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Original Article

RISK FACTORS AND INDICATORS OF CARDIOVASCULAR ILLNESSES IN LATE ADOLESCENT PERIOD

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Abstract. *Epidemiological studies of previous decades indicate that cardiovascular illnesses present a dominant part of the structure of mortality in the majority of developed countries in the world. The goal of this research was to establish the most common risk factors of this group of illnesses, as well as statistically significant differences and correlations between risk factors and cardiovascular illnesses in the late adolescent period. A cross-study was performed in three high school graduate classes in Serbia (Valjevo), in April 2015, on an incidental sample of 240 subjects of both genders, aged (19 ± 0.5 years). A statistically significant difference in the frequency of hypertension in male adolescents (2.54%) and female adolescents (0.0%) was not established. Obesity was significantly more manifested in male graduates (6.93%), with a significant level, than in female graduates (1.10%). Abdominal obesity is, with a confidence interval – range (99% CI), much more common in male graduates (10.01%), than in female graduates (1.26%). Among smokers, a significant gender difference was not established Alcohol was, with a probability level ($p \leq 0.01$) consumed much more by male graduates (19.93%) than female graduates (8.01%). A statistically significant linear correlation between variables of systolic and diastolic blood pressure, body mass index, and waist circumference was observed. Risk factors in late adolescents are significantly different when it comes to gender. With a goal of prevention of cardiovascular diseases in high school graduate students, it is imperative to reduce obesity, cigarette smoking, and alcohol consumption, as well as implementation of regular physical activity*.

Key words: *High school graduates, risk factors, hypertension, obesity, cigarette smoking, alcohol consumption*

Introduction

The first and second decade of the 21st century is characterized by a rise in cardiovascular diseases (CVDs) which have become a dominant cause of morbidity and mortality in the developed countries of the world. CVDs are a result of interaction of different somatic, environmental, and behavioral factors. Risk factors (RFs) comprise certain illnesses, pathological states, traits or habits that cause or contribute to the development of a certain illness or its complications. The most significant traditional risk factors for CVDs include genetic predisposition, obesity, arterial hypertension (HTN), insufficient physical activity, improper diet (food rich with fats of animal origin), nicotinism – habit of cigarette smoking, diabetes mellitus (DM), men older than 55 years, post-menopausal women, acute stress disorder (ASD), and other [1]. Recognizing these RFs, as well as their mutual relationships will enable a new approach to the phenomenon of disease of the cardiovascular system, but to the personality of the diseased individual as well [2].

According to data of the World Health Organization (WHO) – by year 2030, 24.000.000 people will die of cardiovascular diseases (CVDs) every year [3], while in the Republic of Serbia, one third of males and one fourth of females die from this disease. In more than 90% of cases the cause of the disease is atherosclerosis of coronary arteries, which starts with damage of the inner layer of the artery, thickening of the vessel wall, narrowing of the artery (AS), and ischemia of the heart muscle (IHD).

European Association of Cardiology (ESC) has proposed a model for prevention of CVDs (0-3-5-140-5-3-0), which directs to a healthy way of living, and suppression of standard risk factors: 0 – no smoking (neither active nor passive), 3 – a minimum of 3 km of walking or 0.5 h of mild physical activity is recommended, 5 – it is desirable to have 5 meals consisting of fruit and vegetables every day (minimum 400–600g), 140 – systolic blood pressure (SBP) < than 140 mmHg, 5 – total cholesterol < than 5 mmol/l, 3 – LDL cholesterol < than 3 mmol/l.0 – no obesity and no diabetes [4].

Medical researchers have turned the attention to the existence of significant mutual dependence between traditional cardiovascular risk factors (RFs) and

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pathological states, as well as mortality from CVDs in humans [5]. The majority of RFs in adolescents manifest a tendency to remain at the same degree in later period of life as well [6]. Effects of each of the individual factors are cumulative, and the conformation of factors, as well as their simultaneous appearance, cause multiplication and increased threat in later life, especially after 30 years of life [7]. During adolescent age, individuals who are exposed to stimuli that contribute to CVDs usually remain in that group later in life, which amplifies the need of early diagnosed diseases, that are not visible at first sight, and a need for their prevention as well. Prevention and protection from diseases in order to reduce and weaken the effects of cardiovascular risk factors has shown to be efficient in a significant number of cases in different age groups, especially in adolescents [8].

Despite numerous researches dealing with CVDs, there isn't a sufficient number dealing with standard RFs that cause the mentioned diseases, which is why it is expected that the obtained results in this research can contribute to a change in understanding RFs as contributors of CVDs in the adolescent population.

The basic goal of this empiric cross-sectional study was directed towards evaluation of the most frequent RFs for CVDs, as well as statistically significant differences and correlations between RFs and CVDs in subjects of both genders in late adolescent period.

Material and Methods

Sample

Research was performed in Technical, Economic, and Agricultural-Veterinary school in Valjevo, in June, 2015. By a transverse study, an incidental sample of 240 graduate students was encompassed (122 female graduates and 118 male graduates), with a mean age of 19 years (± 0.5 months).

Student evaluation, measurement of morphological characteristics, alimentary status and functional capability of the cardiorespiratory system was conducted by the authors of this paper. Before initiating this process, subjects were introduced with the goal and the method of the study, after which they gave a written consent to use their data in the planned study.

Instruments

Based on the questionnaires that were fulfilled anonymously, information regarding gender and age were analyzed, as well as habits regarding physical activity, cigarette smoking and alcohol consumption.

Information regarding gender and age were obtained through an anonymous questionnaire. The questionnaire and the results of measurements of the subject were registered under the same coded number.

In regard to the category variable cigarette smoking, subjects declared in one of the following ways: never smoked cigarettes, former smoker, and active cigarette smoker. Smokers are defined as individuals who have declared to smoke every day. Former or occasional smokers are classified as non-smokers.

On the category variable alcohol consumption, subjects could respond in one of the following ways: does not consume alcohol, occasional consumption, and everyday consumption.

Variable for estimation of physical inactivity of graduate is defined through the criteria of conducting mild physical activity (speed walking, housework, sport-recreational activities). Subjects who claimed that they exercise at least three times weekly, in duration of 45 minutes or more, were classified as individuals with regular physical activity.

Morphological indicators and alimentary status

By using standardized anthropometric instruments, having in mind the principles of the International Biological Program, body height, body mass (BM), and waist circumference were measured. All measurements of subjects, who were lightly dressed and without shoes, were conducted during morning hours at the same time (± 2 hours), with the same instruments, using the same techniques, and according to standard procedure. Measurements were performed three times, after which the arithmetic mean was automatically calculated.

Continued variable body height (BH) of subjects were measured in a standing position, by using the *Harpenden* anthropometer (*Holtain Ltd, Crosswell, UK*), from head to toe, with joined feet. Heels, scalp, and scapulae were in the same plane, and the head was in parallel position to the "Frankfurt plane" (an imagined plane that passes through the line that connects the apical point on the external ear canal – orbits, with the point that is located on the lowest part of the inferior margin of the orbit – *porion*), with a precision of ± 0.1 cm. Measurement of BM was conducted using a medical decimal scale with mobile weights, with precision of 0.1 kg. Waist circumference measurement (WC) was conducted in a standing position with the *Holtain* measuring tape (on the level of the lowest rib and anterior iliac spine), at the end of normal expiration, with a precision of ± 0.1 cm.

In order to evaluate the alimentary status, body mass index (BMI) was calculated, which presents the relation between the body mass and body height expressed in meters squared, based on the mathematical formula: BMI = BM/height^2 (kg/m^2). According to the criteria of World Health Organization (WHO), alimentary status is classified in the following way: underweight (BMI < 18.50 kg/m^2), normal (BMI = 18.50–24.99 kg/m^2), overweight (BMI = 25.00–29.99 kg/m2) and obese (BMI ≥ 30 kg/m^2).

For evaluation of the amount of abdominal obesity waist circumference values were used. Based on the criteria of WHO (NCEP ATP III criteria from the *National Cholesterol Education Program, Adult Treatment Panel* III, or AL II from *action level* II), the adopted borderline values for waist circumference in females of ≥ 80 cm matched to an increased cardiovascular risk, while values of ≥ 88 cm in males matched to an increased cardiovascular risk.

Indicators of functional capabilities of cardiorespiratory system

The discrete variable blood pressure (BP) was measured using a standard calibrated lead manometer and and adequate cuff on the upper arm above the brachial artery, after a rest of at least 10 minutes. Subjects were in a sitting position, on a chair with a back, with feet on the floor. The cuff was pumped 20–30 mmHg above the values of expected SBP, and it was released with the speed of 2–3 mmHg/s. The mean value of BP in three subsequent measurements was used.

Hypertension is defined as SBP ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg, and prehypertension as: SBP of 130–140 mmHg and/or DBP between 85–90 mmHg.

Statistical analysis

Depending on the tested variables, methods of descriptive statistics were used: parameter variables that were observed were presented with arithmetic mean (AM) and standard deviation (SD), while category values were presented through a percentage structure. In order to establish statistical presence of certain risk factors and significant differences of frequencies of certain variables between genders, the nonparametric Pearson's χ^2 test was used (chi-square test). In order to establish correlations between parametric variables of certain risk factors (in female and male gender separately), Pearson's coefficient of bivariate correlation (*r*) was used. The borderline of statistical significance was defined for the probability level ($p \leq .05$ or $p \leq .01$).

Data were analyzed by using the program – *Statistical Package for Social Science* (SPSS) for Windows (version 15.0).

Results

Table 1 depicts statistical magnitudes of BP and frequency of HTN in the examined gender groups. The obtained empiric findings suggest that the frequency of increased BP is minimal (4.09% in males and 0.90% in females). Frequency of prehypertension is also minimal: only three subjects (2.54%) are distributed into the cluster with "borderline hypertension".

Consideration of the empiric values of BMI with the assumed has turned the attention to the fact that, with a 99% confidence interval, every third graduate student is distributed in the cluster of overweight, while 6.93% of subjects are obese (Table 2). The mean value of BMI in male subjects is around 24 kg/m^2, which denominates the borderline value of normal alimentary status. On the other hand, chi-square distribution analysis, with a significance ($p \leq 0.0001$) showed a significantly decreased presence of obesity in female subjects – 1.10% female subjects are obese, while 8.03% of female subjects are distributed into the cluster of overweight.

Based on the provided empiric results of nonparametric chi-square distribution (Table 3), it can be observed that the squares of differences between the obtained (observed) and expected (theoretical) frequencies in abdominal obesity, with a confidence interval – range (99% CI), are a much more common issue in male graduates than in female classmates. Every 24th graduate student in our sample had a WC value on the interval scale that proposed a risk of CVDs, while in female subjects; the presence of AG was 1.26%.

Table 1. Comparison of values of blood pressure (BP) and frequency of hypertension in the examined high school graduate population

Subjects	SBP (mmHg)	DBP (mmHg)	Frequency of prehypertension	Frequency of hypertension
	AM ± SD	AM ± SD	(%)	(%)
Male graduates	123.2 ± 7.2	68.1 ± 6.4	0	4.09
Female graduates	109.5 ± 8.7	70.2 ± 6.3	2.54	0.90
All subjects	117.6 ± 10.4	70.1 ± 10.0	0.49	0.49

Statistically significant difference (males/females): $p < 0.01$; SBP, systolic blood pressure; DBP, diastolic blood pressure; AM, arithmetic mean; SD, standard deviation.

Table 2. Distribution of body mass index (BMI) and the frequency of obesity in the examined high school graduate population

Gender	BMI (kg/m^2)			Frequency of preobesity	Frequency of obesity	*p**
	AM ± SD	Min	Max	(%)	(%)	
Male graduates	24.9 ± 2.16	18.2	36.0	37.93	6.93	≤ 0.001
Female graduates	20.8 ± 2.47	17.4	29.3	8.03	1.10	
All subjects	21.7 ± 3.11	17.5	36.2	15.86	3.42	

*Nonparametric Pearson's χ- test (goodness of fit model). AM – arithmetic mean; SD – standard deviation; Min – minimal value; Max – maximal value; *p* – statistical significance at the level $p \leq 0.001$.

Table 3. Differences in frequencies of waist circumference and abdominal obesity values in the examined population of high school graduates

Gender	Waist circumference (cm)			Prevalence of abdominal obesity	p*
	AS ± SD	Min	Max	(%)	
Male graduates	89.15 ± 8.79	70	114	9.09	≤ 0.001
Female graduates	68.60 ± 6.55	58	93	1.26	
All subjects	74.08 ± 1.61	58	114	16.02	

*Nonparametric Pearson's χ- test (goodness of fit model). AM, arithmetic mean; SD, standard deviation; Min, minimal value; Max, maximal value; p – statistical significance at the level $p \leq 0.001$.

According to the data calculated by the sum of squares of Pearson's χ- test shown in Table 4 and theoretical, i.e. borderline table values, there is no statistically significant difference in the examined sample in the variable cigarette smoking when it comes to gender. Every fourth subject, regardless of gender, is a cigarette smoker: among male subjects, 20.14% are active smokers, and 14.36% of female subjects are smokers, respectively.

Table 4. Differences in frequencies of smoking habits, alcohol consumption and physical inactivity

Variables	Gender	Frequency (%)	p
Cigarette smoking	male	25.42	
	female	25.23	
Alcohol consumption	male	18.18	≤ 0.001
	female	2.65	
Physical inactivity	male	36.32	≤ 0.001
(< 3.5 hours/week)	female	66.90	

Pearson's χ- test (goodness of fit model) for comparison of the analyzed category variables between genders

Alcohol consumption is statistically more common in male students than in female ($p \leq 0.001$). A significant statistic difference between empiric and theoretical frequencies in alcohol consumption was established: 19.93% of male graduates and 8.01% regularly consume alcohol. Additionally, every other female graduate (48.34%) and 18.2% of male graduates do not consume alcoholic beverages at all. With a 99% CI confidence interval, statistically significant squared differences between the obtained and expected frequencies in relation to the expected frequencies were obtained in the nonmetric parameter physical inactivity as well. Male subjects are by far more physically active than female subjects. The prevalence of physical inactivity in male subjects is 34.51%, with a p-value (level of significance) ≤ 0.001. On the other hand, 65.12% of female subject claimed that they have mild physical activity (speed walking, mild housework, swimming, and other sport-recreational activities), less than 3.5h during the week.

In order to establish a statistically significant correlation in the frequencies of the two attributive characteristics, or between the obtained (observed) frequencies and theoretical frequencies, the Pearson's coefficient of correlation was used (Table 5). With bivariate correlational analysis of cardiovascular risk factors, it was shown that in the group of male graduate students, the frequency of the size of the discrete variable – SBP – is statistically significant and mildly positively correlated with DBP (r = 0.59, $p \leq 0.01$), BMI (r = 0.39, $p \leq 0.01$), and WC (r = 0.40, p ≤ 0.05), as well as the fact that DBP was statistically significantly different than zero, together with BMI (r = 0.41, $p \leq 0.01$) and WC (r = 0.28, $p \leq 0.05$). In the population of female graduates, age was, with a level of significance of $p \leq 0.05$, in positive and weak correlation with SBP (r = 0.33), WC (r = 0.30), and cigarette smoking (r = 0.28). Also, SBP is in statistically significant and positive mutual dependence with DBP (r = 0.62, $p \leq 0.01$), BMI (r = 0.27, $p \leq 0.01$) and WC (r = 0.19, $p \leq 0.05$) in female subjects. Results of DBP in female graduate students are statistically significantly positive and exhibit mild mutual relation with BMI (r = 0.20, $p \leq 0.05$), and are in negative with the category variable physical inactivity (r = 0.19, $p \leq 0.05$). Additionally,

Table 5. Correlation of cardiovascular risk factors of male graduates (under the diagonal) and female graduates (over the diagonal)

Male graduates/ variables	Female graduates/variables							
	SBP	DBP	BMI	Waist circumference	Cigarette smoking	Alcohol consumption	Physical inactivity	Age
SBP (mmHg)	1.0	0.62**	0.27**	0.19**	0.07	0.07	0.01	0.05
DBP (mmHg)	0.59	1.0	0.20**	0.15*	0.13*	0.04	-0.19**	0.11*
BMI (kg/m2)	0.39**	0.41**	1.0	0.78**	0.13*	0.07	-0.05	-0.02
Waist circumference (cm)	0.40**	0.32**	0.80**	1.0	-0.03	0.04	-0.26**	-0.03
Cigarette smoking	0.08	0.07	-0.26**	0.01	1.0	0.39**	-0.15*	0.19**
Alcohol consumption	0.21**	-0.03	-0.09	-0.08	0.13*	1.0	0.01	-0.13*
Physical inactivity	0.16*	-0.02	-0.20**	-0.23**	-0.04	-0.04	1.0	-0.08
Age	0.33**	0.25**	0.10	0.30**	0.28**	0.15*	0.14	1.0

SBP, systolic blood pressue; DBP, diastolic blood pressure; BMI, body mass index.
Values of Pearson's coefficient of correlation (r).
$^{*}p \leq 0.05$; $^{**}p \leq 0.01$

frequencies of values of BMI and waist circumference, cigarette smoking, and age of female graduate students are with a p-value ≤ 0.01, statistically highly significant and positively correlated ($r = 0.80$, $p = 0.19$).

The obtained positive and statistically significant linear correlations between cardiovascular RFs point to the fact that an increase in value of one variable stipulates higher scores in another variable, i.e. a higher degree of RFs for the onset of CVDs in the examined high school graduate population.

Discussion

HTN is a dominant cause of cardiovascular mortality. The fact that the values of SBP in the range between 140–159 mmHg and diastolic pressure between 90–99 mmHg cause about 60% mortality amplifies the need for empiric research of this silent and insidious disease [9]. Research conducted in Croatia showed that HTN was registered in 45.6% of males and 43% of female subjects [10]. However, despite clear evidence about the positive effects of treatment, and awareness of the relevance of the problem, HTN is still not sufficiently diagnosed, and inappropriately treated [11, 12]. Increased BP can occur in adolescents, but it is characterized by an insidious and atypical symptomatology, so that it often goes undiagnosed. The obtained results in our research, together with the results in the Croatian study [13], have manifested minimal HTN in the late adolescent period. Research that was also conducted in Croatia on a school population showed increased values of arterial pressure in 38.9% of subjects, with a much higher prevalence in male subjects than in female (44.5%, i.e. 32.5%, respectively) [14]. It is important to emphasize the fact that prevalence of HTN is significantly higher in relation to male graduate students (4.09%) and female graduates (0.90%) in our study.

Obesity is a chronic metabolic disorder that is characterized by excessive buildup of fat tissue in the organism, and because it is drastically more present today, it becomes one of the more dominant health priorities, both in developed and underdeveloped countries, and even in Serbia. The majority of referenced studies indicate that obesity occurs as a consequence of lifestyle (improper diet and markedly decreased physical activity). It significantly affects the cardiovascular system (CVS), as well as endocrine, digestive, metabolic, locomotor, and mental health as well [15, 16]. The obtained results in our study point to the fact that male graduates are more obese than female subjects, which is consistent with the findings of other authors [17]. However, it is assumed that female adolescents take more care about their constitution, about the food they eat, as well as the amount of food they eat [18]. They are often unsatisfied with their body, and strive to be more slim [19]. Additionally, findings from this research turn the attention to the fact that younger female subjects have a lower BMI and are less obese than their older classmates of the same gender [20].

Abdominal obesity and/or insulin resistance IR is an indirect indicator of risk for development of CVDs in adolescent age [21]. The obtained results in our empiric study signify that male adolescents are particularly prone to this risk, while female adolescents had a much lower prevalence of WC over optimal values.

Regardless of the harmful effects of the bad habit of cigarette smoking in the examined population, it is still present in a certain number of adolescents. A quarter of the examined subjects of both genders smoke every day, which matches to the findings of research conducted in other parts of the world [22]. According to these results, prohibition of cigarette smoking is much lower in female adolescents than in male, and in mature age, due to different external environmental factors, cigarette smoking detains on the same level, or tends to increase over time.

The obtained results regarding alcohol consumption in this research are typical for adolescents, which is compatible with the results from Croatian research [23]. Results of other foreign authors point to the fact that different environmental factors (traditional habits, socioeconomic state, family habits, level of education, and individual personality traits) influence alcohol consumption in adolescents [24].

There are a significant number of researches that turn the attention to the significance of mild physical activity in preserving and improving health, as well as preventing a large number of CVDs [25–28]. Findings in our study point to the fact that physical inactivity is a much bigger issue among female adolescents than in male. This signalizes the fact that male subjects understand the importance of regular physical activity, and spend a lot of time in certain sport-recreational activities, i.e. compensatory physical activity.

According to the results of this research, it was established that IR in male graduate students correlated with higher values of SBP and DBP. However, the obtained values of BP are not yet in the cluster of "hypertensive". Also, it is observed that even in this age, obese adolescents are in a greater threat from CVDs. Considering the fact that RFs (IR, increased values of SBP and DBP) are more expressed in female graduate students in the examined population, it is assumed that they have a higher risk for developing CVDs. Additionally, the fact that female subjects who consume alcohol also smoke cigarettes in the majority of cases is rather interesting.

The obtained positive mutual dependence between age and RFs (SBP, WC, and cigarette smoking) points to a probability of development of CVDs. These findings in the adolescent school population enable appropriate and precise planning of sanitary and educational work in order to prevent cardiovascular illnesses.

Certain researches emphasize the fact that food habits, as well as other health habits and traditional customs in adolescent population, can present a danger to health [29–31]. For instance, in Peruvian subjects of both genders, a statistically significant relation of BMI and WC with SBP and DBP was established [32]. Also, a linear correlation of BMI and HTN, i.e. reduced physical activity as a relevant indicator of obesity in adolescents in late adolescent age was defined in certain research [33–36].

Findings in our study showed that some standards risk factors for cardiovascular diseases are more expressed in male adolescents (increased BMI parameters, IR, regular cigarette smoking, alcohol consumption, and insufficient physical activity), while in female adolescents, RFs of everyday cigarette smoking and insufficient physical activity are particularly present, which is similar to results from the study performed on students from Niš [13].

Limitations in the conducted transverse research included financial problems, due to which laboratory testing of indicators of functional capability of cardiorespiratory system on a larger number of subjects were not applied, which would, for a margin of error $p \leq 0.01$, enable a more complete defining of risk factors for development of cardiovascular diseases. For these reasons, it is necessary that the upcoming longitudinal research include laboratory testing, with a greater number of subjects, so that, with a confidence interval of (99% CI) – a more complete identification of increased RFs for development of CVDs could be performed.

Conclusion

Findings in our study emphasize that in male graduate students, modifiable RFs are statistically significantly expressed, most notable being BMI values, abdominal obesity, cigarette smoking, alcohol consumption, and insufficient physical activity. In addition, RFs (smoking, and particularly insufficient physical activity) are present among female graduate students, generate the development of CVDs, and accompanying adverse effects. In addition, a statistically significant correlation between SBP and DBP, BMI, and WC was established, while age was in positive correlation with the variables SBP, WC, and cigarette smoking. In female students, SBP was correlated with DBP, BMI, and WC, while DBP was associated with BMI and physical inactivity, and cigarette smoking was linked with variables alcohol consumption and age.

From the obtained findings, it can be concluded that timely implementation of preventive measures (adoption of a healthy lifestyle – change of nutritional habits, cessation of smoking, increase of physical activity, regulation of BM and BP), as well as changing life habits, i.e. reduce RFs in the adolescent population, is essential in reducing the mortality and morbidity of CVDs.

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