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Patterns of food and nutrient consumption in northern Iran, a high-risk area for esophageal cancer

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Abstract

Objectives—To investigate patterns of food and nutrient consumption in Golestan province, a high-incidence area for esophageal cancer (EC) in northern Iran.

Methods—Twelve 24-hour dietary recalls were administered during a one year period to 131 healthy participants in a pilot cohort study. We compare here nutrient intake in Golestan with Recommended Daily Allowances (RDAs) and Lowest Threshold Intakes (LTIs). We also compare the intake of 27 food groups and nutrients among several population subgroups, using mean values from the twelve recalls.

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Contributors: The authors have contributed to the manuscript by planning the study (DDRC, IARC, NNFRI), collecting data (DDRC, NNFRI, GRCGH), calculating the nutritional components (DDRC, NNFRI), analysis of data (DDRC, IARC, NCI), and preparation and revision of the manuscript (all authors). DDRC: Digestive Disease Research Center, Shariati Hospital, Medical Sciences/ University of Tehran, Tehran, Iran; IARC: International Agency for Research on Cancer, Lyon, France; NNFRI: National Nutrition and Food Science Research Institute of Shaheed Beheshti University of Medical Science, Iran; GRCGH: Golestan Research Center of Gastroenterology and Hepatology, Gorgan, Iran; NCI: Nutritional Epidemiology Branch, Division of Cancer Epidemiology and Genetics National Cancer Institute, Bethesda, MD, USA.

Results—Rural women had a very low level of vitamin intake, which was even lower than LTIs ($P < 0.01$). Daily intake of vitamins A and C was lower than LTI in 67% and 73% of rural women, respectively. Among rural men, the vitamin intakes were not significantly different from LTIs. Among urban women, the vitamin intakes were significantly lower than RDAs, but were significantly higher than LTIs. Among urban men, the intakes were not significantly different from RDAs. Compared to urban dwellers, intake of most food groups and nutrients, including vitamins, was significantly lower among rural dwellers. In terms of vitamin intake, no significant difference was observed between Turkmen and non-Turkmen ethnics.

Conclusions—The severe deficiency in vitamin intake among women and rural dwellers and marked differences in nutrient intake between rural and urban dwellers may contribute to the observed epidemiological pattern of EC in Golestan, with high incidence rates among women and people with low socioeconomic status, and the highest incidence rate among rural women.

Keywords

esophageal cancer; Iran; Caspian Littoral; Golestan; Turkmen; diet record

Introduction

Golestan province in northern Iran is known as an area with a very high incidence of esophageal cancer (EC), and squamous cell carcinoma is by far the most prevalent histologic type [Mahboubi et al., 1973; Semnani et al., 2006; Islami et al., 2004]. In most parts of the world, incidence of EC is higher in men than in women, with the male to female ratio often surpassing threefold [Blot et al., 2006]. In very high incidence areas of EC, such as Linxian, China, and Golestan province, the male to female ratio is close to one [Blot et al., 2006] and smoking and alcohol consumption are not as important risk factors as in Western countries [Cook-Mozaffari et al., 1979; Tran et al., 2005; Nasrollahzadeh et al., 2008]. General nutrition deficiencies may be important risk factors in these areas [WCRF/AICR Expert Report, 2007]. Some other risk factors, such as opium consumption, drinking hot tea, and exposure to polycyclic aromatic hydrocarbons have also been suggested as important causes of the high incidence in Golestan; however, few of them have been investigated in detail [Kamangar et al., 2007; Hakami et al., 2008].

Dietary insufficiencies have been associated with higher risks of EC in epidemiological studies [Blot et al., 2006]. A significant inverse association between fruit and vegetable intake and the risk of EC has been reported in several studies [IARC Handbook, 2003], as well as a protective effect for beta-carotene and Vitamins C and E [Chainani-Wu, 2002]. An association between deficiency of other food groups and nutrients, such as vitamin A, and EC risk has been reported as well, but the results are less consistent. Nonetheless, there are limited data on the role of diet as cause of EC in Golestan province [Joint Iran-IARC Study Group, 1977; Hormozdiari et al., 1975; Cook-Mozaffari et al., 1979; Siassi et al., 2000; Siassi and Ghadirian, 2005]. None of the nutritional studies from this area were prospective, and they utilized short-term dietary assessment methods, such as 24-hour dietary recalls. Among them, the only large scale case-control study showed an association between a lower intake of fresh fruit and vegetables and the risk of EC [Cook-Mozaffari et al., 1979].

In order to validate a food frequency questionnaire (FFQ), in preparation for a prospective cohort study in this area, we administered 12 24-hour dietary recalls and obtained repeated biological samples to measure biomarkers of food intake in 131 Golestan adults [Malekshah et al., 2006]. We compare here the dietary intake of selected nutrients in this area with recommended daily intake values. Since the highest EC incidence rate in the 1970s' cancer registry was reported for females in northeastern part of Golestan, which was mainly a rural

area [Mahboubi et al., 1973], we performed these comparisons by gender and residence place to investigate possible differences in nutrient intake patterns between men and women in urban and rural areas. In addition, we report the distribution of daily intake of 27 food groups and nutrients in this subset of the Golestan population. Since an inverse association between education and socioeconomic status (SES) levels and the risk of EC have been reported in this area [Cook-Mozaffari et al., 1979], and the highest incidences of EC have been reported from areas which were mainly inhabited by Turkmen ethnics [Mahboubi et al., 1973], we report the results by gender, ethnicity, place of residence (as an indicator of SES), and education.

Materials and methods

Study subjects

Details of subject selection and data collection have been reported earlier [Malekshah et al., 2006]. Briefly, study subjects were a sub-sample of 142 subjects, selected by stratified random sampling by place of residence, from 1349 participants in a cohort pilot study of EC in the eastern part of Golestan province [Pourshams et al., 2005]. The participation rates in the cohort pilot were 67.9% and 87.9% in urban and rural areas, respectively, and in the present study, all 142 subjects signed a written informed consent and agreed to participate. The participants included 57 subjects from Gonbad, the largest city in the study area, and 85 subjects from three surrounding villages.

The study protocol and the informed consent used for this investigation were approved by the ethical review boards of DDRC and the IARC, and analysis of the data was exempted from review by the ethical committee of the NCI.

Data collection

During the validation study, we administered 24-hour dietary recalls in face-to-face interviews at the subjects' homes each month from June 2002 through June 2003, excluding the month of Ramadan (September 2002), when Muslims refrain from food and drink from dawn to dusk. All food and beverage items consumed the previous day were recorded using an open questionnaire. In total, we collected 12 24-hour recall questionnaire data for each participant. For most items, the USDA food consumption table (USDA, Release 11, 1994), which was adapted for Iranian foods, was used to calculate nutrient values (for both uncooked and cooked foods), daily nutrient intake, and daily energy intake. For some items such as bread, vetch, pepper green, wild plum, mint, sweet canned cherry and sour cherry, an Iranian food composition table was consulted [Azar and Sarkisian, 1981]. Food groups and nutrients were grouped into 15 and 12 categories, respectively.

Statistical Analysis

Mean daily intake of each food group or nutrient was calculated for each subject as an average of all recorded intakes in the 12 24-hour recalls. The normality of the dietary intake variable distributions was assessed by Q-Q plots and the Shapiro-Wilk W test, and the distributions were found to be severely skewed. Therefore, we utilized geometric means in our analyses. We compared geometric mean of daily nutrient intakes in Golestan with recommended daily allowances (RDAs) and lowest threshold intakes (LTIs) for Ireland [Food Safety Authority of Ireland, 1999], by performing one sample t-tests. An RDA value is the amount of nutrient that is enough for almost every individual. LTI is the level of nutrient intake below which nearly all individuals will be unable to maintain metabolic integrity. The nutrients that we compared with the Irish RDAs and LTIs were protein and vitamins A and C. We utilized the Irish system because no recommended intake values have been validated for Iran, most of the Irish values were identical to their equivalents in the United Kingdom or the Commission of the European Communities systems, and the Irish system was updated for a few items, including vitamin C,

more recently. We did not utilize the US RDAs, because these values were generally much higher than the European values, and they might not be appropriate to be compared with values from the present study.

We also calculated geometric mean differences in intake of food groups and nutrients by study subgroups, and their 95% confidence intervals (95% CIs), with adjustment for age, gender, place of residence, ethnicity, education history, and energy intake in linear multiple regression models. As urban/rural residence and Turkmen/non-Turkmen ethnicity were correlated, we reported geometric mean differences (and 95% CIs) for selected food groups and nutrients in strata defined by residence place and ethnicity, with adjustment for age, energy intake, gender, and education. Throughout this paper, *P* values <0.05 are considered statistically significant.

Results

Of the 142 subjects invited to participate, 10 were excluded because of incomplete data and one was excluded because of adherence to a special dietary regimen. The mean age for the remaining 131 subjects included in the analysis was 50.3 (standard deviation $\pm$ 11.2, range 35–65) years. Table 1 shows demographic and anthropometric characteristics of the participants by gender.

Table 2 shows the proportion of the study population whose intake of protein, vitamin A, or vitamin C was lower than RDAs and LTIs. Figure 1 shows mean daily intake of these nutrients in rural and urban areas by gender, the corresponding RDAs and LTIs, and *P* values for difference between the daily intakes and RDAs and LTIs. Rural women had a very low level of vitamin intake. Daily intake of vitamin A was lower than RDA and LTI in 94% and 67% of rural women, respectively. The corresponding numbers for vitamin C intake were 100% and 73%. For both vitamins, the mean daily intake among rural women was lower than LTIs ($P < 0.01$). Vitamins A and C intakes by rural men were lower than RDAs ($P < 0.01$), but they were not significantly different from LTIs. In urban area, daily intake of vitamins A and C was lower than RDA in 61% and 64% of women, respectively. For both vitamins, the daily intakes among urban women were significantly lower than RDAs, but were significantly higher than LTIs. Among urban men, there was no significant difference between intake of vitamins A and C and RDAs. In both rural and urban areas, intake of proteins among men was significantly higher than the RDAs ($P < 0.01$), and women's protein intake was not significantly different from RDAs.

Tables 3 and 4 show adjusted geometric mean differences in daily intake of food groups and nutrients by population subgroups among men and women. More significant differences were observed among women than men. Compared to rural dwellers, urban dwellers of both genders used more vegetables, fruit, meat, fat (nutrient), saturated fatty acids (SFA), cholesterol, vitamin C, and beta-carotene and less bread, cereal, and carbohydrates. Urban men had a higher legume and condiment intake than rural men, and urban women had a higher intake of fish, egg, dairy products, sugar, mono-unsaturated fatty acids (MUFA), and vitamins A and E and lower intake of potato compared to rural women. For both genders, intake of tea, fat (nutrient), SFA, and MUFA by Turkmen was higher, and intake of bread was lower, than by non-Turkmen. Turkmen men had a higher intake of fruit, non-Alcoholic beverages, and poly-unsaturated fatty acids (PUFA), and lower intake of beta-carotene, compared to non-Turkmen men. Turkmen women had a higher intake of meat, fish, sugar, and cholesterol, and lower intake of legumes, vegetables, and carbohydrates, compared to non-Turkmen women. When we investigated food group and nutrient intakes among subjects with some school attendance and subjects without a history of attending school, only intake of bread and dairy products by men was different between these two subgroups.

Table 5 shows differences of adjusted geometric means for daily intake of selected food groups and nutrients in strata defined by place of residence and ethnicity. In rural areas, Turkmen had a significantly higher intake of fruit, meat, total fat (nutrient), SFA, MUFA, PUFA, and cholesterol and a lower intake of bread and carbohydrates than non-Turkmens, but in urban areas only intake of legumes and vegetables were significantly different, being lower among Turkmen. In both Turkmen and non-Turkmen ethnic groups, urban dwellers had higher intake of all food groups and nutrients except for bread and carbohydrates, and most of these differences were statistically significant.

Discussion

Our study showed a deficiency in vitamin intake among women and rural dwellers in Golestan. The most severe deficiency was observed among rural women, where the intake of the studied vitamins was even less than the lowest thresholds levels. These deficiencies may contribute to the reported very high incidence of EC among rural women in Golestan [Mahboubi et al., 1973]. As discussed earlier, tobacco use in Golestan is not a prominent risk factor for EC. However, tobacco and opium consumption in Golestan is still much more common among men, compared to women [Cook-Mozaffari et al., 1979; Pourshams et al., 2005]. Therefore, we may expect a higher EC incidence rate for men than for women. Our findings may partly explain why in Golestan the incidence rate of EC in women is not lower than in men. When we compared nutritional intake patterns in Golestan subgroups, in both genders the most striking differences were observed between rural and urban dwellers, where intake of several potentially protective nutrients, such as vitamin C, were significantly lower among rural dwellers. These rural-urban differences were observed for both Turkmen and non-Turkmen individuals. Since on average, rural dwellers in Golestan have more limited access to a number of facilities and consequently may have lower SES compared to urban dwellers, the observed inequalities may contribute to the suggested higher incidence of EC among people with low SES. Compared to Irish RDAs, protein intake was not deficient in any of the studied groups, which is in agreement with an earlier study [Joint Iran-IARC Study Group, 1977].

Although there were some differences between Turkmen and non-Turkmens in food group and nutrient intakes, such as higher intake of fat and fatty acids by Turkmen, no significant difference in vitamin intake was observed between these two ethnic groups. It implies that the observed higher intake of fruits by Turkmen, compared to non-Turkmens, compensates for lower intake of legumes and vegetables, at least in terms of vitamin intake. Intake of several other food groups and nutrients in rural areas was higher among Turkmen, but nutrient intake patterns in these ethnic groups were not significantly different in urban areas. Although it has been reported that the incidence of EC in the Caspian littoral is higher in areas mostly inhabited by Turkmen [Mahboubi et al., 1973], it is not known whether within the high-incidence area the rates are higher among this ethnic group. If incidence of EC among Turkmen is truly higher than among non-Turkmens, our results suggest that nutritional deficiency does not contribute significantly to this difference.

Our results did not show significant differences in intake of the investigated food groups and nutrients between educated and non-educated individuals. In previous studies in this area, education has been reported to be inversely associated with EC risk [Cook-Mozaffari et al., 1979]. Thus, it seems that education may influence the risk of EC in this area through factors other than dietary intakes, or the association between education and EC is confounded (e.g. by ethnicity).

One of the limitations of our study is that results of a relatively small group of people may not provide conclusive evidence, but we think that the observed differences among subgroups in Golestan may be helpful for defining better hypotheses to be tested further. Another limitation

is that we performed several comparisons in our analyses; therefore, some significant findings might have emerged by chance. The main strength of our study is that our results come from 12 24-hour recalls, administered monthly during one year, which takes into account possible seasonal changes and reduces the limitation of recording dietary intakes only once or a few times. In addition, our study subjects were randomly selected from different socioeconomic groups and our data was adjusted for education and place of residence, as indicators of SES; therefore, our results are not likely to be confounded by SES.

In summary, intake of the investigated vitamins among women and rural dwellers was lower than the recommended values, with rural women having the lowest intakes. The most marked differences in food and nutrient intake among population subgroups in Golestan were observed between residents of rural and urban areas, with rural residents reporting significantly lower intake of several food groups and nutrients, including vitamins. Our findings may partly explain the observed epidemiological pattern of EC in Golestan, with a high incidence rate among women and among people with low SES, and the highest incidence rate among rural women. Nutrition deficiencies may contribute to high incidence of EC by enhancing susceptibility to the effects of other environmental or genetic risk factors, for example, by altering metabolism of carcinogens or by impairing DNA repair [Ames and Wakimoto, 2002; Milner, 2006; Davis, 2007]. In contrast to low-incidence areas of EC, a much smaller proportion of EC cases are attributed to tobacco smoking and alcohol drinking in high-incidence areas, including Golestan. Therefore, nutritional insufficiencies may have a larger impact on disease development in these areas, and the number of EC cases attributable to these insufficiencies may be considerably higher. This analysis provides background information on which dietary intakes to focus on in future prospective studies in Golestan. Finding relevant deficiencies in specific food groups or nutrients could lead to specific preventive measures, which might significantly reduce the incidence of this lethal disease in such high-incidence areas.

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A. Urban population **B. Rural population**

Figure 1. Mean daily intake of selected nutrients in urban and rural population of Golestan, and corresponding RDAs and LTIs, by gender

Note: *P* values for difference between RDAs and LTIs with corresponding values from Golestan are shown in parentheses. To make the figure size more appropriate, the units of vitamins A and C intake in this figure are milligram and 10 milligrams, respectively.

* Gram per kilogram body weight

Abbreviations: RDA, Recommended Daily Allowance; LTI, Lowest Threshold Intake.

Table 1
Demographic and anthropometric characteristics of study subjects by gender

Variable	Men (n=49)	Women (n=82)
Age (year) *	51.2 (±13.2)	49.9 (±9.8)
Residence place (rural)	33 (66.0%)	48 (59.3%)
Ethnicity (Turkmen)	36 (72.0%)	56 (69.1%)
Education (some school)	26 (52.0%)	26 (32.1%)
Height (cm) *	167.7 (±6.8)	153.5 (±5.1)
Weight (kg) *	67.6 (±12.1)	62.3 (±13.8)
BMI (kg/m ²) *	24.0 (±3.9)	26.5 (±5.8)

* Mean (±standard deviation)

Table 2

Proportion of subjects with daily intakes lower than RDAs or LTIs

	Urban men	Urban women	Rural men	Rural women
Protein				
< RDA (0.75 g/kg body weight)	5.9 %	51.5 %	6.1 %	37.5 %
< LTI (0.45 g/kg body weight)	0.0 %	9.1 %	0.0 %	4.2 %
Vitamin A				
< RDA (700 RE µg for men, 600 RE µg for women)	70.6 %	60.6 %	75.8 %	93.8 %
< LTI (300 RE µg for men, 250 RE µg for women)	5.9 %	3.0 %	36.4 %	66.7 %
Vitamin C				
< RDA (60 mg for both genders)	41.2 %	63.6 %	97.0 %	100 %
< LTI (32 mg for both genders)	5.9 %	21.2 %	42.4 %	72.9 %

Abbreviations: RDA, Recommended Daily Allowance; LTI, Lowest Threshold Intake; RE, retinol equivalents.

Table 3

Adjusted¹ geometric mean differences (95% CIs) in daily intake of food groups and nutrients by population subgroups (only men)

Food groups/ nutrients (unit)	Urban - Rural ²	P Value	Turkmen - Non-Turkmen ²	P Value	Some School - No School ²	P Value
Bread (g)	-141.7 (-209.5 - -85.3)	<0.01	-143.4 (-211.2 - -86.9)	<0.01	-35.1 (-73.8 - -1.02)	0.04
Cereal (g)	-106.7 (-191.5 - -32.1)	0.01	-28.9 (-110.3 - 42.7)	0.44	-5.2 (-58.5 - 43.6)	0.84
Legumes (g)	14.1 (2.1 - 19.3)	0.03	-3.8 (-24.2 - 5.2)	0.51	2.8 (-6.6 - 8.0)	0.47
Vegetables (g)	60.7 (29.8 - 81.5)	<0.01	-24.3 (-72.8 - 8.2)	0.16	-5.4 (-31.8 - 14.7)	0.63
Fruit (g)	230.9 (156.1 - 246.9)	<0.01	69.8 (8.6 - 83.0)	0.04	13.0 (-78.1 - 44.6)	0.65
Potato (g)	1.8 (-19.6 - 13.6)	0.83	-2.7 (-26.0 - 10.3)	0.74	-3.5 (-17.9 - 6.1)	0.52
Meat (g)	29.6 (10.4 - 39.8)	0.01	9.1 (-12.0 - 20.4)	0.31	5.8 (-9.4 - 15.7)	0.38
Fish (g)	-1.7 (-10.7 - 1.0)	0.34	-1.5 (-11.2 - 1.4)	0.47	2.1 (-0.9 - 3.5)	0.12
Eggs (g)	8.8 (-1.8 - 13.0)	0.08	-0.2 (-14.7 - 5.7)	0.97	0.1 (-8.3 - 4.6)	0.97
Dairy products (g)	32.6 (-16.8 - 58.1)	0.15	5.9 (-49.3 - 34.5)	0.77	50.4 (23.1 - 67.7)	<0.01
Fat [food group] (g)	1.3 (-11.5 - 10.8)	0.81	10.0 (-0.6 - 17.9)	0.06	1.3 (-7.0 - 8.2)	0.73
Sugar (g)	23.1 (-6.6 - 34.2)	0.10	7.9 (-24.0 - 19.8)	0.48	-8.5 (-35.7 - 5.3)	0.29
Tea (ml)	188.8 (-112.0 - 388.2)	0.18	277.9 (37.0 - 437.9)	0.03	-70.4 (-294.5 - 98.5)	0.44
Nonalcoholic Beverages (ml)	200.6 (-102.5 - 404.3)	0.16	268.1 (18.0 - 436.5)	0.04	-69.8 (-295.7 - 102.2)	0.46
Condiments (g)	10.9 (5.3 - 15.0)	<0.01	-0.6 (-7.6 - 4.5)	0.85	-0.4 (-5.0 - 3.2)	0.83
Carbohydrate (g)	-27.2 (-51.0 - -5.0)	0.02	-21.0 (-45.0 - 1.5)	0.07	-6.8 (-22.6 - 8.4)	0.38
Protein (g)	2.9 (-2.9 - 8.1)	0.30	-4.3 (-10.5 - 1.3)	0.13	3.0 (-0.9 - 6.7)	0.12
Fat [nutrient] (g)	13.4 (1.8 - 23.0)	0.03	13.2 (2.5 - 22.0)	0.02	2.8 (-5.5 - 10.0)	0.48
SFA (g)	5.8 (2.3 - 8.4)	<0.01	3.8 (0.6 - 6.2)	0.03	2.0 (-0.6 - 4.0)	0.12
MUFA (g)	4.3 (-1.0 - 8.4)	0.10	6.0 (1.4 - 9.7)	0.01	0.10 (-3.6 - 3.3)	0.95
PUFA (g)	2.1 (-2.2 - 5.4)	0.30	4.0 (0.3 - 6.9)	0.04	0.87 (-2.0 - 3.3)	0.53
Cholesterol (mg)	74.6 (13.9 - 108.7)	0.02	21.8 (-44.8 - 59.3)	0.43	29.1 (-14.6 - 58.6)	0.16
Vit. A (RE µg)	231.4 (-135.2 - 386.1)	0.15	74.6 (-318.8 - 241.2)	0.59	167.1 (-61.3 - 293.3)	0.12
Vit. C (mg)	22.0 (12.7 - 28.9)	<0.01	-5.1 (-18.0 - 4.5)	0.32	1.3 (-6.3 - 7.4)	0.71
Vit. E (mg)	0.32 (-0.20 - 0.55)	0.16	-0.26 (-1.15 - 0.13)	0.27	0.14 (-0.21 - 0.34)	0.35
Beta-carotene (µg)	48.6 (9.2 - 65.7)	0.03	-151.4 (-151.4 - -1.5)	0.04	-13.0 (-51.2 - 8.4)	0.29
Energy ³ (kcal)	-334.5 (-876.4 - 101.9)	0.14	-63.0 (-588.7 - 376.7)	0.79	43.8 (-167.3 - 437.2)	0.33

¹ Adjusted for energy intake, age, place of residence (urban vs. rural), ethnicity (Turkmen vs. non-Turkmen), and education (some school vs. no school), excluding the variable of interest from adjustments.

² Geometric mean of daily intake by the first population subgroup minus geometric mean of daily intake by the second population subgroup.

³ Similar to ¹ except for no adjustment for energy intake.

Abbreviations: RE, retinol equivalents; SFA, saturated fatty acids, MUFA, mono-unsaturated fatty acids, PUFA, poly-unsaturated fatty acids.

Table 4

Adjusted¹ geometric mean differences (95% CIs) in daily intake of food groups and nutrients by population subgroups (only women)

Food groups/ nutrients (unit)	Urban – Rural ²	P Value	Turkmen – Non-Turkmen ²	P Value	Some School – No School ²	P Value
Bread (g)	-154.7 (-264.0 – -72.2)	<0.01	-87.0 (-196.2 – -5.0)	0.04	-35.8 (-119.9 – 28.9)	0.30
Cereal (g)	-63.4 (-124.6 – -8.0)	0.02	-7.7 (-67.8 – 46.7)	0.79	-14.8 (-69.7 – 35.2)	0.57
Legumes (g)	5.9 (-2.8 – 10.3)	0.14	-13.4 (-34.1 – -2.7)	0.01	-4.3 (-15.4 – 1.7)	0.20
Vegetables (g)	35.9 (7.8 – 55.8)	0.02	-45.5 (-94.0 – -11.6)	0.01	0.52 (-29.9 – 22.5)	0.97
Fruit (g)	250.5 (195.2 – 270.2)	<0.01	57.6 (-10.7 – 81.5)	0.08	-4.1 (-122.7 – 41.0)	0.91
Potato (g)	-16.2 (-39.8 – -1.5)	0.03	0.58 (-18.8 – 12.6)	0.94	12.5 (-2.6 – 22.3)	0.09
Meat (g)	33.1 (18.5 – 41.2)	<0.01	14.7 (0.28 – 22.6)	0.05	3.9 (-14.8 – 14.6)	0.61
Fish (g)	3.4 (0.40 – 4.7)	0.03	3.7 (2.0 – 4.5)	<0.01	-0.33 (-4.1 – 1.5)	0.79
Eggs (g)	7.5 (4.0 – 9.4)	<0.01	1.2 (-3.3 – 3.7)	0.50	2.5 (-1.6 – 4.8)	0.18
Dairy products (g)	97.4 (48.1 – 126.8)	<0.01	41.5 (-11.2 – 72.2)	0.10	24.4 (-29.2 – 58.1)	0.31
Fat [food group] (g)	5.0 (-3.8 – 11.9)	0.24	6.4 (-1.9 – 12.8)	0.12	-1.1 (-9.9 – 5.8)	0.77
Sugar (g)	14.0 (-0.11 – 23.6)	0.05	12.4 (-0.27 – 21.0)	0.05	-0.03 (-15.0 – 10.4)	1.00
Tea (ml)	-8.6 (-268.8 – 188.7)	0.94	213.4 (-3.0 – 376.9)	0.05	-92.4 (-341.4 – 100.3)	0.38
Nonalcoholic Beverages (ml)	223.0 (-593.5 – 613.3)	0.47	180.0 (-617.0 – 542.2)	0.55	-174.6 (-1085.8 – 267.8)	0.53
Condiments (g)	3.9 (-1.3 – 7.7)	0.12	-4.3 (-11.2 – 0.80)	0.11	0.04 (-5.2 – 4.0)	0.99
Carbohydrate (g)	-30.3 (-50.2 – -11.3)	<0.01	-19.2 (-39.6 – 0.58)	0.05	-2.3 (-20.2 – 14.8)	0.80
Protein (g)	4.2 (-0.47 – 8.5)	0.08	-1.5 (-6.5 – 3.0)	0.52	1.6 (-2.8 – 5.7)	0.46
Fat [nutrient] (g)	15.2 (5.8 – 23.1)	<0.01	10.9 (1.7 – 18.5)	0.02	0.79 (-8.9 – 8.9)	0.86
SFA (g)	6.8 (4.4 – 8.8)	<0.01	3.4 (1.0 – 5.4)	0.01	0.83 (-1.9 – 3.0)	0.51
MUFA (g)	4.6 (0.32 – 8.0)	0.04	4.3 (0.29 – 7.5)	0.04	-0.12 (-4.4 – 3.4)	0.95
PUFA (g)	1.8 (-1.8 – 4.6)	0.29	3.1 (-0.13 – 5.7)	0.06	0.3 (-3.1 – 3.1)	0.84
Cholesterol (mg)	113.1 (54.3 – 130.9)	<0.01	39.7 (10.9 – 58.9)	0.01	19.1 (-15.0 – 42.8)	0.23
Vit. A (RE µg)	519.8 (385.3 – 596.4)	<0.01	18.7 (-202.8 – 143.6)	0.83	-92.4 (-326.9 – 46.3)	0.23
Vit. C (mg)	23.5 (12.9 – 31.2)	<0.01	-0.2 (-14.0 – 10.0)	0.97	7.3 (-4.1 – 15.7)	0.19
Vit. E (mg)	0.78 (0.51 – 0.93)	<0.01	0.06 (-0.35 – 0.29)	0.70	-0.03 (-0.44 – 0.20)	0.83
Beta-carotene (µg)	82.5 (61.5 – 93.5)	<0.01	4.9 (-30.6 – 23.1)	0.72	12.1 (-18.5 – 28.8)	0.35
Energy ³ (kcal)	-231.4 (-590.9 – 71.0)	0.14	-128.6 (-498.5 – 181.1)	0.44	204.2 (-99.5 – 462.5)	0.17

¹ Adjusted for energy intake, age, place of residence (urban vs. rural), ethnicity (Turkmen vs. non-Turkmen), and education (some school vs. no school), excluding the variable of interest from adjustments.

² Geometric mean of daily intake by the first population subgroup minus geometric mean of daily intake by the second population subgroup.

³ Similar to ¹ except for no adjustment for energy intake.

Abbreviations: RE, retinol equivalents; SFA, saturated fatty acids, MUFA, mono-unsaturated fatty acids, PUFA, poly-unsaturated fatty acids.

Table 5

Adjusted¹ geometric mean differences (95% CIs) for selected food groups and nutrients after stratification by place of residence and ethnicity

Food groups/ nutrients	Rural Turkmen - Rural Non-Turkmen ²	P Value	Urban Turkmen - Urban Non-Turkmen ²	P Value	Urban Non-Turkmen - Rural Non-Turkmen ²	P Value	Urban Turkmen - Rural Turkmen ²	P Value
Bread (g)	-231.81 (-455.55 – -72.61)	<0.01	-58.19 (-141.74 – 4.16)	0.07	-255.87 (-825.88 – 9.62)	0.06	-136.52 (-188.99 – -91.50)	<0.01
Legumes (g)	-0.29 (-25.15 – 5.24)	0.94	-14.45 (-33.38 – -3.32)	0.01	18.58 (5.40 – 23.64)	0.02	6.57 (-0.17 – 9.96)	0.05
Vegetables (g)	7.28 (-41.69 – 31.53)	0.69	-49.93 (-87.21 – -20.61)	<0.01	80.28 (33.90 – 106.20)	0.01	33.70 (13.82 – 48.37)	<0.01
Fruit (g)	36.2 (35.8 – 36.3)	<0.01	30.0 (-54.1 – 82.8)	0.41	137.2 (136.9 – 137.3)	<0.01	146.7 (95.2 – 168.0)	<0.01
Meat (g)	17.60 (7.99 – 20.90)	0.01	6.71 (-17.06 – 21.56)	0.51	36.45 (27.03 – 39.36)	<0.01	25.11 (11.98 – 33.43)	<0.01
Carbohydrate (g)	-54.50 (-98.38 – -14.88)	0.01	-11.54 (-26.91 – 3.17)	0.12	-67.46 (-113.03 – -26.48)	<0.01	-23.72 (-39.92 – -8.24)	<0.01
Fat [nutrient] (g)	25.62 (15.48 – 32.81)	<0.01	6.19 (-1.12 – 12.63)	0.09	30.47 (20.83 – 37.39)	<0.01	9.75 (1.78 – 16.64)	0.02
SFA (g)	6.76 (4.83 – 7.97)	<0.01	2.18 (-0.08 – 4.09)	0.06	9.38 (7.57 – 10.56)	<0.01	5.01 (2.80 – 6.82)	<0.01
MUFA (g)	11.12 (7.28 – 13.80)	<0.01	1.83 (-1.47 – 4.65)	0.25	12.30 (8.34 – 14.92)	<0.01	2.19 (-1.31 – 5.15)	0.20
PUFA (g)	7.44 (4.09 – 9.72)	<0.01	1.63 (-1.43 – 4.12)	0.27	6.92 (2.31 – 9.69)	0.01	0.48 (-2.25 – 2.79)	0.71
Cholesterol (mg)	49.50 (18.54 – 60.21)	0.01	12.84 (-33.95 – 47.74)	0.54	125.28 (107.41 – 133.55)	<0.01	88.79 (51.93 – 112.50)	<0.01

¹ Adjusted for energy intake, age, gender (female vs. male), and education (some school vs. no school).

² Geometric mean of daily intake by the first population subgroup minus geometric mean of daily intake by the second population subgroup.

Abbreviations: SFA, saturated fatty acids, MUFA, mono-unsaturated fatty acids, PUFA, poly-unsaturated fatty acids.