Dietary macronutrient intake of Saudi males and its relationship to classical coronary risk factors

Eman M. Alissa, *BSC,* ***Suhad M. Bahijri,*** *BSC, PhD,* ***Gordon A. Ferns,*** *MRCS, FRCPath.*

ABSTRACT

Objective: To investigate whether the dietary intake of energy; macronutrients; and fiber differ between age groups, racial groups and socio-economic classes among males from the Western province of Kingdom of Saudi Arabia (KSA).

Methods: Data were collected from 303 male subjects, aged 15-80 years. They were selected randomly from King Abdul-Aziz University Hospital, Jeddah, KSA from October 2001 to November 2003 and grouped according to their age into 3 groups. The subjects were asked to complete a questionnaire concerning their demographic characteristics, health history, lifestyle, and dietary habits.

Results: Energy and carbohydrates intake fell with age ($p<0.05$). Total dietary carbohydrates and fat intake were similar for all groups when expressed as a percentage of energy intake. The percentage energy as protein increased with age ($p<0.05$). Mean cholesterol intake was high for all groups, but fell with age group ($p<0.0001$). Saturated fat and monounsaturated fat intake, expressed as percentage energy intake were both high, whereas polyunsaturated fat intake was low. The youngest group had the highest percentage energy provided by saturated fatty acid ($p<0.001$), and the lowest percentage energy as polyunsaturated fatty acid ($p<0.05$) compared to the other groups. The intake of fibre rose with age was significantly higher in the older group ($p<0.05$).

Conclusion: Diet consumed by urban dwellers in KSA appears to have resulted in an imbalance of macronutrient intake among all sectors of the population. This problem can only be averted by raising public awareness and the development of appropriate population-specific nutritional guidelines.

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The risk of several chronic conditions, for example coronary heart disease is known to vary markedly geographically, by ethnicity and socio-economic status. Some of these differences may be explained in part by differences in dietary intake.[1-3] However, most of these studies have been undertaken in Western Caucasian populations. There is limited comparative information in other populations that may have different dietary patterns and lifestyles. The global prevalence of cardiovascular disease is rising rapidly, and it has been estimated to be the major cause of mortality by 2020.[4] The wide spread adoption of a western-type diet has been blamed for this. The Kingdom of Saudi Arabia (KSA) has undergone a significant improvement in socio-economic status over the last 3 decades. This has been paralleled by changes in lifestyle and diet including an increased

From the Faculty of Medicine (Alissa, Bahijri), King Abdul-Aziz University, Jeddah, *Kingdom of Saudi Arabia* and the Centre for Clinical Science and Measurement (Alissa, Ferns), School of Biomedical and Molecular Science, University of Surrey, Guildford, *United Kingdom*.

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Address correspondence and reprint request to: Dr. Eman M. Alissa, Clinical Biochemistry Demonstrator, Clinical Biochemistry Department, Faculty of Medicine, King Abdul-Aziz University, PO Box 12713, Jeddah 21483, *Kingdom of Saudi Arabia*. Tel. +966 (2) 6644444 Ext. 25242. Fax. +966 (2) 6643499. E-mail: em_alissa@yahoo.com

consumption of processed food, which is known for its suboptimal content of minerals especially trace elements; a reduction in physical activity[5,6] and an increase in smoking habit.[7] Data on the nutrient intake and the nutritional status of the Saudi population are scarce.[8,9] Furthermore, the relationship between diet, socio-economic status, lifestyle and cardiovascular risk factors has not been studied in KSA. This information may be important for the assessment of future health needs, and perhaps allow the initiation of a preventive strategy. The aim of the present study is to investigate whether the dietary intake of energy; macronutrients; and fiber differ between age groups, racial groups and socio-economic status class among a diverse sample of males from the western province of KSA, a region containing a heterogeneous population of native Arabs and immigrants.

Methods. Data were collected from 303 male subjects, aged 15-80 years from the period October 2001 to November 2003. They were recruited randomly from King Abdul-Aziz University as well as blood donors and patients from the King Abdul-Aziz University Hospital (KAUH), Jeddah, KSA. They were grouped according to their age tertiles into 3 subgroups: <33 years, 34-49 years, and ≥ 50 years. Sampling was carried out using the systematic random sampling method. Eligibility criteria for inclusion were subjects who were currently healthy and/or had no evidence of established coronary disease (such as orthopedic patients). Exclusion criteria included the use of on antacids, laxatives, painkillers, or antioxidant supplements and subjects with established renal or hepatic disease. Subjects were classified ethnically according to the place of origin of their ancestors using the following categories; Arabian tribes, Africans, Caucasian Mid-Asians, Indian Asians, Far Eastern Asians, and Mediterraneans. Informed consent was obtained from the study participants.

The subjects were students and staff of KAUH and they were instructed to complete an interviewer-administrated questionnaire concerning their demographic characteristics, health history, lifestyle habits, and dietary habits. The latter was used to assess their dietary intake of energy and macronutrients. Subjects were also questioned concerning symptoms of peripheral vascular disease, current use of prescription and non-prescription medications and supplements. Nine clinical factors were assessed: age, history of diabetes, history of hypertension, history of dyslipidemia, and family history of diabetes and coronary heart disease (first-degree relative with myocardial infarction or cardiac death before age of 55). Hypercholesterolemia was defined as a total cholesterol level ≥5.2 mmol/L, low-density lipoprotein-cholesterol ≥3.36 mmol/L and high-density lipoprotein-cholesterol <1.04 mmol/L.[10] Hypertension was defined as systolic blood pressure (BP) >140 mm Hg or diastolic BP >90 mm Hg, or current use of antihypertensive medication.[11] Diabetes was defined as a history of diabetes (fasting blood glucose >7 mmol/L) or treatment with insulin or oral hypoglycemic agents.[12] Anthropometric measurements included height (m^2); weight (kg), and body mass index (BMI). Body mass index was calculated as weight in kg/m^2 and classified into normal; defined as BMI<25 kg/m^2, over weight as BMI = 25-29.9 kg/m^2, obese as BMI ≥30 kg/m^2.[13] With regard to smoking habits, non-smoker, ex-smoker, and current smoker formed the 3 major categories. Physical activity was graded by the participant according to the number of episodes of exercise undertaken per week and were categorized as active (≥ 3 times/week) or inactive (<3 times/week) according to the recommendations of the American Heart Association consensus statement on primary prevention of coronary diseases and from the United States of America (USA) Surgeon General's report.[14] The socio-economic status was classified into 3 categories: low, middle, and upper social classes based on an aggregate score of the educational attainment, occupation, and material conditions.

Assessment of dietary intake. Dietary intake was assessed using a validated food frequency questionnaire.[15] The dietary intake of all nutrients for each individual was then expressed in terms of percentage recommended nutrient intake (RNIs) for United Kingdom (UK) adults. As currently there are no published nutrient requirements for the Saudi population, the most recent version of UK dietary reference values[16] was used as a standard for the evaluation of the pattern of nutrient intake. The recommended nutrient intake was set as the mean ± 2SDs. The food frequency questionnaire (FFQ) asked about frequency of intake of 94 food items and beverages in the past year. Foods and beverages were expressed in serving sizes (grams), household measures (cup, spoon) or natural units (slice of bread, apple). Food items were classified into 11 categories: grains (5 items), bread (5 items), fruits (11 items), vegetables (19 items), legumes (4 items), nuts (4 items), meats, poultry and fish (12 items), dairy products (10 items), fat and oil (3 items), soft drinks (6 items), miscellaneous (12 items) and junk food (3 items). Subjects were asked to select either per day, per week, per month or almost never as a denominator and then to enter frequency of use. The nutrient data used was based primarily on the UK food composition tables, supplemented by the food composition tables for use in East Asia and the USA handbook of food composition[17] and all were used for computing the macronutrients intake, while data on the nutrient composition of traditional local foods not included in the tables were derived from another local study.[15]

Descriptive statistics were calculated, and results were expressed as mean±SD for normally distributed data and as median and inter quartile range for non-normally distributed data and as proportions for categorical data. Mean ± SD nutrients and energy intake were estimated. The distribution of the intake frequency for these dietary constituents was examined for the total sample stratified by age. The percentage of total energy contributed by fat, protein, and carbohydrates was also calculated. Macronutrient intake was adjusted for energy according to the method of Willett and Stampfer.[18] Each age subgroup was then compared for demographic characteristics and nutrients intake using x^2 or Kruskal-Wallis tests. Associations between characteristics were examined using Pearson and Spearman correlation coefficients. Values of $p<0.05$ were accepted as statistically significant. Statistical analysis was carried out using the Statistical Package for Social Sciences (version 11.5) software.

Results. The demographic characteristics of the study population, stratified by age groups are shown in **Table 1**. The distribution of racial characteristics was similar for each age group ($p>0.05$), with approximately 54% of the total population being of Arabic descent. Body mass index increased significantly with age ($p=0.001$), as did the prevalence of diagnosed hypertension, hypercholesterolemia and diabetes mellitus ($p<0.0001$). The prevalence of hypertension was particularly high (58%) in the subgroup which was >50 years old, and approximately 37% of these subjects were diabetic. The prevalence of these

Table 1 - Demographic characteristics of subjects in different age groups.

Variables	Age groups (years) <33 n (%)	34-49 n (%)	≥50 n (%)	*p* value
Number of patients	101	99	103	
Age (years) mean±SD	24.8 ± 4.7	41.5 ± 5.2	61 ± 9.5	Not significant
Height (cm) mean±SD	170 ± 8.7	168.5 ± 7.2	168.3 ± 8.2	Not significant
Weight (kg) mean±SD	76.8 ± 16.8	82.6 ± 16	81.6 ± 15.9	<0.05
Body mass index (kg/m2) mean±SD	26.5 ± 5.2	29 ± 5†	28.8 ± 5.2‡	<0.0001
Systolic blood pressure (mm Hg) mean±SD	120.3 ± 9.5*	123.7 ± 14.7	128.1 ± 20.9‡	<0.05
Diastolic blood pressure (mm Hg) mean±SD	79 ± 7.1	80 ± 8.9	80 ± 10.5	Not significant
Hypertensive	4 (4)	20 (20)	60 (58)	<0.0001
Hypercholesterolemic	3 (3)	17 (17)	27 (26)	<0.0001
Diabetics	1 (1)	18 (18)	38 (37)	<0.0001
Body mass index				0.001
Normal	47 (47)	20 (20)	26 (25)	
Overweight	27 (27)	39 (39)	38 (37)	
Obese	27 (27)	40 (40)	39 (38)	
Family History				Not significant
Heart disease	25 (25)	26 (26)	20 (19)	
Diabetes mellitus	51 (51)	51 (52)	41 (40)	
Race				Not significant
Arabian tribes	63 (62)	52 (53)	50 (49)	
Africans	6 (6)	8 (8)	12 (12)	
Caucasians	9 (9)	9 (9)	9 (9)	
Indians	9 (9)	6 (6)	7 (7)	
Far Easterns	7 (7)	8 (8)	2 (29)	
Mediterraneans	7 (7)	16 (16)	23 (22)	
Socio-economic status				<0.0001
Low	31 (31)	33 (33)	58 (56)	
Middle	68 (67)	61 (62)	35 (34)	
High	2 (2)	5 (5)	10 (10)	
Smoking status				<0.0001
Never	51 (51)	44 (44)	56 (54)	
Former	9 (9)	16 (16)	35 (34)	
Current	41 (41)	39 (39)	12 (12)	
Physical activity				<0.05
<3 times/week	46 (46)	37 (37)	58 (56)	
≥3 times/week	55 (55)	62 (63)	45 (44)	
On a diet	18 (18)	29 (29)	28 (27)	Not significant

Categorical data were compared by x^2 test, continuous variables were compared by Kruskal-Wallis test.
*$p<0.05$ (young and middle age groups), †$p<0.001$ (young and middle age groups), ‡$p<0.05$ (young and old age groups)

latter conditions was considerably higher in our population than reported for Western populations. Approximately 38% of the older age groups were classified as obese. Although the prevalence of obesity and overweight was lower in the youngest group (p=0.001), approximately 27% of this subgroup was obese. A family history of heart disease was reported in approximately 23% of the sample. A family history of diabetes was reported in 47% of the study population, again high compared to a Western Caucasian population. A positive smoking habit was reported in a higher proportion of young subjects (p<0.0001), though more of these subjects engaged in physical exercise more than 3 times weekly compared to the older group (p<0.05).

There were considerable differences in the distribution of several demographic characteristics with ethnicity (**Table 2**). Obesity was lowest among subjects of African descent and most prevalent among the subjects with a Mediterranean background. Self-reported physical activity was greatest among subjects with a Far Eastern background and lowest among Indian Asians. A positive smoking history was most frequently reported among Caucasians. Socio-economic status and BMI classes varied significantly by ethnicity (p<0.05).

The nutrient intake of the study population stratified by age groups is shown in **Table 3**. Energy intake fell with age (p<0.05). Intake was low compared to the RNI for all age groups. Total fat and protein intake fell with age, but was similar for all groups when expressed as a percentage of energy intake. For all groups, the mean value of the latter was higher than the RNI. The percentage energy in the form of carbohydrate fell with age, with a low mean value for carbohydrate compared to the RNI. Mean cholesterol intake was higher than the RNI for all groups, but fell with age group (p<0.0001). Saturated fat and monounsaturated fat intake, expressed as percentage energy intake were both high compared to the RNI, whereas polyunsaturated fatty acid (PUFA) intake was lower than the RNI. The youngest group had the highest percentage energy provided by saturated fatty acid (SFA) (p<0.001), and lowest percentage energy as PUFA (p<0.05) compared to the other groups. The intake of fibre rose with age, and was significantly higher in the older group, but lower than the RNI in all groups.

Table 4 shows the association between different coronary risk factors with macronutrients intake. socio-economic status (SES) was positively correlated with carbohydrates intake in grams and inversely correlated with the percentage of calories provided by PUFA intake. Body mass index was inversely correlated to dietary SFA.

Table 5 shows the association of age with macronutrient intake within each racial group. Age was inversely associated with energy intake, carbohydrates, total fat, cholesterol, SFA, and monounsaturated fatty acid (MUFA) intake within Arabian tribes. Similarly, age was inversely correlated with carbohydrates within Africans and with SFA intake within Far Easterns subjects.

Table 2 - Variation in some demographic variables with ethnicity in Saudi sample population.

Variables	**Racial groups**					***p* value**
	Arabian tribes N=165 n (%)	**Africans N=26 n (%)**	**Caucasians N=27 n (%)**	**Far Easterns N=17 n (%)**	**Mediterraneans N=46 n (%)**	
Body mass index						<0.05
Normal	56 (34)	13 (50)	7 (26)	6 (35)	3 (7)	
Overweight	60 (36)	6 (23)	11 (41)	3 (18)	18 (39)	
Obese	49 (28)	7 (27)	9 (33)	8 (47)	25 (54)	
Socio-economic status						<0.05
Low	66 (40)	19 (73)	3 (11)	5 (29)	23 (50)	
Middle	90 (55)	7 (27)	21 (78)	11 (65)	21 (46)	
High	9 (6)	0 (0)	3 (11)	1 (6)	2 (4)	
Smoking status						Not significant
Never	81 (49)	17 (65)	9 (33)	9 (53)	22 (48)	
Former	34 (21)	6 (23)	6 (22)	3 (18)	9 (20)	
Current	50 (30)	3 (12)	12 (44)	5 (29)	15 (33)	
Physical activity						Not significant
<3 times/week	74 (45)	14 (54)	12 (44)	5 (29)	23 (50)	
≥3 times/week	91 (55)	12 (46)	15 (56)	12 (71)	23 (50)	

Categoric data were compared by using x^2 test.

Table 3 - Summary of dietary nutrient intake of the sample population of male Saudi categorized by age.

Nutrient	**RNI**	**Age groups (years)**			***p* value**
		34-49	**34-49**	**≥50**	
Energy (Kcal)	2755 (15-18) 2550 (19-59) 2380 (60-74) 2100 (75+)	2036.6 ± 497.9**	1936.3 ± 465.9	1834.9 ±4 60.9	<0.05
Unadjusted protein (gm)		72.6 ± 18.6	71.3 ± 19.7	69.7 ± 18.2	Not significant
Percentage of energy	15%	14.4 ± 2.3	14.8 ± 2.3	15.2 ± 1.7**	<0.05
Energy-adjusted protein (gm)		67.3 ± 1.1	67.5 ± 1.1	67.7 ± 0.8**	<0.05
Unadjusted carbohydrate (gm)		247.1 ± 67.1**	229.7 ± 64.7‡	213.1 ± 57.7	0.001
Percentage of energy	55%	48.6 ± 5.9	47.5 ± 7.4	46.6 ± 6.5	Not significant
Energy-adjusted carbohydrate (gm)		222.2 ± 0.8	222 ± 1.2	221.8 ± 0.9	Not significant
Unadjusted total fat (gm)		84.2 ± 24.4	81.3 ± 25.7	78.2 ± 24.7	Not significant
Percentage of energy	30%	37 ± 5.7	37.8 ± 6.9	38.1 ± 6.1	Not significant
Energy-adjusted fat (gm)		77.9 ± 0.9	78 ± 1.2	78.1 ± 0.9	Not significant
Cholesterol (mg)		280.9 ± 103.1**	261.4 ± 111.1	223.4 ± 109.2	<0.0001
Categories of cholesterol intake	<200 mg	20 (20)	34 (34)	50(49)	<0.0001
	>200 mg	81 (80)	65 (66)	53(52)	
Unadjusted SFA (gm)		30.4 ± 9.3§**	26.7 ± 10.3	25.4 ± 9.8	<0.0001
Percentage of energy	10%	15 ± 3.5*†	13.7 ± 3.4	13.6 ± 3.1	<0.05
Energy-adjusted SFA (gm)		25.9 ± 1.0	25.6 ± 1.1	25.6 ± 0.9	<0.05
Unadjusted MUFA (gm)		29.9 ± 7.1*	28.8 ± 8.9	27.7 ± 9.1	<0.05
Percentage of energy	10%	15 ± 2.8	15 ± 2.9	15 ± 2.9	Not significant
Energy-adjusted MUFA(gm)		27.5 ± 0.9	27.6 ± 1.1	27.6 ± 1.0	Not significant
Unadjusted PUFA (gm)		16.9 ± 6.1	17.7 ± 6.8	17 ± 6.3	Not significant
Percentage of energy	10%	8.4 ± 2.3	9.2 ± 2.7*	9.3 ± 2.7†	<0.05
Energy-adjusted PUFA (gm)		15.2 ± 0.9	15.5 ± 1.1	15.5 ± 1.0	<0.05
P:S ratio	NA	0.55 ± 0.25	0.68 ± 0.3	0.68 ± 0.35	<0.0001
Fiber (gm)	18 gm	16.9 ± 5.3	17.9 ± 5.4	18.5 ± 6.4†	<0.05

Numeric data are presented as median±IQR and categorical data as number and percentage. *p<0.05 (young and middle age groups), †p<0.001 (young and middle age groups), ‡p<0.05 (young and old age groups), §p<0.001 (young and old age groups), **p<0.05 (middle and old age groups). NA - not available, P:S ratio - PUFA is to SFA ratio, SFA - saturated fatty acid, PUFA - polyunsaturated fatty acid, MUFA - monounsaturated fatty acid, RNI - recommended nutrient intake.

Table 4 - Correlation coefficients between classical coronary risk factors and macronutrient intake.

Variables	**r**	***p* value**
BMI versus energy-adjusted SFA	-0.147	0.011
Age versus energy	-0.183	0.001
Age versus fiber	0.126	0.029
Age versus cholesterol	-0.235	<0.00001
Age versus energy-adjusted protein	0.137	0.017
Age versus energy-adjusted SFA	-0.137	0.017
Age versus energy-adjusted PUFA	0.139	0.016
SES versus carbohydrates	0.141	0.014
SES versus percentage of calories provided by PUFA	-0.117	0.043

BMI - body mass index, SFA - saturated fatty acid, PUFA - polyunsaturated fatty acid

Table 5 - Correlation coefficients between age and macronutrient intake within racial groups.

Racial groups	**Macronutrient**	**r**	***p* value**
Arabian tribes	Energy	-0.235	0.002
	Carbohydrates	-0.241	0.002
	Fat	-0.22	0.004
	Cholesterol	-0.271	<0.00001
	SFA	-0.311	<0.00001
	MUFA	-0.243	0.002
Africans	Carbohydrates	-0.457	0.019
Far Easterns	SFA	-0.487	0.047

SFA - saturated fatty acid, MUFA - monounsaturated fatty acid

Discussion. Elements of a Western diet are becoming more accessible to urban dwellers in the Middle East and elsewhere. Dietary habits may vary by ethnic group and may be affected by other socio-demographic factors such as age and education. The prevalence of chronic conditions, such as diabetes, dyslipidemia, obesity and coronary heart disease, once associated with a Western lifestyle, is increasing globally, and specifically in the Arabian peninsula.[19,20] The purpose of this present study was to investigate the dietary and social habits of adult male Saudis in a multi-ethnic community. We hypothesized that these habits may be influenced by age, ethnicity and socio-economic status, and these potentially confounding characteristics were evaluated by questionnaire. A number of anthropometric features associated with increased risk of chronic disease, were also determined at the time of interviewing the participants.

Jeddah, KSA is an ethnically diverse city and the sample population reflected this. There was no reason to suspect that the sample population was unrepresentative of the male population from which it was drawn. A good sample from each category of socio-economic class, age and race was obtained.

Dietary intake was assessed using a food frequency questionnaire, and macronutrient intake estimated using food tables. This approach for estimating nutrient intake has been used in several previous studies[21-23] in the West. A limited number of studies have also been conducted in the Middle East.[24] These studies have also reported low total calorie intakes in the populations under investigation compared to the estimated average requirement (EAR). This may be partially related to a systematic under-estimation of dietary intake by the participants, the fact that a proportion of the subjects reported being on a diet, the high proportion of sedentary participants in the study, and the possibility that the EAR is designed for a Caucasian population.

Macronutrient intake may be influenced by several factors including accessibility, socio-economic status, ethnicity, cultural background and food preference. It is also possible that physical activity, smoking habit and other demographic characteristics affect preference.[25,26] We found that total energy intake was highest in the young age group of subjects

A high proportion (69%) of the total study population was either overweight or obese, and although lower in the youngest age group (53%) it was still substantial. A large proportion of the oldest group was hypertensive (60%), although many of these subjects were on medication for this. The prevalence of diabetes mellitus also rose dramatically with age, with 37% of the oldest group having this condition. It is likely that the majority of these were type II diabetics, and that obesity was a contributory factor. Hypercholesterolemia was found in 26% of the older group of subjects. A high reported prevalence of a family history of diabetes mellitus in the population as a whole (47%) is consistent with these findings. Of particular concern was the high frequency of a positive smoking habit among the youngest group of subjects (41%). The extent of self reported exercise is also a matter of concern, as a high proportion of the youngest subjects undertook less than 3 episodes per week (55%). This was more than for the intermediate age group (63%), and in combination with the high energy intake may account for the high prevalence of obesity in the youngest group of subjects.[27] Overall the risk of cardiovascular disease for the population as a whole is extraordinarily high.

Dietary cholesterol and percentage energy derived from saturated fat, were both higher than the RNI for all 3 age groups, and varied with race. This may relate to the availability and consumption of high levels of food products of animal origin.[28] On the other hand, percentage energy from carbohydrate and polyunsaturated fat was low in all groups, as was dietary fibre intake. This macronutrient profile has previously been associated with increased risk of coronary disease.[29] The low dietary fibre is possibly due to an inadequate intake of fruit, vegetables and pulses. Low fibre consumption is reported to be associated with hyperinsulinemia and insulin resistance,[30] and previous studies of Saudi populations have reported low levels of dietary fibre.[31,32]

Dietary intake estimates are prone to error. Because the frequency of consumption was estimated rather than the actual number of servings, the FFQ tends to underestimate the proportion of individuals who meet the suggested guidelines. Furthermore, the intakes presented are based on nutrient content of raw or minimally cooked foods. Hence, the actual nutrient intake may be affected by the method of cooking, although macronutrient content is unlikely to vary greatly. Despite the possibility of underestimation of actual intake, the reported differences with age are likely to reflect real differences, assuming that biases in self-reported dietary intakes are similar among all age groups. On the other hand, the FFQ used in this study is semi-quantitative, referring to the limited quantification of serving sizes by this instrument. It is plausible that although the FFQ overestimated means for certain nutrients, it did so in a consistent manner.

Despite these limitations, these data provide insight into different dietary patterns within the Saudi population and their impact on macronutrient intake. Apparently, dietary recommendations are not being followed. While the reasons for this are complex, knowledge on diet does influence food choice and dietary behavior.

In conclusion, the increasing availability of Western-type diets to urban dwellers in the KSA appears to have resulted in an imbalance of macronutrient intake among all sectors of the population. Young men appear to be particularly prone to this, and appear to have a high intake of cholesterol and energy as saturated fat, and a low PUFA/ SFA ratio. This is further compounded by a high prevalence of other coronary risk factors, including diabetes mellitus, a sedentary lifestyle, positive smoking habit and obesity. This is likely to lead to an escalation in the incidence of cardiovascular disease over the next decade. This problem can only be averted by raising public awareness and the development of appropriate population-specific nutritional guidelines.

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