, despite the increased CVD risk, placing doubt on the use of these DQS in this population in relation to CVD risk prevention. On a nutrient level however, the urban groups also showed 'improved' intakes, with higher micronutrient intakes in the urban groups and, although macronutrients were also higher, they were still below CVD prevention guidelines.

A different picture emerges, however, when looking at the results from a different perspective. It is clear that the fat intakes in the urban groups are fast approaching the CVD guideline of 30% of total energy and also that the intakes of micronutrients with suggested CVD protection were particularly low, even in the urban groups. It is therefore possible that without the protective effect of these micronutrients, the 40% higher fat intakes in the urban group, despite not being higher than the CVD prevention cut-off, may even at this level result in increased CVD risk factors. Macronutrient guidelines in populations with low micronutrient intakes therefore need to be interpreted with caution and may need to be revisited to take these low intakes into consideration.

Lastly, the use of the DQS in populations with such low intakes of macronutrients and micronutrients should also be interpreted with caution. The probable reason why the DQS indicated improved diet quality in the urban compared with the rural group is that the urban group had higher micronutrient intakes than the rural group, as well as in comparison with the EAR. From Table 4 it is clear that the median intake of the urban group for 12 of the 18 micronutrients was greater than 100%, while in the rural group only 4 were higher. Since the EAR/AI was used as the cut-off values in the Adapted Thiele Score, this would mean more urban participants would have a higher Deficiency Score than the rural participants, as can be seen from the median 17% higher Deficiency Score of the urban groups. Owing to the relatively low fat intakes of this population, however, while intakes were higher in the urban group, they did not yet reach the CVD cut-off and those participants would therefore not be penalised in the DQS for high fat intakes. This is supported by the small increase in the Excess Score in the urban compared with the rural groups (0.4 and 2%). Therefore, the

higher micronutrient intake in the urban group is reflected in the DQS while the higher fat intake is not, resulting in a net higher DQS.

In conclusion, urbanisation in black South Africans is associated with increased CVD risk, especially in women. Urban men and women had significantly higher intakes of both macronutrients and micronutrients, with macronutrient intakes well within the recommended CVD guidelines. While micronutrient intakes of the urban groups were generally higher than those of the rural groups, intakes of selected micronutrients were disconcertingly low in both groups. Both versions of DQS indicated improved diet quality in the urban groups and showed good agreement between the scores, although they seem to measure different aspects of diet quality. When interpreting and selecting a DQS, it should be clear how these cut-offs protect against the development of CVD, in other words, will a higher amount of a specific nutrient protect against (adequacy) or cause (prudence) CVD? When applying a predefined DQS in non-Western populations for the purpose of prevention of CVD risk, the scores, furthermore, should be interpreted against the background of the absolute levels of nutrient intakes and how these intakes relate to the cut-offs used, and should also be tailored to the specific population. Current guidelines for prevention of CVD may need to be revisited for populations with low dietary intakes, owing to the absence of the protective effect that results from adequate micronutrient intake.

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