4 "Make starchy foods part of most meals": a food-based dietary guideline for South Africa

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Abstract

A national working group, convened by the Directorate Nutrition in the Department of Health, recently revised the set of South African food-based dietary guidelines (FBDGs). The objective of this technical review paper is to motivate and support the FBDG "Make starchy foods part of most meals". The wording of this FBDG has not changed substantially from the original, but international scientific developments in carbohydrate nutrition necessitated a new look at the importance of this guideline. A brief review of the classification, definition and terminology used to describe the different types of dietary carbohydrates as advised by a Food and Agriculture Organization of the United Nations and World Health Organization consultation is followed by a discussion of the beneficial physiological and metabolic health effects of dietary carbohydrates. The review further warns against the practice of a low-carbohydrate diet and shows that, although carbohydrate intake may still be high in some South Africans, there is an unfortunate pattern of decreased intake of total carbohydrates and increased intake of added sugar as part of the nutrition transition. The implications of existing nutrient intake data on South Africans and the proven beneficial effects of minimally processed starchy foods (additional micronutrients and dietary fibre to the total diet) support the recommendation that South Africans should eat starchy foods in the form of minimally processed or whole grains, legumes and root vegetables, rather than as refined starches and sugars. It is recommended that this FBDG should not be implemented and promoted in isolation. Consumers should be informed about food that contributes starch to the diet, and to eat this food as part of a varied diet.

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Introduction

A national working group, convened by the Directorate Nutrition in the Department of Health, recently revised the set of South African food-based dietary guidelines (FBDGs). The FBDG message "Make starchy foods part of most meals" has not changed much from the message in the first set of FBDGs which advised South African to "make starchy foods the basis of most meals".[1,2] The corresponding paediatric FBDG[3] recommends that after six months of exclusive breastfeeding, babies should receive small amounts of solid food with gradual increases, so that by one year of age, the basis of most of these small meals should be starchy foods. The purpose of this FBDG was, and still is, to promote the intake of sufficient dietary carbohydrates from minimally processed, traditional and indigenous foods that are rich in starch, such as whole-grain and cereal products, legumes and some root vegetables, such as potatoes and sweet potatoes. The FBDG is formulated in a way to motivate consumers to plan meals around "starchy" or high-carbohydrate food, rather than protein food. These foods and their products are also sources of other types of carbohydrates and many micronutrients. The technical support paper motivating the message in 2001[2] focused on the classification of dietary carbohydrates, their role in human nutrition and health and the prevention of chronic diseases, the intake of carbohydrates in South Africa and how to choose appropriate carbohydrate-containing foods.

During the past 10 years, there have been many developments in our understanding of the role of different carbohydrates in health and disease, in harmonisation with terminology that classifies and measures the different types of carbohydrates and in the measurement of these types, and a renewed focus on controversies surrounding a low-carbohydrate diet.

This new technical support paper builds on the original one.[2] The classification of carbohydrates and the terminology recommended for use by the Food and Agriculture Organization (FAO) of the United Nations and the World Health Organization (WHO) will be briefly reviewed and updated from the recent literature. This will be based on:

- The chemical classification and physiological effects of carbohydrates.
- The use of the glycaemic index and glycaemic load to plan diets.
- The benefits of different carbohydrates, food and diets that are rich in carbohydrates.
- The short- and long-term effects of low- carbohydrate diets.

The paper includes new information on carbohydrate intake by South Africans during the present nutrition transition from a traditional to a more Westernised diet. It also recommends how to implement this important FBDG.

The classification of dietary carbohydrates

Carbohydrates are a diverse group of substances, each with distinct properties. In 1998, the FAO/WHO consultation[4] recommended that the classification and description of dietary carbohydrates should be based primarily on molecular size, dependent on the degree of polymerisation of monomeric (single sugar) units, with additional terms used to define nutritional groupings based on physiological properties.

There are three classes of chemically defined dietary carbohydrates, i.e. sugars, oligosaccharides and polysaccharides, as shown in Table I. Most of these carbohydrates are stored in plant-based foods. The main carbohydrates in foods from animal sources are lactose (milk sugar), milk oligosaccharides, and limited amounts of glucose (in the blood) and glycogen (a polysaccharide in liver and muscle meat).

Carbohydrate terminology

Several terms, often based on physiological properties, are used to describe dietary carbohydrates, and also for labelling purposes. These terms, as defined by the FAO/WHO,[4,5] are briefly described below. Although there is a separate FBDG for sugar and a technical support paper to support this FBDG,[6] the recommended terminology to describe sugar is included in this section for purposes of clarity.

Total carbohydrate

The term, "total carbohydrate" is often used to identify carbohydrates in food composition tables and is derived using two methods. The first calculates carbohydrate content "by difference", where the moisture, protein, fat, ash and alcohol contents of a food are determined, and subtracted from the total weight of the food. The difference is considered to be carbohydrates.[5] The problem with this approach is that the value includes non-carbohydrate components, such as lignin, organic acids, tannins, waxes and some Maillard products. The method also combines the analytical errors of the other analyses. The second approach measures total carbohydrate by direct analysis and summation of all carbohydrate components. This approach has been used in the UK since 1929.[7] The obtained total carbohydrate value does not include cell-wall polysaccharides, and was termed "available carbohydrates" by McCance and Lawrence.[7] This is the preferred method used to measure total carbohydrates.[5]

The value given in the South African food tables[8] for total carbohydrates is the sum of "available carbohydrates plus dietary fibre". Available carbohydrate values are also given, and defined as the sum of the free sugars, dextrins, starch and glycogen. The value includes added sugar (in any form), and includes sugars, oligosaccharides, starch (including dextrins), sugar alcohol and glycogen for vegetables and fruit.[8]

Sugar and sugars

The term "sugar" refers to sucrose (table sugar), while the term "sugars" is used to describe the monosaccharides (glucose, fructose and galactose) and disaccharides (sucrose, maltose and lactose) in food. Corn syrup is glucose syrup produced by the hydrolysis of corn starch, while high-fructose corn syrup contains both glucose and fructose. High-fructose corn syrup is used in some countries, but not in South Africa, to sweeten beverages and other products. The sugar alcohol, such as sorbitol, that is found in some fruit or manufactured from glucose is used to replace the sucrose in food, for example, in weight-loss and diabetic diets.[5]

The term "total sugars" is defined as all mono- and disaccharides, other than polyols, and is regarded as the most useful way of describing sugars.[5]

The term "free sugars", in contrast to "intrinsic sugars", was originally used to describe the mono- and disaccharides that are present in foods, including lactose. In recent

Table I: Classification of dietary carbohydrates[4,5]

Class	Degree of polymerisation	Subgroups	Principal components
Sugars	1	Monosaccharides	Glucose, fructose and galactose
	2	Disaccharides	Sucrose, lactose, maltose and trehalose
	2	Polyols (sugar alcohol)	Sorbitol, mannitol, lactitol, xylitol, erythritol, isomalt and malitol
Oligosaccharides	3-9	Malto-oligosaccharides (α-glucans)	Maltodextrins
		Non-α-glucan oligosaccharides	Fructo- and galacto-oligosaccharides, raffinose and stachyose
Polysaccharides	10 and more	Starch (α-glucans)	Amylose, amylopectins and modified starches
		Non-starch polysaccharides	Cellulose, hemicelluloses, pectin, arabinoxylans, ß-glucan, glucomannans, plant gums, plant mucilages and hydrocolloids

years, the term has been used to describe mono- and disaccharides added to food by manufacturers, cooks or consumers, and includes sugars that are naturally present in honey, syrups and concentrated fruit juices. This term is synonymous with the terms "non-milk extrinsic sugars" and "added sugars". The latter terms may be confusing, and their use is not recommended.[5]

However, the term "added sugars" is used in South Africa and is synonymous with "free sugars", indicating sugars that are added to food and beverages during the manufacturing of products, home preparation, cooking and eating, and include table sugar and brown sugar (sucrose), honey, molasses, fruit juice concentrate, corn sweetener, lactose, glucose, high-fructose corn syrup and malt syrup.[5]

The South African food composition tables[8] give values for "added sugar", which include "all mono- and disaccharides added to food and do not include sugars that are naturally present in the food, e.g. the lactose in milk and the fructose in fruit. Added sugar also includes honey". The values for added sugars versus intrinsic sugars cannot be determined in a laboratory, so are derived from recipe analysis.

Starch, modified starch and resistant starches

Starch consists of glucose polymerised to form amylose (non-branched helical chains with a degree of polymerisation of approximately 10^3) and amylopectin (highly branched chains with a degree of polymerisation of 10^3-10^4). Starches occur in partially crystalline granules in plant foods. Starch is the principal carbohydrate in most diets because it is the storage carbohydrate in plant foods, such as cereals, grains, root vegetables and legumes.[5] Most common cereals contain 15-30% amylose, but some foods, such as "waxy" maize, sorghum or rice, contain mostly amylopectin.[5]

The term "modified starch" is used to describe starches in which the amylase to amylopectin ratio has been modified by plant breeding or other techniques during manufacturing to change the functional properties of the starch to produce foods with a high-resistant starch content.[5] "Resistant starch" is the term to describe the sum of starch and its digestion products, such as maltose, maltotriose and α-limit dextrins that are not hydrolysed and absorbed as glucose in the small intestine.

As reviewed by Cummings and Stephen,[5] the crystalline configuration of amylose and amylopectin confers distinct X-ray diffraction patterns on starch granules. The "A" type is characteristic of cereals, the "B" type of potato, green banana and high amylose starches, and the "C" type of legume starch. When raw, B-type starches are resistant to amylase digestion in the small gut. When cooked, starch granules gelatinise, lose their crystalline structure and can be digested by amylase. However, when cooled, starch granules re-crystallise because of retrogradation and become resistant to digestion in the small gut.[5] This characteristic is nutritionally important, because it partly determines the glycaemic response to starch. Cold starches have a lower glycaemic index than hot, starchy food. Also, starch that is not digested in the small gut will move to the large gut, where it will be fermented, together with non-starch polysaccharides, with all the health benefits of this process. Therefore, as mentioned previously, "resistant starch" is the term to describe the sum of starch and its digestion products, such as maltose maltotriose and α-limit dextrins that are not hydrolysed and absorbed as glucose in the small gut.

Functionally, resistant starch can be divided into four groups:[9]

- Resistant starch I: Starch that is physically inaccessible to digestive enzymes in the mouth and small gut, and which is mostly present in whole grains.
- Resistant starch II: Starch granules with "B" diffraction patterns, e.g. potato, green banana and waxy starches.
- Resistant starch III: Retrograded starch, e.g. starchy foods that have cooled after processing and cooking.
- Resistant starch IV: Modified starches that are resistant to digestion in the small gut.

Oligosaccharides

Oligosaccharides or short-chain carbohydrates[5] are a diverse group of carbohydrates,[5,10] with a degree of polymerisation of between 2 and 9 (sometimes more than 9, as in insulin) consisting of monosaccharides joined by glycosidic linkages that are resistant to digestion in the small gut. They include raffinose, stachyose, verbacose, inulin and other fructo- and galacto-oligosaccharides. Oligosaccharides are found in plant seeds, such as peas, beans and lentils, and in artichokes, chicory, asparagus, onions, garlic and leeks, as well as in human milk as lacto-N-tetraose. Because they are indigestible, they move to the large gut, where they are fermented. The oligosaccharides in human milk are the principal growth factor for bifidobacteria in the infant gut.[5] Therefore, they act as prebiotics and are now developed by the food industry as ingredients.

Prebiotics

The term "prebiotics" is a physiological one used to designate all carbohydrates (disaccharides, oligosaccharides and polysaccharides) that are not digested in the small gut, and which are fermented in the large gut.[5,10] During this process, they stimulate the growth and activity of bifidogenic and lactic acid bacteria in the large gut, with beneficial effects for the host.[11] They are thought to "balance" the microflora in the large gut to a healthier distribution thereof, and there is some evidence that they improve gut health, increase calcium absorption and bone mineral density, and prevent the risk of several diseases.[11] "Probiotics" is the term used to describe the

live microorganisms that are found in naturally fermented products. They may be added to food, such as yoghurt, because of their health benefits.

Non-starch polysaccharides and dietary fibre

"Dietary fibre" is an umbrella term that describes a group of intrinsic cell wall non-starch polysaccharides that are not digested in the small gut, but are fermented in the large gut to short-chain fatty acids (acetic, butyric and propionic acids). These products are absorbed, provide energy, and have distinct physiological and metabolic effects in the gut.[5,12] The fact that dietary fibre is broken down in the large gut to provide energy and other substances for metabolism is the reason why fibre and nondigestible starch should not be described as "unavailable carbohydrates".

The controversy surrounding an internationally agreed definition of dietary fibre, how to label the attributes of fibre-containing food products, and how to measure the dietary fibre content of foods,[5,12] resulted from a complex set of circumstances. These circumstances were the verification of the original hypothesis from the 1970s that diets that are high in fibre protect against many noncommunicable diseases (NCDs) (which established the concept that fibre "is healthy"), the promotion and marketing of high-fibre products by the food industry (developed by adding fibre components and novel fibre and oligosaccharides to food products), and the inability to agree on dietary fibre measurements. Most of the methods in use, except the measurement of non-starch polysaccharides, also measure non-carbohydrate substances which gives false high values for dietary fibre.

The terms "soluble dietary fibre" and "insoluble dietary fibre" were adopted to describe groups of fibre components with different, but overlapping, physiological effects. Soluble fibre, mainly from legumes, some fruit and oats, has beneficial metabolic effects, because it influences digestion and the absorption of glucose and lipids. Insoluble fibre, mainly bran from cereals, exerts a beneficial effect in the large gut, affecting fermentation, stool weight and bowel habits.[5] However, the measurement of these components is pH dependent[5] and the description is not useful, because it does not reflect the physiological properties of whole foods.

Glycaemic carbohydrates

The term "glycaemic carbohydrates" is used to describe all carbohydrates that are digested and absorbed as glucose for metabolism. Glycaemic carbohydrates include most mono- and disaccharides, some oligosaccharides (maltodextrins) and rapidly digested starches. Slowly digested starches are also glycaemic, but resistant starch, non-starch polysaccharides and most oligosaccharides are nonglycaemic. Most foods contain a mixture of glycaemic and non-glycaemic carbohydrates. The extent to which a carbohydrate food raises blood glucose, compared to the equivalent amount of carbohydrates in a reference food, has been expressed as the glycaemic index of the food and can be used to describe the physiological effect of a particular carbohydrate-containing food.[5]

Glycaemic index and glycaemic load

As mentioned, the terms "glycaemic index" and "glycaemic load" are based on the ability of a food to raise blood glucose levels.[13] The glycaemic index of a food is the ability of a fixed amount of carbohydrates in the food to raise blood glucose, in comparison with the same amount of carbohydrates from glucose or another reference food. It is expressed as a percentage of the area under the glucose response curve after ingestion of the food, in relation to the area obtained with glucose or the reference food.[13] Low-glycaemic index foods are used to plan diabetic diets, in particular.[13] However, the glycaemic index of foods is influenced by many food factors (e.g. the presence of dietary fibre and protein and fat) and processing methods, and also individual factors that influence digestion and absorption. Therefore, the glycaemic index is variable, and should be used with care when planning diets, because it is only one characteristic of the food. For example, low-glycaemic index foods may be high in saturated fat or low in micronutrients. The concept of the glycaemic load was developed because different serving sizes of carbohydrate-containing foods are eaten.

The glycaemic load also takes into account the total amount of carbohydrates eaten. It is calculated as the product of the glycaemic index and the glycaemic carbohydrates in the serving size. Therefore, the glycaemic load of whole diets can also be calculated. Venn and Green[13] reviewed the evidence of the beneficial, although small, effects of the consumption of low-glycaemic index and low-glycaemic load foods and diets. Their review showed that the glycated proteins haemoglobin A_{1c} and fructosamine could be lowered by reducing the glycaemic index of the carbohydrate foods consumed by patients with diabetes. This effect was modest, and the long-term impact of such a modest effect has not been tested. The review also indicated that there are many controversies and conflicting findings on the effects of lowering the glycaemic index or glycaemic load of foods and total diet on specific blood lipids [total cholesterol and low-density lipoprotein (LDL) and high-density lipoprotein (HDL) cholesterol], the insulin response, satiety and the control of body weight. The authors concluded that there are limitations to a previous FAO/WHO statement[4] that "the concept of the glycaemic index of a food provides a useful means of selecting the most appropriate carbohydrate-containing food for the maintenance of health and several disease states". These limitations include the wide inter- and intra-individual variations of the glycaemic index of foods (especially

if only a small number of subjects is studied to measure the glycaemic index of a food), and our present lack of knowledge about the magnitude of possible beneficial long-term effects of low-glycaemic index foods and low-glycaemic load diets on health. As mentioned above, it is important to utilise glycaemic index with care, because it is only one characteristic of the food and does not provide information on the total nutrient composition.

Whole grains

"Whole grain" is defined by the South African Department of Health[14] in the *Government Gazette* as "grains from cereals, which, after milling (if milled), naturally contain all the components, namely endosperm, bran, germ and all the macronutrients, micronutrients and trace elements of the original unprocessed whole kernel". Other authorities, such as the US Food and Drug Administration,[15] have similar, but slightly differently worded, definitions: "Whole grains are cereal grains that consist of the intact, ground, cracked or flaked caryopsis, whose principal anatomical components, the starchy endosperm, germ and bran, are present in the same relevant proportions as they exist in the intact caryopsis".

Wholegrain products are actively promoted as desirable foods for both adequate dietary intake and protection against NCDs. There is scientific evidence that whole grains provide energy, macronutrients (proteins, carbohydrates, fats and dietary fibre), micronutrients (vitamins and minerals) and several anti-nutrient phytochemicals in proportions and forms that contribute to nutrient requirements, and slower digestion and absorption of carbohydrates, the colonic fermentation of fibre and resistant starch, bile acid excretion (lower blood cholesterol levels) and numerous other physiological and biochemical effects. Collectively, these effects result in improved maintenance of optimal body weight and a reduced risk of many NCDs. However, evaluating the evidence at population level is difficult, because of the many variations of the wholegrain content of products that are eaten. More research is needed on the effects of specific wholegrain products.

In the USA and other countries, a product may bear the stamp of the Whole Grain Council, which also carries a number that indicates the percentage of whole grain in the product. A stamp labelled "100%" means that all of the grain ingredients in the product are whole grain. Three servings of this product would provide the recommended daily amount of whole grain. Therefore, a lower number implies that more servings would need to be consumed. In the USA, manufacturers can make factual statements about whole grain on the label (e.g. 100% or 10 g of whole grains), provided that the claims are not false or misleading.[15] The absence of officially formulated and published requirements or guidelines for labelling whole-grain products in South Africa has resulted in varied practices related to the labelling of wholegrain products, and may lead to confusion among consumers.

The benefits of a high carbohydrate intake

The discussion on the terminology used to describe and define carbohydrates in food, based on chemical, physical and physiological (health outcome) characteristics, suggests that this diverse group of substances has a number of positive effects. Although many experimental and controlled studies have indicated the specific effects of exact carbohydrates, the basis of dietary recommendations is epidemiological evidence, which has demonstrated that a diet that is rich in whole grains and cereals, fruit, vegetables and legumes is protective against the development of NCDs.[16-21] As mentioned, the purpose of the FBDG "Make starchy foods part of most meals", is to ensure that sufficient unrefined or minimally processed foods that are rich in starch and non-starch polysaccharides are consumed by South Africans. "Starchy foods" include grains or cereals (mainly wheat, maize, rice, oats and sorghum in South Africa), legumes (dried beans, lentils, peas and soya) and some root vegetables, such as potatoes and sweet potatoes.

Dietary energy and adequacy

All food groups contribute to dietary adequacy. However, carbohydrates from whole grains and minimally processed starchy foods should be the principal energy source in the diet. These foods also provide many other substances, such as fibre and micronutrients, that are necessary for adequate nutrition. The physiological effects of carbohydrates depend on the extent, site and rate of digestion or fermentation and the absorption of the end products, which are influenced by the food matrix, processing, effects of other consumed foods, and individual gut function. The 2003 FAO/WHO consultation[16] advised that 55-75% of total dietary energy should be provided by carbohydrates, with less than 10% from added sugars. The subsequent FAO/WHO consultation[17] questioned the justification of the lower recommended limit, and suggested a revision to 50%. The consultation also concluded that "the nature of dietary carbohydrates appears to be a more important determinant of health outcomes than the proportion of dietary energy derived from carbohydrate intake".[17]

In South Africa, the staples, maize meal and white and brown bread flour, have been fortified with several micronutrients since October 2003 to contribute to dietary adequacy. The amount (frequency, number and size of the serving) of carbohydrate-rich foods needed to provide 50% of total energy depends on the age and energy requirements of individuals. A general guideline is to eat 10 food guide units daily, which could include porridge, a carefully selected breakfast cereal that is rich in whole grain (without added sugar), and rice, pasta, potatoes and bread. One food guide unit is equivalent to one slice of bread (35-40 g).

Protection against NCDs

Diets that are rich in starchy foods (e.g. grains and cereals in minimally processed forms, legumes and root vegetables), help to protect against the development of NCDs such as heart disease, diabetes and cancer, through a variety of mechanisms.[16-21] Evidence of these effects, reviewed by Mann[20] in relation to cardiovascular disease and diabetes, and by Key and Spencer[21] in relation to cancer, comes from randomised controlled trials that measured dietary effects on risk factors and markers of cardiovascular disease.[20] Epidemiological studies that examined the relationship between dietary exposure and morbidity and mortality, in relation to several NCDs, also provide support. The mechanisms include the replacement of fat, especially saturated fat, in the diet,[16-21] and the presence of oligosaccharides, resistant starch and dietary fibre contributed by these foods, which all have beneficial effects on blood lipids.[20] These foods also ensure that the glycaemic index of meals and the total diet is low, protecting against insulin resistance and several NCDs.[20] The presence of dietary fibre, oligosaccharides and resistant starch in these foods stimulates fermentation in the colon, contributing to health by having a positive effect on stool volume and frequency, beneficial bacterial growth, the production of butyric acid (which protects against colon cancer), the absorption of calcium, and the strengthening of immune responses.[16-21]

Variety and satiety: healthy food behaviour

Although there is controversy on the satiety value of specific foods and diets, there is some evidence that diets that are high in dietary fibre, oligosaccharides and resistant starch have a high satiety index and will counter the intake of too much energy and overweight.[16,18] These foods also bring variety to the diet and help to expose children to different foods, once they have been introduced to complementary foods. This helps to develop healthy eating patterns.[22]

Affordability and traditional eating patterns

Starchy foods, and specifically grains (cereals), are staples in many countries because of their availability and affordability. Thus, they became part of traditional eating patterns which are generally known to protect against NCDs. The adequacy and protein quality of traditional diets can be improved by adding sufficient amounts of legumes, vegetables, milk or fermented milk, or small amounts of peanuts and meat (chicken), to cereal-based diets.[23] Cereals, and thus, carbohydrates, will form the largest part of energy intake, up to 70% of total energy, in any country struggling with poverty, food and nutrition insecurity and malnutrition. The challenge is to convince consumers that these foods should largely be eaten in minimally processed forms, and that a variety of other foods should be eaten with the starchy staple.

Low-carbohydrate diets

The scientific evidence on low-carbohydrate diets has been reviewed by several authors.[24,25] These reviews clearly indicate that the weight loss achieved by low-carbohydrate diets can be ascribed to lower energy intake, and not specifically to low carbohydrate intake. Furthermore, the reviewers have demonstrated that low-carbohydrate diets are not sustainable. They often do not contain sufficient dietary fibre, thiamine, folate, vitamins A, E and B_6, calcium, magnesium and potassium, which may lead to ketosis, raised blood uric acid, dehydration, gastrointestinal symptoms and hypoglycaemia. All these potentially pose a serious health risk to individuals. Potential long-term effects include detrimental changes in serum lipids (increases in LDL cholesterol and decreases in HDL cholesterol) with an increased risk of cardiovascular disease, as well as mobilisation of calcium from the bones (because of chronic metabolic acidosis) and the consequent effects on bone health.

Therefore, it is unfortunate and irresponsible that low-carbohydrate diets are promoted aggressively in South Africa, especially against the background of our high burden of disease, including chronic diseases and conditions related to underdevelopment.[26] Cereal and other starchy food form an important part of the diet, especially in countries suffering from poverty, food and nutrition insecurity and malnutrition. There is no good reason to limit the intake of cereals, and specifically whole-grain cereals with little added sugar, in the diets of both children and adults. Detrimental effects on health and the risk of disease have been documented as a result of low-carbohydrate diets. If individuals have to follow a low-carbohydrate diet, necessary adjustments (i.e. increases) to vegetable and dairy intake should be made in an effort to increase dietary adequacy and the protective effects against NCDs.

The carbohydrate intake of South Africans

The Medical Research Council computer programme, based on the new South African food composition tables,[8] provides data on starch and individual mono- and disaccharide sugars. Unfortunately, these data are not available for all foods, and cannot be used to evaluate the mean nutrient intake at population level. However, although limited, some data on total and "available carbohydrates", added sugar and the dietary fibre intake of South African groups are available. These data have been analysed and reviewed by Steyn.[27]

The pattern that emerged from the review is that white, coloured and Indian South Africans have a relatively low total carbohydrate intake (mean < 50% of energy) and a high intake of added sugar (mean > 10% of energy), while Africans, especially rural Africans, have a high intake of total carbohydrates (50-70% of energy) and varying

Table II: Mean (95% confidence intervals) of carbohydrate intake of Prospective Urban and Rural Epidemiological study subjects in 2005 and 2010*

Variable	Rural men	Urban men	Rural women	Urban women
Year	**2005**	**2005**	**2005**	**2005**
Number	332	392	634	592
Total energy (kJ)	6 973 (6 627-7 319)	10 054 (9 641-10 468)	6 107 (5 914-6 300)	9 008 (8 694-9 323)
Total carbohydrates (g)**	259 (246-271)	334 (320-349)	236 (229-243)	294 (283-304)
% energy of total energy	63	56	65	55
Added sugar (g)	26 (23-29)	43 (40-47)	27 (25-29)	46 (43-48)
% energy of total energy	6	7	7	8
Total dietary fibre (g)	19 (18-19)	28 (25-28)	17 (17-18)	23 (22-24)
Year	**2010**	**2010**	**2010**	**2010**
Number	212	205	469	367
Total energy (kJ)	9 924 (9 207-10 642)	13 922 (13 186-14 659)	9 589 (9 174-10 005)	12 000 (11 487-12 513)
Total carbohydrates (g)	343 (318-369)	449 (423-474)	343 (328-358)	388 (372-405)
% energy of total energy	58	54	60	54
Added sugar (g)	61 (53-70)	74 (67-82)	64 (57-71)	78 (72-85)
% energy of total energy	10	9	11	11
Total dietary fibre (g)	26 (24-28)	37 (34-39)	25 (24-27)	32 (31-34)

* Unpublished data, with the permission of the study leaders
** "Available carbohydrates" according to South African food composition tables[8]

amounts of added sugar. All groups seem to have a relatively low total dietary fibre intake (mean < 20 g/day).

Several of the reviewed studies also reported that, with the urbanisation of Africans and the corresponding rapid nutrition transition that has been observed in South Africa, there has been a decrease in total carbohydrate and an increase in added sugar intake.[27]

In Table II, the carbohydrate intake of rural and urban African men and women in the North West province, followed up for five years in the Prospective Urban and Rural Epidemiological (PURE) study, is provided to illustrate these unfortunate changes during the nutrition transition (unpublished data). Total carbohydrate intake was lower in urban men and women, and added sugar intake higher. Total carbohydrate intake decreased and added sugar intake increased over time in both rural and urban areas. These findings indicate a change in the type of carbohydrate-rich foods chosen, contributing less total carbohydrates, but more added sugar. The dietary fibre intake actually increased, probably as result of the reported higher availability and intake of vegetables and fruit in urban areas, and over time in these subjects.

The existing pattern of relatively low intake of total carbohydrates and dietary fibre and relatively high intake of added sugar in many groups of South Africans, as well as the changes observed during the urbanisation of Africans, is a strong motivation to promote an increased intake of starchy foods in unrefined and minimally processed form.

Promotion of the FBDG message "Make starchy foods part of most meals"

In summary, this paper has indicated that most South Africans should eat, and continue to eat, starchy foods in unrefined forms for many health reasons. The current national fortification of the staples, maize meal and bread flour, is a step in the right direction, especially given the widespread subclinical micronutrient deficiencies present in South Africa.[28]

The real challenge lies in encouraging South Africans to eat more wholegrain foods and not to rely on highly processed foods, such as breakfast cereal with added dietary fibre extracts and sugar. Because of the lack of appropriate labelling regulations, South African consumers may be misled by food labels that indicate "whole grain". A product made from refined flour with a few whole grains sprinkled on top is not a wholegrain product. An alternative would be to use the word "minimally processed" to promote the intake of wholegrain foods and products.

Concomitant with the promotion of whole grains, increased consumption of legumes and root vegetables is advised. In addition to explaining the health benefits of these foods to consumers through programmes that utilise social marketing principles, such food must be made available and affordable to everybody. When providing food and supplements for the vulnerable (e.g. those in antenatal clinics and participating in school nutrition programmes), the focus should be on wholegrain, legume and root vegetable products. A barrier to implementation may be the shorter shelf life of wholegrain or minimally

processed foods and products. The reason for the shorter shelf life is that the oils found in the germ of wholegrains may be negatively affected by exposure to heat, light and moisture over long periods.[29,30] Consumers should be informed on how to overcome this barrier, for example, by buying smaller quantities more often, or storing these foods and products in airtight containers in a cool, dry place or in the fridge or freezer.

When implementing this guideline, it is important that it is promoted with the whole set of FBDGs, especially the legume and vegetable and fruit FBDGs, to educate consumers that starchy food could constitute one or more of these foods. This could be carried out by focusing on traditional recipes in the different population groups where whole grains, legumes and root vegetables are combined together in dishes.

Conclusions and recommendations

The pattern of declining total carbohydrate intake of South Africans was confirmed by the results of the PURE study, which compared the carbohydrate intake of rural and urban Africans over time. The PURE study also showed an increased intake of added sugar, indicating an unfortunate change in the type of carbohydrate-rich foods eaten. Therefore, existing nutrient intake data provide the motivation for South Africans to eat more starchy foods in the form of whole grains (minimally processed cereal and grain products), legumes and root vegetables, to increase their total carbohydrate intake without increasing added sugar consumption.

It is recommended that nutritionists in South Africa use the terminology to describe different carbohydrates that is advised by the FAO/WHO consultation. It is also suggested that this terminology should be used in South African food legislation. It is further advised that the implementation of this FBDG should not be promoted in isolation, that consumers should be made aware that starchy foods include whole grains, legumes and root vegetables, and that food from these three groups is often eaten together in traditional diets.

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