RISK PROFILE AND HEMODYNAMIC CHARACTERISTICS IN YOUNG SUBJECTS WITH HIGH NORMAL ARTERIAL BLOOD PRESSURE

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ABSTRACT

INTRODUCTION: The European Society of Cardiology classifies arterial pressure bellow 140/90 mmHg as optimal(below 120/80 mmHg), normal (120-129 mmHg for systolic and/or 80-84 mmHg for diastolic) and high normal (130-139 mmHg for systolic and/or 85-89 mmHg for diastolic). The argument is concerned with different cardiovascular risk. The possibility of arterial hypertension (AH) to appear is higher in individuals with high normal arterial pressure (HNAP). Such individuals could be treated with non-drug therapy as the idea is the appearance of AH to be delayed and the cardiovascular risk to be reduced. The *aim* of the study was the risk and hemodynamic profile of the students of medicine with HNAP to be examined.

MATERIAL AND METHODS: The object of the investigation is focused on students of medicine with HNAP. The two followed-up groups – with HNAP and with optimal arterial blood pressure (OBP) assumed this pattern on the base of inquiry and screening among 116 students (60 men and 56 women). Inquiry and anthropometric methods, arterial pressure monitoring and impedance cardiography were carried up.

RESULTS: The dominance of some factors, predisposing hypertension appearance as overweight, increased salt consumption, family history was registered in HNAP group. Hemodynamic evaluation manifested hyperkinetic type of circulation.

CONCLUSION: Medical students' risk and hemodynamic profile within HNAP group is close to that of the hypertensive individuals. That makes them a special risk group and there is a necessity of non-drug therapy means application in order for AH expression to be delayed.

Keywords: *high normal AP, risk factors, impedance cardiography*

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Received: August 4, 2015
Accepted: September 3, 2015

INTRODUCTION

The arterial blood pressure (AP) is an integral index reflecting the functional state of the cardiovascular system. Instead of it being a dynamic parameter with short- term and circadian deviations, it is maintained in definite referent values. The argument of the European Society of Cardiology (ESC) to define AP values under 140/90 mmHg in three catego-

ries - optimal (under 120/80 mmHg), normal (120-129 mmHg for systolic and/or 80-84 mmHg for diastolic) and high normal (130-139 mmHg for systolic and/or 85-89 mmHg for diastolic) is connected to the different cardiovascular risks (1,2). The risk of arterial hypertension (AH) to develop is higher in individuals with high normal AP (HNAP) (3,4,5,6,7,8).

The individuals with HNAP are of interest because of the possibility of them to be treated by a non-drug therapy and thus delaying the AH appearance and reducing the cardiovascular risk. Students of medicine are a special group, taking into consideration their non-dynamics and proclivity for obesity, predisposing thus to AH.

The objective of the study is for the risky profile and some haemodynamic indices in the students of medicine to be followed.

MATERIAL AND METHODS

Screening of AP, measured by Microlife, Switzerland device, was carried out among 116 students of medicine at the age of 23±1.3 years (60 men and 56 women). Two groups were formed: with HNAP (n=23: 12 men and 11 women; 19,8%) and controls with optimal AP (OAP, n=28: 14 men and 14 women; 24,1%).

Inquiry method: Family history, reduced physical activity, dietary habits leading to the appearance of AH and smoking as a separate risk factor for cardiovascular diseases were registered.

Anthropometric examination, carried out by the *TANITA BC-420 device.* Body Mass Index (BMI) - standard index for obesity assessment was a follow-up. It is calculated as the body mass in kilograms is divided by the height in square meters, BMI=kg/m² (9, 10, 11). The percentages of fat and water were calculated too.

Monitoring of AP and heart rate (HR) by CNAP® "HD" (Biopac Instruments, USA). The systolic, diastolic, mean AP and heart rate were followed within 15 minutes after rest at night and 15 minutes at rest. The device consists of two cuffs - single and double. The single, i.e. standard one is placed on the arm, while the double one - on the hand's fingers. CNAP® "HD" (Biopac Instruments, USA) works using the method of „vessel emptying" based on the Penaz' principle (12,13,14). The pressure outside, carried by the finger cuffs could be changed thus maintaining constant blood volume within the fingers (the vessel is clamped by a constant diameter). The fingers' blood volume is measured by an infrared sensor. The change of the vasomotor tone to each heart beat is corrected by a rapid analysis of the pulse wave, giving precise AP measurement of up to ±5 mmHg (6 kPa).

Impedance cardiography (ICG), carried out by *NICO100C (Biopac Instruments, USA).* ICG is based on electrical voltage changes registered in the thoracic region (due to changes in the volume of ejected blood within the systole) when an alternating current with fixed frequency and amplitude is conducted (15, 16,17,18,19,20 ,21,22). Seventeen hemodynamic indices are followed up by ICG and are reflected in details in table 5.

The statistical processing was carried out by SPSS 16 package - descriptive analysis and paired t-test.

RESULTS

The inquiry data (Table 1) show AH risk factors dominance in the HNAP group. The percentage of smoking in this group is 61.5%, while in the OAP group it is 38.5%. Almost doubled is the percentage of increased consumption of salt - 79% in HNAP individuals, compared to that in the controls - 43%.

Table 1. Inquiry data in HNAP and OAP groups

GROUPS / RISK FACTORS	HNAP	OAP	P
Tobacco smoking - 10 cigars mean per day	61.5%	38.5%	p<0.05
Family history for arterial hypertension	17 %	14 %	NS
Increased consumption of salt	79 %	43 %	p<0.05
Reduced physical activity	71%	49%	p<0.05

Scripta Scientifica Medica, vol. 47, No 3, 2015, pp. 9-15

The physical activity is almost twice as low in the students with HNAP - 71% to 49% in OAP individuals. The family history for AH is of a higher percentage (17%), compared to the controls (14%).

The results from the anthropometric examination show that there is no significant difference between both groups regarding IBM and the percentage of body fats and water (Table 2).

sented on Table 4. Significantly higher (91.41±10.64) and shorter (0.26±0.03) are the heart rate and the mechanic systole duration in HNAP students in comparison to OAP, 70.53±10.91 and 0.29±0.02, respectively. Velocity indices and vascular resistance show tendency to be increased and the stroke volume to be decreased in HNAP individuals.

Table 2. Anthropometric indices, measured by TANITA BC-420 devise in HNAP and OAP groups

GROUPS / INDICES	OAP Mean± SD	HNAP Mean± SD	P
BMI (kg/m²)			
men	23.10±2.58	23.06±2.28	>0.05
women	19.72±2.49	20.92±1.80	>0.05
% FATS			
men	15.88 ± 7.4	14.38±4.35	>0.05
women	17.89 ±8.43	21.76± 5.69	>0.05
% WATER			
men	58.72±5.07	58.34±4.93	>0.05
women	51.03±14.58	54.64±3.47	>0.05

BMI - body mass index

The AP monitoring data reflect into details the systolic, diastolic and pulse AP values and HR values in both groups (Table 3).

DISCUSSION

The AP values under 140/90 mmHg are not a

Table 3. Arterial pressure (AP) and heart rate (HR) values in HNAP and OAP groups

GROUPS / VALUES	HNAP Mean± SD N =23	OAP Mean± SD N =28	P
S P (mmHg)	132.84±4.7	115.76±3.7	< 0.01*
D P (mmHg)	86.44±2.5	72.80±6.24	< 0.01*
H R (imp/min)	93.7± 16.4	70.7± 11	< 0.01*
P P (mmHg)	46.4± 2.2	42.96± 4.35	< 0.01*

SP – systolic pressure, DP- diastolic pressure, PP - pulse pressure, HR - heart rate, NHAP – high normal arterial pressure group; OAP – optimal arterial pressure group

The monitoring indices mean values of the blood flow, peripheral vascular resistance and contractility thoracic flow content registered by ICG are repre-

homogenic category. It is often divided by ESC into tree sub categories - optimal, normal and high normal (1,2). The students of medicine are an object of investigation due to the stress and the possible re-

Table 4. Hemodynamic indices, registered by ICG in HNAP and OAP groups

INDEX / GROUPS	OAP Mean±SD	HNAP Mean±SD	P
Heart rate, **HR (imp/s)**	70.53±10.91	91.41±10.64	**<0.01***
Thoracic fluid content, **TFC (1/Ω)**	0.033±0.01	0.033±0.01	>0.05
Velocity index, **VI (1/s)**	0.05±0.04	0.06±0.03	>0.05
Pre-ejection period, **PEP(s)**	0.13±0.02	0.12±0.01	>0.05
Left ventricular ejection time, **LVET(s)**	0.29±0.02	0.26±0.03	**<0.05***
Stroke volume, **SV(mL/beat)**	104.75±56	79.08±24.81	>0.05
Stroke index, **SI (mL/beat)/m²**	54±33.9	42±13.61	>0.05
SV / SI	1.99±0.19	1.88±0.09	>0.05
Cardiac output, **CO(L/min)**	6.9±2.48	7.1±3.18	>0.05
Cardiac index, **CI (L/min)/m²**	3.5±1.57	3.8±**1.79**	>0.05
CO /CI	1.99±0.18	1.9±**0.14**	>0.05
Systemic vascular resistance, **SVR (dynes/s/cm^{-5})**	1017.87±283.29	1194±386.29	>0.05
Systemic vascular resistance index, **SVRI (dynes.s. cm^2. cm^{-5})**	2032.5±578.69	2265.6±675.96	>0.05
Acceleration index, **ACI(1/s²)**	0.97±0.64	0.9±0.54	>0.05
Left cardiac work, **LCW(kg.m)**	6.98 ±2.50	7.15±3.20	>0.05
Left cardiac work index, **LCWI (gm.m/m²)**	3.57±1.57	3.78±1.80	>0.05
Systiolic time ratio, **STR**	0.43±0.05	0.60±0.36	>0.05

HNAP – high normal arterial pressure group; OAP – optimal arterial pressure group.
The Stroke volume is calculated by Sramek-Bernstein formule (22)

duced physical activity they undergo. The percentage of HNAP individuals is comparatively high (19.8%). As reasons there could be pointed predisposing factors such as increased consumption of salt, overweight, reduced physical activity. Higher percentage of family history for AH is present in this group too. It seems that the risk profile in hypertensives as in HNAP individuals is one and the same. In regard to this, the risk profile correction in HNAP objects will prevent the AH appearance (3,4,7,8,23,24,25,26,27,28,29).

As far as the hemodynamic assessment is concerned, the deviations in the HNAP group are similar to that seen in the first stage of AH - hyperkinetic type of circulation. Increased HR and shortened duration of left ventricular ejection are registered too. This implies that the increased sympathetic tone, being a basis for the hyperkinetic model, is present in the HNAP students. Sympathetic tone dominance coupled with family pre-disposition is the leading factor in AH pathogenesis (29,30,31).

CONCLUSION

The risk factors for HNAP are the same as those for AP. The hemodynamic profile of HNAP students of medicine indicates increased cardiac frequency and shortened duration for the left ventricular ejection and could be connected to increased sympathetic nerve activity.

As far as the HNAP individuals' therapeutic plan is concerned, the recommendation is directed to risk profile correction - reduction of body weight, consumption of salt, no smoking. The increased physical activity could regulate the autonomic nerve system disorder and reduce the sympathetic tone activity. The early risk factors correction in students of medicine will delay the appearance of AH and will reduce the possibility of the appearance of cardiovascular incidents.

Scripta Scientifica Medica, vol. 47, No 3, 2015, pp. 9-15

Table 5. Referent values and nomenclature of ICG indices by literally data

INDEX	REFERENT VALUES
Heart rate, HR (imp/s)	58-86
Thoracic fluid content, TFC (1/Ω)	0.021- 0.050
Velocity index, VI(1/s)	0.033 - 0.065
Pre-ejection period, PEP(s)	0.05 - 0.12
Left ventricular ejection time, LVET(s)	0.25 - 0.35
Stroke Volume, SV (mL/beat)	60 - 250
Stroke Index, SI (ml/beat)/m^2	35 - 65
Cardiac output CO(L/min)	4 - 8
Cardiac index (CI) (L/min)/m^2	2.5 - 4.7
Systemic vascular resistance, SVR (dynes/s/cm^{-5})	742 - 1378
Systemic vascular resistance index, SVRI (dynes.s.cm^2. cm^{-5})	1337 - 2483
Acceleration index, ACI (1/$s^{2)}$	0.7 – 1.7
Left cardiac work, LCW(kg.m)	3 – 5.5
Systiolic time ratio, STR	0.3 - 0.5

REFERENCES

1. Kaplan, N. Kaplan's Clinical Hypertension - ninth edition, Philadelphia, Lippincott, Williams&Wilkins, 2006, 11-12.
2. Reappraisal of European guidelines of hypertension management. Journal of Hypertens. 2009; 27(11):2121-2158.
3. Gupta AK, McGlone M, Greenway FL et al. Prehypertension in disease-free adults: a marker for an adverse cardiometabolic risk profile. Hypertens Res. 2010; 33: 905-910
4. Lee M, Saver J, Chang B et al. Presence of baseline prehypertension and risk of incident stroke - a meta-analysis. Neurology. 2011; 77: 1330-1.
5. Conroy RM, Pyörälä K, Fitzgerald AP et al. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. European Heart Journal. 2003; 24: 987-1003.
6. Lifon et al. Molecular mechanism of human hypertension. Cell. 2001; vol 104, issue 4, 545-556.
7. FJ, Mac Gregor GA. A comprehensive review on salt and health and current experience of worldwide salt reduction programmes. J Hum Hypertens. 2009 ; 23(6):363-84.
8. Dickinson HO, Mason JM, Nikolson DJ, Compbell F, BeyerFR, Cook JJ, WilliamsB, Ford GA. Lifestyle interventions to reduce raised blood pressure: a systematic review of randomized controlled trials. Journal Hypertension. 2006; 2015-2033.
9. Gray DS, Fujioka K. Use of relative weight and Body Mass Index for the determination of adiposity. J Clin Epidemiol.1991; 44 (6): 545–50.
10. Berrington de Gonzalez A, Hartge P, Cerhan JR, Flint AJ, Hannan L, MacInnis RJ et al. Body-Mass Index and Mortality among 1.46 Million White Adults. N. Engl. J. Med. 2010; 363 (23): 2211–9.
11. Koleva D, Mitkov M, Orbetsova M. Screening of obesity as a main risk factor for the development of metabolic syndrome.MedInfo.2012;4,7-9. (in Bulgarian)
12. Dueck R, Jameson LC. Reliability of hypotension detection with noninvasive radial artery beat-to-beat versus upper arm cuff BP monitoring. Anesth Analg. 2006; 102 Suppl:S10.
13. Fortin, J, Marte, W, Grüllenberger, R, Hacker, A, Habenbacher, W, Heller, A et al. Continuous non-invasive blood pressure monitoring using concentrically interlocking control loops. Computers in biology and medicine. 2006; 36(9), 941–57.
14. Cybulsky G. Ambulatory Impedance Cardiography: The System and their Applications. 2011.
15. Sanidas EA, Grammatikopoulos K, Anastasiadis G, Papadopoulos D, Daskalaki M, Votteas V. Thoracic fluid content and impedance cardiography: a

novel and promising noninvasive method for assessing the hemodynamic effects of diuretics in hypertensive patients. 2009 Nov-Dec;50(6):465

16. Stevanović P, Šćepanović R , Radovanović D, Bajec D , Perunović R, Stojanović D, Stevanović D. Thoracic electrical bioimpedance theory and clinical possibilities in perioperative medicine . Signa Vitae 2008; 3 Suppl 1: S 22 - 27

17. Van De Water JM, Miller TW, Vogel RL, Mount BE, Dalton ML. Impedance cardiography: the next vital sign technology? Chest. 2003;123:2028-33.

18. Shoemaker WC, Wo CC, Bishop MH, Thangathurai D, Patil RS. Noninvasive hemodynamic monitoring of critical patients in the emergency department. Acad Emerg Med 1996;3:675-81.

19. Humeau A, Steenbergen W, Nilsson H, Strömberg T, (2007) Laser Doppler perfusion monitoring and imaging: novel approaches. Med. Biol. Eng. Comput. 2007;45:421-435.

20. Iliev I, Tabakov S. Multichannel wideband measuring of bio-impedance with logarithmic characteristics. Available from: http://ecad.tu-sofia.bg/et/2000/Statii%20ET2000-III/Multichanel%20Device%20for%20Bioimpedance%20Measurement%20with%20Logarithmic%20Characteristic.pdf (in Bulgarian)

21. Petrov G, Tsvetkov P, Iliev P. Non-invasive medical measuring devices. Metrology and metrological provision. Sozopol, 2006. (in Bulgarian)

22. Biopac MP hardware and software manuals.

23. Nikolov F.P. , Nikolov P. ,Nikolova J. Prevalence and Risk Profile of Prehypertension in South Bulgaria. Conference on PreHypertension & Cardio Metabolic Syndrome ;February 24-27, 2011, Vienna, Austria, PO-51.

24. Vasan RS, Larson MG, Leip EP et al. Impact of high-normal blood pressure on the risk of cardiovascular disease. N EnglJ Med. 2001;345:1291-7.

25. Wang Y, Wang QJ. The prevalence of prehypertension and hypertension among US adults according to the new National Joint Committee Guidelines. Arch. Int. Med. 2004; 164 (19):2126-34.

26. Greenlund KJ, Croft JB, Mensah GA . Prevalence of heart disease and stroke risk factors in persons with pre hypertension in the United States. Arch. Int. Med .2004;164(19):2113-8.

27. Neter JE, Stam BE, Kok FJ, Grobbee DE, Geleijnse JM. Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. Hypertension. 2003; 42:878–884 MA.

28. He FJ, MacGregor GA. How far should salt intake be reduced. Hypertension. 2003; 42:1093–1099 RV.

29. Narkiewicz K, Phillips BG, Kato M et al. A gender selective interaction between aging, blood pressure and sympathetic nerve activity. Hypertension. 2005; 45;522-52.

30. Cornelissen VA, Fagard RH. Effects of endurance training on blood hypertensive patients. Circulation. 2005; 111:1012–1018.

31. Julius S. et al. Sympathetic overactivity in hypertension Am J Hypertens. 1996; 113-120.