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Evidence for nutrition transition in Kuwait: over-consumption of macronutrients and obesity

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Abstract

Objectives: To describe nutrient intakes and prevalence of overweight and obesity in a nationally representative sample of Kuwaitis and to compare intakes with reference values.
Design: Cross-sectional, multistage stratified, cluster sample.
Settings: National nutrition survey covering all geographical areas of the country.
Subjects: Kuwaitis (*n* 1704) between 3 and 86 years of age.
Results: Obesity was more prevalent among women than men (50 % and 70 % for females aged 19–50 years and ≥51 years, respectively, *v.* 29 % and 42 % for their male counterparts). Boys were more obese than girls, with the highest obesity rate among those aged 9–13 years (37 % and 24 % of males and females, respectively). Energy intake was higher than the estimated energy requirements for almost half of Kuwaiti children and one-third of adults. The Estimated Average Requirement was exceeded by 78–100 % of the recommendation for protein and carbohydrates. More than two-thirds of males aged ≥4 years exceeded the Tolerable Upper Intake Level for Na. Conversely, less than 20 % of Kuwaitis, regardless of age, consumed 100 % or more of the Estimated Average Requirement for vitamin D, vitamin E, Ca, *n*-3 and *n*-6 fatty acids. Less than 20 % of children met the recommended level for fibre.
Conclusions: Nutrition transition among Kuwaitis was demonstrated by the increased prevalence of obesity and overweight, increased intakes of energy and macronutrients and decreased intakes of fibre and micronutrients. Interventions to increase awareness about healthy foods combined with modifications in subsidy policies are clearly warranted to increase consumption of low-energy, nutrient-dense foods.

Keywords
Nutrient intake
Nutrition transition
Obesity
Kuwait
Epidemiology

The relationship between food intake and non-communicable diseases (NCD), where excessive and unbalanced intakes of energy, SFA, *trans*-fatty acids, salt and sugar are associated with nutrition-related NCD, is well established[1]. The Gulf countries have the highest reported prevalence of NCD in the world[2]. Kuwait is a Gulf country with a total land area of 17 818 km^2 and a population of 3·3 million, of whom about 31 % are Kuwaiti citizens. About 80 % of adult Kuwaiti citizens[2,3] are reported to be either overweight or obese and many of them suffer from one or more nutrition-related NCD such as diabetes (15 %)[3,4], metabolic syndrome (24 %)[3], CHD, hypertension (26 %)[5] and/or dyslipidaemia (33 %)[5–7]. Kuwait has the highest childhood overweight problem among the Gulf countries and obesity is reportedly on the rise[2]. El-Bayoumy *et al.*[8] reported that 30·7 % and 14·6 % of children between the ages of 10 and 14 years were overweight and obese, respectively; while 43·3 % and 21·3 % of children between 14 and 19 years of age were overweight and obese, respectively[7].

Before the discovery of oil, Kuwait's food supply was limited. Available foods consisted mainly of rice, dates, seafood, camel milk, sheep and goat meat and their by-products[9]. Meat was an indicator of wealth and the frequency of consumption of meat for the general population was weekly or monthly. Arabic coffee and milk represented main beverages while sweetened tea was served only on special occasions. Kuwait has experienced continued economic growth represented as increases in gross national income per capita (purchasing power parity)[10], gross domestic product[11] and population growth rate[12]. Economic growth in Kuwait has been

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accompanied by an increase in food availability, mainly of imported foods, which comprise 85 % of all foods available in the market. Traditional foods have been replaced by foods typical of the Western diet through fast-food outlets and restaurants[9]. Increased food availability and reduced food prices (due to government subsidy) have contributed to increased energy intakes[13]. Increased daily consumption of energy-dense, nutrient-poor foods, increasing frequency of snacks and meals consumed away from home, shifts from drinking water and milk to drinking sugar-sweetened beverages and increased portion sizes are among the most commonly reported dietary changes associated with the nutrition transition, consequently increasing rates of nutrition-related NCD[14–20]. Increased prevalences of obesity and nutrition-related NCD occur with increased intakes of energy, sugar, fat and protein and decreased intake of fibre[1,2,14–20].

Except for a few studies reporting low fruit and vegetable intakes or increased consumption of fast foods and sugary snacks among Kuwaitis, mainly in children[21–24], there is a paucity of national data on dietary intakes and assessment of compliance with dietary guidelines. Therefore the aims of the current study were to describe nutrient intakes and the prevalence of overweight and obesity in a nationally representative sample of Kuwaitis and to investigate the dietary determinants for nutrition transition by comparing dietary data with reference intake guidelines.

Experimental methods

Sample

This is a random representative national sample of Kuwaiti households. Kuwaiti households from the six governorates (Al Asema, Hawalli, Al Jahra, Al Farwania, Al Ahmadi and Mubarak Al Kabeer) were divided into eighty-two localities proportionate to Kuwaiti population density. Each locality was divided into clusters. Clusters of twenty households were selected using stratified sampling. Out of the total 5418 households contacted, 2862 households agreed to participate with a response rate of 53 %. At the household level, 1830 individuals (48 % males and 52 % females) were randomly selected from 545 separate Kuwaiti households from all six geographical strata, taking into consideration census gender distribution and age category. A screening form was completed per household and included demographic and socio-economic data and household composition. Data obtained were used to identify randomly selected individuals to survey from each age category and gender. Male household heads were recruited from odd-numbered households, while female household heads were selected from even-numbered households. In the case of having more than one participant within the same age group, both were selected if they were of different genders, or the male with odd serial number or the female with even serial number if both were of same gender. Interviews were conducted at seven primary health-care clinics of the Ministry of Health located at various districts of Kuwait during the period July 2008 to November 2009 with a response rate of 24 %.

For the current paper, socio-economic, anthropometric and dietary data were analysed on a subsample of 1704 participants between the ages of 3 and 86 years for whom 24 h recalls were completed. Socio-economic, health and dietary data were collected on 655 children aged 1–18 years and 1049 adults aged ≥19 years. Anthropometric measurements and blood indices were taken. The study was approved by the Ethics Committee of the Kuwait Ministry of Health. Two consent forms were obtained, one from the head of the household and the other from each participant, including children, selected at the household level. Parents signed on behalf of their children. Consent forms were written in Arabic, as were the questionnaires. A raking method was used to calculate non-response-adjusted weights, producing a final set of person weights to perform data analyses.

Anthropometric data

Weight was measured using a Tanita 310 body composition analyser for children aged ≥7 years and adults, while SECA scales were used for weight measurements of children <7 years of age. Measurements were taken to the closest 100 g. A SECA 416 infantometer was used to obtain the length measurement of infants, while a SECA 214 stadiometer was used for measuring the height of older children and adults to the nearest 1 cm.

BMI (kg/m^2) was calculated by dividing weight in kilograms by the square of height in metres. Overweight and obesity were defined based on WHO standards. For adults, overweight was defined[25] as BMI ≥ 25·0 kg/m^2 and obesity as BMI ≥ 30·0 kg/m^2. For participants ≤5 years of age, overweight was defined as BMI *Z*-score ≥2 and obesity as BMI *Z*-score ≥3 using WHO standards[26]. For participants from 6 to 19 years of age[27], overweight was defined as BMI *Z*-score ≥1 and obesity as BMI *Z*-score ≥2.

Dietary data

A single 24 h recall was collected from participants over 2 years of age using the multiple-pass method[28,29] developed by the US Department of Agriculture and a food instruction booklet developed to standardize dietary data collection and reflect cultural and traditional eating behaviours[30]. In addition, food photographs and household measures (cups, spoons, etc.) were used to estimate portion sizes of foods. Food photographs were developed at the Kuwait Institute for Scientific Research where foods were cooked, served, weighed and photographed. Experienced dietitians were trained to collect the dietary data using the multiple-pass method and food instruction booklet. Mothers and/or other family members who were knowledgeable about the child's food intake were asked to

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provide types and quantities of food and beverages the child had consumed within the 24 h period preceding the interview. Adolescents responded for themselves. Given the lack of experience in collecting dietary 24 h recalls in Kuwait and the cultural context, we tested the quality of dietary data during the fieldwork for indicators of completeness and reasonability using a sample of 737 adults. For each adult participant, energy intake (EI) and BMR were calculated, the latter using the Schofield equations[31], and the ratio EI:BMR was determined. A cut-off value for EI:BMR of <0·9 was used to classify participants as under-reporters[32,33]. Furthermore, the estimated energy requirement (EER) was calculated according to the US Dietary Reference Intakes (DRI)[34] from each participant's age, weight, height, gender and physical activity, and the ratio EI:EER computed. EI:EER provides an additional comparison capturing significant under-reporting or over-reporting. These analyses revealed that 89 % of males and 62 % of females were adequate reporters. In addition, mean EI:BMR was 1·55 for adult females and 1·26 for adult males, denoting a mean under-estimation percentage within acceptable cut-off points. We concluded that under-reporting is not likely to be a problem with the current study and in this cultural context.

Dietary data processing

The ESHA Food Processor software version 10·3[35] was used for dietary data entry after adding 103 chemically analysed local Kuwaiti composite dishes to the software database[36–41]. Recipes were created for an additional forty-six local foods reported in the 24 h recall. The nutrient composition of twenty breads and bakery products was obtained from Kuwait Flour Mills Company's nutrient analysis laboratory. Many commonly eaten food products in the market were investigated for nutrient content and adjusted in the nutrient database to reflect food fortification and enrichment in the Kuwaiti market. In the case of missing nutrient data for unanalysed food items, the closest similar food in the ESHA Food Processor program was selected to impute the missing nutrients.

The 24 h recalls were coded and foods closest in description and nutrient content were selected from US dietary databases. After initial data entry, a second coder checked each recall to verify accuracy. All recall surveys were rechecked by survey research supervisors. Dietary recalls were analysed for macronutrients, nine vitamins and seven minerals.

Nutrient intakes were compared with the US DRI since Kuwait does not have its own dietary guidelines. Kuwaitis' nutrition status was evaluated when appropriate against the Estimated Average Requirement (EAR), Adequate Intake (AI) and Acceptable Macronutrient Distribution Range (AMDR) developed by the Institute of Medicine's Food and Nutrition Board[34,42–48] for all reported nutrients. The percentages of consumers meeting 100 % or more of the appropriate DRI were calculated.

Statistical analysis

The SPSS statistical software package version 16 was used to calculate weighted means and standard errors of the nutrient intakes using individual weights developed based on census data and taking into account the complex sampling design. The percentage of energy from macronutrients and the percentage of participants who over-consumed energy and nutrients by age category and gender were estimated. Student's *t* test was used to compare between male and female participants. The percentage of overweight and obese participants was estimated by age and gender. ANOVA was performed to test differences in mean intake by social factors at 95 % confidence interval with a significance level of $P < 0{\cdot}05$.

Results

Description of the population

As shown in Table 1, more than half of all adult participants were female (55·3 %) and most (74·1 %) were married. Some 52·9 % of adult participants had a monthly income of 1000–2000 Kuwaiti Dinars (approximately $US 3500–7000), 7·4 % were either illiterate or functionally illiterate (can read and write but with no formal education),

Table 1 Characteristics of the sample of Kuwaiti adults (*n* 1049), 2009–2010

Characteristic	*n*	%
Gender		
Male	469	44·7
Female	580	55·3
Education		
Illiteracy/functional illiteracy	78	7·4
Less than high school	239	22·8
High school/diploma	433	41·3
More than high school	299	28·5
Marital status		
Married	777	74·1
Single	177	16·9
Divorced/widower	95	9·0
Employment		
Salary employed	463	44·1
Work at home	250	23·8
Retired	212	20·2
Unemployed/student	111	10·7
Self-employed	12	1·1
Monthly family income (KD)		
<1000	243	23·2
1000–1499	289	27·6
1500–1999	265	25·3
>2000	252	24·1
BMI category		
Underweight	17	1·6
Overweight	347	33·1
Obese	452	43·1
	Mean	SD
Weight (kg)	79·5	19·2
Height (cm)	163·7	10·8
Waist circumference (cm)	96·3	16·6

KD, Kuwaiti Dinars.

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44·1 % were salary employed in either the government or private sector, and 23·8 % of them worked at home (including housewives).

Prevalence of overweight and obesity

Weighted data revealed that mean BMI increased with age among males and females (Table 2). Overweight and obesity were more prevalent among male children (≤18 years) compared with female children especially the 9–13 years age group. More than two-thirds of the adults were either overweight or obese, reaching a high of 78 % and 93 % in males and females aged ≥51 years, respectively.

Nutrient intakes

Table 2 shows that a large percentage of Kuwaitis exhibited over-consumption of energy. However, that over-consumption decreased with age: 31·5–72·6 % of children and 15·5–31·4 % of adult participants exceeded the recommended energy requirements. The daily energy intake of children ranged from 5347 to 11 068 kJ (1278–2645 kcal), while adults consumed between 6078 and 10 524 kJ (1454–2515 kcal). Males consumed more energy than females. Although macronutrient (protein, carbohydrates, fat) consumption fell within the AMDR for most ages, almost a third of the sample exceeded the upper limit of the AMDR for fat (35 % of total energy) except for children aged 1–3 years and adults aged ≥51 years. On the other hand, ≥51-year-old adults exceeded the upper limit of the AMDR for carbohydrates. Marked under-consumption of *n*-3 and *n*-6 fatty acids occurred across all age and gender groups, showing no gender differences.

Table 3 shows that the ranges of mean intake of carbohydrates, protein and fat for females were 184–264 g, 48–71 g and 44–75 g, respectively; corresponding values for males were 175–355 g, 48–110 g and 45–96 g. The mean intake of cholesterol was less than the recommended 300 mg, except for males aged 19–50 years. Mean fibre intake was less than the recommended AI value for all age groups among both males and females. Mean intake of fibre increased with age, with about a third of males and females aged ≥51 years consuming 100 % or more of the recommended amount of fibre for their age.

Excluding intakes of vitamins and minerals obtained from supplements, Figs 1 and 2 show the general inadequacy

Table 2 Prevalence of obesity, overweight and over-consumption of energy and macronutrients by age group and gender: nationally representative sample of Kuwaitis, 2009–2010

Age (years)	1–3		4–8		9–13		14–18		19–50		≥51	
Gender	Male (*n* 22)	Female (*n* 19)	Male (*n* 120)	Female (*n* 108)	Male (*n* 111)	Female (*n* 94)	Male (*n* 95)	Female (*n* 86)	Male (*n* 315)	Female (*n* 400)	Male (*n* 154)	Female (*n* 180)
Anthropometry												
Normal weight (%)	51·1	59·9	68·1	76·9	33·5	55·5	41·8	54·7	27·9	27·3	21·6	7·0
Overweight (%)	21·1	23·2	14·1	9·4	16·7	14·6	22·7	22·4	37·9	20·3	35·4	23·2
Obese (%)	18·4	11·8	6·7	10·2	36·5	24·0	25·3	17·5	29·3	49·5	42·3	69·8
BMI (kg/m^2)												
Mean	17·0	16·6	15·4	16·1	20·6	19·7	23·5	23·6	28·1	30·0	29·3	33·2
SE	0·3	0·2	0·3	0·3	0·9	0·9	0·9	0·8	0·7	0·6	0·7	0·6
Diet												
Energy (kJ/d)												
Mean	5347	5595	7414	6796	9356	8336	11 068	7599	10 524	7144	8343	6078
SE	385	625	308	226	444	387	431	352	267	174	354	296
Energy (kcal/d)												
Mean	1278	1337	1772	1624	2236	1992	2645	1816	2515	1707	1994	1453
SE	92	149	74	54	106	92	103	84	64	42	85	71
% over-consumption relative to EER	40·9	57·6	61·9	72·6	43·5	63·3	31·5	50·8	31·4	28·5	25·2	15·5
Protein												
% energy/d	14	13	15	15	15	14	15	15	17	16	17	18
% met AMDR	82·4	90·0	93·5	90·7	86·3	86·0	92·4	89·3	99·6	98·4	100·0	96·4
% above AMDR	17·6	10·0	0	0	0	0	0	0	0·4	0·7	0	3·6
Carbohydrates												
% energy/d	56	57	52	53	53	53	54	53	53	54	57	56
% met AMDR	72·1	50·7	64·6	74·2	69·8	69·5	62·8	67·9	57·9	64·1	49·0	56·7
% above AMDR	10·0	31·8	12·7	8·3	13·8	13·6	17·2	13·3	15·6	16·4	30·4	27·6
Fat												
% energy/d	30	30	33	32	32	33	31	32	30	30	26	26
% met AMDR	46·4	30·7	41·7	53·7	42·3	45·7	41·8	47·3	53·7	59·2	47·4	58·3
% above AMDR	13·6	15·3	40·8	36·3	39·7	38·7	31·4	37·8	33·6	32·9	22·9	16·7
n-3 Fatty acids												
% energy/d	1·1	0·6	0·7	0·8	0·8	0·9	0·9	1·3	1·1	1·1	1·0	1·1
% met AMDR	8·7	0	3·1	3·3	2·2	5·1	3·6	6·7	6·1	6·0	3·1	3·6
% above AMDR	0	0	0	0	0·8	0	1·1	0	0·8	0·8	0	1·3
n-6 Fatty acids												
% energy/d	2·0	2·4	4·0	3·5	3·7	3·6	3·6	2·8	3·2	3·8	3·3	3·3
% met AMDR	12·0	4·2	16·5	22·5	28·1	25·9	28·7	16·7	19·5	20·7	16·1	9·2
% above AMDR	0	3·1	7·1	2·7	1·3	0·5	2·3	0·9	1·1	4·7	4·4	4·5

EER, estimated energy requirement; AMDR, Acceptable Macronutrient Distribution Range.

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Table 3 Weighted means, standard errors and percentage consumption of macronutrients in excess of the Dietary Reference Intakes† by age group and gender: nationally representative sample of Kuwaitis, 2009–2010

Age (years)	1–3		4–8		9–13		14–18		19–50		≥51	
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Protein (g)												
EAR	11	11	15	15	27	28	44	38	46	38	46	38
Mean	47·9	47·8	69·8	62·5	87·1	70·8	99·1	68·9	110·1	67·4	90·0	67·2
SE	5·6	7·1	3·3	2·8	6·3	4·2	4·9	3·3	4·1	2·3	4·2	4·2
% exceed	100·0	100·0	99·4	100·0	94·8	92·5	89·9	77·7	91·0	80·7	82·6	83·6
Carbohydrates (g)												
EAR	100	100	100	100	100	100	100	100	100	100	100	100
Mean	174·8	184·1	226·1	215·1	295·5	264·2	355·4	240·2	327·6	228·4	276·0	201·4
SE	12·2	13·9	10·2	9·4	14	11·2	17·1	12·3	8·8	8·4	12·1	9·5
% exceed	95·1	95·3	95·1	96·9	97·2	97·8	99·2	96·3	98·4	90·9	97·1	92·6
Fat (g)												
EAR	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mean	45·1	47·5	67·2	59·2	81·1	75·4	95·7	67·2	87·3	60·7	61·8	44·4
SE	4·1	8·2	3·7	2·2	4·4	4·6	5·6	3·6	3·1	2·1	3·9	3·4
Fibre (g)												
EAR	19	19	25	25	31	26	38	26	38	25	30	21
Mean	8·5	13·8	14·3	11·7	18·1	16	20·5	16·9	26·2	20·5	29·7	20·3
SE	1·1	1·6	1·1	0·7	1·6	1·3	1·9	1·6	1·5	0·7	2·0	1·3
% exceed‡	1·3	7·9	13·6	5·7	14·7	13·4	9·0	19·3	19·7	27·5	38·6	33·4
Cholesterol (mg)												
EAR	300	300	300	300	300	300	300	300	300	300	300	300
Mean	141·9	126·4	270·0	211·3	272·7	220·2	277	217·1	345·5	220·5	256·7	187·8
SE	32·8	24·2	23·5	20·5	20·9	29·8	24·5	28·6	20·7	16·0	26·3	21·0
% exceed§	4·0	2·2	33·8	21·3	35·0	25·3	29·6	18·3	47·9	21·9	30·5	20·1

EAR, Estimated Average Requirement; ND, not defined.
†Percentage of participants who consumed ≥100 % of the EAR.
‡Percentage of participants who consumed ≥100 % of the Adequate Intake for fibre (g).
§Percentage of participants who consumed ≥300 mg/d.

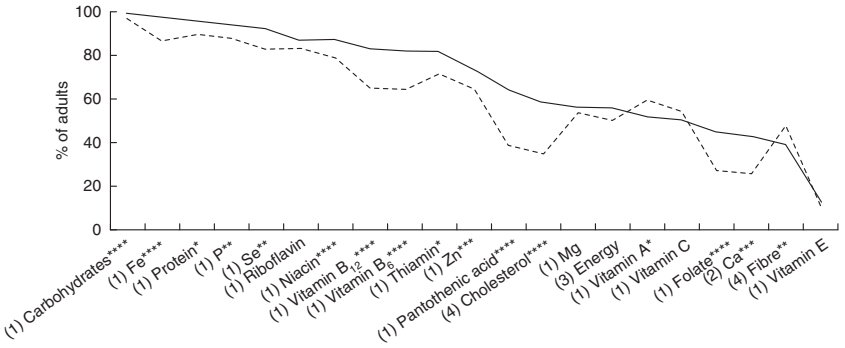

Fig. 1 Percentage of Kuwaiti adults meeting the Dietary Reference Intakes (1 = Estimated Average Requirement, 2 = Adequate Intake; 3 = estimated energy requirement, 4 = Acceptable Macronutrient Distribution Range) by gender (——, males; – – –, females), 2009–2010. Significance levels for comparisons by gender: *$P < 0{\cdot}05$, **$P < 0{\cdot}01$, ***$P < 0{\cdot}001$, ****$P < 0{\cdot}0001$

of nutrient intakes among adults and children. Recommended intakes of vitamin E, fibre, folate and Ca were met by less than half of the adult population with a significantly low intake of most nutrients by women. Fewer than 10 % of adults met the EAR for vitamin E, and less than 50 % for fibre, Ca, folate and vitamin C. Similarly, low intakes were observed among children; however, significant gender differences were observed only for vitamin B_{12}, Zn, Ca and P. More adult Kuwaitis met the recommended EAR values for Zn, P and Mg than did children.

Table 4 shows mean intake of vitamins by age category and gender. Results revealed extremely low percentages of participants consuming 100 % or more of the EAR for vitamin D, vitamin E and folate (<2 % for vitamin D and <10 % for vitamin E). Prevalence of low serum levels of 25-hydroxyvitamin D (<25 nmol/l) was also found among the participants (17 % for males and 33 % for females), with the prevalence being significantly higher among females than males (data are not shown).

Conversely, mean intakes of vitamin A, vitamin C, thiamin, riboflavin, niacin, vitamin B_6 and vitamin B_{12} were greater than the EAR values across all age categories in both males and females. Vitamins A, C and B_{12} were

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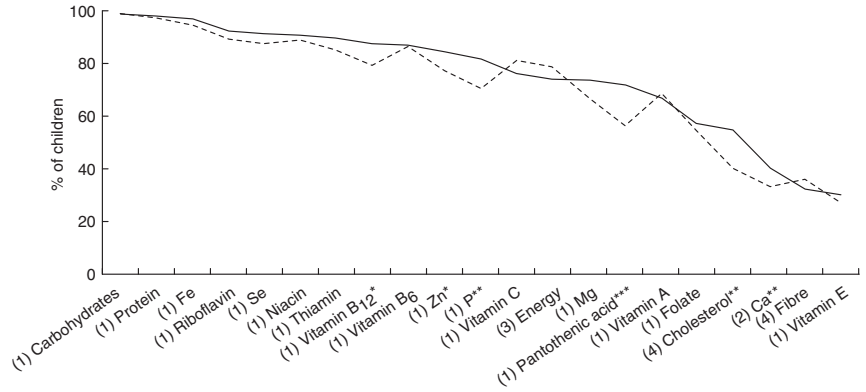

Fig. 2 Percentage of Kuwaiti children meeting the Dietary Reference Intakes (1 = Estimated Average Requirement, 2 = Adequate Intake, 3 = estimated energy requirement, 4 = Acceptable Macronutrient Distribution Range) by gender (——, males; – – –, females), 2009–2010. Significance levels for comparisons by gender: $^{*}P < 0{\cdot}05$, $^{**}P < 0{\cdot}01$, $^{***}P < 0{\cdot}001$

measured in serum and the majority of participants had all vitamin and trace element levels within the normal range (data not shown).

Table 5 shows the mean intake of minerals by age category and gender. Mean Fe intake for males was two to three times the recommended value. On the other hand, the mean Ca intake was markedly less than the recommended amount for both males and females across different age groups. The lowest mean Ca intakes were 543·8 mg and 518·7 mg for females aged 9–13 years and 14–18 years, respectively.

Females 14–18 years of age reported the lowest percentage of those consuming 100 % or more of the EAR for Ca, Mg and P, although 50 % of them consumed 100 % or more of their energy requirement. Mean intake of Zn was low only among females aged 14–18 years (6·8 mg). Mean intake of Na exceeded the Tolerable Upper Intake Level for all age groups. Salt added at the table was not quantified in the survey.

Tables 6–8 show mean macronutrient, vitamin and mineral intakes by education, occupation, marital status and family income among adults. Males consumed significantly more nutrients than females. Mean nutrient intakes were significantly highest among the self-employed compared with other occupations and lowest among illiterate and functionally illiterate participants compared with those of higher educational attainment. Surprisingly, mean nutrient intakes did not differ by family income except for riboflavin and niacin. Mean nutrient intakes differed significantly by marital status but the direction of differences was inconsistent.

Discussion

The present study is the first to our knowledge to describe nutrient intakes of a nationally representative sample of Kuwaitis based on actual food consumption and not on estimated food availability. The large percentage of the population which over-consumes energy and energy-yielding nutrients, coupled with the high prevalence of obesity and overweight, clearly show that the nutrition transition is extant in Kuwait[49]. Almost half of the population consumed more than their energy, protein and carbohydrate requirements. The range of mean energy intakes was 5347–11 068 kJ (1278–2645 kcal) for males and 5595–8336 kJ (1337–1992 kcal) for females. As expected, these empirically derived findings are lower than those estimated in the FAOSTAT data set for total energy (13 010 kJ or 3108 kcal), carbohydrates (100 g), protein (92 g) and fat (114 g)[14,50]. This difference is due the fact that FAOSTAT is an estimation of energy intake based on aggregated data sources. We expect our data set to contain age and gender differences contributing to the observed discrepancies in addition to other uncalculated losses.

The prevalence of overweight and obesity was high across almost all age groups, with the highest prevalence being seen among women ≥20 years of age. This finding is consistent with previous reports[2,7,51]. Our results showed a slightly higher prevalence of obesity among adults in the same age range compared with those reported by Al Rashdan and Nesef[3], who found 36·4 % of adult males to be obese and 47·9 % of adult females. For children and adolescents, obesity prevalence ranged from 7 % to 37 % for males and from 10 % to 24 % for females. The comparison of childhood obesity rates with those found in previous studies is difficult because of the use of different cut-offs and standards. However, it is worth noting that Ng *et al.*[2] reported increased obesity prevalence for all children in Kuwait compared with the other Gulf countries and estimated an increased rate of 1·7 % and 3·9 % among women and men between 30 and 60 years of age, respectively.

Our study also showed over-consumption of Na and cholesterol at an early age, which may help to explain the high prevalence and early onset of CVD among Kuwaitis[5,6]. Additionally, the high Na intake is consistent

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Table 4 Weighted means, standard errors and percentage of consumption of vitamins in excess of the Dietary Reference Intakes by age group and gender: nationally representative sample of Kuwaitis, 2009–2010

Age (years)	1–3		4–8		9–13		14–18		19–50		≥51	
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Vitamin A (μg RE)												
EAR	210	210	275	275	445	420	630	485	625	500	625	500
Mean	328·9	292·3	524·5	555·9	744·4	777·1	588·7	924·5	867·2	1021·1	1183·9	995·8
SE	35·7	25·4	57·9	101·4	138·3	218·9	67·4	178·1	105·0	137·4	141·0	114·8
% exceed	23·3	19·1	60·6	60·9	51·1	39·1	31·0	50·6	39·5	45·8	48·3	45.8
Vitamin E (mg)												
EAR	5	5	6	6	9	9	12	12	12	12	12	12
Mean	2·5	2·8	4·7	3·5	4·8	4·2	5·4	4·1	5·3	1·5	4·9	4·8
SE	0·3	0·5	0·8	0·3	0·4	0·3	0·5	0·4	0·3	0·2	0·3	0·2
% exceed	1·6	5·1	15·4	12·0	9·6	5·7	7·1	1·9	5·8	4·6	4·4	4·1
Thiamin (mg)												
EAR	0·4	0·4	0·5	0·5	0·7	0·7	1·0	0·9	1·0	0·9	1·0	0·9
Mean	1·0	1·4	2·2	1·8	2·0	1·4	2·6	1·5	2·8	1·5	3·4	1·6
SE	0·3	0·6	0·4	0·3	0·3	0·2	0·5	0·3	0·3	0·2	0·6	0·2
% exceed	21·8	25·0	83·9	82·8	76·5	73·9	68·7	40·0	66·7	54·2	70·5	45·3
Riboflavin (mg)												
EAR	0·4	0·4	0·5	0·5	0·8	0·8	1·1	0·9	1·1	0·9	1·1	0·9
Mean	1·3	1·2	1·5	1·5	1·8	1·3	1·8	1·3	1·8	1·3	1·8	1.3
SE	0·2	0·1	0·1	0·1	0·1	0·1	0·1	0·9	0·1	0·1	0·2	0·1
% exceed	27·7	26·3	91·0	91·2	86·2	75·6	77·7	56·3	77·6	68·2	73·7	69·3
Niacin (mg)												
EAR	5	5	6	6	9	9	12	11	12	11	12	11
Mean	12·6	13·1	18·1	18·3	22·8	18·9	26·3	17·7	26·6	17·4	22·4	15·2
SE	2·4	1·4	1·2	1·1	2·2	1·3	2·0	1·3	1·1	0·7	2·7	1·1
% exceed	19·9	23·0	87·2	88·6	77·6	80·4	80·1	68·8	79·3	68·1	73·2	58·4
Vitamin B_6 (mg)												
EAR	0·4	0·4	0·5	0·5	0·8	0·8	1·1	1·0	1·1	1·1	1·4	1·4
Mean	1·0	1·2	1·4	1·4	1·6	1·2	1·8	1·3	1·7	1·2	1·8	1·2
SE	0·3	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·1	0·0	0·2	0·1
% exceed	21·7	26·4	84·3	83·6	72·0	67·3	67·8	52·0	73·4	47·4	55·6	35·9
Vitamin B_{12} (μg)												
EAR	0·7	0·7	1·0	1·0	1·5	1·5	2·0	2·0	2·0	2·0	2·0	2·0
Mean	2·5	2·4	3·2	3·6	3·7	3·3	3·7	2·2	4·4	2·7	5·3	2·9
SE	0·3	0·4	0·3	0·4	0·4	0·8	0·4	0·2	0·3	0·3	0·9	0·3
% exceed	28·1	23·1	81·8	79·1	82·0	61·7	70·0	40·6	79·2	41·2	71·9	60·6
Folate (μg)												
EAR	120	120	160	160	250	250	330	330	320	320	320	320
Mean	117·0	146·3	178·0	177·4	224·8	195·5	249·0	175·1	256·1	209·0	244·0	188·4
SE	18·2	18·9	10·2	14·4	23·1	12·3	18·8	15·6	10·7	8·4	14·6	13·3
% exceed	11·2	13·5	45·1	48·7	34·9	23·9	24·7	10·5	26·6	14·6	20·6	12·4
Vitamin C (mg)												
EAR	13	13	22	22	39	39	63	56	75	60	75	60
Mean	72·7	59·5	87·6	89·2	94·2	101·5	124·7	108·5	104·5	82·9	86·3	75·8
SE	17·7	12·1	8·2	9·1	8·2	12·5	22·1	12·5	11·3	6·0	7·6	8·5
% exceed	23·2	18·7	74·9	86·9	64·2	63·8	59·1	54·2	42·9	45·4	40·3	37·6
Vitamin D (IU)†												
EAR	400	400	400	400	400	400	400	400	400	400	400	400
Mean	116·7	76·3	72·4	91·3	75·3	49·5	67·7	40·0	68·4	72·4	94·5	77·3
SE	31·0	17·2	8·3	12·4	8·0	7·2	15·9	6·7	5·9	16·0	9·4	9·0
% exceed	1·3	2·4	0	0	0·7	0	2·4	0	0·3	1·6	1·2	1·6

RE, retinol equivalents; EAR, Estimated Average Requirement.
†To convert to μg, divide IU by 40.

with the reported increased consumption of fast foods and French fries among children and the high Na content shown in the nutrient composition data of dishes commonly consumed in the Arab Gulf countries[52].

Despite their increased energy intake, more than 90 % of Kuwaiti adults and children did not consume 100 % or more of the EAR for vitamin D, vitamin E, *n*-3 and *n*-6 fatty acids; more than two-thirds did not meet the EAR for Ca, Mg, folate and fibre; and half did not meet the EAR for vitamins A and C and Zn. This indicates low-nutrient-dense food choices. The low intakes of Ca, Zn, vitamin D and folate found in the present study are consistent with findings from college women in Kuwait[53] and from adolescents in Saudi Arabia[54,55] and Qatar[56]. Moreover, increased prevalence of osteoporosis has been reported in Kuwait[57] and Saudi Arabia[55,58]. The US National Health and Nutrition Examination Survey 2001–2002 report identified vitamins A, E and C as potential problems for most gender/age groups based on comparisons with EAR values[59]. Vitamin B_6 was considered a potential

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Table 5 Weighted means, standard error and percentage consumption of minerals in excess of the Dietary Reference Intakes by age group and gender: nationally representative sample of Kuwaitis, 2009–2010

Age (years)	1–3		4–8		9–13		14–18		19–50		≥51	
Gender	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ca (mg)												
EAR†	500	500	800	800	1100	1100	1100	1100	800	800–1000	1000	1000
Mean	620	449·3	583·9	570·6	717·6	543·8	775·3	518·7	799·7	618·4	760·2	626·4
SE	84·8	57·7	31·4	43·6	39·4	38·8	60·9	42·2	37·7	30·3	46·6	30·6
% exceed	14·5	8·7	20·3	19·4	16·4	6·7	21·3	6·3	41·5	23·9	4·2	10·0
Fe (mg)												
EAR	3·0	3·0	4·1	4·1	5·9	5·7	7·7	7·9	6·0	8·1	6·0	5·0
Mean	7·8	9·9	12·2	11·4	15·2	13·2	16·9	11·7	18·2	12·4	16·5	11·3
SE	1·2	0·8	0·7	0·7	1·1	0·8	0·8	0·7	0·6	0·4	0·9	0·6
% exceed	24·7	27·7	92·9	93·5	87·4	90·0	92·2	69·1	96·4	71·5	92·3	93·1
Mg (mg)												
EAR	65	65	110	110	200	200	340	300	330	255	350	265
Mean	137·2	125·2	171·8	160·3	216·6	182·1	246·0	171·6	295·4	219·8	296·7	227·4
SE	13	8·4	7·9	6·6	15·7	8·7	14·1	8·5	10·5	7·9	11·8	9·6
% exceed	28·1	26·4	80·5	78·1	48·2	31·4	14·8	8·6	32·0	29·3	28·4	31·3
P (mg)												
EAR	380	380	405	405	1055	1055	1055	1055	580	580	580	580
Mean	709·5	578·1	876·1	785·6	1070·9	827·2	1146·0	768·6	1241·7	863·2	1139·8	882·8
SE	83	60·3	48·1	41·8	75·2	41·4	67·7	40·8	36·9	30·0	49·7	45·2
% exceed	27·1	21·4	87·7	81·1	41·4	27·1	51·6	14·1	88·9	74·6	84	77·4
Se (μg)												
EAR	17	17	23	23	35	35	45	45	45	45	45	45
Mean	39·1	42·2	68·8	59·3	83·5	67·8	92·2	57·5	108·3	81·1	112·4	83·1
SE	5·6	9·0	5·2	5·8	8·6	4·6	5·7	4·3	4·1	6·7	6·9	5·9
% exceed	22·2	25·2	87·0	84·5	75·5	80·7	81·5	56·9	84·7	68·8	79·1	76·3
Na (mg)‡												
UL	1500	1500	1900	1900	2200	2200	2300	2300	2300	2300	2300	2300
Mean	1607·6	2038·5	2610·7	2339·8	3508·2	2975·7	3679·3	2652·6	3950·3	2857·7	3083·4	2353·8
SE	153·3	203·9	118·7	98·5	172·4	175·7	184·8	140	130·4	105·3	153·4	103·4
% exceed	11·9	21·9	70·8	63·8	72·8	61·2	80·0	46·0	82·2	57·9	67·2	43·9
Zn (mg)												
EAR	2·5	2·5	4·0	4·0	7·0	7·0	8·5	7·3	9·4	6·8	9·4	6·8
Mean	5·1	5·3	7·9	7·2	9·1	7·3	10·4	6·8	11·5	7·2	9·9	7·1
SE	0·5	0·9	0·5	0·5	0·7	0·4	0·7	0·4	0·5	0·2	0·6	0·4
% exceed	28·1	25·4	78·5	72·9	59·5	44·3	64·3	39·0	58·2	43·5	44·5	42·7

EAR, Estimated Average Requirement; UL, Tolerable Upper Intake Level.
†The EAR for Ca is 800 mg for women aged 19–30 years and 1000 mg for women aged 31–50 years.
‡The UL for Na was used to estimate the percentage of participants exceeding the safe Na intake level.

problem for older adult females, Zn for older adult males and females and teenage females, and P for pre-teens and teenage females. These findings are comparable to the results of the current study.

Unlike a previous report showing low Fe intake among anaemic and non-anaemic girls aged 14–20 years in Kuwait (10·6 and 10·8 mg/d, respectively)[60], the current study showed a mean Fe intake of 11·7 mg/d for the same gender and age group.

Similar to our findings, the British Columbia Nutrition Survey reported that income level did not affect nutrient intakes while educational attainment affected only the intakes of vitamins C and B_{12}[61]. On the contrary, the trend in nutrient intake among Mexican Americans between 1982 and 2006 showed increased energy and fat intakes and decreased total protein and carbohydrate intakes with increasing income and educational attainment[62]. The lack of effect of income on food intake among Kuwaitis could be explained by low food prices and current subsidy policies. All Kuwaiti citizens are eligible to subsidized food. Subsidized food items include polished white rice, refined table sugar, lentils, tomato paste, powdered full-fat milk or long-life liquid full-fat or skimmed milk, infant formula, instant cereal, vegetable oil, frozen chicken and full-fat spread cheeses. The current Kuwaiti consumption patterns highlight the importance of revisiting subsidy policies to gear them towards subsidizing healthy foods. There is a need to substitute energy-dense foods (oil, sugar, ghee) with more nutrient-rich, Ca-rich fruits and vegetables.

Limitations

Estimation bias of the dietary measurements cannot be excluded because of the present study's reliance on the assessment of a single 24 h recall. Multiple 24 h recalls would be necessary to confirm individual intakes. Privacy of held food and cultural beliefs was a real challenge to dietary data collection and limited our ability to collect a second 24 h recall even for a subsample. However, the results of biochemical tests revealed that the majority of

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Table 6 Unweighted mean macronutrient intakes of adults according to demographic characteristics: nationally representative sample of Kuwaitis, 2009–2010

Characteristic	Energy (kJ)	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Cholesterol (mg)	Fibre (g)
Gender							
Male	9829	2349·1	312·2	101·9	79·8	305·2	27·1
Female	6797	1624·5	218·6	66·5	56·1	202·1	20·4
P	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Marital status							
Married	8274	1977·5	265·0	83·8	67·3	250·4	24·4
Not married	8525	2037·4	267·5	84·6	72·1	263·4	21·5
Widowed	6004	1434·9	191·5	65·7	47·2	201·3	18·8
Divorced	7073	1690·4	236·0	66·4	56·0	202·8	18·2
P	0·0	0·0	0·0	0·004	0·0	0·154	0·008
Education							
Illiterate/functional illiterate	6091	1455·9	208·4	66·0	42·1	182·7	18·6
<High school	8389	2005·0	274·5	87·8	64·5	267·8	24·5
High school	7968	1904·5	250·3	78·9	67·5	246·8	22·2
>High school	8768	2095·5	277·6	87·1	73·5	251·6	25·5
P	0·0	0·0	0·0	0·0	0·0	0·027	0·004
Occupation							
Self-employed	9611	2297·0	300·2	109·3	76·8	272·8	36·7
Salary employed	8917	2131·1	280·3	88·4	75·3	266·1	23·4
Retired	8271	1976·8	274·1	88·0	61·9	253·5	28·0
Full-time work at home	6626	1583·7	215·3	67·5	52·7	214·7	21·5
Unemployed	8019	1916·6	249·3	76·8	70·1	236·6	17·4
P	0·0	0·0	0·0	0·0	0·0	0·046	0·0
Monthly family income (KD)							
<1000	8071	1929·0	259·2	81·9	65·4	239·9	22·8
1000–1499	8005	1913·2	256·5	80·3	65·6	233·4	22·6
1500–1999	8597	2054·7	275·8	86·9	69·6	255·8	24·8
>2000	7932	1895·9	250·1	80·2	66·0	265·2	23·3
P	0·179	0·179	0·109	0·298	0·618	0·311	0·465

KD, Kuwaiti Dinars.
$P < 0·05$.

Table 7 Unweighted mean vitamin intakes of adults according to demographic characteristics: nationally representative sample of Kuwaitis, 2009–2010

Characteristic	Thiamin (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin B_6 (mg)	Vitamin B_{12} (μg)	Folate (μg)	Pantothenic acid (mg)	Vitamin C (mg)	Vitamin E (mg)	Vitamin A (μg RE)
Gender										
Male	3·1	1·8	24·3	1·7	4·2	261·6	5·0	97·2	5·6	1019·1
Female	1·5	1·3	16·3	1·2	2·8	199·6	3·4	83·3	4·6	1110·7
P	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·024	0·0	0·429
Marital status										
Married	2·3	1·6	20·0	1·4	3·5	233·0	4·3	89·6	5·2	1131·3
Not married	1·8	1·4	21·0	1·4	3·5	227·2	4·0	104·5	5·1	885·7
Widowed	1·3	1·2	16·4	1·1	2·8	174·5	3·3	62·0	3·9	1140·0
Divorced	1·9	1·3	17·1	1·2	2·8	189·0	3·2	60·8	4·3	606·3
P	0·136	0·011	0·073	0·046	0·52	0·025	0·004	0·008	0·194	0·158
Education										
Illiterate/functional illiterate	2·3	1·3	14·8	1·1	3·1	154·8	3·7	46·2	3·2	550·6
<High school	2·5	1·6	21·2	1·5	3·9	229·1	4·7	90·1	4·9	926·3
High school	2·1	1·4	19·3	1·3	3·3	221·5	3·8	88·2	4·9	1129·4
>High school	2·0	1·6	20·9	1·5	3·4	253·1	4·1	102·3	5·8	1233·5
P	0·525	0·006	0·001	0·0	0·331	0·0	0·0	0·0	0·0	0·017
Occupation										
Self-employed	2·2	1·5	23·4	1·9	2·5	313·6	5·7	120·9	5·9	1021·2
Salary employed	2·4	1·6	21·9	1·4	3·5	239·8	4·2	96·1	5·3	934·7
Retired	2·7	1·7	20·6	1·5	4·1	237·5	4·7	85·4	5·1	1359·4
Full-time work at home	1·7	1·4	15·9	1·2	3·1	200·7	3·7	78·5	4·7	1236·7
Unemployed	1·5	1·2	18·4	1·3	3·0	205·9	3·3	91·8	4·6	712·4
P	0·031	0·0	0·0	0·0	0·131	0·002	0·0	0·149	0·317	0·008
Monthly family income (KD)										
<1000	2·2	1·4	20·5	1·4	3·3	221·3	4·0	82·9	5·0	866·0
1000–1499	2·1	1·5	18·9	1·3	3·4	220·8	4·0	88·0	5·0	1032·4
1500–1999	2·2	1·7	21·9	1·5	3·7	232·5	4·5	91·4	5·0	1090·8
>2000	2·1	1·5	18·1	1·4	3·4	235·0	4·0	95·8	5·1	1287·0
P	0·993	0·04	0·005	0·471	0·779	0·635	0·074	0·519	0·984	0·09

RE, retinol equivalents; KD, Kuwaiti Dinars.
$P < 0·05$.

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Table 8 Unweighted mean mineral intakes of adults according to demographic characteristics: nationally representative sample of Kuwaitis, 2009–2010

	Ca (mg)	Fe (mg)	P (mg)	Se (μg)	Na (mg)	Zn (mg)	Mg (mg)
Gender							
Male	809·4	17·7	1215·1	110·5	3714·0	10·8	300·7
Female	616·2	12·2	857·1	77·1	2714·0	7·2	219·1
P	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Marital status							
Married	731·2	15·0	1046·7	95·0	3201·2	9·0	266·3
Not married	638·6	14·7	976·1	84·0	3255·0	8·7	226·4
Widowed	589·4	10·9	868·4	91·5	2514·8	6·8	230·1
Divorced	585·0	13·5	829·3	71·6	2847·1	7·1	209·6
P	0·002	0·004	0·005	0·044	0·033	0·004	0·0
Education							
Illiterate/functional illiterate	574·5	10·2	853·9	84·8	2415·4	7·1	207·2
<High school	732·1	15·2	1100·3	102·8	3155·0	9·4	275·8
High school	667·9	14·3	960·9	84·8	3109·4	8·4	240·4
>High school	762·7	16·0	1074·7	95·8	3435·3	9·2	273·8
P	0·001	0·0	0·0	0·004	0·0	0·002	0·0
Occupation							
Self-employed	826·4	20·9	1297·9	105·6	3708·1	10·8	360·8
Salary employed	736·6	15·7	1062·0	94·8	3399·8	9·3	264·6
Retired	775·9	15·7	1128·3	105·0	3199·3	9·6	294·4
Full-time work at home	625·1	12·2	891·5	84·2	2649·3	7·4	230·1
Unemployed	582·9	13·5	871·8	71·8	3186·0	7·6	189·5
P	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Monthly family income (KD)							
<1000	666·8	14·7	991·4	94·9	3129·9	8·4	254·4
1000–1499	721·5	14·2	1018·9	92·9	3083·2	8·8	253·8
1500–1999	709·1	15·5	1059·8	89·4	3285·9	9·3	263·4
>2000	708·7	14·4	995·1	91·0	3149·2	8·6	250·4
P	0·491	0·273	0·441	0·804	0·611	0·272	0·733

KD, Kuwaiti Dinars.
$P < 0·05$.

participants had all vitamin and trace element levels within the normal range. The detailed blood sample analysis and its association with dietary indices are beyond the scope of the current paper.

Conclusions

Kuwait is a country with a food-abundant environment. Food is available at low cost and Kuwaitis have low nutrition awareness. In this context Kuwaitis are experiencing a nutrition transition that is evidenced by increased prevalences of obesity, overweight and nutrition-related NCD and high consumption of foods that are energy dense, high in macronutrients and low in fibre and micronutrient density. The present study quantifies food intake in a representative sample of Kuwaiti individuals. As such, it represents a critical step in understanding how to modify dietary intake to reduce the prevalence of nutrition-related NCD in Kuwaitis. There is an urgent need to increase nutrition awareness of healthy food choices and to conduct interventions aimed at modifying subsidy policies in Kuwait and limiting Na intake.

Further analyses are needed to identify high energy and Na sources in the Kuwaiti diet and to estimate the differential contributions of Western *v.* traditional foods (such as soft drinks and fruit drinks *v.* milk and fruit juices) to energy and nutrient intakes and to determine whether Kuwaitis are meeting the recommended intakes of fruit and vegetables.

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