

Summary of PhD thesis

**SCREENING OF ADOLESCENT HYPERTENSION,
AND EVALUATION OF TARGET ORGAN DAMAGES**

DEBRECEN HYPERTENSION STUDY

Written by

Dénes Páll M.D.

Tutors

Béla Fülesdi M.D., Ph.D.

Péter Polgár M.D., Ph.D.

University of Debrecen, Medical and Healthy Science Center

1st Department of Internal Medicine

2002.

I. INTRODUCTION

1. Epidemiology of adolescent hypertension

The literature is inconclusive regarding the prevalence of hypertension in 15-18 year old adolescents: large-scale studies place the range between 0.4-12%. The wide range in prevalence is primarily attributed to the fact that diagnostic criteria were not uniform. There are also marked variations in studies performed by the latest guidelines, between the results of different populations. The reasons may be geographical or ethnic differences. The most acceptable prevalence of adolescent hypertension is 1-1.5%.

2. The relation between adolescent and adult hypertension

The importance of adolescent blood pressure (BP) measurements, and the derived conclusions from it is determined by the type of relationship between adolescent and adult BP. The relation between adolescent and adult BP is demonstrated by the „tracking” phenomenon: those children and adolescents whose BP are at the upper percentiles, will have their BP staying at the same range after their growth and development. Thus, adolescent BP may refer to higher cardiovascular risk in the later period of life, e.g in the adulthood. With other words: screening examination of adolescents is of a high importance, because adolescent BP is predictive for adult blood pressures.

3. The measurement of blood pressure in adolescents

The concordant guidelines for modern societies is that all physicians who care for children 3 years of age through adolescence should be encouraged to measure individuals BP at least once a year, as part of the routine physical examination. Repeated measurements are necessary to get reliable results, and make precise conclusions. The circumstances and technique of BP measurements in recognizing high BP in adolescents are also very important. Only truly hypertensive adolescents should be treated as patients. Standard resting conditions, validated equipments and repeated measurements are of high importance.

During the last decades, oscillometric BP measuring equipments have become widely used. The advantage of these equipments are the ease of use, so these are recommended for both home BP measurements and screening examinations. The mercury manometer can be substituted with oscillometric devices not only in children, but also in adults, measuring both the systolic and diastolic BP.

4. Factors determining blood pressures

Normal BP values of the two gender can be different because of the various growth spurts of adolescents. Body size is the most important determinant of BP in adolescence. BP increases physiologically with age and height. The concept that growth rates are different in adolescents - besides age and gender - a more precise classification is possible if height also taking into consideration. The normal values and percentile curves of adolescent BP should be determined by classifying individuals into age, gender and height specific subgroups.

5. Definition of adolescent hypertension

BP varies continuously, therefore setting up a threshold between normal and pathological measurements is rather arbitrary. To diagnose hypertension in adolescents, consecutive and repeated measurements are required, because BP shows a decreasing tendency during repeated measurements.

Hypertension is a quantitative, but not a qualitative deviation from normal value, but for everyday clinical practice it is obligatory to define the abnormal threshold. The definition of hypertension in adolescents, like in children is largely epidemiological: hypertension is present if BP exceeds mean + 2SD.

Normal BP is defined as lower systolic and diastolic BPs than the 90th percentile for age, gender, and height. Based on international and national guidelines, hypertension can be diagnosed based upon at least 3 BP measurements. If the mean value of the 3 BP

measurements exceeds the 95th percentile for the given subgroup the diagnosis of hypertension can be drawn.

In 1996, the Update on the 1987 Task Force Report on High Blood Pressure in Children and Adolescents - which involved more 61,000 children and adolescents - summarized the data from ten different epidemiological studies performed in the United States. This recommendation consists of the 90th and 95th percentile values of the adolescents in a certain age, gender and height group.

II. THE EXPLANATION OF THE CHOICE OF SUBJECT AND THE AIMS OF THE STUDY

There hadn't been any population-based, representative study performed so far to examine the BPs and the prevalence of hypertension in 15-18 year old adolescents in Hungary. The current recommendation - which is available for everyday practice - consists of BP nomograms from ten epidemiological surveys, which were conducted between 1976 and 1991. All studies were done in the United States, and almost half of the participants were not Caucasians. The data of the nomograms were calculated from the first BP measurements, because in some studies BP was measured only once. Due to the wide geographical and ethnic differences, normal BP values of adolescents 15-20 years ago is representative of that particular population and is not applicable to the Hungarian adolescent population.

Due to the lack of comprehensive and reliable data concerning the status of hypertension in the adolescent population both in Hungary and Central-Europe, and because of the difficult adaptation of the available (American) data, we performed a screening examination for hypertension in Debrecen's secondary school students.

Besides getting epidemiological data we emphasized preventive goals also for our study. This has been decided, because - from our point of view - if we diagnose hypertension

in time, with the use of an adequate therapy, and follow-up of the adolescents, we may prevent or delay the manifestations of complications and target organ damages.

The aims of the study:

1. To perform a BP screening program in Debrecen's secondary school students according to international guidelines. To get epidemiological data from factors influencing adolescent BP by a questionnaire.
2. To compare the results of 3 consecutive BP readings.
3. To define the normal and abnormal BP percentile values in age, gender and height specific subgroups.
4. To compare our data with the results of the North American recommendation.
5. To examine factors influencing adolescent BP.
6. To repeat the BP measurements in case of elevated systolic and/or diastolic readings, and to determine the prevalence of adolescent hypertension in Debrecen.
7. To perform further examinations for the hypertensive adolescents, with a view to determining the aetiopathogenesis of the hypertension.
8. To get the epidemiological characteristics of the hypertensive adolescents.
9. To examine the target organ damages (intima-media thickness of the carotid artery, left ventricular mass index, retinopathy and microalbuminuria).
10. To confirm or to rule out the diagnosis of hypertension with the help of ambulatory BP monitoring.
11. To treat and to follow-up the hypertensive adolescents.

III. EXAMINED SUBJECTS AND METHODS

1. The arrangement of the survey

The phases of the study

1. Planning the study, getting the required permissions, informing the secondary school students, their parents and teachers about the aim of the study. Training the investigators, and performing the „pilot study”.
2. Performing a population-based screening examination of Debrecen’s secondary school students: filling out a questionnaire and measuring BP on 3 consecutive occasions, including height and weight.

We performed the examination on each secondary school student in Debrecen, who cooperated with us, and who signed the informed consent letter. Each student from the 26 schools was investigated except those who were absent on the day of the measurements: 10,359 adolescents took part, while 22 refused participation.

On the questionnaire there were simple questions with alternative answers about the age, gender, family history (hypertension, myocardial infarction, diabetes), social conditions, eating habits, salt intake, stress situations, smoking habits, alcohol consumption, blood pressures detected earlier, previous diseases and actual complaints. The questionnaires were filled out by the students, and trained investigators helped them when it was necessary. Those questions on which the adolescents could get help from their parents (family history, earlier detected BP, birth weight) were presented at the back of the patient information paper, also. Thus, the correct answers could always be ascertained with the help of their parents.

All BP measurements were done in classrooms of the secondary schools, at the same time, between 8-13 hours, under standardized conditions. After a resting period of 10 minutes, 3 consecutive measurements were taken on the right upper arm, in the sitting

position, each measurement being separated by 5 minutes from the next. To obtain the measurements we used automated digital OMRON M4 device, which had been validated.

3. Data were recorded by Access for Windows using a „cross-check” technique. In the population where further examination was necessary it was done by SPSS Windows version 8.0.

Based on age, gender and height, subjects were divided into 32 subgroups. Using age we formed 4 subgroups: 15, 16, 17 and 18 year old subgroups. Taking gender into account 8 subgroups have been specified. In each group, we described the distribution of height and formed additional subgroups by the quartiles of height. Following latest international guidelines and the procedure described above, we further divided the initial 8 subgroups by quartiles of height. After this we performed the nomograms of the subgroups, especially for the 90th and 95th percentile values.

Based on international guidelines, repeated measurements were needed in those adolescents, whose systolic and/or diastolic BP exceeded the 90th percentile value for age, gender and height specific subgroups.

4. Further measurements in case of elevated BP

One-thousand-sixhundred and fourteen adolescents' BP exceeded the 90th percentile BP value for the age, gender and height specific subgroups, from the population participating in the second phase of the study. From the above mentioned population we had the possibility of repeating measurements in 1,461 cases. Thus, finally 3x3=9 BP measurements were performed in this group in order to prove their hypertension.

5. The selection of hypertensive adolescents, and the prevalence of hypertension based on the averages of the nine casual BP measurements, and taking the 95-percentile value of the initial BP measurements of the whole population into account, finally 216 young secondary school students (2,01%) were considered to have hypertension.

6. Further examinations of the hypertensive adolescents were carried out including the examination of the cardiovascular risk status, and target organ damages (blood- and urine evaluation, ECG, abdominal ultrasound, carotid artery ultrasound, transthoracic echocardiography, ophthalmological examination). To confirm the diagnosis of hypertension we performed ambulatory blood pressure monitoring.

Laboratory evaluations: Blood sample was taken from all individuals for the following examination: sodium, potassium, glucose, urea, creatinine, uric acid, cholesterol, triglycerid, HDL-cholesterol, LDL-cholesterol. Urine analysis was also performed.

Measurement of intima-media thickness by B-mode ultrasound: Carotid arteries were insonated with a 7.5 MHz linear array probe of Hewlett-Packard Sonos 2000 device.

Transthoracic echocardiography: All subjects underwent transthoracic M-mode and bidimensional echocardiography (3.5 MHz probe of Acuson Secuoia equipment). According to the suggestions of Devereux, left ventricular mass (in grams) and left ventricular mass indices were calculated by correcting left ventricular mass for body surface area.

24 hour ambulatory blood pressure monitoring: The measurements were performed by validated, ABPM-04 oscillometric device.

3. Statistical analysis

Statistical analyses were done by SPSS Windows version 8.0. Descriptive statistics included mean, standard deviation and proportions (%). For directional hypotheses, one-tailed Pearson correlation coefficients were obtained (χ^2 test), in all other cases two-tailed tests and repeated measurements analysis of variance (ANOVA) were employed. We assessed normal distribution of sample characteristics by visual aids (histograms) as well as with the one sample Kolmogorov-Smirnov test. To indicate differences between groups, independent sample t-tests were used. Multiple regression analysis was employed to predict systolic and

diastolic BP. Control group was randomized from normotensive adolescents. Level of significance was set at 5%.

IV. RESULTS

1. Epidemiological characteristics of the study population

Gender distribution was almost equal in our sample: 50.64 % male (n=5163), 49.36 % female (n=5031). The mean age of the subjects was 16.55 ± 0.99 years, with no significant difference between the groups. Boys were taller by 10 cm and heavier by 10 kg on the average, and body mass index (BMI) was higher by 1 kg/m^2 than in girls. BMI above 25 kg/m^2 was in 7.7% of cases, while obesity ($\text{BMI} > 30 \text{ kg/m}^2$) was in 1.7%. Hypertension in family history was prevalent in 10.8% for mothers and in 11.7% for fathers.

At the time of the survey every fifth adolescent was a regularly smoker. 452 adolescents smoked 11-20 cigarettes/day, while 74 were smoked more than 20 cigarettes per day. A further 17.3% of the adolescents were occasional smokers. 12.2% of the studied population drank alcohol on a weekly basis, with almost two times more boys than girls (15.6% vs. 8.7%). Leisure time sporting activity was characteristic only for every third adolescent, boys sporting activity being better. 11.2% of the youngs usually felt stress, which was two times more frequent in girls. 15.1% of the secondary school students regularly salted their food, which was more frequent among boys. Low birth weight (< 2500 gram) was recorded in 6.7% of the adolescents.

2. Blood pressure values during the 3 consecutive measurements

Both the systolic and diastolic BP decreased during the 3 measurements (5 minute intervals), not only in the whole study population, but also in groups specified by gender. The mean difference between the first and third measurements was $4/2.5$ mmHg. The differences based on repeated measurements by analysis of variance was significant, and both systolic ($F=413.51$; $p < 0.001$), and diastolic ($F=180.98$; $p < 0.001$) values were highly significant. This

statistical difference could be observed also, if we analyzed boys' and girls' data separately. Although statistically significant, the decrease in pulse rate for boys appeared clinically irrelevant ($F=15.57$; $p<0.01$).

3. The normal and abnormal blood pressure values of the studied adolescents

Forming subgroups by age and gender, and taking quartiles of height into consideration we formed 32 subgroups based on age, height, weight and sex in order to determine the distribution of BP values in the different subgroups.

In every subgroup we examined the distribution of systolic and diastolic BP, and determined the 50th, 90th and 95th percentile values. We had to know the 90th percentile values to select those who needed further examination, and later the 95th percentile values to set up the diagnosis of hypertension.

4. Factors influencing adolescent blood pressure

- a. Gender: Mean BP of the total sample was $116.94\pm 14.17/68.51\pm 8.93$ mmHg. Boys systolic BP was significantly higher, by 11 mmHg, (122.51 ± 13.47 vs. 111.24 ± 12.5 mmHg; $t=43.69$, $p<0.001$), while the difference in diastolic BP was 2 mmHg (69.58 ± 8.92 vs. 67.41 ± 8.92 Hgmm; $t=12.31$, $p<0.001$). The pulse rate of girls was higher by 1.5/min.
- b. Age, height, weight and BMI: Significant associations were found between BP and all other variables. Systolic BP had a stronger relationship with each variable than diastolic BP values. Separate analysis for gender showed a stronger correlation for boys in all examined parameters. There was no correlation between the above mentioned factors and pulse rate. The strongest association was found between BP and weight (systolic: $r=0.42$; $p<0.001$ and diastolic: $r=0.285$; $p<0.001$). We also found positive relationships between systolic BP and height ($r=0.326$; $p<0.001$), while diastolic BP was associated with height ($r=0.145$; $p<0.001$) to a lesser extent. There was also a positive correlation between BP and BMI (systolic: $r=0.312$; $p<0.001$ and diastolic: $r=0.268$; $p<0.001$). Age and BP

weakly correlated regardless of gender (systolic: $r=0.058$; $p<0.01$ and diastolic: $r=0.055$; $p<0.05$). Separate analyses revealed moderate correlation between age and systolic BP for boys ($r=0.104$, $p<0.001$) but no such association existed for girls ($r=-0.021$, $p>0.05$). Similar results are available for diastolic BP, with moderate correlation for boys ($r=0.095$, $p<0.001$) but no significant relationship for girls ($r=-0.014$, $p>0.05$).

- c. Family history: Comparing the BP of those whose parents had hypertension with those who had no elevated BP in family history, we found a statistically significant, but clinically irrelevant difference, while their pulse rate didn't differ.
- d. Birth weight: We compared the BP of low birth weight adolescents with those of normal birth weight. The mean BP of both groups was within the normal interval, but low birth weight adolescents had a 2 mmHg higher BP than those in the normal birth weight control group ($p=0.024$). There were no differences in diastolic BP and in pulse rate among the groups.
- e. Smoking, alcohol intake, lifestyle and eating habits: Neither systolic, nor diastolic BP differed significantly, between regular smokers and non-smokers and between those drinking alcohol on a weekly basis or not at all. Adolescents with sporting activities had the same BP as those without any leisure time activity. We did not find any differences between BP of groups with or without high salt intake, and also those with frequent stress situations or not.
- f. Factors influencing adolescent blood pressure assessed by a multiple regression model. Multiple regression has been used to examine the influence of the independent influencing factors on BP. Separate models have been devised to predict systolic and diastolic outcomes. Entering independents together accounted for 28.2% of the total variance in systolic and for 18.1% in diastolic pressure. Gender ($\beta=0.36$), BMI ($\beta=0.25$), hypertension of father and mother ($\beta=0.04$, ill. $\beta=0.02$), smoking, drinking and age determined systolic

outcomes in descending order. BMI remained an underlying independent factor in the diastolic model as well ($\beta=0.25$). However, the relative contribution of gender diminished significantly between the two models ($\beta=-0.09$). Interestingly, exercise, salt-intake, low birth weight and self-appraised health status had relatively minor influence in determining either systolic or diastolic pressure.

5. Comparison of the Hungarian and American adolescents

We also compared internationally recommended BP thresholds (90th and 95th percentile) of the different height percentiles of 15-17 year old adolescents, which serve as references for everyday practice, with data obtained from this study. Considering the fact that grouping of the Hungarian and American adolescents was performed by height percentiles (and not by height values), direct statistical comparison was not executed.

Boys in our sample had 6 to 11 mmHg higher systolic BP than boys in the North American guideline. In contrast, the difference for girls was slight (0-6 mmHg). In comparison, diastolic BP showed less marked deviations for both boys and girls. Data from our study evidenced a lowering trend in diastolic BP with increasing age in several of the subgroups, which was especially obvious in the 17-year old age group.

Differences in height were explicit between reports from the present study and from that of the US. Boys in the current study emerged taller than their US counterparts; the difference was 7cm in the 15-year old age group, and remained consistently 3cm with advancing age groups. The greatest difference in weight was also recorded in the 15-year old male age group; Hungarian subjects weighed 6kg more than those in the same age group in the US. Although girls showed similar patterns regarding height (our subjects being 4-5cm taller), they weighed 3-6kg less than US subjects of the same age group.

6. Prevalence of adolescent hypertension

Based on the 3 consecutive BP measurements, systolic and/or diastolic BP exceeded the 90th percentile for the given subgroups in 1,614 cases out of the 10,194 adolescents. Repeated measurements were performed in 1461 cases. Averaging the 9 (3x3) measurements, the systolic and/or diastolic BP was higher than the 95th percentile for the age, gender and height specific subgroups in 216 (2.12%) cases, with these subjects being confirmed as having hypertension.

In determining the prevalence of hypertension 2 other factors were also taken into account. On one hand we hypothesized that the frequency of hypertension was the same in those 153 adolescents, who didn't take part in the control measurements, meaning an additional 23 hypertensive cases. On the other hand, at the beginning of the study there were 19 adolescents on hypertensive drug treatment, who were excluded from further analysis. Altogether 258 adolescents of the examined 10,213 had hypertension. Thus, the prevalence of the disease in our population was 2.53% (2530/100000).

7. Pathogenesis of hypertension

Among 216 hypertensive adolescents further evaluation of 128 students was carried out. We found secondary reasons for hypertension in 8 cases (3 renoparenchymal, 2 of renovascular origin and in 3 cases oral contraceptives). We were unable to find any specific reason in 120 cases and so we diagnosed as essential hypertension.

8. Characteristics of the hypertensive adolescents

Comparing the data of the hypertensive (n=216) and normotensive adolescents (n=9825), the Hungarian hypertensive subjects - beside having the same height - had a 10 kg higher body weight, and a 3 kg/m² higher BMI. Hypertension in the family history (both in mothers and fathers) of the hypertensive adolescents was more frequent. We compared the hypertensives with a normotensive control group (n=59). There was no difference in gender

distribution. The age difference of the 2 groups was of only statistical, but not clinical importance: normotensives were younger by 6 months. Comparing the BMI of the 2 groups: the BMI of hypertensives was higher by 2.5 kg/m², compared to the control group. The serum sodium, blood urea nitrogen, and creatinine were significantly higher in hypertensives, while potassium levels did not differ in the 2 groups. Fasting blood sugar, total cholesterol and LDL fraction were also higher in hypertensives, but mean values were normal in both groups. There were more overweights (25% vs. 5.1%), elevated fasting blood sugar (17.5% vs. 1.7%) and lipid disorders (14.2% vs. 3.8%) among the hypertensives compared to the control group.

9. Target organ damages in essential hypertensive adolescents

The diameter of the left atrium of the hypertensives was more than that of control group (p=0.021). There were no differences between the 2 groups with regard to the diameter of the end-systolic and end-diastolic sizes of the left ventricle. Septum and posterior walls were thicker in hypertensives (p=0.002 and p=0.008). The left ventricular mass indices of the hypertensive adolescents - based on the Devereux-formula - were significantly higher, than those of the normotensive controls (103.23±30.61 vs. 91.14±25.23 g/m²; p<0.01). We also found differences between the 2 groups with regard to the intima-media thickness of the carotid artery: hypertensives had a significantly thicker carotid artery (0.55±0.1 vs. 0.48±0.08 mm; p<0.01).

We performed a regression analysis in all our 179 (120 hypertensive and 59 control) subjects to study the independent contributions of hypertension and other risk factors to the dependent factor carotid IMT. Also we studied the contribution of risk factors to IMT in the hypertensive and control groups separately. In general, IMT was associated with age (r=0.26; p=0.001) and body mass index (r=0.19; p=0.015). A significant positive relationship was found between triglyceride concentration and IMT in the pooled group (r=0.15; p=0.04) and the control subjects (r=0.36; p=0.02), but not in hypertensives (r=0.06; p=0.48). No

association was found between any of the lipid-fractions and the IMT. Thickness of the intima-media layer in normotensive subjects was not associated with any of the assessed confounding factors. Similarly, in the hypertensive group, the majority of the assessed confounding factors was not associated with the IMT, only the age of the subjects showed a significant positive relationship with intima-media thickness ($r=0.19$; $p=0.04$). Intima media thickness of all adolescents correlated with the mean of the first three BP measurements both in systolic ($r=0.33$; $p<0.001$) and diastolic ($r=0.15$; $p=0.04$) values. Analyzing the groups separately we found a correlation only between systolic BP and IMT in the control groups ($r=0.34$; $p<0.01$). An interesting finding is the significant relationship between the left ventricular mass index (LVMI) and the IMT in the pooled and in the hypertensive group ($r=0.18$; $p=0.018$ and $r=0.18$; $p=0.05$). While IMT and LVMI had a positive, significant correlation with BP, we were unable to make similar findings in normotensive adolescents ($r=0.04$; $p=0.73$). The other parameters of the echocardiography (left atrium, end-systole, end diastole of the left ventricle, septum, posterior wall) have no correlation with the IMT. This suggests that IMT and LVMI are increasing parallel along with hypertension, while in the normotensive adolescents such relationship does not exist.

Based on ophthalmological examinations the diagnosis of stage I. retinopathy was made on 14 adolescents (11.7% of the investigated essential hypertensives). Such abnormalities were not detected in the normotensive control group. A significantly higher number of microalbuminuria cases were detected in the essential hypertensive group than in the normotensive group (28.3% vs. 10.2%; $p<0.001$).

10. Ambulatory blood pressure monitoring of young essential hypertensives.

Our results were analysed with reference to the 95th percentile values recommended for adolescent ambulatory BP monitoring.

The mean 24 hour (BP_{24}), daytime and nighttime systolic BP - similar to repeated manual BP results - were significantly elevated (boys: $BP_{24}=132.42\pm 8.51$ vs. girls: $BP_{24}=124.65\pm 9.31$ mmHg; $p<0.001$). Slightly elevated diastolic BP values were observed in girls (boys: $BP_{24}=68.92\pm 6.65$ vs. girls: $BP_{24}=71.07\pm 6.32$ mmHg; $p=0.073$). Daytime fluctuations in BP (diurnal index: DI) remained within limits ($DI_{syst}:13.01\pm 6.01\%$; $DI_{diast}:12.95\pm 5.63\%$). The diurnal index values were almost identical in both gender groups. At all times (24 hours, day and night) the percent time elevation index (PTI) and the hypertension load (hyperbaric impact: HBI) were elevated with regard to systolic values, while they remained normal at diastolic values. The 24-hour systolic percent time elevation index (44.23 ± 21.43 vs. $24.69\pm 22.36\%$; $p<0.001$) and hypertension load (139.61 ± 104.6 vs. 69.69 ± 87.93 mmHg \times h; $p<0.001$) were significantly higher for boys than for girls. The investigated diastolic BP parameters were not different in both gender groups.

ABPM confirmed only 60.8% (70 persons) of the cases of hypertension diagnosed by repeated manual BP measurements, while 16.7% (20 persons) were considered borderline hypertensives. ABPM showed normal values in 22.5% of cases considered as hypertensives by repeated BP measurements. One-half of the girls were confirmed as having hypertension, while one-third were considered white coat hypertensives.

In Debrecen, the frequency of isolated systolic hypertension was highest within the 15-18 year old group. Isolated systolic hypertension was observed in 61.6% (45 individuals) of the adolescents confirmed by ABPM as hypertensives, while in one-third of the cases systolic-diastolic hypertension was proved. Isolated diastolic hypertension was seen only in three individuals. While isolated systolic hypertension was almost three times more frequent than systolic-diastolic hypertension in boys, in girls the frequency of systolic and systolic-diastolic hypertension was the same.

V. SUMMARY

Our hypertension screening was initiated in order to cover all juveniles in secondary schools throughout the city of Debrecen. Extensive review of the literature indicate that such a far reaching study covering 15-18 year olds has never been conducted in Hungary or East and Central Europe. To rectify this lack of available data, we deemed it necessary to undertake a large cross-sectional study involving juveniles. Epidemiological and preventive measures were taken into account during the planning and conduction of the study.

We realised that there were limitations in the application of the recommended nomograms for our 15-18 year olds in Debrecen. Results of investigations conducted 10-20 years ago were based on single or first BP values, and on data from nearly 50% of non-Caucasians. Besides the well known geographic and ethnic differences, the limitations of the previously mentioned recommendations, in our country, were further compounded by antropometric variations and differences in the number of measurements.

From the epidemiological point of view, data were obtained from the characteristics, values and factors influencing BP in the 15-18 year old population. By selecting and further examining the adolescents with hypertension we were able to determine the point-prevalence of juvenile hypertension.

In our opinion, every centre dealing with juvenile hypertension has to design its own BP nomogram on the basis of age, gender and height. Our results, characterising the juvenile population of Debrecen, is more or less representative of Hungary and perhaps the whole Eastern-European region.

The recognition of hypertension among the juvenile population, along with clarification of its origin, treatment and follow-up is of immense importance. The extent of damage to target organs is dependent on the hypertension load. The pressure load correlates

with the time of existence, and with the severity of hypertension. Failure to diagnose hypertension could lead to damage to target organs extending over decades, therefore a relatively mild hypertension may result in many irreversible abnormalities.

By thoroughly examining juveniles with suspected hypertension, together with a follow-up and treatment regimen if indicated, the development of complications can be effectively reduced.

VI. NEW RESULTS

1. We carried out the first population-based hypertension screening examination in Central-Eastern Europe, involving more than 10,000 adolescents between the ages of 15-18 years.
2. During the screening - performed according to international guidelines - the first time in Hungary we determined the normal and abnormal BP values of 15-18 year adolescents based on age, gender and height.
3. We were the first to carry out a comparative study of our results involving adolescent hypertension with similar data from the US, which still serve as international guidelines. We drew attention to the many discrepancies, and gave possible explanations.
4. We collected data on the prevalence of adolescent cardiovascular risk factors and their relation to BP, and prepared a model for the factors influencing adolescent hypertension.
5. During the population-based screening exercise we picked out adolescents with occasionally elevated BP, and performed further measurements. It was on account of these repeated measurements that we were able to determine the point prevalence of adolescent hypertension.
6. As part of the investigations conducted on the young hypertensives, we first time in the medical literature reported on higher intima-media thickness and left ventricular mass index among adolescent hypertensives. Also we were the first to prove a positive relationship between intima-media thickness of the common carotid artery and as well as left ventricular muscle mass in adolescent hypertension
7. Our results support the need for ambulatory BP monitoring in the setting up of the diagnosis of adolescent hypertension.

VII. LIST OF PUBLICATIONS

1. Publication on the subject of the PhD thesis

1. **Páll D**, Katona É, Fülesdi B, Zrínyi M, Zatik J, Bereczki D, Polgár P, Kakuk G: Blood pressure distribution of a Hungarian adolescent population: a comparison to US normal values. **J Hypertens** In press; 2002. **(IF: 4,21)**
2. **Páll D**, Settakis G, Katona É, Csiba L, Kakuk G, Limburg M, Bereczki D, Fülesdi B: Increased common carotid artery intima-media thickness in adolescent hypertension. - Results from the Debrecen Hypertension Study. **Cerebrovasc Dis** 14(5):312-318, 2002. **(IF: 1,662)**
3. **Páll D**, Katona É, Paragh G, Kakuk G, Polgár P: A hypertonia epidemiológiája, szűrésének és gondozásának aktuális kérdései. **Magyar Alapellátási Arch** 1-2:257-263; 2001.
4. **Páll D**, Katona É, Fülesdi B, Jenei Z, Paragh G, Polgár P, Kakuk G: A serdülőkori hypertonia epidemiológiája és a vérnyomást befolyásoló tényezők. **Orv Hetil** 142(35):1891-6; 2001.
5. **Páll D**, Katona É, Fülesdi B, Polgár P, Paragh G, Kakuk G: A serdülőkori hypertonia diagnosztikájának és terápiájának aktuális kérdései. **Lege Artis Medicinae** 11(6-7):418-425; 2001.
6. **Páll D**: A szűrővizsgálat helye és szerepe a megelőzésben. A serdülőkori hipertónia epidemiológiai vizsgálata, a Debrecen Hypertension Study. **Egészségügyi Menedzsment** 3(2):72-75; 2001.
7. **Páll D**, Katona É, Fülesdi B, Zrínyi M, Takács E, Polgár P, Kakuk G: Debrecen középiskolás fiataljainak vérnyomásértékei. A „Debrecen Hypertension Study” lebonyolításának menete, kezdeti eredmények **Hypertonia és Nephrologia**, 5(4-5):237-243; 2001.
8. **Páll D**, Settakis G, Katona É, Zatik J, Polgár P, Paragh G, Kakuk G, Fülesdi B: Az arteria carotis communisok intima-media vastagságának összehasonlítása hypertóniás és egészséges serdülőkben **Magyar Belorvosi Arch** 54:127-130; 2001.

9. **Páll D**, Settakis G, Katona É, Hegedűs I, Fülöp T, Kakuk G, Polgár P, Csiba L, Füleddi B: Az arteria carotis communis intima-media vastagságának, valamint a szív falvastagságának vizsgálata hypertóniás és egészséges serdülőkön. **Cardiologia Hungarica** közlésre elfogadva; 2002.

2. Other publications

1. **Páll D**, Juhász A, Karányi Z: Benazeprillel ambuláns vérnyomás-monitorozás során szerzett tapasztalataink enyhe és közepsúlyos hipertóniában. **Orv Hetil** 36:1973-1978; 1996.
2. **Páll D**, Jenei Z, Katona É, Bojti T, Hunyadi B, Zilahi Z, Karányi Z, Polgár P, Kakuk G: Középiszkolások vérnyomásműzűrése során szerzett kezdeti tapasztalataink. **Magyar Belorvosi Arch** 52:292-297; 1999.
3. Polgár P, **Páll D**, Jenei Z, Karányi Z, Katona É, Bodor M, Kakuk G: CARD'96 – Cardiovascularis Rizikószűrés, Debrecen. A vizsgálat I. fázisának főbb eredményei. **Magyar Belorvosi Arch** 52:261-265;1999.
4. Jenei Z, **Páll D**, Katona É, Polgár P, Karányi Z, Bodor M, Kakuk G: A cardiovascularis rizikótényezők alakulása Debrecen város dohányos és nem dohányos lakossága körében. **Magyar Belorvosi Arch** 53:29-34; 2000.
5. Katona É, **Páll D**, Jenei Z, Polgár P, Karányi Z, Kakuk G: Debrecen túlsúlyos felnőtt lakosainak epidemiológiai adatai, különös tekintettel a cardiovascularis rizikótényezőkre. **Magyar Belorvosi Arch** 53:239-243; 2000.
6. Jenei Z, **Páll D**, Katona É, Polgár P, Karányi Z, Bodor M, Kakuk G: Prevalence of cardiovascular risk factors of the smokers and non-smokers in the city of Debrecen. **Public Health** 114:295-299;2000. (IF: 0,6)
7. Zatik J, Aranyosi J, Molnár C, **Páll D**, Borsos A, Füleddi B: Effect of hyperventillation on cerebral blood flow velocity in preeclamptic pregnancies: is there evidence for an altered cerebral vasoactivity? **J Neuroimaging** 11(2): 179-183, 2001. (IF: 0,926)
8. Zatik J, Aranyosi J, Mihálka L, **Páll D**, Major T, Füleddi B: Comparison of cerebral blood flow velocity as measured in preeclamptic, healthy pregnant, and nonpregnant women by transcranial Doppler sonography. **Gynecol Obstetric Invest** 51(4):223-227;2001. (IF: 0,884)

9. Kovács T, **Páll D**, Abafalvi Z, Karányi Z, Wórum F, Mátyus J, Kárpáti I, Balla J, Ujhelyi L, Kakuk G: Klinikánk akut toxikológiai esetei az elmúlt 10 év során. **Orv Hetil** 143(2):71-76; 2002.
10. Jenei Z, **Páll D**, Katona É, Kakuk G, Polgár P: The epidemiology of hypertension and its associated risk factors in the city of Debrecen, Hungary. **Public Health** 116(3):138-44; 2002 (**IF: 0,486**).
11. Paragh G, Szabó J, Kovács É, Keresztes T, Kárpáti I, Balogh Z, **Páll D**, Fóris G: Altered signal pathway in angiotensin II stimulated neutrophils of patients with hypercholesterolaemia. **Cell Signal** 14(9):787-792; 2002. (**IF: 3,398**)
12. Zatik J, Aranyosi J, Settakis G, **Páll D**, Tóth Z, Limburg M, Fülesdi B: Breath holding test in preeclampsia: lack of evidence for altered cerebral vascular reactivity. **Int J Obst Anaesth** 11(3):160-163; 2002. (**IF: 1,187**)
13. Kárpáti I, Balla J, Szőke G, Bereczky Z, **Páll D**, Ben T, Toma K, Katona E, Mohácsi A, Paragh G, Varga Z, Kakuk G, Muszbek L: A hyperhomocysteinaemia gyakorisága, folsavpótlásban részesülő hemodializált betegekben. **Orv Hetil** 143(27):1635-1640; 2002.

3. Book chapters

1. **Páll D**: A vesebetegségek rizikófaktorai és prevenciója. Essentialis hypertonia. In: Nephrologiai Ismeretek, Ed: Kakuk G, Kárpáti I. Airport Travel KFT, Debrecen, pp:141-147; 1998.
2. **Páll D**: A hypertonia sürgősségi ellátása. In: Nephrologia 1999. Ed: Kakuk G, Kárpáti I. Airport Travel KFT, Debrecen, pp:175-181; 1999.
3. **Páll D**: A szűrés és gondozás az alapellátásban. In: Nephrologia 2000. Ed: Kakuk G, Kárpáti I. Airport Travel KFT, Debrecen, pp:161-167; 2000.
4. **Páll D**: A renoparenchymás hypertonia. In: Nephrologia. Ed: Kakuk G., Medicina Könyvkiadó, Budapest. megjelenés alatt
5. **Páll D**: A renális hypertonia kezelése. In: Nephrologia. Ed: Kakuk G., Medicina Könyvkiadó, Budapest. megjelenés alatt

4. Abstracts

1. **Páll D**, Juhász A, Karányi Z: Ambuláns vérnyomásmérő monitorozás során észlelt negatív diurnális index gyakorisága és klinikai jelentősége essentialis hypertóniában. **Cardiol Hung** S1:41; 1994.
2. **Páll D**, Juhász A, Karányi Z: Tapasztalataink benazeprillel vérnyomás monitorozás során enyhe és közép súlyos hypertóniában. **Cardiol Hung** S1:26; 1995.
3. **Páll D**, Juhász A, Karányi Z: The effect of benazepril on mild to moderate hypertension studied by ambulatory blood pressure monitoring. **Cardiol Hung** S3: 33; 1995.
4. **Páll D**, Jenei Z, Bojti T, Katona É, Hunyadi B, Zilahi Z, Polgár P, Kakuk G: 5053 középiskolás vérnyomás-szűrésével szerzett kezdeti tapasztalataink. **Cardiol Hung** 1996, S1:79; 1996.
5. Jenei Z, **Páll D**, Bojti T, Katona É, Hunyadi B, Zilahi Z, Polgár P, Kakuk G: Eseti hipertenziós középiskolások további vizsgálata során szerzett kezdeti tapasztalataink. **Cardiol Hung** S1:78;1996.
6. **Páll D**, Jenei Z, Bojti T, Katona É, Hunyadi B, Zilahi Z, Polgár P, Kakuk G: First experience with blood pressure screening of secondary school students. **J Hypertens** 14(S1):S361; 1996. **(IF: 2,611)**
7. Jenei Z, **Páll D**, Kárpáti I, Mátyus J, Újhelyi L, Zilahi Z, Juhász A, Kakuk G: Blood pressure changes during hemodialysis using dialysis solution 35 C°, 36 C° and 37 C°. **J Hypertens** 14(S1):S41; 1996. **(IF: 2,611)**
8. **Páll D**, Jenei Z, Bojti T, Katona É, Hunyadi B, Zilahi Z, Polgár P, Kakuk G: Epidemiological data of 5053 secondary school students' blood pressure in Debrecen, Hungary. **Eur Heart J** 17(S3):344; 1996. **(IF: 1,682)**
9. Jenei Z, **Páll D**, Kárpáti I, Mátyus J, Újhelyi L, Zilahi Z, Juhász A, Kakuk G: Effect of cool temperature (35 C°) dialysis solution for intradialytic blood pressure changes. **Eur Heart J** 17(S3):339; 1996. **(IF: 1,682)**
10. **Páll D**, Jenei Z, Polgár P, Bojti T, Katona É, Hunyadi B, Zilahi Z, Kakuk G: Epidemiological data of 5053 secondary school students' urine analysis and blood pressure. **Am J Kidney Dis** S219; 1997. **(IF: 2,813)**

11. **Páll D**, Jenei Z, Polgár P, Karányi Z, Kakuk G: Debrecen 30-65 éves lakosainak nem befolyásolható cardiovascularis rizikótényezői. **Cardiol Hung** S3:28; 1997.
12. Jenei Z, **Páll D**, Polgár P, Kanyári Z, Kakuk G: Debrecen 30-65 éves lakosainak életmód változtatással befolyásolható cardiovascularis rizikótényezői. **Cardiol Hung** S3:28; 1997.
13. **Páll D**, Jenei Z, Polgár P, Karányi Z, Kakuk G: The cardiovascular risk factors which can be influenced with life-style changes among the inhabitants between the ages of 30-65 in Debrecen, Hungary. **J Hypertens** 15(S4):S177; 1997. **(IF: 2,801)**
14. Jenei Z, **Páll D**, Polgár P, Karányi Z, Kakuk G: The non-influent cardiovascular risk factors among the inhabitants between the ages of 30-65 in Debrecen, Hungary. **J Hypertens** 15(S4):S153; 1997. **(IF: 2,801)**
15. Polgár P, **Páll D**, Jenei Z, Karányi Z, Kakuk G: CARD'96 - Cardiovascular risk screening in the city of Debrecen, Hungary. **J Hypertens** 15(S4):S183; 1997. **(IF: 2,801)**
16. **Páll D**, Jenei Z, Polgár P, Karányi Z, Kakuk G: The cardiovascular risk factors which can be influenced with life-style changes among the inhabitants between the ages of 30-65 in Debrecen, Hungary. **Canad J Cardiol** 13:248B; 1997. **(IF: 0,589)**
17. Jenei Z, **Páll D**, Polgár P, Karányi Z, Kakuk G: The non-influent cardiovascular risk factors among the inhabitants between the ages of 30-65 in Debrecen, Hungary. **Canad J Cardiol** 13:247B; 1997. **(IF: 0,589)**
18. Polgár P, **Páll D**, Jenei Z, Karányi Z, Kakuk G: CARD'96 - Cardiovascular risk screening in the city of Debrecen, Hungary. **Canad J Cardiol** 13:247B; 1997. **(IF: 0,589)**
19. **Páll D**, Jenei Z, Polgár P, Karányi Z, Katona É, Bodor M, Kakuk G: Debrecen 30-65 éves lakosainak szív és érrendszeri rizikótényezői, különös tekintettel a hipertóniára (CARD '96) **Hypertonia és Nephrologia** 1(S2):43; 1997.
20. Homoródi N, **Páll D**, Jenei Z, Polgár P, Katona É, Bodor M, Kakuk G: Fiatalok ambuláns vérnyomás monitorozása hipertónia gyanú esetén. **Hypertonia és Nephrologia**. 1(S2):31; 1997.
21. Bodor M, **Páll D**, Jenei Z, Polgár P, Katona É, Homoródi N, Kakuk G: The diagnosis of hypertension in Hungarian students by screening examination and ABPM. **Am J Kidney Dis** S1:76; 1998. **(IF: 3,084)**

22. **Páll D**, Jenei Z, Polgár P, Katona É, Bodor M, Kárpáti I, Mátyus J, Újhelyi L, Kakuk G: Effect of cooler temperature dialysate on blood pressure changes and on dialysis hypotension in „high risk” patients. **JACC** 31(5C):130C-131C; 1998. (IF: 7,282)
23. **Páll D**, Homoródi N., Jenei Z, Polgár P, Katona É, Bodor M, Kakuk G: Emelkedett eseti vérnyomású fiatalok ambuláns vérnyomás monitorozása. **Cardiol Hung** S1:25; 1998.
24. Jenei Z, **Páll D**, Polgár P, Karányi Z, Bodor M, Katona É, Kakuk G: A dohányosok cardiovascularis rizikótényezőinek főbb jellegzetességei Debrecenben. **Cardiol Hung** S1: 25; 1998.
25. Katona É, Polgár P, **Páll D**, Jenei Z, Karányi Z, Kakuk G: Epidemiological data of the overweight population of Debrecen, especially the other cardiovascular risk factors. **Diabetologia** 41(S1):124; 1998. (IF: 4,986)
26. Homoródi N, Polgár P, **Páll D**, Jenei Z, Bodor M, Katona É, Kakuk G: Ritmuszavarok előfordulási gyakorisága fokozott cardiovascularis rizikójú egyéneknél. **Cardiol Hung** S4:205; 1998.
27. **Páll D**, Kissik K, Jenei Z, Katona É, Bodor M, Kárpáti I, Mátyus J, Balla J, Újhelyi L, Kakuk G: Krónikus hemodialízis kezelésben részesülő betegek hipertóniájának jellemzői. **Hypertonia és Nephrologia** 2(S3):103; 1998.
28. Jenei Z, **Páll D**, Bodor M, Katona É, Polgár P, Kakuk G: 24 órás ambuláns vérnyomás monitorozás jelentősége renális célszerv károsodás megítélésében. **Hypertonia és Nephrologia** 2(S3):64; 1998.
29. Bodor M, **Páll D**, Jenei Z, Polgár P, Katona É, Homoródi N, Kakuk G: Ambuláns vérnyomás monitorozás emelkedett vérnyomású fiatalok esetében. **Hypertonia és Nephrologia** 2(S3):66; 1998.
30. Jenei Z, **Páll D**, Polgár P, Katona É, Bodor M, Karányi Z, Kakuk G: Hypertonia gyakorisága Debrecen város magas cardiovascularis rizikójú lakossága körében. **Cardiol Hung** S1:17; 1998.
31. **Páll D**, Takács E, Katona É, Jenei Z, Zrínyi M, Polgár P, Kakuk G: Középiszkolás fiatalok vérnyomásának epidemiológiai jellemzői (első eredmények). **Hypertonia és Nephrologia** 3(S1):34; 1999.

32. Jenei Z, **Páll D**, Polgár P, Bodor M, Karányi Z, Katona É, Kakuk G: Kezeletlen és a nem megfelelően kezelt hypertonia gyakorisága Debrecen magas cardiovascularis rizikójú lakossága körében. **Hypertonia és Nephrologia** 3(S1):64; 1999.
33. **Páll D**, Katona É, Takács E, Zrínyi M, Jenei Z, Polgár P, Kakuk G: Vérnyomás szűrés eredményei egy nagy esetszámú serdülő populációban. Debrecen Hypertension Study. **Cardiol Hung** 3:27; 2000.
34. **Páll D**, Katona É, Takács E, Zrínyi M, Jenei Z, Polgár P, Kakuk G: Outcomes of a blood pressure survey in a large Hungarian adolescent population. The Debrecen Hypertension Study. **J Hypertens** 18(S2):S276; 2000. **(IF: 3,64)**
35. **Páll D**, Katona É, Takács E, Zrínyi M, Jenei Z, Polgár P, Kakuk G: Factors influencing blood pressure outcomes in a large adolescent population in Hungary. The Debrecen Hypertension Study. **J Hypertens** 18(S4):S154; 2000. **(IF: 3,64)**
36. Jenei Z, **Páll D**, Polgár P, Katona É, Bodor M, Kakuk G: A hypertonia és a társult cardiovascularis rizikótényezők epidemiológiai vizsgálat Debrecenben. **Magyar Belorvosi Arch** 53(S2):27; 2000.
37. Kovács T, Abafalvi Z, **Páll D**, Kanyári Z, Kakuk G: A DEOEC I. sz. Belgyógyászati Klinikája Toxikológiai eseteinek feldolgozása 1989-1998 között. **Magyar Belorvosi Arch** 53(S2):57; 2000.
38. **Páll D**, Katona É, Takács E, Zrínyi M, Jenei Z, Polgár P, Kakuk G: 14-18 éves fiatalok vérnyomásának jellemzői. **Magyar Belorvosi Arch** 53:(S3):131; 2000.
39. Kovács T, Abafalvi Z, **Páll D**, Karányi Z, Kakuk G: A DEOEC I. sz. Belgyógyászati Klinika toxikológiai eseteinek feldolgozása 1989-98 között. **Magyar Belorvosi Arch** 53(S3):108; 2000.
40. **Páll D**: Az ambuláns vérnyomás monitorozás szerepe a serdülőkori hypertonia diagnosztikájában. **Hypertonia és Nephrologia** 4(S3):93; 2000.
41. Jenei Z, **Páll D**, Polgár P, Katona É, Bodor M, Kakuk G: A hypertonia és rizikófaktorainak epidemiológiai vizsgálata Debrecenben. **Hypertonia és Nephrologia** 4(S3):84; 2000.
42. **Páll D**, Katona É, Jenei Z, Katona E, Hegedűs I, Fülesdi B, Zrínyi M, Kakuk G, Polgár P: Az ambuláns vérnyomás monitorozás szerepe a serdülőkori hypertonia diagnosztikájában. Debrecen Hypertension Study. **Cardiol Hung** S2:34; 2001.

43. Rácz I, **Páll D**, Hegedűs I, Fülöp T, Kristóf É, Bódi A, Péter A, Katona É, Édes I: Echocardiographias vizsgálatok hypertóniás fiatalokon. **Cardiol Hung** S2:53; 2001.
44. Bednársky I, **Páll D**, Hegedűs I, Fülöp T, Kristóf É, Bódi A, Péter A, Katona É, Édes I: Fiatal hypertóniások szívizom Doppler vizsgálata. **Cardiol Hung** S2:53; 2001.
45. **Páll D**, Katona É, Jenei Z, Katona E, Hegedűs I, Fülesdi B, Zrínyi M, Kakuk G, Polgár P: Use of ambulatory blood pressure monitoring to establish proper diagnosis of hypertension in adolescents. The Debrecen Hypertension Study. **J Hypertens** 19:S4; 2001. **(IF: 4,21)**
46. Katona É, **Páll D**, Takács E, Zatik J, Zrínyi M, Jenei Z, Kakuk G, Polgár P: Factors influencing blood pressure outcomes in a large adolescent population in Hungary. The Debrecen Hypertension Study. **J Hypertens** 19:S58; 2001. **(IF: 4,21)**
47. **Páll D**, Katona É, Fülesdi B, Zrínyi M, Polgár P, Kakuk G: Debreceni serdülők vérnyomásértékei a nemzetközi ajánlás adatainak tükrében – Debrecen Hypertension Study. **Hypertonia és Nephrologia** 5(S4):173; 2001.
48. Settakis G, **Páll D**, Katona É, Zatik J, Csiba L, Polgár P, Kakuk G, Fülesdi B: Angiotensine-converting enzyme gene polymorphism, carotid intima-media thickness and left ventricular mass index in adolescent hypertension. **Hypertonia és Nephrologia** 5(S4):178; 2001.
49. Settakis G, **Páll D**, Katona É, Zatik J, Csiba L, Polgár P, Kakuk G, Fülesdi B: Increased common carotid artery intima-media thickness in adolescent hypertension. **Hypertonia és Nephrologia** 5(S4):179; 2001.
50. Kovács T, **Páll D**, Juhász M, Zrínyi M, Balla J, Kárpáti I, Mátyus J, Újhelyi L, Kakuk G: Krónikus hemodialízis kezelés során észlelt vérnyomásváltozások jellemzői, különös tekintettel a dialízis hypotenzióra. **Hypertonia és Nephrologia** 5(S4):184; 2001.
51. Varga Z, **Páll D**, Katona É, Polgár P, Kakuk G: Az endotel funkció és a lipidperoxidáció néhány biokémiai paramétere (nitrogén-monoxid, endothelin-1, TBARS, E vitamin) esszenciális hipertóniás fiatalokban. **Hypertonia és Nephrologia** 5(S4):197; 2001.
52. Juhász M, **Páll D**, Kovács T, Zrínyi M, Balla J, Kárpáti I, Mátyus J, Újhelyi L, Kakuk G: Krónikus hemodialízisben részesülő hypertóniás betegek jellemzői. **Hypertonia és Nephrologia** 5(S4):211; 2001.

53. **Páll D**, Settakis G, Katona É, Hegedűs I, Fülöp T, Csiba L, Polgár P, Kakuk G: Az angiotenzin konvertáló enzim gén polimorfizmus, a carotis intima-media vastagság és a bal kamra tömeg index serdülőkori hypertóniában. **Cardiol Hung** S1:44; 2002.
54. **Páll D**, Settakis G, Hegedűs I, Katona É, Zatik J, Polgár P, Kakuk G, Fülesdi B: Increased common carotid artery intima-media thickness and left ventricular mass index in adolescent hypertension. **JACC** 35:165B; 2002. **(IF: 6,374)**
55. **Páll D**, Settakis G, Katona É, Zatik J, Csiba L, Polgár P, Kakuk G: Increased common carotid artery intima-media thickness and left ventricular mass index in adolescent hypertension. **J Hypertens** 20(S4):S72; 2002. **(IF: 4,21)**
56. Katona É, Settakis G, **Páll D**, Zatik J, Csiba L, Polgár P, Kakuk G: Angiotensin-converting enzyme gene polymorphism, carotid intima-media thickness and left ventricular mass index in adolescent hypertension. **J Hypertens** 20(S4):S72; 2002. **(IF: 4,21)**
57. Varga Z, **Páll D**, Katona É, Fülesdi B, Kakuk G. Nitric oxide, endothelin-1, T-bars and Viamin E concentrations in adolescent essential hypertensives. **Nephrol Dial Transplant** 17(S1):80; 2002. **(IF: 2,432)**

Impact factors:

Impact factor of the in extenso publications: 13,353

Impact factor of the abstracts: 69,847