Int J Public Health (2016) 61:57–68
DOI 10.1007/s00038-015-0765-9

ORIGINAL ARTICLE

Relationship between health behaviour and body mass index in the Serbian adult population: data from National Health Survey 2013

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Received: 6 July 2015 / Revised: 2 November 2015 / Accepted: 4 November 2015 / Published online: 18 November 2015

Abstract
Objectives To determine relationship between health behaviour and body mass index (BMI) in a Serbian adult population.
Methods Study population included adults aged 20 and more years. A stratified, two-stage national representative random sampling approach was used for the selection of the survey sample.
Results Regarding BMI, out of the 12,461 subjects of both sexes, 2.4 % were underweight, 36.5 % overweight and 22.4 % obese. Multivariate logistic regression analysis showed that both in men and women, risk factors for obesity were former smoking, irregular eating breakfast and low physical activity level, while in women only risk of obesity was associated with alcohol consumption. In both sexes, risk factors for overweight were former smoking and low physical activity level, and in women additionally those were alcohol consumption, irregular eating breakfast, always adding salt to meals and consumption of 2–4 portions of fruit daily. Smoking and irregular eating of breakfast in men were risk factors for underweight.
Conclusions Physical activity, alcohol consumption, smoking, irregular breakfast consumption, adding salt to meals, frequency of vegetable and fruit consumption were related to BMI in adult Serbian population.

Keywords Body mass index · Health behaviour · Cross-sectional study

Introduction

Overweight and obesity are increasing in prevalence representing growing public health problem worldwide. According to estimates of the World Health Organization (WHO 2013), more than 50 % of the adult population in the WHO European Region are overweight and more than 20 % are clinically obese. Data from the National Health Survey (2014) show that 35.1 % of the adult population in Serbia (≥20 years old) are overweight (BMI 25.0–29.9 kg/m^2) and 21.2 % obese (BMI ≥ 30 kg/m^2). Obesity predisposes people to a series of risk factors for chronic noncommunicable diseases (Wyatt et al. 2006; James et al. 2004) that contribute to the highest burden of disease in Serbia (Atanaskovic-Markovic et al. 2003).

Although obesity has a strong genetic background (Heberbrand et al. 2000), health behaviours, such as unhealthy diet, physical inactivity, sedentary lifestyle, alcohol consumption and smoking cessation, are commonly considered to be the underlying cause of the increase of body weight (Borodulin et al. 2010; Rodriguez

Electronic supplementary material The online version of this article (doi:10.1007/s00038-015-0765-9) contains supplementary material, which is available to authorized users.

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Martin et al. 2009). A study by Ishizaki et al. (2004) showed association between BMI and sedentary lifestyle while BMI was inversely associated to physical activity, educational level and tobacco use. Alcohol use was associated to overweight and obesity in several studies especially in men (Klumbiene et al. 2004; El Rhazi et al. 2010). Epidemiological studies have generally shown an inverse relationship between smoking and body weight (Rodriguez Martin et al. 2009; Klumbiene et al. 2004). A study by Rodriguez et al. (2009) did not find significant difference in the prevalence of overweight and obesity between smokers and non-smokers. However, the metabolic effects of smoking seem to be overridden by other health habits such as unhealthy diet, low physical activity or inactivity and alcohol intake (Chhabra et al. 2011). Studies performed in Finland and Estonia have shown that leisure time physical activity is associated with low obesity prevalence (Klumbiene et al. 2004). Increased production of processed food, rapid urbanization and changing lifestyles have resulted in a shift in dietary patterns and contributed to the rise of overweight and obesity. Globalization of diet habits that contribute to obesity includes irregular meals, high use of processed foods rich in sugars and fats and large portion sizes (WHO 2003). Also, the presence of a spouse/partner can lead to changes in diet and physical activity that favour weight gain (Woo et al. 1999; Hu et al. 2002). In a very few studies concerning underweight, BMI < 18.50 has been related to sex, age, marital status, smoking, alcohol consumption and socio-economic status (Pavilińska-Chamara et al. 2007; Park et al. 2013; Che 2002).

The aim of the present study was to determine relationship between body mass index (BMI) and health behaviour (dietary habits, physical activity, smoking, and alcohol consumption) in the Serbian adult population.

Methods

Study population

Data for this study were obtained from the 2013 National Health Interview Survey that was carried out by the Ministry of Health of Serbia and the Institute of Public Health of Serbia "Dr Milan Jovanovic Batut". The study population included adults $\geq$20 years old, permanent residents of the Republic of Serbia. Exclusion criteria were age below 20 years, persons who live in collective households and/or institutions, residents of Kosovo and Metohija region (under the UN Mission) and persons who were mentally unable to participate in the survey. Participants with missing data for the required variables were not included in the data analysis. Out of 12,722 interviewed subjects, data were analysed for 12,461 subjects after excluding those with missing data, with the exception of 340 persons for whom only data on smoking were missed.

Sampling design

National Health Survey 2013 was performed in line with the EUROSTAT recommendations for the performance of European Health Interview Survey (EHIS wave 2 Methodological manual 2013). A stratified, two-stage national representative random sampling approach was used for the selection of the survey sample. The 2011 Serbian Population Census framework was used for the selection of clusters. A sample of 6700 households was selected and the household response rate was 64.4 %. All members of the chosen households aged 20 and above were included. Out of 12,722 adults $\geq$20 years old in the selected households who were interviewed, 12,461 were included in the analysis.

Instruments and variables

Data sources were questionnaires created according to the European Health interview survey questionnaire (EHIS questionnaire 2006): questionnaire for population above 15, self-administered questionnaire for population above 15 years of age and household questionnaire. Variables included sociodemographic characteristics (age, gender, education, marital status), health-related behaviour variables (smoking status, alcohol consumption, level of physical activity, diet habits) and objective findings (weight, height). Marital status was defined in two categories: married/living with partner and living without partner (including unmarried, divorced or widowed). Educational level was defined in three categories: primary or lower ($\leq$8 years), secondary or middle (9–12 years) and post-secondary or high (>12 years, including university and post university education).

All health-related behaviours were self-reported. Related to smoking, participants were divided into non-smokers (those who have never smoked), former smokers (those who have stopped smoking 12 months ago and earlier) and current smokers (those who smoked in the 12 months prior to the survey including those who quit within that year).

Alcohol consumption was assessed with questions on the use of alcohol drinks in the past 12 months with the following outcome categories: 1. those who have never drunk or have not drunk alcohol in the past 12 months (abstainers); 2. those who drink once a month and less; 3. those who drink 2–3 times per month and 4. those who drink once a week and more. In the analysis of data, the second and third categories were joined as category "three times per month or less".

Level of physical activity was determined with a question related to duration of daily transport physical activity (walking or riding a bicycle) with three outcome categories: low (10–29 min per day), moderate (30–59 min per day) and high level (more than 60 min per day).

Diet intake variables included breakfast frequency, adding salt at table, type of bread used, type of fat for food preparation, fruit/vegetable consumption frequency and number of fruit/vegetable portions consumed daily.

Measurements

Measurements of weight and height were performed using standard procedures (WHO 2000). The BMI was calculated by dividing body weight by height squared (kg/m^2) and categorized according to the World Health Organization criteria: BMI range of <18.50 kg/m^2 was considered as underweight, BMI of 18.50–24.99 kg/m^2 as normal weight, BMI of 25.00–29.99 kg/m^2 as overweight and BMI ≥30.00 kg/m^2 as obesity (WHO 2000).

Statistical analysis

Continuous variables were described with means and standard deviations, while categorical ones with frequencies and percentages. Prevalence rates with appropriate 95 % confidence intervals were estimated for the core study outcomes, namely: four categories of BMI, separately for males and females participants. All reported age-adjusted estimates and their 95 % confidence intervals (CI) were weighted using probability-sampling weights calculated to reflect an underlying population of inhabitants in the Republic of Serbia in 2013. The Chi-square test was used to find statistically significant differences between BMI categories and health-related behaviours. The two-way ANCOVA with post hoc Bonferroni test was used to analyse differences between prevalences of separate BMI categories according to categories of examined health-related behaviours and sex.

Associations between categories of BMI and health behaviour variables were analysed with univariable and multivariable logistic regression analysis. The dependent variables formed three different multivariable models—underweight, overweight and obesity, each of them vs. normal weight as referent category, separately for males and females. Independent variables were: smoking status, alcohol consumption, breakfast consumption frequency, adding salt to food, type of fat for food preparation, type of bread used, frequency of fruit/vegetables consumption, number of daily consumed portions of fruit/vegetables, level of transport-related physical activity, and, as confounding variables, age (as continuous variable), level of education and marital status. They were reported with odds ratios and their 95 % CI, along with probability p.

All statistical analyses were performed using SPSS version 21.0 software (SPSS Inc., Chicago, IL, USA) and STATA version 11.1 (StataCorp LP College Station, TX, USA) with the complex sampling design taken into account. Statistical significance was set at two-sided $p < 0.05$.

Results

The study population comprised 12,461 subjects, 6008 (48.2 %) men and 6453 (51.8 %) women. Most participants were married or living with a partner (65.2 %), were less than 45 years of age (42.9 %), and had middle formal education (57.5 %). Regarding health habits, most of the survey subjects were non-smokers (49.0 %), abstainers (47.7 %) with low level of transport physical activity (42.6 %). As for the diet habits, most of the subjects eat breakfast every day (77.8 %), never add salt to food (51.6 %), use white bread (72.7 %), vegetable oil for food preparation (72.0 %) and eat fruit and vegetables once a day or more (46.4 % and 58.8 %, respectively). Regarding BMI, 2.4 % were underweight, 36.5 % overweight and 22.4 % obese. Overweight subjects were more frequently men (57.3 %) than women (42.7 %), while obesity was more frequent in women (53.9 %) than men (46.1 %) ($p < 0.001$). Significant differences between BMI groups were noticed for all variables except for the type of bread used and number of daily consumed portions of vegetables, while there was borderline significance for frequency of daily consumed portions of vegetables ($p = 0.060$) (data are shown in supplementary table, online resource 1).

Prevalences of BMI categories in percentages with 95 % confidence interval (CI) according to health behaviour and adjusted for age are presented in Table 1 for men and women.

Some components of health behaviour were significantly related to BMI categories: smoking status was significantly related to all BMI categories in men, and to normal weight and obesity in women; alcohol consumption was significantly associated with underweight in men, and normal weight and obesity in women; breakfast frequency was related to underweight in men, and the type of fat for food preparation to overweight and obesity in men; frequency of fruit consumption was significantly related to all BMI categories in men and to underweight in women, and the number of daily fruit portions was related only to underweight and overweight in women; vegetable consumption frequency was significantly associated with underweight and normal weight in men, while number of vegetable portions was significantly associated with normal

Table 1 Prevalences of body mass index (BMI) categories in % with 95 % CI according to health behaviour and adjusted for age, by sex, Republic of Serbia 2013

Health behaviour	Men/BMI categories				Women/BMI categories				p value[#]
	<18.50 ($n = 66$)	18.50–24.99 ($n = 2047$)	25.00–29.99 ($n = 2608$)	≥30.00 ($n = 1287$)	<18.50, ($n = 232$)	18.50–24.99 ($n = 2775$)	25.00–29.99 ($n = 1940$)	≥30.00 ($n = 1506$)	
Total	1.1 (0.8–1.4)	33.4 (32.2–34.7)	43.4 (42.1–44.7)	22.0 (21.0–23.1)	3.3 (2.9–3.8)	40.9 (39.8–42.1)	31.1 (30.0–32.2)	24.6 (23.4–25.8)	
Cigarette smoking (%)									<0.001
Non-smokers	0.5 (0.1–0.9)	32.9 (31.1–34.8)	45.3 (43.4–47.3)	21.2 (19.6–22.8)	3.3 (2.8–3.9)	39.3 (37.8–40.8)	32.1 (30.6–33.6)	25.3 (24.0–26.6)	
Former smokers	1.2 (0.6–1.7)	27.6 (25.1–30.0)	45.7 (43.1–48.2)	25.6 (23.5–27.7)	2.6 (1.5–3.7)	39.2 (36.2–42.1)	30.2 (27.3–33.1)	28.0 (25.4–30.6)	
Smokers	1.6 (1.2–2.1)	39.8 (37.8–41.9)	39.2 (37.1–41.4)	19.3 (17.5–21.1)	3.9 (3.0–4.7)	46.0 (43.8–48.2)	29.5 (27.4–31.7)	20.6 (18.6–22.5)	
p value[##]	0.001	<0.001	<0.001	<0.001	0.215	<0.001	0.129	<0.001	
Alcohol consumption, groups (%)									<0.001
Abstainers	1.2 (0.8–1.7)	35.9 (33.7–38.0)	41.3 (39.0–43.6)	21.6 (19.7–23.5)	3.2 (2.7–3.7)	37.9 (36.5–39.3)	31.8 (30.4–33.1)	27.2 (25.9–28.4)	
Three times per month and less	0.6 (0.2–1.1)	33.3 (31.2–35.3)	44.4 (42.2–46.6)	21.7 (19.9–23.5)	3.9 (3.0–4.7)	46.0 (43.8–48.2)	29.6 (27.4–31.7)	20.6 (18.6–22.6)	
Once a week and more	1.4 (1.0–1.8)	33.1 (31.1–35.1)	44.0 (42.0–46.1)	21.4 (19.7–23.2)	2.9 (1.3–4.6)	50.8 (46.5–55.0)	30.8 (26.6–35.0)	15.5 (11.6–19.3)	
p value[##]	0.039	0.134	0.111	0.285	0.363	<0.001	0.250	<0.001	
Breakfast frequency (%)									0.754
Every day	0.8 (0.5–1.1)	33.9 (32.6–35.3)	43.9 (42.5–45.3)	21.4 (20.2–22.5)	3.2 (2.7–3.7)	41.4 (40.1–42.6)	31.0 (29.8–32.3)	24.4 (23.3–25.5)	
Sometimes	2.3 (1.6–2.9)	34.1 (31.2–37.0)	41.2 (38.1–44.2)	22.5 (19.9–25.0)	3.6 (2.6–4.6)	38.8 (36.2–41.4)	32.3 (29.8–34.9)	25.3 (23.0–27.6)	
Never	1.9 (0.5–3.3)	35.1 (28.7–41.5)	41.3 (34.6–48.1)	21.6 (16.1–27.2)	4.7 (2.6–6.9)	43.0 (37.2–48.7)	27.1 (21.6–32.7)	25.2 (20.0–30.3)	
p value[##]	<0.001	0.941	0.241	0.642	0.370	0.173	0.240	0.773	
Adding salt (%)									0.534
Always	1.0 (0.2–1.7)	35.4 (31.9–38.9)	40.9 (37.3–44.6)	22.7 (19.6–25.7)	4.8 (3.2–6.5)	35.2 (31.0–39.5)	34.5 (30.3–38.7)	25.4 (21.6–29.2)	
Sometimes	0.2 (0.9–1.3)	34.1 (32.3–35.8)	44.6 (42.7–46.4)	20.5 (19.0–22.0)	3.4 (2.6–4.1)	41.3 (39.4–43.3)	31.5 (29.6–33.4)	23.8 (22.0–25.5)	
Never	1.3 (0.9–1.7)	33.6 (31.8–35.4)	42.6 (40.7–44.5)	22.4 (20.9–24.0)	3.2 (2.6–3.7)	41.4 (40.0–42.8)	30.5 (29.1–31.9)	25.0 (23.7–26.2)	
p value[##]	0.230	0.652	0.148	0.773	0.156	0.024	0.182	0.517	

Table 1 continued

Health behaviour	Men/BMI categories				Women/BMI categories				p value[#]
	<18.50 ($n = 66$)	18.50–24.99 ($n = 2047$)	25.00–29.99 ($n = 2608$)	≥30.00 ($n = 1287$)	<18.50, ($n = 232$)	18.50–24.99 ($n = 2775$)	25.00–29.99 ($n = 1940$)	≥30.00 ($n = 1506$)	
Type of bread used (%)									0.597
Wholemeal bread	0.4 (NA)	33.0 (28.3–37.7)	43.4 (38.4–48.4)	23.2 (19.1–27.3)	2.4 (1.1–3.7)	43.0 (39.5–46.5)	31.1 (27.7–34.5)	23.4 (20.3–26.6)	
All types of bread	1.3 (0.7–1.9)	31.4 (28.6–34.2)	44.8 (41.9–47.8)	22.5 (20.0–24.9)	2.7 (1.7–3.7)	41.2 (38.6–43.8)	32.4 (29.9–35.0)	23.7 (21.4–26.0)	
Refined bread	1.1 (0.8–1.4)	34.7 (33.3–36.1)	43.0 (41.5–44.4)	21.2 (20.1–22.4)	3.7 (3.1–4.2)	40.6 (39.3–41.9)	30.8 (29.5–32.1)	25.0 (23.8–26.2)	
p value[##]	0.331	0.107	0.542	0.144	0.087	0.424	0.510	0.447	
Type of fat for food preparation (%)									0.014
Vegetable oil	1.1 (0.8–1.4)	34.1 (32.7–35.2)	44.6 (43.1–46.0)	20.2 (19.0–21.5)	3.4 (2.9–3.9)	41.4 (40.1–42.7)	31.0 (29.7–32.2)	24.2 (23.0–25.3)	
Animal fats (lard, butter, margarine)	1.1 (0.6–1.5)	33.8 (31.6–36.0)	40.4 (38.1–42.7)	24.7 (22.8–26.6)	3.1 (2.3–3.9)	39.6 (37.5–41.7)	31.5 (29.4–33.6)	25.8 (23.9–27.7)	
p value[##]	0.887	0.824	0.003	0.021	0.467	0.153	0.664	0.153	
Fruit consumption frequency (%)									0.447
Once a day and more	0.8 (0.4–1.2)	32.2 (30.3–34.0)	45.0 (43.1–47.0)	22.0 (20.4–23.6)	2.8 (2.2–3.4)	40.2 (38.7–41.8)	32.2 (30.7–33.7)	24.8 (23.4–26.1)	
4–6 times per week	0.8 (0.3–1.3)	34.6 (32.3–36.8)	43.3 (40.9–45.7)	21.3 (19.3–23.2)	3.3 (2.4–4.1)	42.1 (39.9–44.3)	30.4 (28.2–32.6)	24.2 (22.2–26.2)	
1–3 times per week and less	1.8 (1.3–2.2)	35.9 (33.8–38.1)	41.0 (38.8–43.3)	21.3 (19.4–23.1)	4.6 (3.7–5.5)	41.3 (39.0–43.6)	29.4 (27.1–31.6)	24.7 (22.6–26.8)	
p value[##]	0.004	0.030	0.033	0.020	0.006	0.370	0.100	0.889	
Fruit consumption, portions (%)									0.416
5 portions per day and more	1.3 (0.9–1.6)	34.9 (33.4–36.4)	42.4 (40.8–44.0)	21.4 (20.1–22.7)	3.9 (3.3–4.5)	41.6 (40.0–43.2)	29.9 (28.4–31.5)	24.5 (23.1–26.0)	
2–4 portions per day	0.9 (0.4–1.5)	31.9 (29.4–34.4)	45.6 (43.0–48.2)	21.6 (19.4–23.7)	2.6 (1.8–3.4)	39.1 (37.1–41.2)	33.8 (31.8–35.8)	24.5 (22.6–26.3)	
1 portion per day and less	0.7 (0.0–1.3)	33.7 (30.8–36.7)	43.4 (40.3–46.5)	22.2 (19.7–24.8)	3.1 (2.2–4.0)	41.8 (39.4–44.1)	30.2 (27.8–32.5)	24.9 (22.8–27.1)	
p value[##]	0.203	0.130	0.127	0.195	0.031	0.131	0.008	0.940	
Vegetable consumption frequency (%)									0.326
Once a day and more	1.1 (0.8–1.5)	32.6 (31.0–34.1)	44.4 (42.7–46.0)	22.0 (20.6–23.3)	3.1 (2.6–3.6)	40.4 (39.0–41.8)	31.8 (30.5–33.2)	24.7 (23.4–25.9	

Table 1 continued

Health behaviour	Men/BMI categories				Women/BMI categories				p value[#]
	<18.50 ($n = 66$)	18.50–24.99 ($n = 2047$)	25.00–29.99 ($n = 2608$)	≥30.00 ($n = 1287$)	<18.50, ($n = 232$)	18.50–24.99 ($n = 2775$)	25.00–29.99 ($n = 1940$)	≥30.00 ($n = 1506$)	
4–6 times per week	0.7 (0.2–1.2)	36.3 (34.2–38.5)	42.2 (39.9–44.4)	20.8 (18.9–22.7)	3.6 (2.6–4.3)	41.8 (39.7–44.0)	9.7 (27.6–31.8)	25.0 (23.1–26.9)	
1–3 times per week and less	1.8 (1.1–2.5)	34.8 (31.7–38.0)	41.7 (38.4–45.0)	21.7 (19.0–24.5)	4.5 (3.2–5.8)	42.0 (38.6–45.4)	30.2 (26.9–33.6)	23.2 (20.2–26.3)	
p value[##]	0.041	0.019	0.180	0.128	0.138	0.449	0.227	0.629	
Vegetable consumption, portions (%)									0.307
5 portions per day and more	1.0 (0.6–1.4)	35.7 (33.9–37.4)	41.9 (40.1–43.8)	21.4 (19.8–22.9)	3.7 (3.1–4.4)	41.9 (40.1–43.7)	29.8 (28.1–31.6)	24.5 (22.9–26.1)	
2–4 portions per day	1.1 (0.7–1.6)	33.1 (31.0–35.2)	43.7 (41.5–45.9)	22.1 (20.3–23.9)	2.7 (2.0–3.4)	40.0 (38.2–41.9)	32.4 (30.6–34.2)	24.9 (23.2–26.5)	
1 portion per day and less	1.1 (0.6–1.7)	32.0 (29.5–34.5)	45.6 (43.0–48.2)	21.2 (19.1–23.4)	3.7 (2.9–4.5)	40.7 (38.5–42.9)	31.2 (29.0–33.3)	24.4 (22.5–26.4)	
p value[##]	0.910	0.038	0.078	0.271	0.065	0.351	0.136	0.930	
Physical activity[a] (%)									<0.001
Low (10–29 min per day)	1.2 (0.8–1.6)	30.6 (28.7–32.5)	44.3 (42.3–46.3)	23.9 (22.2–25.5)	3.2 (2.6–3.9)	39.2 (37.5–40.8)	31.6 (30.0–33.2)	26.0 (24.5–27.5)	
Moderate (30–59 min per day)	1.1 (0.6–1.6)	34.8 (32.6–37.0)	44.9 (42.5–47.2)	19.3 (17.4–21.2)	2.5 (1.7–3.3)	41.6 (39.4–43.7)	32.1 (30.0–34.2)	23.8 (21.8–25.7)	
High (more than 60 min per day)	1.0 (0.5–1.4)	37.4 (35.3–39.5)	40.8 (38.6–43.0)	20.8 (19.0–22.6)	4.4 (3.6–5.2)	43.4 (41.2–45.6)	29.2 (27.1–31.3)	23.0 (21.1–25.0)	
p value[##]	0.729	<0.001	0.020	<0.001	0.006	0.007	0.108	0.034	

NA not applicable

[#] significance according to sex and [##] significance between categories of independent variable with each BMI category according to two-way ANCOVA

[a] Physical activity—refers to transport-related physical activity (walking or riding a bicycle)

weight in men. Level of transport physical activity was significantly related to all weight categories in both sexes with the exception of underweight men and overweight women.

Associations of health behaviours with underweight, overweight and obesity by multivariable logistic regression are shown in Table 2 separately for men and women.

Among men, the multiple logistic regressions showed that obesity risk was significantly higher in former smokers (OR = 1.32), and significantly lower in current smokers (OR = 0.68) compared with non-smokers. Risk was also significantly higher in subjects who sometimes ate breakfast (OR = 1.22) compared to those who ate breakfast every day. Obesity risk was significantly higher in men who used animal fats in food preparation (OR = 1.25) compared to those who used vegetable oil. Obesity risk was significantly higher in men with low vs. high level of transport physical activity (OR = 1.39). Obesity risk was also related to ageing (OR = 1.02) and being married/living with a partner (OR = 2.19). Regarding overweight in men risk was higher for former smokers (OR = 1.19) and lower in current smokers (OR = 0.70). Risk was also higher in men with low level of transport physical activity (OR = 1.29). Overweight risk was related to age (OR = 1.00) and being married/living with a partner (OR = 1.72) while risk of being overweight was lower in men with a low level of education (OR = 0.66). Risk of being underweight was significantly higher in former smokers (OR = 3.17) and current smokers (OR = 2.40) and in men who ate breakfast sometimes (OR = 2.25), while risk was lower in men who drank alcohol three times per month or less (OR = 0.44), in those who added salt to food both sometimes (OR = 0.51) or always (OR = 0.41), and who ate vegetables 4–6 times per week (OR = 0.46) (Table 2).

In women, obesity risk was significantly higher in former smokers (OR = 1.37), and significantly lower in current smokers (OR = 0.72) compared with non-smokers. Obesity risk was significantly higher in women who consumed alcohol both three times per month or less (OR = 1.50) and once a week and more (OR = 2.28), ate breakfast sometimes (OR = 1.24) and had low level of transport physical activity (OR = 1.32). Ageing (OR = 1.05) and being married/living with partner (OR = 1.78) also significantly increased obesity risk, as well as low and middle level of education (OR = 3.53 and 2.19, respectively). Risk for overweight was significantly lower in women who were current smokers (OR = 0.74), and it was significantly higher in women who drank alcohol once a week and more (OR = 1.30), ate breakfast sometimes (OR = 1.21), always added salt to meals (OR = 1.41), consumed 2–4 portions of fruit daily (OR = 1.19) or had a low level of transport physical activity (OR = 1.21). As in overweight men, ageing contributed to higher risk of being overweight (OR = 1.04), as well as low and middle education (OR = 1.48 and 1.26) and marriage/living with a partner (OR = 1.64). There was no significant risk for being underweight related to any of the examined health behaviour variables. However, regarding confounding variables risk for underweight was lower in women who were married or living with a partner (OR = 0.45) and higher in women with low level of education (OR = 1.98) (Table 2).

Discussion

In the present study, relationship between BMI and health behaviour (dietary habits, transport physical activity, smoking, and alcohol consumption) in the Serbian adult population was explored.

In most populations, smokers weight less than non-smokers. Our results also suggest negative associations between smoking and nutritional status. In both men and women, overweight and obesity were independently of other factors inversely related to current smoking. A study by Chhabra et al. (2011) showed that the proportion of overweight and obese subjects was greater among non-smokers as compared to smokers, while in a study by Lahti-Koski et al. (2002) conducted in Finland, obesity was more frequent among former smokers for both sexes, but less frequent among female current smokers. A Brazilian study showed no difference in BMI for smokers versus non-smokers in both sexes (Peixoto et al. 2007); however, the same study showed that mean BMI in female former smokers was higher than for non-smokers. Smoking was a risk factor for underweight in the Serbian adult population as well as in the population of Canada (Che 2002) and South Korea (Park et al. 2013). However, an inverse association between smoking and BMI cannot compensate its overwhelmingly negative effect on health. Epidemiologic findings on the association between alcohol consumption and body weight seem to be controversial (Lahti-Koski et al. 2002). According to our results, alcohol consumption was significantly associated with underweight in men, and with overweight and obesity in women. Moreover, risk of obesity was higher in women who drank once a week or more. A study by Peixoto et al. (2007) showed a negative association, for both men and women, between alcohol consumption and BMI. Results from Finland showed that women who reported no alcohol use and men who consumed 10 or more portions of alcohol during the previous week were more likely to be obese compared to those who consumed 1–3 portions per week (Lahti-Koski et al. 2002). A study by Rohrer et al. (2005) showed that subjects who consumed alcohol three or more

Table 2 Associations of body mass index (BMI) categories in men and women with health behaviour variables by multivariate logistic regressions, Republic of Serbia 2013

Health behaviour	OR (95 % CI); *p* value					
	Men			Women		
	Underweight vs. normal (66 vs. 2047)	Overweight vs. normal (2608 vs. 2047)	Obesity (all) vs. normal (1287 vs. 2047)	Underweight vs. normal (232 vs. 2775)	Overweight vs. normal (1940 vs. 2775)	Obesity (all) vs. normal (1506 vs. 2775)
Cigarette smoking						
Non-smokers	1	1	1	1	1	1
Former smokers	3.17 (1.40–7.18); 0.006	1.19 (1.00–1.40); 0.041	1.32 (1.09–1.60); 0.005	1.02 (0.66–1.56); 0.944	0.98 (0.82–1.18); 0.886	1.37 (1.12–1.69); 0.002
Smokers	2.40 (1.19–4.84); 0.014	0.70 (0.61–0.81); <0.001	0.68 (0.57–0.82); <0.001	1.10 (0.81–1.51); 0.541	0.74 (0.63–0.86); <0.001	0.72 (0.60–0.86); <0.001
Alcohol consumption						
Abstainers	1	1	1	1	1	1
Three times per month and less	0.44 (0.23–0.86); 0.015	0.96 (0.83–1.11); 0.587	0.98 (0.82–1.18); 0.868	1.34 (0.77–2.33); 0.305	1.03 (0.79–1.33); 0.829	1.50 (1.06–2.13); 0.022
Once a week and more	0.85 (0.44–1.62); 0.631	0.87 (0.75–1.02); 0.082	0.96 (0.80–1.16); 0.704	1.28 (0.73–2.24); 0.387	1.30 (1.01–1.67); 0.036	2.28 (1.64–3.17); <0.001
Breakfast frequency						
Every day	1	1	1	1	1	1
Sometimes	2.25 (1.25–4.05); 0.007	1.08 (0.92–1.28); 0.350	1.22 (1.00–1.50); 0.051	1.03 (0.73–1.45); 0.878	1.21 (1.03–1.43); 0.024	1.24 (1.03–1.49); 0.026
Never	2.12 (0.71–6.33); 0.173	1.04 (0.75–1.44); 0.832	1.12 (0.75–1.68); 0.572	1.29 (0.71–2.34); 0.400	0.87 (0.63–1.23); 0.440	1.01 (0.70–1.46); 0.941
Adding salt						
Always	0.41 (0.17–0.98); 0.046	0.96 (0.78–1.18); 0.715	0.98 (0.76–1.25); 0.859	1.40 (0.89–2.22); 0.144	1.41 (1.10–1.81); 0.006	1.28 (0.95–1.74); 0.100
Sometimes	0.51 (0.29–0.91); 0.021	1.10 (0.96–1.25); 0.165	0.92 (0.79–1.09); 0.338	1.02 (0.75–1.38); 0.893	1.03 (0.89–1.80); 0.652	0.98 (0.84–1.15); 0.801
Never	1	1	1	1	1	1
Type of bread used						
Wholemeal bread	0.37 (0.06–2.13); 0.270	0.96 (0.74–1.24); 0.741	1.01 (0.75–1.38); 0.936	0.59 (0.34–1.04); 0.068	1.00 (0.81–1.25); 0.940	1.23 (0.96–1.58); 0.093
All types of bread	1.29 (0.69–2.43); 0.419	1.06 (0.90–1.24); 0.520	1.17 (0.96–1.42); 0.120	0.74 (0.49–1.10); 0.138	1.11 (0.95–1.32); 0.188	1.13 (0.80–1.11); 0.490
Refined bread	1	1	1	1	1	1
Type of fat for food preparation						
Vegetable oil	1	1	1	1	1	1
Animal fats (lard, butter, margarine)	0.91 (0–50–1–63); 0.750	0.94 (0.82–1.08); 0.390	1.25 (1.06–1.47); 0.007	0.91 (0.66–1.28); 0.600	1.01 (0.88–1.18); 0.801	0.94 (0.80–1.11); 0.490
Fruit consumption frequency						
Once a day and more	1	1	1	1	1	1
4–6 times per week	1.04 (0.47–2.31); 0.912	0.92 (0.78–1.09); 0.357	0.96 (0.78–1.18); 0.665	1.16 (0.78–1.7); 0.467	0.91 (0.77–1.09); 0.337	0.91 (0.74–1.11); 0.354
1–3 times per week and less	1.64 (0.81–3.32); 0.168	0.89 (0.75–1.05); 0.163	0.92 (0.75–1.14); 0.453	1.30 (0.89–1.88); 0.166	0.86 (0.7–1.03); 0.109	0.99 (0.81–1.23); 0.986
Fruit consumption, portions						

Table 2 continued

Health behaviour	OR (95 % CI); *p* value					
	Men			Women		
	Underweight vs. normal (66 vs. 2047)	Overweight vs. normal (2608 vs. 2047)	Obesity (all) vs. normal (1287 vs. 2047)	Underweight vs. normal (232 vs. 2775)	Overweight vs. normal (1940 vs. 2775)	Obesity (all) vs. normal (1506 vs. 2775)
5 portions per day and more	1	1	1	1	1	1
2–4 portions per day	0.94 (0.44–2.02); 0.889	1.13 (0.95–1.34); 0.179	1.04 (0.84–1.28); 0.720	0.79 (0.54–1.18); 0.248	1.19 (1.00–1.42); 0.043	1.03 (0.85–1.26); 0.730
1 portion per day and less	0.53 (0.20–1.38); 0.198	0.93 (0.77–1.13); 0.480	1.03 (0.82–1.29); 0.802	0.81 (0.54–1.20); 0.290	0.99 (0.83–1.19); 0.966	0.99 (0.81–1.23); 0.949
Vegetable consumption frequency						
Once a day and more	1	1	1	1	1	1
4–6 times per week	0.46 (0.22–0.94); 0.036	0.91 (0.78–1.06); 0.224	0.87 (0.71–1.05); 0.143	0.96 (0.67–1.40); 0.855	0.89 (0.76–1.07); 0.220	0.93 (0.76–1.13); 0.455
1–3 times per week and less	0.85 (0.41–1.74); 0.658	0.99 (0.81–1.21); 0.906	0.98 (0.77–1.25); 0.876	1.10 (0.70–1.72); 0.674	0.96 (0.76–1.22); 0.742	0.81 (0.62–1.06); 0.127
Vegetable consumption, portions						
5 portions per day and more	1	1	1	1	1	1
2–4 portions per day	1.58 (0.80–3.13); 0.186	1.08 (0.92–1.27); 0.326	1.13 (0.93–1.37); 0.230	0.87 (0.59–1.26); 0.454	1.11 (0.93–1.32); 0.243	1.14 (0.94–1.39); 0.172
1 portion per day and less	1.69 (0.82–3.49); 0.152	1.14 (0.96–1.36); 0.138	1.05 (0.85–1.31); 0.631	1.22 (0.83–1.78); 0.316	1.12 (0.93–1.34); 0.237	1.14 (0.93–1.41); 0.208
Physical activity[a]						
Low (10–29 min per day)	1.65 (0.87–3.13); 0.124	1.29 (1.11–1.49); 0.001	1.39 (1.16–1.65); <0.001	0.93 (0.67–1.29); 0.654	1.21 (1.03–1.41); 0.017	1.32 (1.10–1.57); 0.002
Moderate (30–59 min per day)	1.62 (0.83–3.18); 0.155	1.13 (0.97–1.32); 0.113	0.91 (0.75–1.11); 0.335	0.74 (0.51–1.07); 0.105	1.10 (0.92–1.31); 0.261	1.16 (0.94–1.41); 0.155
High (more than 60 min per day)	1	1	1	1	1	1
Confounding variables						
Age in years	0.99 (0.97–1.01); 0.286	1.00 (1.00–1.01); <0.001	1.02 (1.01–1.02); <0.001	0.97 (0.97–0.99); <0.001	1.04 (1.03–1.04); <0.001	1.05 (1.04–1.05); <0.001
Education						
Low	2.33 (0.82–6.60); 0.109	0.66 (0.53–0.81); <0.001	0.87 (0.67–1.12); 0.276	1.98 (1.22–3.21); 0.005	1.48 (1.19–1.83); <0.001	3.53 (2.73–4.57); <0.001
Middle	1.79 (0.70–4.57); 0.220	0.92 (0.78–1.08); 0.313	1.11 (0.90–1.37); 0.317	1.08 (0.75–1.55); 0.693	1.26 (1.06–1.50); 0.008	2.19 (1.74–2.77); <0.001
High	1	1	1	1	1	1
Marital status						
Married/living with partner	0.37 (0.20–0.66); 0.001	1.72 (1.50–1.97); <0.001	2.19 (1.84–2.61); <0.001	0.45 (0.34–0.60); <0.001	1.64 (1.43–1.88); <0.001	1.78 (1.51–2.09); <0.001
Living without partner	1	1	1	1	1	1

Normal (0) and other BMI categories (1); 1.00, referent value; the dependent variables formed three different models: each BMI category vs. normal weight as referent category, separately for males and females

[a] Physical activity—refers to transport physical activity (walking or riding a bicycle)

days per month had lower odds of being obese in comparison to non-drinkers. Alcohol consumption was related to lower frequency of underweight among Korean adults of both sexes (Park et al. 2013) and among men in the population of Serbia. Population-based studies have consistently shown that our diet has an influence on health (Togo et al. 2004). Consuming at least 400 g (5 portions) of fruit and vegetables a day, intake of whole grains instead of refined grains, limiting daily intake of free sugars to 10 % and fat intake to less than 30 % of total energy intake and use of less than 5 g of salt per day (Burkert et al. 2014) are recommendations for a healthy diet. Data from our study suggest that the Serbian adult population has a low daily intake of fruit/vegetables together with a predominant use of refined bread and high percentage of subjects adding salt to food for both sexes.

Previous research studies have suggested that breakfast skipping as one of the characteristics of dietary behaviour may influence body weight (Newby et al. 2003; Togo et al. 2004). Our results showed that those who ate breakfast irregularly had a significantly higher risk of obesity (both men and women) and overweight (only women) which is consistent with study of Grujic et al. (2009) which showed 10.0 % greater odds for obesity in subjects who ate breakfast sometimes or never. Skipping breakfast was associated with a significantly higher risk of obesity in a study by Ma et al. (2003). Subjects who regularly skipped breakfast had 4.5 times the risk of obesity than those who regularly consumed breakfast. There are also reports suggesting that individuals who do not eat breakfast have a greater overall daily energy intake. A study from Bangladesh showed that breakfast skippers were significantly more likely to be obese (Goon et al. 2014). Obesity was detected among 39.5 % of breakfast skippers and they showed significantly high prevalence. Other studies including Berkey et al. (2003) have yielded similar results, showing that inconsistent or irregular breakfast eating was significantly associated with being overweight. Researchers suggest that individuals who do not eat early in the day tend to be more hungry later resulting in consuming more calories in the evening as compared to subjects who eat regularly during the day (Wyatt et al. 2002). However, in the present study, irregular breakfast eating was also the risk factor for underweight in men.

According to our results, adding salt to food was inversely associated with underweight in men, whereas risk for overweight was significantly higher in women who always added salt to meals. A possible explanation might be that individuals tend to eat more if salt is added. A study by Donaldson et al. (2009) showed that overweight women have a stronger salt liking than normal-weight and obese women.

Type of bread used was not associated with weight status in both men and women. However, results of previous studies indicated that dietary patterns including whole-grain bread did not positively influence weight gain and therefore might be beneficial to weight status (Bautista-Castano et al. 2012).

We found that the type of fat for food preparation was associated with obesity in men: obesity risk was significantly higher in men who used animal fats in food preparation compared to those who used vegetable oil. Potential underlying mechanisms are related to satiety, energy density, palatability and/or metabolic responses (Swinburn et al. 2004). No association was found between type of fat used for food preparation and obesity in the Finnish study (Lahti-Koski et al. 2002).

Data directly relating intake of fruits and vegetables with risk of obesity and long-term weight gain are limited. Although a study on food intake patterns indicated that a diet rich in fruits and vegetables was associated with smaller gains in body mass index (BMI) (Togo et al. 2004), other studies on dietary pattern and BMI could not consistently predict changes in BMI or obesity development (Martinez-Gonzales et al. 1999).

Our study shows that Serbian women who consume 2–4 portions of fruit daily have a greater risk of becoming obese compared to those eating more than five portions per day. Frequency of vegetable intake showed negative association with BMI in Brazilian men (Peixoto et al. 2007). Data from a 12-year prospective cohort study showed that increased intake of fruits and vegetables was associated with a significantly lower risk of obesity among generally healthy middle-aged women (He et al. 2004). The mechanisms for the inverse association between fruit and vegetable intake and body weight are uncertain and can be explained by intake of dietary fiber that induces greater satiety as well as by their low energy density that might be a mediator of energy intake.

WHO (2003) recommends at least 30 min of physical activity daily and extensive research identifies physical inactivity to be a risk factor for a number of non-communicable diseases. Our results are consistent with observations from other studies that overweight and obese subjects tend to be physically inactive (Lahti-Koski et al. 2002; Martinez-Gonzales et al. 1999). Our results show that 42.6 % of subjects had a low level of transport physical activity as was shown in other studies, as in France where 36.8 % of adults had a low level of physical activity (Castetbon et al. 2009). Leisure time physical activity was inversely correlated with BMI in study of Peixoto et al. (2007). Women who walked or cycled at least 15 min/day were less likely to be obese than women who were less physically active or inactive (Lahti-Koski et al. 2002) while this pattern was less clear in men. The same study

showed that subjects of both sexes who were moderately or highly active in their leisure time were less likely to be obese than those with a low level of physical activity.

As for other variables such as age, marital status and level of education, the results of our study show that the age effect was strong for both sexes. Risk for overweight and obesity increased with age, and these findings are supported by earlier literature (Kifle et al. 2012; Kavikondala et al. 2009). Our study showed that there was a positive relationship for both sexes between high BMI and being married or living with a partner. Various studies suggest that being married is associated with a higher risk of overweight/obesity such as Hanson et al. (2007) who showed that married men were more likely to be overweight than men in all other marital-status categories except for those living with partners. The results of Lipowicz et al. (2002) indicated that in general, both married men and women were more likely to be overweight and obese than never married individuals. Underweight people were more frequently single (Che 2002) or unmarried (Park et al. 2013). In the present study, a risk for underweight was lower in men who were married/living with a partner. Current literature is ambiguous as to how marriage impacts diet/physical activity (PA). The social and domestic responsibilities of marriage may decrease the available time for activity, but the presence of an active partner may increase motivation for PA. The fact that in our population, in women, low and middle educations were positively related to overweight and obesity, and low education even to underweight is in agreement with other studies. Analyses of health survey data from Australia, Canada, England and Korea (Devaux et al. 2011) showed that most educated individuals displayed lower rates of obesity (with the exception of Korean men), the education gradient in obesity being stronger in women than in men. The authors suggested that most of the effect of education on obesity was direct, and that the positive effect of education was determined by at least three factors, i.e. greater access to health-related information, clearer perception of the risk connected with some lifestyles and improved self-control of better educated individuals. Inverse association of overweight with low education in men in the present study could probably be related to their occupational physical activity and/or socio-economic status. In some investigations, cultural background and ethnicity were also related to BMI (O'Dea et al. 2014).

Limitations of this study include: (1) cross-sectional study design which implies that no causal conclusion about the relationship between health behaviour variables and BMI can be made; (2) the data based on self-reporting could lead to recall bias, which may have prevented us from accurately estimating the association between health behaviour variables and BMI.

Reducing obesity and overweight is a major public health and clinical challenge. In addition to the development of national and community-based strategies and initiatives, it is important for dietitians and clinicians to counsel individuals on lifestyle and behaviour modification. Although the benefits of healthy lifestyle choices are well established among the general population, greater public awareness of the need to practice healthy lifestyles is indicated.

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