

Assessment of the Hand Grip Test usefulness in early prophylactics of arterial hypertension in junior high school students in the region of south-east Poland — a cross-sectional study

Ocena przydatności testu *Hand Grip* we wczesnej profilaktyce nadciśnienia tętniczego wśród młodzieży szkół ponadgimnazjalnych w regionie południowo-wschodniej Polski — badanie przekrojowe

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Abstract

Introduction. It is assessed that the increased reaction of arterial pressure to physical exertion occurs in about 20% of healthy young people and it is connected with hyperkinetic reaction of the circulatory system. Early identification in young people may be of vital importance in early prophylactics and treatment of arterial hypertension (HT). The aim was to assess the relation between the use of the Hand Grip Test (HGT) and early diagnosis of the primary arterial hypertension (PHT) in youth aged 16–19.

Material and method. Research was carried out using a survey questionnaire among 511 people aged 16–19 and their parents. The surveyed youth had blood pressure measured in various conditions, including after a provocative stimulus — HGT. In the statistical study we used the ANOVA single factor analysis of variance, χ^2 independence test, the V-Kramer test, the tau-b Kendall test and the method: percentages (%), arithmetical average (X) and standard deviation (SD).

Results. Increased pressure rise after HGT test regarded more frequently the systolic aspect (34.8%) rather than the diastolic aspect (7.0%) ($p < 0.001$). Increased response of systolic blood pressure was observed more frequently in persons with its elevated, rather than normal values ($p < 0.05$). Increased response for both systolic and diastolic blood pressure was found in persons with a high HT intensity history in the family more often than in youth with low hyper intensity or no propensity towards HT, with predominance of systolic pressure ($p < 0.01$ vs. $p < 0.05$).

Conclusions. Our research shows that the HGT, which is used to detect hyper reactivity of the circulatory system, is a viable method for identification of people susceptible to PHT. The application of the test may result in the lowered costs of treatment of people suffering from a hypertension disease.

Key words: hyperkinetic reaction of circulatory system, Hand Grip Test, youth, arterial hypertension

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Introduction

A growing problem of the primary arterial hypertension (PHT) at an adolescent age points to a need not only for an early clinical intervention but most of all for an early identification of the persons from the group of higher risk. Among cases of HT within the group of higher risk are those characterized with hyperkinetic blood circulation [1]. As a reaction to stress, persons with hyperactive circulation system react with a substantial stimulation of the sympathetic system, which results in a rise of blood pressure (BP), which may lead to a constant HT [2]. The literature on the subject suggests that an increased, BP improper reaction to a stimulus, including physical exertion, is a sign of a propensity to the development of HT. However, it does not prove such a relation [1, 3, 4]. The lack of unanimous position regarding this subject points to the need for further studies and analyses, therefore we undertook an attempt to evaluate the relation between the use of Hand Grip Test (HGT) and the early diagnosing of primary HT in youth, between 16–19 years old.

Material and methods

The research was conducted between 2011 and 2013 based on the interview method using an original question-

naire in randomly selected secondary schools in the district of Rzeszów. 511 students, aged 16 to 19 and their parents were surveyed. On the basis of the size of the population we calculated the size of the test group which allowed us to obtain results with an error margin of $\pm 3.5\%$, with the materiality level of $p < 0.05\%$. A detailed diagram of the selection of the tested population is presented in Figure 1.

We interviewed the parents of the youth, qualified for the study, using a survey which contained questions concerning an HT history in the family. On the basis of the obtained data we evaluated the frequency of HT occurrence in individual family members. Additionally, we assessed the risk of HT occurring in all the surveyed students on the basis of the HT history in their families. Maximally 4 family members had been diagnosed with HT, which was used to work out the following scale of intensity of HT occurrence: Lack (HT does not occur in the family); low intensity (HT occurs in 1 or 2 family members), high intensity (HT occurs in 3 or 4 family members). Parents and grandparents were included as family members. The tested teenagers were interviewed and BP blood work was performed (in random conditions, in basic conditions and after a stimulus). The measurement was performed using auscultator method with Amido San (No. 0483) apparatus. To evaluate and classify BP measured in the basic conditions we used its mean value from three measurements. Analysis of the

Representation method Random multi-stage selection	
Initial population N = 16 014	Teenagers aged 16–19 from secondary schools from the Rzeszów region
Stage I – random selection of schools	Selection of 3 out of 28 schools from Rzeszów region
Stage II – random selection of classes	Selection of 2 classes from each year in all of the selected schools <ul style="list-style-type: none"> • preparation of information meetings for the selected students and their parents
Stage III – selection of people from group N = 607	<p>Inclusion criteria:</p> <ul style="list-style-type: none"> • stage I – student and parent written consent to participate in the test; N = 553 • stage II – student – no primary or secondary HT at the stage of diagnosing and/or treatment; N = 547 • source of information: <ul style="list-style-type: none"> – parents – analysis of medical documentation <p>Exclusion criteria:</p> <ul style="list-style-type: none"> • stage I – student and/or parent – lack of written consent to participate in the test; N = 54 • stage II – student – presence of primary or secondary HT at the stage of diagnosing and/or treatment; N = 6 • source of information: <ul style="list-style-type: none"> – parents – analysis of medical documentation
Loss of data	<ul style="list-style-type: none"> • resignation of participation in the test; N = 11 • lack of comprehensive data (surveys and/or measurements); N = 25
Tested population N = 511	

Figure 1. The diagram of the selection of the tested population; HT – hypertension

Information + instruction
Test person: <ul style="list-style-type: none"> • comfortable seating position, feet flat on the ground, back supported • dominant upper limb bent at elbow at a 90 degree angle, shoulder along the body, forearm well supported
Evaluation of the maximum exertion: <ul style="list-style-type: none"> • min. 30 min prior to the primary test • adjust the handle width • 3 max. attempts of hand squeeze – with the dominant hand • calculation of the mean value of the squeeze from three attempts
Minimum 30 minutes rest in a seating position
Measurement of arterial pressure on the dominant arm just before the rest
Pressing of hand dynamometer for 3 min with the dominant hand with 30% to 50% of the maximum effort
Measurement of arterial pressure on the dominant arm just after the test

Figure 2. Hand Grip Test procedure

obtained results is presented separately for the systolic and diastolic component, on the basis of absolute pressure values or on their classification. Because of the age span of the test group, the results of blood pressure values for persons under 18 are classified on the basis of growth charts for a given age, sex and height (according to: The Fourth Report on the Diagnosis, Evaluation and Treatment of High Blood Pressure in Children and Adolescents – 2004). Blood pressure values for younger teenagers were assessed in accordance with the classification for adults (according to: The guidelines of the Polish Society of Hypertension and the College of Family Physicians in Poland – 2011).

Hand Grip Test was used to assess the pressure reaction to a stimulus. A manual hydraulic dynamometer (Jamar, No. 30807410), with adjustable handle and pressure measurement within 2 kg. The test procedure is presented in Figure 2. The pressure values after the test are compared with the values obtained prior to the test, and the difference between the measurements is the scope of the BP reaction to the stimulus. The obtained growth values are presented in three groups in accordance with the following scheme: increase up to 8 mm Hg – diminished response; increase from 10 to 18 mm Hg – normal response; an increase ≥ 20 mm Hg – increased response [5].

We obtained permission to carry out the tests from the principals of the schools and from the official educational authorities and the NHS. The Bioethical Commission of the Department of Medicine at the University of Rzeszów, accepted the test which was in accordance with the Declaration of Helsinki. The test was performed as a part of a project Medical-Environmental Centre for Innovative Research realized by the University of Rzeszów within the Regional Operational Programmed for Podkarpacie Region for 2007–2013 (contract No. UDA-RP-PK.01.03.00-18-004/12-00).

Collected data were statistically analyzed using PASW/SPSS 17.0 software. Statistical analysis and statistical concluding were applied. For quantity variables we calculated mean values (\bar{X}) and their standard deviation (SD). For quality variables we used the frequency of occurrence of features in subgroups presented as percentage values. Statistical concluding was carried out on the basis of a mono-factor analysis of ANOVA variation, a chi-squared test, the V-Kramer test and the tau-b Kendall test. Obtained results are presented in a form of a table.

Results

The tested teenagers were between 16 and 19 years old, including 50.3% of boys and 49.7% of girls ($p < 0.05$). The average age of the girls was 17.4 ± 1.4 . The average age of the boys was 17.8 ± 1.9 years ($p < 0.05$). Most of the tested teenagers were characterized with normal systolic and diastolic BP values: $n = 411$ and $n = 449$, respectively. Elevated BP values (pre-hypertension state and HT) were more frequent regarding the systolic component ($p < 0.001$) (Fig. 3). Similarly, increased response of arterial pressure after a stimulus was observed more often in the case of systolic than diastolic pressure ($p < 0.001$). Increased arterial systolic pressure (SBP) was observed in over 1/3 of the tested subjects (Fig. 4).

The average pressure value after the provocative test depended on pressure values measured in neutral conditions for both systolic and diastolic components ($p < 0.001$) (Tab. 1).

In the compilation of the BP increase values after the provocative test, along with its classification, we presented the relations regarding only the systolic component. Increased response of systolic BP occurred more frequently in the group of persons with diagnosed pre-hypertension

Table 2. Classification of blood pressure (BP) and the increase of systolic and diastolic pressure after the provocative test

Scopes of increase of systolic pressure	Classification of systolic arterial BP							
	Normal BP values		Pre-hypertension state		Arterial hypertension		Total	
	N	%	N	%	N	%	N	%
Up to 8 mm Hg	99	24.1	14	22.2	6	16.2	119	23.3
10–18 mm Hg	174	42.3	22	34.9	18	48.7	214	41.9
≥ 20 mm Hg	138	33.6	27	42.9	13	35.1	178	34.8
Total	411	100.0	63	100.0	37	100.0	511	100.0
p < 0.05								
Scopes of increase of diastolic pressure	Classification of diastolic arterial BP							
	Normal BP values		Pre-hypertension state		Arterial hypertension		Total	
	N	%	N	%	N	%	N	%
Up to 8 mm Hg	248	55.2	26	60.5	8	42.1	282	55.2
10–18 mm Hg	170	37.9	13	30.2	10	52.6	193	37.8
≥ 20 mm Hg	31	6.9	4	9.3	1	5.3	36	7.0
Total	449	100.0	43	100.0	19	100.0	511	100.0
p > 0.05								

N – number of valid observations

Table 3. Intensity of occurrence of arterial hypertension in the family and the scopes of increase of systolic and diastolic arterial blood pressure in tested teenagers after the provocative test

Scopes of increase of systolic pressure	Intensity of occurrence of arterial hypertension in the family							
	None		Low		High		Total	
	N	%	N	%	N	%	N	%
Up to 8 mm Hg	103	31.0	9	7.9	7	10.8	119	23.3
10–18 mm Hg	121	36.5	66	57.9	27	41.5	214	41.9
≥ 20 mm Hg	108	32.5	39	34.2	31	47.7	178	34.8
Total	332	100.0	114	100.0	65	100.0	511	100.0
p < 0.01								
Scopes of increase of diastolic pressure	None		Low		High		Total	
	N	%	N	%	N	%	N	%
	N	%	N	%	N	%	N	%
Up to 8 mm Hg	193	58.1	65	57.0	24	36.9	282	55.2
10–18 mm Hg	124	37.4	40	35.1	29	44.6	193	37.8
≥ 20 mm Hg	15	4.5	9	7.9	12	18.5	36	7.0
Total	332	100.0	114	100.0	65	100.0	511	100.0
p < 0.05								

N – number of valid observations

of HT in the family (12.7%). The intensity of HT occurrence in the family turned out to be a factor greatly affecting the BP values after the provocative test. Increased response of the systolic and diastolic BP more often regarded persons from the group with high HT occurrence in the family (47.7% vs. 18.5%), as opposed to the teenagers from the group with low HT occurrence (34.2% vs. 7.9%). A stronger relation was noticed regarding SBP ($p < 0.01$) rather than DBP ($p < 0.05$) (Tab. 3).

Discussion

On the basis of our own test results, we conclude that simple tests of the autonomous system, especially those based on physical exertion, including isometric exertion (HGT), may be a valuable tool for the evaluation of circulatory system reactivity in identification of teenagers from HT risk group. We are aware of the fact that diagnosis of primary HT at an early stage is difficult. In some teenagers occurs

only a temporary increase of BP, which is diagnosed by accident, during stressful or painful experiences. Therefore, it is recommended that BP testing should be performed in stressful situations, which allows to evaluate the functionality of the circulatory system during loads stimulating a typical activity in children and teenagers [6].

On the basis of the tests conducted on a group of adults, it is assumed that the initial (often hidden) stage of primary HT is characterised with the occurrence of hyperkinetic circulation. Hyperkinetic circulation is considered to be one of the hemodynamic disturbances in primary HT pathomechanism [7–9]. In the initial stage, persons with hyperactive circulatory system react with a substantial, but temporary, increased BP due to stress factors [10]. In order to evaluate an individual pressure reaction to stimuli and a potential clinical importance of this phenomenon, various stimuli, mostly physical, are used. In international research of the subject (in tests carried out in adult population), the aim of the research is still the relation between the reaction of arterial pressure to physical provocative tests and HT and the risk of cardio-vascular complications. The results obtained so far have not been conclusive. They demonstrate both the lack of preventive meaning of blood pressure reaction to the tests used [4] and to positive correlations which confirm that an excessive BP increased during physical exertion allows to predict the development of arterial hypertension [2, 3, 11].

The literature on the subject of reactivity of the circulatory system to provocative tests in children and teenagers is still limited and inconclusive [7, 12, 13]. Some of them point to a lack of clear evidence of a characteristic reaction of the sympathetic system to a physical stress and its hyperactivity, particularly among people with increased pressure values [14]. Other scientific evidence points to the occurrence of higher values of mostly SBP in children with an excessive reaction of blood pressure to physical exertion, as opposed to children with normotensive reactions. Also, they underline the correlation between SBP values measured after physical exertion with heightened risk of developing chronic hypertension [15, 16]. Similarly, our own research showed that increased response of arterial pressure occurred more often in persons with HT and in the pre-hypertension state, rather than in persons with normal BP, but only regarding the systolic component. It is worth mentioning that chronic hypertension often precedes the pre-hypertension state in which changed, incorrect reactivity is observed of the cardio-vascular system to environment and behavioural factors, including dynamic and isometric physical exertion [17]. Thus, it should be stressed even more that our test results showed that almost half of the teenagers in whom we observed pre-hypertension state increased response of arterial pressure after the provocative test.

Another field of research for incorrect reaction of the circulatory system to stress stimuli are the children of people with HT. Also here the data in the literature of the subject are inconclusive. Some research suggests the dependence of pressure reaction from family interviews confirming HT history [18, 19]. Varied degree of the participation of the sympathetic system in the primary HT genesis, and in various stages of its development is indicated as a reason for the lack of that dependence. Additionally, there is a hypothesis that increased activity of the sympathetic system, observed in the initial stages of primary HT, in some cases leads to a constant increase of the tension of choke vessels. As a result, a reaction to additional stimuli no longer has the characteristics of increased response [18, 19]. In other research we have a confirmation that in children with pre-hypertension state and a family history of HT, the occurrence of exertion hypertension in connection with an extremely incorrect result of BP measurement (ABPM, ambulatory blood pressure measurement), creates a high probability of the development of hypertension in the future [6]. The literature also shows proof that the reaction to stress stimuli, especially exertion test in children from families with a history of HT, may in the early phase of hypertension reveal a hidden tendency for exertion hypertension. This tendency is caused by a defective ability of vessels in the skin and muscles to widen under exertion [20]. The results of our own tests correspond to the observations presented above. We concluded that a high occurrence of HT in the family has an effect on the increase of SBP. Almost half of the teenagers with high occurrence of HT in the family increased response to the provocative stimuli.

Despite many positive observations, it is not recommended to perform the HGT routinely, or other tests of the autonomous system in order to diagnose HT or to forecast changes in persons with HT. This is the result of certain limitations such as the lack of a sufficient testing methodology or a single definition. Additionally, the literature of the subject lacks a unanimous stance as to the relation between pressure values obtained during provocative tests with the range of particular organ complications [21, 22]. Also the variety of pressure reactions to the used tests of the autonomous system in patients with early stages of primary HT is stressed [23]. However, in certain situations a BP reaction to used tests may be an indication to perform ambulatory measurement of blood BP in order to detect hidden hypertension or to predict a poor long-term prognosis [4, 24, 25].

Bearing in mind the positive test results, we conclude that provocative tests towards detecting hypertensive reactions should be a constant element of screening tests towards arterial blood pressure disorders in school-age youth. Such tests can be successfully performed, just like

blood pressure measurements by a school nurse. Due to their simplicity and non-invasive nature, they do not require long-term and expensive implementation procedures, and their use may bring very beneficial results.

Conclusions

The results of our research show that HGT, which detects hyperactivity of the circulatory system, is a good method

to reliably identify persons at a high risk of arterial hypertension. The use of the test could bring tangible results in the form of a reduction in the funding for the treatment of people with HT disease in the future.

Conflicts of interest(s)

The authors of the paper do not declare any conflicts of interests.

Streszczenie

Wstęp. Szacuje się, że zwiększona reakcja ciśnienia tętniczego (HT) na wysiłek fizyczny występuje u około 20% młodych zdrowych osób i jest związana z hiperkinetyczną reakcją układu sercowo-naczyniowego. Wczesna identyfikacja młodych osób może mieć istotne znaczenie we wczesnej profilaktyce i leczeniu nadciśnienia tętniczego. Celem pracy była ocena związku między stosowaniem testu *Hand Grip* (HGT) a wczesnym wykrywaniem pierwotnego nadciśnienia tętniczego u młodzieży w wieku 16–19 lat.

Materiał i metody. Badania przeprowadzono metodą wywiadu z użyciem kwestionariusza wśród 511 osób w wieku 16–19 lat i ich rodziców. U młodzieży wykonano pomiary ciśnienia tętniczego w różnych warunkach, w tym po bodźcu prowokacyjnym (HGT). W opracowaniu statystycznym wykorzystano jednoczynnikową analizę wariancji ANOVA, test niezależności χ^2 , test V-Kramera, test *tau-b* Kendalla oraz metody statystyki opisowej – wartości procentowe (%), średnią arytmetyczną (\bar{x}) i odchylenie standardowe.

Wyniki. Zwiększony przyrost ciśnienia po HGT dotyczył częściej komponenty skurczowej (34,8%) niż rozkurczowej (7,0%) ($p < 0,001$). Hiperreakcję skurczowego ciśnienia tętniczego częściej obserwowano u osób z jego podwyższonymi niż prawidłowymi wartościami ($p < 0,05$). Hiperreakcja zarówno ciśnienia skurczowego, jak i rozkurczowego częściej dotyczyła osób w grupie z dużą intensywnością HT w rodzinie niż młodzieży z małą intensywnością lub brakiem obciążenia w kierunku HT, z przewagą ciśnienia skurczowego ($p < 0,01$ v. $p < 0,05$)

Wnioski. Z badania wynika, że HGT, wykrywający nadreaktywność układu sercowo-naczyniowego, jest dobrą metodą do identyfikacji osób zagrożonych pierwotnym nadciśnieniem tętniczym. Zastosowanie testu może przynieść wymierne efekty w postaci zmniejszenia w przyszłości nakładów na leczenie osób z chorobą nadciśnieniową.

Słowa kluczowe: hiperkinetyczna reakcja układu krążenia, test *Hand Grip*, młodzież, nadciśnienie tętnicze

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