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ORIGINAL ARTICLE

Epidemiology of obesity and hypertension and related risk factors in Uzbekistan

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Objective: This study examined the prevalence of obesity and hypertension and associated behavioral risk factors in adult men and women in Uzbekistan. The study also examined the association between obesity and hypertension.
Method: The analysis used data from the 2002 Uzbekistan Health Examination Survey, which included a nationally representative sample of 2333 men aged 15–59 years and 5463 women aged 15–49 years. The survey measured height, weight and blood pressure and included questions on physical activity, dietary habits, tobacco smoking, alcohol use and other characteristics. The analysis was conducted using binary and multinomial logistic regression methods, separately for men and women.
Results: Eating animal source protein and tobacco smoking in the past were positively associated with obesity, but there were no consistent associations with other dietary indicators, physical activity level or alcohol use. Obese men and women were about three times as likely to suffer from hypertension as those with a normal BMI (odds ratio (OR) = 3.01; 95% confidence interval (CI): 1.67–5.44; $P<0.001$ for men and OR = 2.82; 95% CI: 2.05–3.86; $P<0.001$ for women), independent of physical activity level, dietary habits, tobacco smoking and other factors. For men, the risk of hypertension was strongly positively associated with BMI only at BMI levels above 25 kg/m^2, but for women a positive relationship was observed at all BMI levels.
Conclusion: The study found a strong positive association between obesity and hypertension in adult men and women in Uzbekistan. The shape of the relationship between BMI and hypertension is different for women than for men, requiring further research to explore this relationship.
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Introduction

Problems of overweight and obesity are caused by chronic imbalance between energy intake and actual energy needs of the body. Declining physical activity and increasing consumption of foods rich in saturated fat and sugar are primary reasons for a growing obesity epidemic worldwide (WHO, 2003). Once considered a problem related to affluence, obesity is now fast growing in many developing countries (WHO, 2003; Monteiro *et al*., 2004) and the burden of obesity within countries is shifting towards groups with lower socioeconomic status (Monteiro *et al*., 2004).

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A recent analysis of anthropometric measurements for women aged 20–49 years in 36 developing countries observed that the proportion overweight exceeded the proportion underweight in a majority of the countries in both urban and rural areas. In this study, the median ratio of overweight to underweight was 5.8 in urban areas and 2.1 in rural areas (Mendez *et al*., 2005). These results are contrary to the general belief that in most developing countries overweight is less prevalent than underweight and that it is primarily concentrated in urban, higher socioeconomic status households.

The growing obesity pandemic in the developing world has been associated with a host of other rapidly growing serious health problems, such as hypertension, diabetes and heart disease (e.g., Gopinath *et al*., 1994; Lerman-Garber *et al*., 1999; Misra *et al*., 2001; Venkatramana and Reddy 2002; Szczygielska *et al*., 2003; Adair 2004; Hu *et al*., 2004; Lee *et al*., 2004; Liu *et al*., 2004; Niskanen *et al*., 2004; Kotsis *et al*., 2005; Nanchahal *et al*., 2005; Sanchez-Castillo *et al*., 2005). These problems are particularly severe in many

developing countries in Eastern Europe and Central Asia, where obesity and associated cardiovascular diseases are already a major cause of ill health and death (Popkin *et al*., 1997; Young *et al*., 2005).

According to the recent burden of disease estimates from the World Health Organization, overweight and hypertension are among the top three leading causes of disease burden among women and among the top five leading causes of disease burden among men in the Central Asian Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan (WHO, 2006a). In each of these countries, about one in three adults are already overweight or obese and cardiovascular diseases account for about two-thirds of all deaths (WHO, 2006b). Yet, there is limited understanding of the scope and the underlying behavioral risk factors of these problems in such settings. A limiting factor has been the lack of reliable data on the prevalence and distribution of obesity and associated chronic diseases.

A recent health examination survey in Uzbekistan measured levels of obesity and hypertension in a nationally representative probability sample of adult men and women. The survey also collected information on health risk behaviors, including level of physical activity, dietary habits, tobacco smoking and alcohol use, as well as sociodemographic characteristics. These data provide a unique opportunity to study the epidemiology of obesity and hypertension in different population groups in Uzbekistan and their associations with selected risk factors. These data also allow a close examination of the relationship between body weight and the risk of hypertension.

Data and methods

Data

The analysis is based on the 2002 Uzbekistan Health Examination Survey (UHES). The survey collected information from 4168 sample households in 219 sample enumeration areas (101 in urban areas and 118 in rural areas). The sampling design for the survey was developed by the State Department of Statistics of the Ministry of Macroeconomics and Statistics. A weighted, multistage, cluster sampling design was used. The sample was designed to represent five major regions of Uzbekistan — Tashkent City and the Western, Central, East-Central and Eastern Regions (see footnotes to Table 1 for a list of oblasts included in these regions). All women aged 15–49 years in the sample households were eligible for interview. All men aged 15–59 years in the selected households in Tashkent City were eligible respondents, but in the remaining four regions men aged 15–59 years were eligible to be interviewed in only every third household. Individual questionnaires were completed for 98% of eligible women and 95% of eligible men. Overall, interviews were completed with 5463 women aged 15–49 years and 2333 men aged 15–59 years. More details on the sample design are provided in the main survey report (AIC, Ministry of Health *et al*., 2004).

The survey collected information on a wide range of adult health issues, including lifestyle factors such as physical activity, diet, smoking, and alcohol use, and other risk factors for cardiovascular disease. The survey also collected data on a number of key biomarkers, including measurements of height, weight and blood pressure for all respondents, as well as measurements of lipids and diabetes for respondents in Tashkent City. The 2002 UHES provides data on these biomarkers and several social and behavioral risk factors representative of the general population, as opposed to clinic-based data.

Measurements of obesity and hypertension

All survey respondents were weighed using a solar-powered scale with an accuracy of ± 100 g. Their height was measured using an adjustable wooden measuring board, specifically designed to provide accurate measurements (to the nearest 0.1 cm) in a developing-country field situation. The weight and height data were used to calculate the body mass index (BMI). BMI was used to define underweight (BMI $<$ 18.5 kg/m^2), normal (18.5 $\leqslant$ BMI $<$ 25.0 kg/m^2), overweight (25.0 $\leqslant$ BMI $<$ 30.0 kg/m^2) and obese (BMI $\geqslant$ 30 kg/m^2) adults.

Blood pressure measurements were taken by female and male interviewers who were nurses and doctors. Before the survey fieldwork, these interviewers were given refresher training in measurement procedures in nonclinical settings. Measurements were made using sphygmomanometers (Mercury safe, TRIMLINEm Mercurial Desk Sphygmomanometer) and stethoscopes according to the protocols of Westat Inc. (1993). Two measurements of systolic and diastolic blood pressure (measured in millimeters of mercury, mm Hg) were taken at an interval of at least 10 min between measurements. Adults were classified as hypertensive if they were taking antihypertensive drugs, or if (according to the second blood pressure measurement) their systolic blood pressure was $\geqslant$130 mm Hg or their diastolic blood pressure was $\geqslant$85 mm Hg (Grundy *et al*., 2004; IDF, 2005). The main survey report used 140 and 90 mm Hg cutoffs for systolic and diastolic blood pressure to define hypertension (AIC, Ministry of Health *et al*., 2004).

Research variables

The risk factors of obesity and hypertension included in the study are: physical activity level (expressed as MET-min per week, where METs are computed by weighting each type of physical activity by its energy requirements; METs are multiples of the resting metabolic rate), eight indicators of diet (frequency of eating animal source protein, carbohydrates, fresh fruits and vegetables, dried fruits and vegetables, canned or pickled fruits and vegetables, and fried foods, and whether salt or fat are added to cooked food), tobacco smoking and alcohol consumption in the last 12 months. For definitions of these variables, see Table 1.

Table 1 Sample distribution (%) of men aged 15–59 years and women aged 15–49 years by selected risk factors and background characteristics, Uzbekistan 2002

Characteristic	*Men*	*Women*
Risk factors		
Physical activity level[a]		
Low	29.5	44.3
Medium	33.7	42.3
High	36.8	13.4
Diet		
Animal protein[b] *(days/week)*		
<2	31.3	27.3
2–3	50.4	49.8
4+	18.3	22.9
Carbohydrate[c]		
Not everyday	52.1	43.0
Everyday	47.9	57.0
Fresh fruits and vegetables[d] *(days/week)*		
<3	23.1	21.4
3–4	40.2	31.8
5+	36.7	46.8
Dried fruits and vegetables[e] *(days/week)*		
<1	27.2	30.1
1–2	45.5	40.8
3+	27.3	29.1
Canned or pickled fruits and vegetables[f]		
Does not eat	59.8	60.8
Eats, <2 days/week	21.0	18.8
Eats, 2+ days/week	19.2	20.4
Fried foods[g] *(days/week)*		
<3	36.9	20.3
3–5	38.6	29.4
6+	24.5	50.3
Adds salt to cooked food		
No	86.6	87.5
Yes	13.4	12.5
Adds fat to cooked food		
No	94.1	82.4
Yes	6.0	17.6
Tobacco smoking[h]		
Never	59.1	98.6
Past only	16.9	0.4
Current	24.1	1.0
Alcohol consumption in last 12 months[i]		
No	33.6	74.8
Yes – not a problem drinker	50.6	24.4
Yes – problem drinker	15.7	0.8
Background factors		
Age		
15–19	16.3	20.8
20–24	16.6	17.5
25–29	17.1	14.0
30–34	12.6	13.7
35–39	11.0	13.1
40–44	9.7	12.0
45–49	8.4	9.0
50–54	6.0	—
55–59	2.3	—
Marital union		
Never married	29.7	27.6
In union	68.6	66.2
Separated/divorced/widowed	1.7	6.2
Education		
Primary/middle	8.0	10.6
Secondary	56.2	58.0
Secondary special	20.1	20.7
Higher	15.6	10.8
Work status[j]		
Not employed	34.8	54.6
White collar	32.6	28.5
Manual/agriculture	32.6	16.9
Making ends meet[k]		
Great difficulty	26.0	28.4
Some difficulty	36.2	34.6
Little or no difficulty	37.8	37.1
Ethnicity		
Uzbek	86.2	85.2
Other[l]	13.8	14.8
Religion		
Muslim	96.8	95.7
Other[m]	3.2	4.3
Residence		
Rural	60.7	59.6
Urban	39.3	40.4
Region[n]		
Tashkent City	8.5	9.5
Western	13.5	12.7
Central	21.8	24.2
East-Central	27.7	25.8
Eastern	28.5	27.8
Number of cases[o]	2333	5146

[a]Physical activity level is expressed as MET-minutes per week. METs are multiples of the resting metabolic rate. Using the International Physical Activity Questionnaire (IPAQ) guidelines (IPAQ, 2004), a physical activity score is calculated for each person based on the information on total number of minutes per week spent walking (×3.3 METs), doing moderate physical activity (×4.0 METs), and vigorous physical activity (×8.0 METs). Persons with a physical activity score <6000 MET-minutes are defined as having a low level of physical activity; 6000–13999 as having a medium level of physical activity; and 14000+ as having a high level of physical activity.

[b]Animal protein intake is measured by an average score, which is calculated by adding number of days in the last week eating foods from each of the following four categories and dividing by four: (1) cheese, yoghurt, kefir, ice cream, milk or other milk products; (2) eggs; (3) red meats; (4) fish and poultry.

[c]Carbohydrate intake is measured by an average score, which is calculated by adding number of days in the last week eating foods from each of the following three categories and dividing by three: (1) roots and tubers such as white potatoes, turnips, radishes or beet root; (2) bread, rice, pasta, cereal, cookies, biscuits or similar products made with wheat or white flour; (3) sugary foods, confectionery, pastry, cakes, chocolates or sweets.

Analysis

Data are analyzed using both descriptive and multivariate logistic regression methods.

All analysis is carried out separately for adult men (15–59 years) and women (15–49 years). Women who were pregnant at the time of the survey and women who had a live birth or a stillbirth during the 2 months preceding the survey were excluded from the analysis. Binary and multinomial logistic regression models were estimated using the STATA statistical software package (Stata Corporation, 2003). The following background characteristics of the respondents were included as controls in the multivariate models: age, marital status, education, work status (employment in the last 12 months and occupation), difficulty in making ends meet (economic status), ethnicity, religion, urban/rural residence and geographic region. Results are presented in the form of odds ratios (OR) and relative risk ratios (RRR) with significance levels and 95% confidence intervals (95% CI). It is important to note that ORs and RRRs in this study only describe an association between characteristics measured at the same time. In the survey, certain states and certain categories of respondents were oversampled and nonresponse rates varied from one geographical area to another. In all analysis in this study, weights are used to restore the representativeness of the sample (AIC, Ministry of Health *et al*., 2004).

Human subjects informed consent

Analysis presented in this paper is based on an analysis of existing survey data with all identifier information removed. Informed consent was obtained from all respondents in the survey before asking questions and separately before obtaining measurements of height and weight and blood pressure.

Results

In Uzbekistan, women (15–49 years) are much less likely than men (15–59 years) to be physically active, smoke tobacco or consume alcohol (Table 1). Women consume animal protein, carbohydrates, fresh fruits and vegetables, fried foods, and add fat to cooked food more frequently than men. Women are slightly less likely to have higher education and considerably less likely to be employed than men. About two-thirds of men and women were married at the time of UHES. A higher proportion of women (6%) than men (<2%) are separated, divorced or widowed. Three-fifths of men and women live in rural areas, more than 85% are Uzbek, and more than 95% are Muslim.

Overall, 26% of men aged 15–59 years in Uzbekistan are overweight and 5% are obese; only 4% are underweight (not shown). Corresponding proportions for women aged 15–49 years are 21% overweight, 7% obese and 6% underweight (Table 2). Notably, women are somewhat less likely to be overweight but more likely to be obese than men. A comparison of anthropometric data for Uzbekistan from the 1996 Demographic and Health Survey and the 2002 Health Examination Survey shows that the proportion overweight or obese among women (15–49 years) increased from 22% in 1996 to 28% in 2002. In the 2002 UHES, 17% of men (15–59 years) and 12% of women (15–49 years) suffered from hypertension. These levels of hypertension are higher from those reported in the main survey report (8% for both men and women) due to the differences in the definition of hypertension (mentioned earlier).

There is a strong positive association between BMI level and prevalence of hypertension in both men and women, as expected. However, prevalence of overweight, obesity and hypertension do not vary much by physical activity level, except that men with a high level of physical activity are less likely than other men to be overweight. Among the diet

Footnote continued from previous page

[d]Fresh fruit and vegetable intake is measured by an average score, which is calculated by adding number of days in the last week eating foods from each of the following three categories and dividing by three: (1) dark green leafy vegetables or condiments such as parsley, dill, spinach, rahon, cilantro, basil, mint, lettuce or cabbage; (2) other fresh vegetables including vegetables in stews, soups, and salads; (3) fresh fruits.

[e]Dried fruit and vegetable intake is measured by an average score, which is calculated by adding number of days in the last week eating foods from each of the following three categories and dividing by three: (1) beans, peas or legumes; (2) nuts or seeds; (3) dried fruits.

[f]Canned or pickled fruit and vegetable intake is measured by an average score, which is calculated by adding number of days in the last week eating foods from each of the following three categories and dividing by three: (1) foods prepared with tomato paste; (2) pickled or canned vegetables; (3) canned fruits.

[g]Number of days fried foods eaten in the last week.

[h]Tobacco smoking in past only includes persons who smoked fairly regularly in the past but do not currently smoke.

[i]Based on the Rapid Alcohol Problems Screen (RAPS) guidelines (Cherpitel, 1997), a person who consumed alcohol in the past 12 months is defined as a problem drinker or alcohol dependent if he/she answered 'yes' to any of the following questions: (1) Do you sometimes take a drink in the morning when you first get up? (2) During the past year, has a friend or family member ever told you about things you said or did while you were drinking that you could not remember? (3) During the past year, have you failed to do what was normally expected of you because of drinking? (4) During the past year, have you lost friends because of your drinking? A fifth screening question on feeling of guilt or remorse after drinking was not included due to problems of interpretation in the Uzbekistan context.

[j]White collar includes professional, technical, managerial, clerical or sales and services; manual/agriculture includes skilled manual, unskilled manual or agriculture.

[k]Making ends meet denotes economic hardship for the household in which the person lives. Little or no difficulty category includes households mentioning a little difficulty, fairly easily, easily, or very easily in response to the question on ability to make ends meet.

[l]Other ethnic groups include Russian, Karakalpak, Tajik and others.

[m]Other religions include Christian, no religion, and others.

[n]Western region includes the Autonomous Republic of Karakalpakstan and Khorezm Oblast; Central region includes Navoi, Bukhara, Kashkadarya and Surkhandarya Oblasts; East-Central region includes Samarkhand, Jizzakh, Syrdarya and Tashkent Oblasts; Eastern region includes Namangan, Ferghana and Andizhan Oblasts.

[o]Actual number of cases for individual variables varies slightly depending on the number of missing cases.

Table 2 Prevalence of overweight, obesity, and hypertension[a] by selected risk factors and background characteristics, by sex, Uzbekistan 2002

Characteristic	*Men*			*Women*		
	Overweight	*Obese*	*Hypertensive*	*Overweight*	*Obese*	*Hypertensive*
Risk factors						
BMI (kg/m²)						
<18.5	—	—	5.3	—	—	4.7
18.5–24.9	—	—	12.7	—	—	7.9
25.0–29.9	—	—	22.7	—	—	17.0
30.0+	—	—	48.7	—	—	38.1
Physical activity level						
Low	29.1	5.6	16.3	20.3	6.9	12.1
Medium	27.5	5.1	18.2	21.6	6.8	11.3
High	23.2	5.2	16.1	18.7	8.2	14.7
Diet						
Animal protein (days/week)						
<2	24.5	2.5	14.6	20.3	6.5	13.6
2–3	25.7	5.1	17.3	20.8	6.5	11.3
4+	31.6	10.6	19.6	20.9	8.9	12.1
Carbohydrate						
Not everyday	28.9	4.0	15.9	19.7	6.3	13.1
Everyday	23.7	6.7	17.9	21.4	7.6	11.4
Fresh fruits and vegetables (days/week)						
<3	27.7	3.0	16.5	19.4	5.9	13.9
3–4	27.4	3.8	15.6	19.9	5.7	11.2
5+	24.5	8.4	18.5	21.8	8.5	11.9
Dried fruits and vegetables (days/week)						
<1	23.7	4.4	19.4	21.2	8.2	11.3
1–2	26.8	4.7	16.5	21.1	6.4	12.4
3+	28.4	7.3	15.0	19.6	6.9	12.6
Canned or pickled fruits and vegetables						
Does not eat	26.6	5.4	17.6	20.6	7.5	12.4
Eats, <2 days/week	27.4	6.4	16.1	20.2	7.9	11.2
Eats, 2+ days/week	24.1	3.8	15.7	21.2	5.0	12.3
Fried foods (days/week)						
<3	26.4	5.6	18.4	22.8	7.0	16.0
3–5	30.9	5.7	15.7	19.7	7.8	13.0
6+	19.4	4.2	16.4	20.3	6.6	10.1
Adds salt to cooked food						
No	25.7	5.3	16.3	20.5	6.4	11.6
Yes	30.7	5.5	20.7	22.3	11.6	16.2
Adds fat to cooked food						
No	26.6	5.1	16.7	20.6	6.7	11.6
Yes	22.8	8.8	19.2	21.2	8.5	14.4
Tobacco smoking						
Never	24.7	3.0	13.9	NI	NI	NI
Past only	29.7	10.2	24.3	NI	NI	NI
Current	28.3	7.4	19.0	NI	NI	NI
Alcohol consumption in last 12 months						
No	22.6	2.7	12.5	20.5	6.2	11.4
Yes – not a problem drinker	28.8	6.0	18.3	21.3[b]	9.5[b]	14.4[b]
Yes – problem drinker	26.6	8.5	21.6			
Background factors						
Age						
15–19	6.3	0.4	4.4	7.5	0.3	3.0

Table 2 *Continued*

Characteristic	*Men*			*Women*		
	Overweight	*Obese*	*Hypertensive*	*Overweight*	*Obese*	*Hypertensive*
20–24	16.0	0.7	9.7	13.0	1.7	3.6
25–29	22.2	2.0	11.0	18.1	3.5	5.8
30–34	29.8	3.0	13.9	24.2	5.6	8.1
35–39	36.3	8.1	14.9	29.1	9.4	16.9
40–44	43.2	9.0	28.3	36.4	17.6	26.7
45–49	44.6	14.3	37.0	31.2	23.0	39.0
50–54	34.4	16.9	41.4	—	—	—
55–59	50.7	17.5	40.9	—	—	—
Marital union						
Never married	10.6	0.3	7.0	8.9	0.9	3.8
In union	33.3	7.5	20.9	24.5	9.3	14.8
Separated/divorced/widowed	24.1	1.7	26.6	31.9	10.6	20.8
Education						
Primary/middle	17.9	1.8	13.4	15.8	8.5	11.8
Secondary	24.1	4.3	14.6	20.2	6.1	11.8
Secondary special	25.3	6.7	18.0	21.7	7.9	11.2
Higher	40.8	8.8	25.2	26.5	9.3	15.7
Work status						
Not employed	20.7	1.9	14.7	17.9	5.7	10.5
White collar	34.7	8.0	19.6	25.5	9.1	13.6
Manual/agriculture	24.2	6.3	16.5	21.8	8.1	14.8
Making ends meet						
Great difficulty	23.1	4.7	18.2	20.1	8.0	14.2
Some difficulty	28.8	4.4	16.1	22.0	6.0	11.1
Little or no difficulty	26.3	6.5	16.7	20.0	7.3	11.3
Ethnicity						
Uzbek	26.7	5.5	15.8	21.1	7.2	12.1
Other	24.2	4.3	23.3	18.5	6.2	12.3
Religion						
Muslim	26.4	5.4	16.6	20.7	7.0	12.0
Other	26.8	1.6	23.8	20.2	7.0	13.8
Residence						
Rural	26.1	4.5	15.3	20.2	6.6	12.7
Urban	26.8	6.6	19.3	21.4	7.8	11.2
Region						
Tashkent City	29.5	5.9	26.2	24.7	9.6	6.3
Western	19.0	7.3	27.3	17.9	9.7	17.0
Central	29.5	6.1	16.6	20.7	8.1	15.3
East-Central	31.1	6.6	15.6	21.3	7.9	13.4
Eastern	22.1	2.3	10.6	20.0	3.3	7.9
Total	26.4	5.3	16.9	20.7	7.0	12.1
Number of cases	604	121	393	1053	359	623

Note: For variable definitions, see Table 1.
[a]Hypertension is defined as either having systolic blood pressure $\geqslant$130 mm Hg, diastolic blood pressure $\geqslant$85 mm Hg, or taking blood pressure medication.
[b]Category includes all alcohol consumers in the last 12 months.
NI: Not included due to small numbers of female smokers in the sample.

indicators, frequency of eating animal protein, carbohydrates, fresh fruits and vegetables and adding fat to cooked food are positively associated with obesity in both men and women, but frequency of eating dried fruits and vegetables is positively associated with obesity only in men and adding salt to cooked food is positively associated with obesity only in women. Adding salt to cooked food and adding fat to cooked food are positively associated with hypertension in

both men and women. The associations of other diet variables with obesity and hypertension are generally small and inconsistent. Tobacco smoking (especially in the past) and alcohol consumption are associated with higher levels of obesity and hypertension.

As expected, there is a strong positive association between age and the prevalence of obesity and hypertension in both men and women. For both men and women, the proportion overweight or obese rises from <8% at age 15–19 years to more than 50% at age 45–49 years. The prevalence of hypertension similarly rises from <5% at age 15–19 years to about 40% at age 45–49 years. Education and marital status are also strongly associated with the prevalence of obesity and hypertension, but there are no consistent patterns for other background factors. Prevalence levels of obesity and hypertension are much lower in the Eastern region than in other regions of Uzbekistan.

Effects of physical activity, diet and other factors on risk of overweight and obesity

Table 3 shows that, independent of the other variables included in the table, physical activity level has no significant effect on the risk of being overweight or obese in both men and women. The frequency of eating animal protein is significantly positively associated with the risk of obesity in both men and women. Independent of physical activity level and other factors, men eating animal protein four or more days per week, on average, are much more likely to be obese than those eating animal protein less than 2 days per week (RRR = 4.21; 95% CI: 1.97–8.99), but this effect is much smaller for women (RRR = 1.73; 95% CI: 1.12–2.68). The results for most other diet variables are inconsistent. For example, contrary to expectation, eating fresh fruits and vegetables 5 or more days per week is positively associated with obesity in both men (RRR = 1.76; $P = 0.166$) and women (RRR = 1.65; $P = 0.022$). Eating dried fruits and vegetables three or more days per week is significantly positively associated with obesity in men (RRR = 2.09; $P = 0.044$), but significantly negatively associated with obesity in women (RRR = 0.65; $P = 0.035$). Similarly, adding salt to cooked food is significantly negatively associated with obesity in men (RRR = 0.49; $P = 0.049$), but significantly positively associated with obesity in women (RRR = 1.67; $P = 0.009$). Reasons for these inconsistent findings are not clear.

In men, tobacco smoking is positively associated with the risk of obesity, but this relationship is stronger for past smoking (RRR = 2.16; $P = 0.017$) than for current smoking (RRR = 1.43; $P = 0.258$) and it is statistically significant only for past smoking. The adjusted effect of alcohol consumption is small and not significant for both men and women.

Among the background factors, age is strongly positively associated with overweight and obesity in both men and women, as expected. Men in union are much more likely to be obese than never married men (RRR = 9.28; 95% CI: 3.18–

Table 3 Adjusted effects (relative risk ratios) of selected risk factors on the risk of overweight and obesity, by sex, Uzbekistan 2002

Characteristic	*Men*		*Women*	
	Overweight	*Obese*	*Overweight*	*Obese*
Risk factors				
Physical activity level				
Low[a]	—	—	—	—
Medium	1.03	1.11	0.97	0.90
High	0.82	0.98	0.84	1.09
Diet				
Animal protein (days/week)				
<2[a]	—	—	—	—
2–3	1.14	2.30*	1.14	1.17
4+	1.56†	4.21***	1.20	1.73*
Carbohydrate				
Not everyday[a]	—	—	—	—
Everyday	0.75†	0.77	1.11	0.93
Fresh fruits and vegetables (days/week)				
<3[a]	—	—	—	—
3–4	0.83	0.86	1.01	1.09
5+	0.64*	1.76	1.05	1.65*
Dried fruits and vegetables (days/week)				
<1[a]	—	—	—	—
1–2	1.26	1.28	0.97	0.77
3+	1.63*	2.09*	0.85	0.66*
Canned or pickled fruits and vegetables				
Does not eat[a]	—	—	—	—
Eats, <2 days/week	0.94	1.10	1.03	1.16
Eats, 2+ days/week	0.82	0.54	1.06	0.99
Fried foods (days/week)				
<3[a]	—	—	—	—
3–5	1.42*	0.95	0.72*	1.02
6+	0.77	0.54	0.75*	1.15
Adds salt to cooked food				
No[a]	—	—	—	—
Yes	0.96	0.49*	1.22	1.67**
Adds fat to cooked food				
No[a]	—	—	—	—
Yes	0.67	1.02	0.96	0.97
Tobacco smoking				
Never[a]	—	—	NI	NI
Past only	0.88	2.16*	NI	NI
Current	0.84	1.43	NI	NI
Alcohol consumption in last 12 months				
No[a]	—	—	—	—
Yes – not a problem drinker	0.78	1.03	0.93[b]	1.05[b]
Yes – problem drinker	0.70	1.31		
Background factors				
Age				
15–19[a]	—	—	—	—
20–24	3.08**	0.35	1.42	4.14*
25–29	4.45***	0.60	1.97**	7.98***
30–34	7.61***	0.71	2.81***	14.04***
35–39	11.01***	2.64	3.82***	27.96***

Table 3 *Continued*

Characteristic	*Men*		*Women*	
	Overweight	*Obese*	*Overweight*	*Obese*
40–44	15.68***	3.65	6.62***	76.40***
45–49	14.80***	5.29*	5.52***	94.82***
50–54	10.12***	7.26*	—	—
55–59	27.20***	12.95**	—	—
Marital union				
Never married[a]	—	—	—	—
In union	1.39	9.28***	1.33	1.54
Separated/divorced/ widowed	0.73	0.73	1.77*	1.60
Education				
Primary/middle[a]	—	—	—	—
Secondary	1.16	2.28	1.07	0.69
Secondary special	1.21	2.66	1.06	0.72
Higher	1.55	2.37	1.05	0.58†
Work status				
Not employed[a]	—	—	—	—
White collar	0.95	1.41	1.14	1.05
Manual/agriculture	0.70†	1.64	0.95	0.85
Making ends meet				
Great difficulty[a]	—	—	—	—
Some difficulty	1.29	0.89	1.12	0.75†
Little or no difficulty	1.18	1.14	1.02	0.96
Ethnicity				
Uzbek[a]	—	—	—	—
Other	0.91	0.44†	0.71*	0.50**
Religion				
Muslim[a]	—	—	—	—
Other	1.00	0.35	0.82	0.87
Residence				
Rural[a]	—	—	—	—
Urban	1.06	1.88*	0.88	0.89
Region				
Tashkent City[a]	—	—	—	—
Western	0.72	1.65	0.75	1.66†
Central	1.16	0.68	0.75	0.97
East-Central	1.04	0.89	0.82	1.01
Eastern	0.53**	0.34*	0.71*	0.35***
Number of cases	2152		4750	

Note: For variable definitions, see Table 1. The 'adjusted' effects for a given variable control for all the remaining variables in the table.
[a]Reference category.
†$P<0.1$, *$P<0.05$, **$P<0.01$, ***$P<0.001$.
[b]Category includes all alcohol consumers in the last 12 months.
NI: Not included due to small numbers of female smokers in the sample.

27.14). Women in union are also more likely to be obese than never married women (RRR = 1.54), but this effect is much smaller and not significant statistically. Non-Uzbek men and women are significantly less likely to be obese than Uzbek men and women (RRR = 0.44 for men and RRR = 0.50 for women). Urban residence is positively associated with obesity in men (RRR = 1.88; $P = 0.044$), but not in women. By geographic region, men and women living in the Eastern region are much less likely to be overweight and obese than those living in Tashkent City (RRR = 0.53 and 0.34 for overweight and obesity in men, and RRR = 0.71 and 0.35 for overweight and obesity in women, respectively). Adjusted effects of education, work status and economic status are generally small and not significant statistically.

Effects of overweight and obesity on the risk of hypertension

Overall, the risk of hypertension is much greater in men than in women at every level of BMI (Figure 1). In men, the risk of hypertension remains relatively constant at BMI levels below 25 kg/m^2, but then it generally increases with BMI. This is consistent with the international cutoff of BMI $\geqslant$ 25.0 kg/m^2 recommended for defining overweight. However, for women the risk of hypertension has a more or less linear positive relationship with the BMI level. Unlike for men, there is no clear BMI cutoff point for women beyond which the risk of hypertension accelerates. To test if the relationship between BMI and hypertension is statistically different for women than for men, we fit both linear and quadratic models and compared the coefficients for the two sexes using the Student's *t*-statistic. In both the linear and quadratic models, the coefficient for women was found to be significantly different than for men ($P<0.01$).

Overweight men and women are more than twice as likely to suffer from hypertension as those with a normal BMI (OR = 2.02; 95% CI: 1.50–2.72 for men and OR = 2.41; 95% CI: 1.90–3.04 for women). The relationship is much stronger for obesity. Obese men are more than six times (OR = 6.55; 95% CI: 4.07–10.55) and obese women are more than seven times (OR = 7.05; 95% CI: 5.35–9.28) as likely to suffer from hypertension as men and women with a normal BMI, respectively. On the other hand, underweight men and women are significantly less likely to suffer from hypertension than those with a normal BMI (OR = 0.39 for men and OR = 0.56 for women).

Controlling for physical activity level, diet variables, tobacco smoking (only for men), alcohol use and other background factors, reduces the effects of overweight and obesity on hypertension, but the effects remain large and statistically significant (Table 4). With all the risk factors and background factors statistically controlled, obese men and women remain about three times as likely to suffer from hypertension as men and women with a normal BMI (OR = 3.01; 95% CI: 1.67–5.44 for men and OR = 2.82; 95% CI: 2.05–3.86 for women). The adjusted effects of overweight on the risk of hypertension are also smaller than the unadjusted effects, but remain positive and statistically significant (OR = 1.35 for men and OR = 1.54 for women).

With BMI level and other factors controlled, none of the risk behaviors have any significant effects on the risk of hypertension in both men and women. Among the background characteristics, only age, work status and geographic

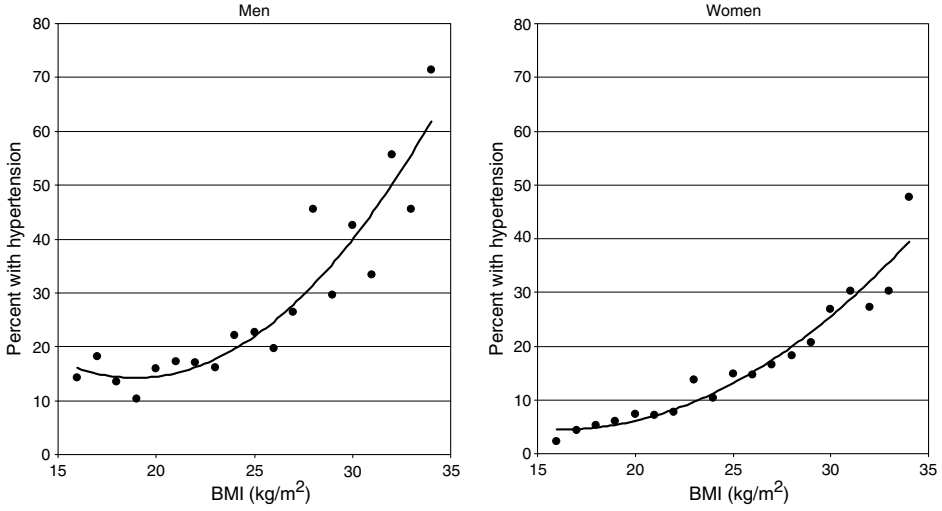

Figure 1 Association between BMI and hypertension, Uzbekistan 2002.

Table 4 Adjusted effects (odds ratios) of overweight and obesity and selected risk factors on the risk of hypertension, by sex, Uzbekistan 2002

Characteristic	*Men*	*Women*
Risk factors		
BMI (kg/m²)		
<18.5	0.53	0.89
18.5–24.9[a]	—	—
25.0–29.9	1.35[†]	1.54***
30.0+	3.01***	2.82***
Physical activity level		
Low[a]	—	—
Medium	1.26	0.89
High	1.06	1.06
Diet		
Animal protein (days/week)		
<2[a]	—	—
2–3	1.26	1.01
4+	1.30	1.09
Carbohydrate		
Not everyday[a]	—	—
Everyday	0.92	0.79*
Fresh fruits and vegetables (days/week)		
<3[a]	—	—
3–4	0.91	0.87
5+	0.98	0.99
Dried fruits and vegetables (days/week)		
<1[a]	—	—
1–2	0.98	1.25
3+	0.85	1.22
Canned or pickled fruits and vegetables		
Does not eat[a]	—	—
Eats, <2 days/week	0.88	0.92
Eats, 2+ days/week	0.82	1.23
Fried foods (days/week)		
<3[a]	—	—
3–5	0.85	0.84
6+	1.22	0.81
Adds salt to cooked food		
No[a]	—	—
Yes	0.93	1.06
Adds fat to cooked food		
No[a]	—	—
Yes	1.05	1.12
Tobacco smoking		
Never[a]	—	NI
Past only	1.36	NI
Current	1.00	NI
Alcohol consumption in last 12 months		
No[a]	—	—
Yes – not a problem drinker	1.02	1.04[b]
Yes – problem drinker	1.11	
Background factors		
Age		
15–19[a]	—	—
20–24	2.61**	1.11
25–29	2.94**	1.95*
30–34	3.37**	2.60**
35–39	3.51**	5.60***
40–44	8.46***	9.21***
45–49	12.46***	17.11***
50–54	13.68***	—
55–59	12.60***	—
Marital union		
Never married[a]	—	—
In union	1.14	0.96
Separated/divorced/widowed	1.42	1.37
Education		
Primary/middle[a]	—	—
Secondary	1.05	1.08
Secondary special	1.13	0.96

Table 4 *Continued*

Characteristic	*Men*	*Women*
Higher	1.36	1.24
Work status		
Not employed[a]	—	—
White collar	0.59*	0.90
Manual/agriculture	0.65*	0.92
Making ends meet		
Great difficulty[a]	—	—
Some difficulty	0.92	0.85
Little or no difficulty	1.02	0.92
Ethnicity		
Uzbek[a]	—	—
Other	1.12	0.86
Religion		
Muslim[a]	—	—
Other	1.01	1.12
Residence		
Rural[a]	—	—
Urban	0.98	0.83
Region		
Tashkent City[a]	—	—
Western	1.09	4.00***
Central	0.47*	2.77***
East-Central	0.44**	2.62***
Eastern	0.30***	1.39
Number of cases	2248	5058

Note: For variable definitions, see Table 1. The 'adjusted' effects for a given variable control for all the remaining variables in the table.
[a]Reference category.
$^{\dagger}P<0.1$, $^{*}P<0.05$, $^{**}P<0.01$, $^{***}P<0.001$.
[b]Category includes all alcohol consumers in the last 12 months.
NI: Not included due to small numbers of female smokers in the sample.

region have significant adjusted effects. Age has a strong positive effect on the risk of hypertension in both sexes; working men are at a significantly lower risk of hypertension, but this relationship is not observed for women; and the effects of geographic region are significant for both men and women, but the magnitude and direction of these effects are inconsistent between the two sexes. Reasons for these regional differences in the risk of hypertension are not clear.

Discussion

Results confirm a strong positive association between obesity and hypertension in adult men and women in Uzbekistan. With physical activity level, diet, tobacco smoking, alcohol use and a number of other potentially confounding background factors controlled statistically, obese men and women in Uzbekistan are about three times as likely to suffer from hypertension as men and women with a normal BMI. This finding is consistent with an earlier study in Central Asia (Kadyrova and Salkhanov 1990) and numerous studies from other parts of the world (e.g., Lerman-Garber *et al*., 1999; Venkatramana and Reddy 2002; Adair 2004; Hu *et al*., 2004; Lee *et al*., 2004; Liu *et al*., 2004; Niskanen *et al*., 2004; Kotsis *et al*., 2005; Sanchez-Castillo *et al*., 2005).

Overall, the risk of hypertension is much greater in men than in women at any given level of BMI. For men, the risk of hypertension is strongly positively associated with BMI only at BMI levels above 25 kg/m^2, but for women a positive relationship is observed at all BMI levels. This indicates that in Uzbekistan the relationship between body weight and hypertension is consistent with the international cutoff of BMI $\geqslant$ 25.0 kg/m^2 for defining overweight for men, but not for women. It is possible that sex differences in certain behaviors, abdominal adiposity, or some other biological factors may explain this finding. Additional research is needed to explore the sex differential in the relationship between BMI and hypertension further.

Our analysis of the risk factors of obesity and hypertension produced mixed results. The study finds no significant association between physical activity level and the risk of obesity or hypertension. Eating animal source protein and tobacco smoking in the past are positively associated with obesity, but there are no consistent associations with other diet indicators or alcohol use. The lack of association of obesity and hypertension with physical activity level and the generally weak, inconsistent associations with diet, current smoking and alcohol use in this study are inconsistent with previous research (Vioque *et al*., 2000; Bell *et al*., 2002; Sobngwi *et al*., 2002; Jakes *et al*., 2003; Djousse *et al*., 2004; Hu *et al*., 2004; Niskanen *et al*., 2004; Okubo *et al*., 2004; Nanchahal *et al*., 2005).

The study finds that, independent of other factors, the prevalence of obesity and prevalence of hypertension have strong positive associations with age in both men and women, as expected (Meigs, 2002). Urban residence has a strong positive association with obesity in men, but not in women (Popkin, 2002). Men in union are considerably more likely to be obese than never married men, but the relationship is not as strong for women (Hu *et al*., 2002; Jeffery and Rick, 2002). Contrary to previous research, educational status and household economic status are not significantly associated with obesity or hypertension in both men and women (Monteiro *et al*., 2001; Nanchahal *et al*., 2005).

A major limitation of our analysis is the cross-sectional nature of the data. In the UHES, the prevalence of overweight, obesity and hypertension, as well as the prevalence of various risk factors, were measured at the time of the survey. A lack of association of obesity and hypertension with physical activity level and generally weak, inconsistent associations with diet, current smoking and alcohol use may be partly due to the fact that some men and women may have altered their physical activity patterns, changed their eating habits or quit smoking after becoming obese or after

being diagnosed with hypertension. Inconsistent and weak associations of obesity and hypertension with physical activity, dietary habits and other risk behaviors may also be partly due to imperfect measurements of these behaviors in the survey. Prospective cohort studies with better measurements of various risk behaviors are needed to better understand the epidemiology of obesity and hypertension.

In this study, we were not able to consider other measures of obesity, particularly abdominal obesity, which may be more relevant for linking obesity with the risk of hypertension. In Asian populations, abdominal or central obesity is more common than obesity defined by BMI, and health risks associated with overweight and obesity occur at lower levels of BMI than in North America or Europe (WHO, IASO, IOTF, 2000).

Another limitation is that the survey did not collect direct information on total energy intake. Instead, it was assessed indirectly from a number of diet history and food frequency questions, which have been evaluated previously and found to be sufficiently valid for etiologic studies (Kabagambe *et al*., 2001; Subar *et al*., 2001).

Moreover, our study could not control directly for the extent of use of medical services in connection with obesity or hypertension, although the set of control variables used in the study includes several measures of socioeconomic status, which are typically correlated with access to and use of medical services.

In conclusion, this study provides important new information on the prevalence of obesity and hypertension in different population groups in Uzbekistan. The results show a strong positive effect of obesity on the risk of hypertension in both men and women. However, the shape of the relationship between BMI and hypertension is different for women than for men. Moreover, several other relationships are observed only for men or only for women. Therefore, the policies and programs related to obesity and hypertension need to be gender sensitive.

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