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STROKE RISK ASSESSMENT AND DIET-RELATED RISK FACTORS – COMPARISON OF TWO CITIES FROM BOSNIA AND HERZEGOVINA

Banjari I.[1,2]*, Han S.[1], Al-Tawil N.[3], Ćorić N.[2], Balkić Widmann J.[4]

[1] Department of Food and Nutrition Research, Faculty of Food Technology, Josip Juraj Strossmayer University of Osijek, Osijek, Croatia
[2] Faculty of Agriculture and Food Technology, University of Mostar, Mostar, Bosnia and Herzegovina
[3] Private Pharmacy "Al-Tawil", Sarajevo, Bosnia and Herzegovina
[4] University Hospital Centre Osijek, Osijek, Croatia

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Abstract

Stroke, as one of the cardiovascular diseases, is becoming more of a priority for health systems around the world, but especially in developing countries. Mortality rates had increased drastically in developing countries in comparison to developed countries. This shift is thought to be driven by multiple reasons; the ageing of population, difference in socioeconomic status, health care, just to name a few. Change in risk factors is driven by the economic development. The majority of stroke risk factors are lifestyle related which is strongly affected by the urbanization processes. For stroke, the most important risk factors are hypertension, high blood cholesterol, diabetes, obesity, lack of physical activity and poor diet.

Present study aimed to calculate the stroke risk in adults from two different urban settings in one developing country.

A cross-sectional observational study was conducted on 210 adults from two cities (Mostar and Sarajevo) in Bosnia and Herzegovina. Stroke risk was calculated with the "Stroke Risk Quiz" developed by the American Heart Association and the American Stroke Association. To assess the compliance of diet with the recommendations for stroke prevention we developed a short point-based questionnaire which focused on the consumption of 16 foods/food groups. Study participants from Sarajevo, capital of Bosnia and Herzegovina, have lower stroke risk compared to those from Mostar, a smaller city close to the Adriatic coast, where we expected to see the protective effect of the Mediterranean lifestyle which is traditional in the area. In Sarajevo, the dominant risk factors identified include increased body weight and blood pressure, and smoking. Only diet in Mostar reflects the Mediterranean, but family history of cardiovascular diseases, higher blood cholesterol levels and lower level of physical activity among study participants from Mostar surpass the benefit of a better diet and lower body mass.

Our findings support the idea that different (urban) settings require public health systems to adapt their educational and intervention activities to improve health indicators of populations and lead to reductions in health care expenses.

Keywords: *stroke, diet, lifestyle, developing countries, Bosnia and Herzegovina.*

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Address for Correspondence:

Ines Banjari, PhD, Assoc. Prof.
Department of Food and Nutrition Research, Faculty of Food Technology
Josip Juraj Strossmayer University of Osijek 18 F. Kuhača Street, Osijek 31000, Croatia
Tel.: (+385 31) 224 339
E-mail: ibanjari@ptfos.hr

Introduction

Stroke is the primary cause of long-term disability [*Norrving B et al., 2018*], and the second-greatest cause of death worldwide, with an incidence of 12.2 million occurrences in 2019 [*Ekkert A et al., 2021*].

Stroke incidents, their long-term sequelae, and the related costs are anticipated to rise sharply as populations continue to grow and live longer [*Wafa H et al., 2020*]. Another worrying trend has been a rise in the incidence of stroke in young people, which has been linked to an increase in conventional stroke risk factors like hypertension and poor dietary habits [*Iadecola C et al., 2020*].

Stroke is more common, with ischemic stroke being the most frequent, in developing countries. Ischemic occlusions account for around 85% of stroke fatalities, with the remaining 15% caused by intracerebral haemorrhage [*Kuriakose D, Xiao Z, 2020*]. Ischemic stroke has a complex ethology which is linked with three main causes: 25% are produced by Lacunar infarcts from minor vascular lesions, 20% are caused by cardiogenic cerebral infarction, and 50% are caused by arteriosclerotic plaques of the cerebral vessels and the rupture of the arteriosclerotic plaque [*Zhao Y et al., 2022*]. Ischemic occlusion in the brain causes thrombotic and embolic disorders. Blood flow is hampered in thrombosis due to artery constriction caused by atherosclerosis. On the other hand, an embolism is caused by decreased blood flow to the brain region: the blood supply to the brain decreases, producing acute stress and premature cell death (necrosis). Necrosis is followed by plasma membrane breakdown, organelle enlargement, leakage of cellular contents into the extracellular space, and neuronal function loss [*Kuriakose D, Xiao Z, 2020*].

Cerebral haemorrhage, which can occur in the brain tissue (intraparenchymal haemorrhage) or the subarachnoid space (subarachnoid haemorrhage), is the other common type of stroke [*Iadecola C et al., 2020*]. Seizures following intracerebral haemorrhage may occur as a result of the haemorrhage's mechanical effects as it grows, as well as by the cortex being irritated by blood metabolic products in the short term as well as by hemosiderin depositions and gliotic scarring in the long term [*Doria J, Forgacs P, 2019*]. Hypertension is one of the most typical contributors to haemorrhagic strokes [*Knight-Greenfield A et al., 2019*].

After brain injury, the pathophysiology of stroke requires a systematic, progressive reaction. The most commonly used treatment for ischemic stroke and brain infarction at the moment is thrombolytic therapy, but more attention is given to the potential of direct removal of the blood vessel occlusions via catheters or arteries [*Zhao Y et al., 2022*].

Stroke survivors face a high risk of long-term disabilities and repeated strokes. Some aftereffects include immobility, deprivation, dementia, depression, speech impairments, and unsteadiness when walking [*Feigin V et al., 2022*].

The most prevalent modifiable risk factors for stroke include hypertension, poor diet, obesity [*Christopher K et al., 2022*], diabetes mellitus, dyslipidaemia, smoking, a lack of physical activity, and atrial fibrillation, and most guidelines promote change of the aforementioned risk factors to reduce stroke risk [*Norrving B et al., 2018*].

According to data from the Institute of Public Health Federation of Bosnia and Herzegovina from 2021, stroke is the third leading cause of death in Federation of Bosnia and Herzegovina, responsible for 2,058 deaths, with men accounting for 42.03% of cases and women accounting for 57.97% [*Institute for Public Health FB&H, 2021*].

The aim of this study was to assess the stroke risk based on (non) modifiable risk factors from two large urban areas (cities of Mostar and Sarajevo, Bosnia and Herzegovina). Special emphasis was put on dietary habits which could act protectively in individuals at increased risk of stroke.

Material and methods

We conducted a cross-sectional observational study on adults from two large cities in Bosnia and Herzegovina (Mostar and Sarajevo).

The research was approved by the Ethics committee for human studies of the Faculty of Food Technology, Osijek.

Study subjects

The questionnaire was completed by a total of 210 participants, 96 male and 114 female. Study participants were recruited from March to May 2021 in city of Mostar (total population 105.797) and Sarajevo (capital of Bosnia and Herzegovina,

total population 275.524).

Participants were recruited randomly (in pharmacies and on the street), and were asked to complete the study-specific questionnaire. Participation was fully voluntary and anonymous.

Questionnaire

The questionnaire was completed once. It included basic and socio-demographic questions (e.g. age, gender, body mass and weight, education level, employment status, finances), stroke risk assessment questionnaire (the so called "Stroke Risk Quiz") developed by the American Heart Association and the American Stroke Association, taken from the Croatian Society for the Prevention of Stroke's website [*Croatian Stroke Society, 2023*].

Based on self-reported weight and height, Body Mass Index (BMI) was calculated, according to which participants were classified as underweight, normal weight, overweight or obese [*World Obesity, 2023*].

Dietary habits in relation to the prevention of stroke assessment was prepared according to the dietary recommendations for stroke prevention [*Larsson S, 2017; Spence J, 2018*]. The analysis of dietary habits was done through consumption frequency of 16 foods/food groups. Consumption frequency correlate to a particular number of points (zero, 1 or 2). If the consumption of a particular food corresponds to the recommendations, than 2 points are given. If a particular food is consumed despite being listed as the stroke risk amplifier, then zero points are given. For example, if a person consumes olive oil every day they get 2 points, but if they add salt to their food without even trying a meal, they get zero points. Higher number of points achieved corresponds with dietary habits which are in line with the recommendations. Maximum number of points was 32.

Data analysis

The Statistica software (TIBCO Software Inc., version 14.0) was used to process statistical data, with a significance level of p0.05 chosen. Graphical data processing was done using MS Office Excel package (version 2016, Microsoft Corp., USA).

All collected categorical data are represented by absolute and relative frequencies, whereas numerical data is defined by arithmetic mean and standard deviation, as well as minimum and maximum, using descriptive statistical methods. To compare categorical data within and between groups, the Chi-square test was performed. The Pearson correlation test was used to determine the correlation between numerical data.

Results

Basic characteristics of study participants are shown in table 1 and figure shows distribution of study participants according to state of nourishment classification.

Participants from Mostar were older but their average BMI was lower in comparison to age and BMI of participants from Sarajevo (Table 1). The difference in participants' state of nourishment is particularly emphasized when shares in particular nourishment category is observed (Figure). There is significantly more overweight (p=0.001) and obese (p=0.016) participants in Sarajevo, in comparison to Mostar. Interestingly, there was no underweight participants in Mostar despite (Figure).

No family history of cardiovascular diseases was reported by 18.3% study participants from

Table 1

Basic characteristics of study participants (n=210)

	Age (*years*)	**BMI** (*kg/m²*)	**p**
Mostar (n=60)			
Mean ± SD	62.9 ± 12.2	25.4 ± 3.4	0.032*
Min – Max	45 – 89	18.2 – 34.5	
Sarajevo (n=150)			
Mean ± SD	55.1 ± 12.1	27.3 ± 3.5	0.042*
Min – Max	35 – 74	18.0 – 40.4	

Notes: *SD – standard deviation, Min – Max – minimum – maximum, BMI – Body Mass Index, *statistically significant at p<0.05*

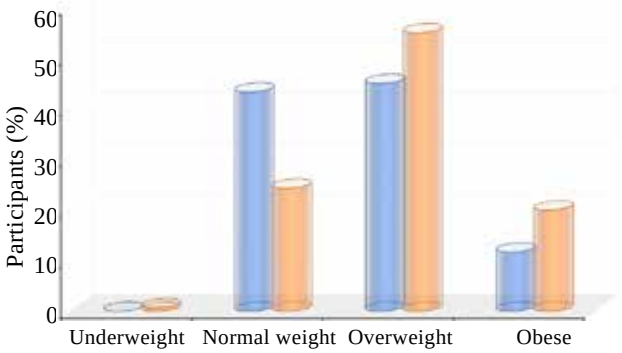

Figure. *Distribution of study participants according to their state of nourishment classification (n=210)*

Mostar and 54.7% from Sarajevo (p<0.001). Even 70.0% of study participants from Mostar and 46.0% from Sarajevo said that they had at least one family member younger than 60 years with cardiovascular (p<0.001). As for the diabetes, in both cities 52.0% of study participants said there was no presence of diabetes diagnosis. 7.3% of study participants in each city were diagnosed with diabetes after the age of 60, while only in Sarajevo there was 6.6% of study participants being diagnosed with diabetes earlier in life (Table 2).

TABLE 2

Family history of cardiovascular disease and diabetes among study participants (n=210)

Stroke risk factor			Mostar	Sarajevo
			n (%)	n (%)
Number of relatives with cardiovascular disease	None		11 (18.3)	82 (54.7)
	Older than 60 years	One	4 (6.6)	21 (14.0)
		Two	3 (5.0)	17 (11.3)
	Younger than 60 years	One	30 (50.0)	15 (30.0)
		Two	10 (16.6)	6 (4.0)
		Three	2 (3.3)	9 (6.0)
Diagnosis of diabetes mellitus (regardless of the type) in participant or family	None		29 (52.0)	78 (52.0)
	A family member		11 (27.3)	41 (27.3)
	Two family members		7 (6.7)	10 (6.7)
	Yes, diagnosed after the age of 60		13 (7.3)	11 (7.3)
	Yes, diagnosed between 20 and 60 years		/	8 (5.3)
	Yes, diagnosed before the age of 20		/	2 (1.3)

TABLE 3

Last known values of systolic blood pressure and total cholesterol among study participants (n=210)

Stroke risk factor		Mostar	Sarajevo
		n (%)	n (%)
Systolic blood pressure (*mm Hg*)	< 120	29 (48.3)	59 (39.3)
	< 130	22 (36.7)	46 (30.7)
	< 140	7 (11.7)	36 (24.0)
	< 160	2 (3.3)	7 (4.7)
	< 180	/	2 (1.3)
Total cholesterol (*mmol/L*)	<4.99	15 (25.0)	66 (44.0)
	5.0-5.99	27 (45.0)	58 (38.7)
	6.0-6.99	17 (28.3)	13 (8.7)
	7.0-7.99	1 (1.6)	11 (7.3)
	8.0-8.99	/	1 (0.7)
	>9.0	/	1 (0.7)

Hypertension (systolic blood pressure ≥ 140 *mm Hg*) or slightly elevated blood pressure (≥ 130 *mm Hg*) represent important stroke risk factors and were reported by smaller share of study participants from Mostar in comparison to Sarajevo (p=0.025 for hypertension, p=0.401 for elevated blood pressure; Table 3). Total blood cholesterol level was within the normal range in 25.0% of study participants from Mostar, and 44.0% of study participants from Sarajevo (p=0.011). On the other hand, more study participants from Mostar in comparison to Sarajevo had slightly increased (< 6 *mmol/L*, p=0.398) and high values of total cholesterol (> 6 *mmol/L*, p=0.042) (Table 3).

Intensive physical activity, including physical and sedentary work, was reported by 23.3% of study participants from Mostar and 30.0% from Sarajevo (Table 4). Moderate intensity is far more frequently reported in both cities, regardless of the work type. There were more former smokers in Mostar than in Sarajevo, and with the number of study participants who never smoked, the role of smoking can be neglected in 71.6% of study par-

TABLE 4

Lifestyle stroke risk factors among study participants (n=210)

Stroke risk factor		Mostar	Sarajevo
		n (%)	n (%)
Physical activity (work-related and leisure time)	Intense, physical work	/	34 (22.7)
	Moderate, physical work	23 (38.3)	50 (33.3)
	Intensive, sedentary work	14 (23.3)	11 (7.3)
	Moderate, sedentary work	12 (20.0)	32 (21.3)
	Mild, sedentary work	9 (15.0)	11 (7.3)
	No, sitting work	2 (3.3)	12 (8.0)
Smoking habit	Never	20 (33.3)	66 (44.0)
	Former smoker	23 (38.3)	26 (17.3)
	Yes, ≤ 10 cig./day	3 (5.0)	11 (7.3)
	Yes, ≤ 20 cig./day	14 (23.3)	26 (17.3)
	Yes, ≤ 30 cig./day	/	16 (10.7)
	Yes, ≥ 40 cig./day	/	5 (3.3)

ticipants from Mostar and 61.3% from Sarajevo. Heavy smokers (≥ 30 cigarettes per day) were identified only in Sarajevo (Table 4). Alcohol consumption was particularly low; less than 10% of study participants said that they consumed alcohol, on special occasions primarily (*Note: the results are not shown*).

The total stroke risk score and the distribution of study participants according to the level of risk are shown in table 5. Study participants from Mostar had higher stroke risk score, with 68.3% with borderline risk (p=0.342) and 30.0% with above-average risk in comparison to study subjects from Sarajevo (p<0.001) (Table 5).

Compliance of diet with the recommendations for stroke prevention revealed slightly better dietary habits in study subjects from Mostar than in Sarajevo. In Mostar, based on the average number of points, study participants complied with the recommendations for stroke prevention in 54.6% while study participants from Sarajevo had 52.8% (Table 6). However, after detailed analysis (*Note: due to extensiveness, these variables are not shown in the manuscript but are available upon request from the corresponding author*) of all observed consumptions of foods in study participants from Mostar, saltwater fish is consumed by 45.0%, olive oil by more than 76.0%, nuts by more than 50.0%, and the majority consume fruits, tomatoes, and garlic (64.0%, 77.0%, and 82.0%, respectively). Yet, excessive salt use was reported by 25% of study participants and a quarter (25.0%) consume

Table 5

Stroke risk score and distribution of study participants according to the level of stroke risk (n=210)

	Stroke risk score (points)	Risk factor					
		No		Borderline		Above-average	
Mostar (n=60)							
Mean ± SD	21.1 ± 5.4	1	0.7	41	68.3	18	30.0
Min - Max	12 – 34						
Sarajevo (n=150)							
Mean ± SD	15.2 ± 14.0	48	32.0	92	611.3	10	6.7
Min - Max	5 – 29						

Notes: *SD- standard deviation; Min – Max – minimum – maximum; *statistically significant at p<0.05*

Table 6

Compliance of diet with the recommendations for stroke prevention among study participants (n=210)

	Diet compliance (points)	
	Mean ± SD	Min - Max
Mostar (n=60)	17.5 ± 3.1	11 – 30
Sarajevo (n=150)	16.9 ± 0.4	6 – 32

Notes: *SD - standard deviation; Min – Max – minimum – maximum*

sweets twice a week or more. Only 7.3% of study participants from Sarajevo reported consuming saltwater fish regularly. Fruits, tomatoes, and garlic are used by 61.3%, 79.3%, and 48.7% of study participants, respectively. Excessive salt is used by 67.3%, while 47.3% reported eating sweets two or more times per week.

We found that the stroke risk score significantly correlates with the participants' age (r=0.360, p=0.001) and BMI (r=0.586, p=0.001), but not with dietary compliance with the recommendations for stroke prevention (r=-0.148, p=0.260). Gender was also found to be a non-significant risk factor for stroke (p=0.130).

Discussion

The number of people over the age of 60 is predicted to rise by 23% during the next ten years [*Feigin V et al., 2022*]. Even though the number of elderly people in Europe is increasing, there is compelling evidence that stroke is a preventable, treatable, and manageable condition [*Norrving B et al., 2018*]. Some of the risk factors that can be improved are hypertension, cigarette smoking, diabetes mellitus, dyslipidaemia, poor nutrition, alcohol consumption, physical inactivity, and obesity [*Silva G et al., 2011*].

Since the 1980s, the incidence of obesity has doubled, making it the second most common preventable cause of death in the world (after smoking) [*Quiñones-Ossa G et al., 2021*]. It is crucial to educate the public about the relevance of increased BMI and the risk of different diseases, particularly cardiovascular diseases. As expected, study participants from Sarajevo had higher BMI and more overweight/obese participants in comparison to study participants from Mostar. Urbanization can

partially explain these differences; more exposure to fast food and more stress could be the underlying factors included in the pathology of overweight/obesity [*Popkin B et al., 2012*].

Depending on the number and age of first-degree relatives who have suffered from cardiovascular diseases, a family history of cardiovascular diseases affects future disease risk [*Kolber M, Scrimshaw C, 2014*]. Family history combines shared genetic and environmental risk factors, and represents a valuable, early sign for conducting a cardiovascular disease screening [*Kulshreshtha A et al., 2014*]. Our study showed that around half of study participants in each city have a positive family history, which is worrying, especially in the case of those with more than one relative and below 60 years of age (Table 2). This is indicative of early screening programmes which are still not part of public health system in many countries, including Bosnia and Herzegovina.

Even though diabetes is a major risk factor for stroke, probably via diabetic kidney disease, and especially at a younger age [*Ylinen A et al., 2021*] our research finding did not identify it as a prevalent risk factor (Table 2). However, rates for Sarajevo support the role of urbanization induced stress since these study participants reported more diabetes cases in comparison to Mostar.

Hypertension is the most important modifiable risk factor for stroke. Antihypertensive medications, regardless of age, gender, or ethnicity, have been extensively proven as beneficial for stroke prevention [*Yu J et al., 2011*]. The DASH (Dietary Approaches to Stop Hypertension) diet is specifically designed to prevent the onset of hypertension, decrease blood pressure, and boost the efficiency of antihypertensive medicine treatment [*Filippou C et al., 2020*]. Our research data shows that the rates of systolic blood pressure of 140 *mmHg* and more is more prevalent in study subjects from Sarajevo in comparison to Mostar (Table 3). That was partially expected given that living in capital (Sarajevo) puts more every day pressure on people, and larger urban areas tend to have higher prevalence of hypertension and other chronic conditions, even in younger population groups [*Kapral M et al., 2019*].

While low levels of blood cholesterol are linked to an increased risk of intracerebral haemorrhage, high levels of total cholesterol, and low-density lipoprotein cholesterol are linked to an increased risk of ischemic stroke [*Hackam D, Hegele R, 2019*]. Only 25.0% of participants from Mostar and 44.0% from Sarajevo had cholesterol level ≤4.99 *mmol/L* (Table 3), which was unexpected given that smaller share of participants had increased BMI (Figure) and had better dietary habits (*Table 6*).

Because of the high mortality rate and large impact of stroke-related morbidity on individuals and health care resources, the significance of physical exercise in stroke prevention is of great interest [*Gallanagh S et al., 2011*]. Moderately active people have a 20% lower risk of stroke incidence or fatality, whereas highly active people have a 27% lower risk [*Do Lee C et al., 2003*]. As shown in table 4, physical activity varies greatly between study participants. Intense physical work was reported only by 22.7% of study participants from Sarajevo. The share of study participants with intensive sedentary job was 23.3% in Mostar and 7.3% in Sarajevo. All others can be considered as not having enough physical activity. Efforts done globally to increase physical activity vary, but in most developing countries these are not the priority of public health systems [*World Health Organization, 2020*].

Stroke risk is increased by smoking three to four times, and 1.5 to two times when environmental smoke is present in the household [*Shah R, Cole J, 2011*]. When talking about alcohol, light-to-moderate alcohol consumption on a regular basis appears to reduce the risk of ischemic stroke. Haemorrhagic and ischemic strokes are both increased by heavy drinking [*Hillborn M, 2006*]. In particular, one more positive impact of wine intake has come to light and been proposed as one of several explanations for the “French paradox”: considering a poor exposure to established cardiovascular risk factors, the French population has a low incidence of cardiovascular disease [*Truelsen T et al., 1998*].

Smoking (Table 6) was not found to be important risk factor in our study subjects, nor was alcohol, which can be attributed to the fact that the majority of study participants are Muslims. Still, for people with diabetes, to whom religion allows, benefits of moderate alcohol consumption should be communicated.

Dietary recommendations to prevent stroke are strongly supported by research evidence and should be clearly communicated through public health systems to populations at increased risk. Both Mediterranean diet and the DASH diet reduce the number of health risks, prevent weight gain over the long term, and are consistently linked to a lower risk of all major clinical events, including stroke [*Mozaffarian D, 2016*]. The primary choice when it comes to dietary recommendations to lower stroke risk is definitely the Mediterranean diet [*Lakkur S, Judd S, 2015*]. Generally, avoidance of excessive salt, regular consumption of olive oil, fish consumption 2 to 3 times per week, abundancy of fresh fruits and vegetables, nuts, and limited consumption of high fit and sugary foods are recommended. City of Mostar is famous for its mild climate and due to close proximity to the Adriatic coast; Mediterranean diet is considered as the traditional dietary pattern. Our findings do not support this: participants from Mostar achieved 54.6% and participants from Sarajevo achieved 52.8% compliance with dietary recommendations for stroke prevention. Additionally, when other previously discussed stroke risk factors are considered, higher stroke risk score is higher in Mostar than in Sarajevo (Table 5). In other words, benefits of the Mediterranean diet and lifestyle are lost and result in significantly higher stroke risk in comparison to a larger urban setting with no connection to the Mediterranean diet or lifestyle.

Conclusion

Stroke is a worldwide problem which is becoming more important due to increasing incidence trends observed in younger populations.

Our research showed that stroke risk factors differ between urban settings in one developing country. In Sarajevo, capital of Bosnia and Herzegovina, more dominant risk factors include increased body weight, increased blood pressure, and smoking. In Mostar, a smaller urban setting close to the Adriatic coast, the influence of the Mediterranean lifestyle, identified in better dietary compliance with the recommendations for stroke prevention, is lost and results in higher stroke risk. Family history of cardiovascular diseases, higher blood cholesterol levels and lower level of physical activity surpass the benefits of lower body mass and more favourable diet.

These findings provide important insight into areas on which public health systems should focus when planning promotional and educational activities to lower the risk of stroke in population. Benefits will be visible on individual and societal level, including reductions in health care expenses.

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University after M. Heratsi.

Address for correspondence:

Yerevan State Medical University
2 Koryun Street, Yerevan 0025,
Republic of Armenia

Phones:

(+37410) 582532 YSMU
(+37493 588697 Editor-in-Chief
Fax: (+37410) 582532
E-mail:namj.ysmu@gmail.com, ysmiu@mail.ru
URL:http//www.ysmu.am

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Armenia, 0023,Yerevan,
Acharyan St. 44 Bulding,
Phone: (+374 10) 62 76 12,
E-mail: las.print@yahoo.com