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Evaluation of selected indicators of health status as risk factors for the development of cardiovascular diseases in children from Kutno district

Ocena wybranych wskaźników stanu zdrowia populacji dziecięcej powiatu kutnowskiego pod kątem ryzyka rozwoju chorób układu sercowo-naczyniowego

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Abstract

Introduction. Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality in the adult population. The prevention of cardiovascular diseases depends to a great extent on eliminating risk factors already present in early childhood, thus avoiding secondary cardiovascular events. The aim of this study was to evaluate selected indicators of health status as risk factors for the development of CVD in a paediatric population from Kutno district as part of the project: 'You live for yourself and others — take care of your health'.

Material and methods. The study included 101 children aged from one to 11 years. All children underwent a physical examination. Based on a questionnaire conducted among the parents of the children, information was obtained regarding perinatal history, physical activity, time spent in front of a television, computer or tablet, eating habits, exposure to passive smoking and any family history of CVD. Laboratory tests were also performed, including a lipid profile. A 12-lead electrocardiogram and a screening echocardiographic examination were carried out.

Results. On physical examination, 9.9% of the children were observed to be overweight and 12.87% to be obese. In 3.96% of this group of children, arterial hypertension was observed. In laboratory tests, significant abnormalities were observed in the lipid profiles. Of the children with an abnormal lipid profile, 11.5% were also found to be overweight or obese or with hypertension. The questionnaire revealed that the average daily time the children spent in physical activity was 4.15 hours. More than half of the children ate fast food occasionally or regularly. Exposure to passive smoking was revealed in 15.84% of the children, and a family history of CVD was identified in 17.82% of the children.

Conclusions. The health of Kutno district children is similar to the health of children from other developed countries. Despite better physical activity and normal glucose values, other risk factors did not differ significantly from other paediatric populations.

Key words: health status, risk factors, cardiovascular diseases, children

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Introduction

Cardiovascular diseases (CVD) are still the main cause of morbidity and mortality in adults in Europe, as is the case in Poland [1]. The clinical manifestation of CVD is rare in children. However, the development of CVD in adults is closely correlated with risk factors already present in childhood. Therefore, it is generally accepted that prevention plays a significant role in reducing the incidence of CVD. Prevention should be implemented not only in adults but especially in children and adolescents.

Based on the multicentre study 'Coronary Artery Risk Development In Young Adults' (CARDIA), which monitored the health of 5,000 participants over 20 years, it was found that CVD prophylaxis is effective. The elimination of CVD risk factors would prevent the occurrence of cardiovascular diseases in more than 80% of cases [2].

The importance of cardiovascular diseases prevention in the developmental age population is emphasised in the document 'Cardiovascular Health Promotion in Children: Challenges and Opportunities for 2020 and Beyond' produced by the American Heart Association (AHA). This study found that most children are born healthy, without risk factors for cardiovascular diseases. To assess children's health status, the AHA has introduced a scale that determines the simultaneous presence of four beneficial health behaviours: no tobacco smoking, normal BMI, adequate physical activity, and a healthy diet, plus three health status indicators (normal total cholesterol level, adequate blood pressure, and normal fasting glucose plasma level) [3].

The aim of our study was to evaluate selected indicators of health status as risk factors for the development of cardiovascular diseases in a paediatric population from Kutno district. The study was prophylactic, conducted as part of the project: 'You live for yourself and others — take care of your health' which is a part of the PL13 programme 'Reducing social inequalities in health'. The aim of the project is to improve public health and reduce social inequalities in health, as well as reduce morbidity for diseases connected to modern lifestyles in Kutno district.

Material and methods

The study included 101 children (50 girls and 51 boys) aged 1–11 years (mean 4.59 ± 1.79 years). The children volunteered with their parents as part of the project 'You live for yourself and others — take care of your health'. The project as a whole encompassed 1,001 people — 900 adults and 101 children. The group characteristics are set out in Table 1. Most (96.04%) participants were children aged 2–7 years (Table 2).

All studied children underwent a physical examination including an anthropometric assessment of height, weight, and body mass index (BMI). Children aged 3 years and over underwent a triple oscillometric measurement of their blood pressure, using a sphygmomanometer with an appropriate cuff adapted to the length and circumference of the child's arm. Measurements were taken after at least five minutes of rest in a seated position.

Based on a questionnaire conducted among the children's parents, information was obtained regarding perinatal history, physical activity, time spent in front of a TV, computer or tablet, eating habits (*i.e.* how often the children ate sweets and fast food such as crisps, and drank sweet carbonated drinks such as cola), passive smoking, and family history of cardiovascular diseases.

Table 2. Age ranges

Age (years)	Number	Percentage [%]
< 2	4	3.96
2–4	42	41.58
5–7	51	50.50
> 7	4	3.96%

Table 1. Group characteristics

Parameter	Examined group, N = 101	
	Min–max	Mean ± SD
Sex (F/M)	50/51	
Age [years]	1–11	4.59 ± 1.79
Gestational age [hbd]	31–41	39.04 ± 1.59
Birth weight [g]	1,690–4,500	3,410.88 ± 515.31
1st minute Apgar points	7–10	9.63 ± 0.69
Current body weight [kg]	5–75	20.23 ± 9.07
Current height [cm]	62–160	108.02 ± 14.89
BMI [kg/m^2]	11.78–29.30	16.59 ± 3.03

N — number; min — minimum; max — maximum; SD — standard deviation; F — female; M — male

All the children also underwent laboratory tests including: morphology, fasting glucose, lipid profile, thyroid stimulating hormone (TSH) and thyroid hormones, cortisol, uric acid, urea, creatinine, glycated haemoglobin and C-reactive protein (CRP).

The final stage of the study involved a 12-lead electrocardiogram recording (ECG) and a screening echocardiographic examination (ECHO) using a Vivid S6 (GE) device, with an assessment of anatomy and the estimation of basic systolic cardiac functions (i.e. ejection fraction [EF] and shortening fraction [SF]). The study was conducted at the Allenort Cardiology Centre in Kutno.

Statistical analysis

All parameters were tested for normal distribution using the Shapiro-Wilk W test and were presented as means standard deviation. Nominal variables were presented as numbers or percentages. The profiles of children with obesity were compared to the profiles of children with normal weight. The characteristics of patients were also collated between groups of patients with normal or high blood pressure, and with healthy or inappropriate eating habits. The differences in characteristics between groups were verified using the Student t-test and the Mann-Whitney U test depending on the distribution of data. The results were regarded as statistically significant if $p < 0.05$ was observed. Statistica package version 13 (StatSoft Inc., Tulsa, OK, USA) was used for all statistical analysis.

Results

The study involved 101 children (50 girls, 51 boys), mainly infants and children of pre-school age. Of the analysed group, six children (6.18%) were born prematurely (before the 37th week of gestation), while most children (93.82%) were born on time. The Apgar score in the first minute after birth only in 2 children was 7 points, but in the 5th and 10th minutes after birth was within normal limits. The rest of the study population scored 8–10 points on the Apgar scale. The mean birth weight was 3,410.88 g (± 515.31 g). Only one child was born with intrauterine growth restriction features, the other children being born as appropriate for gestational age.

On physical examination, ten children (9.9%), seven boys (6.93%) and three girls (2.97%), were observed to be overweight, (BMI 85th-95th percentile for sex and age) and 13 children (12.87%), seven boys (6.93%) and five girls (4.95%), were found to be obese (BMI ≥ 95th percentile for sex and age). Overall, overweight and obesity were reported in 23 children, i.e. 22.77% of the studied group (13.86% of boys and 7.92% of girls). In addition, four children (3.96%) were diagnosed with abnormal blood pressure values, defined as the mean of three systolic and/or diastolic blood pressure measurements over the 95th percentile for sex and age. In 12 subjects, (11.88%) pre-hypertension, defined as mean blood pressure between 90 to 95 percentiles for sex and age, was found. Of these, one patient was overweight and two were obese. All the children with overweight, obesity and hypertension were aged three years or over.

In laboratory tests, no child was reported to have significant abnormalities in parameters such as morphology (red blood cells, haemoglobin, haematocrit, leukocytosis, platelets), fasting glucose level and glycated haemoglobin, TSH and thyroid hormones, cortisol, uric acid, urea, creatinine and CRP (Table 3). Significant abnormalities were observed in the lipid profiles. As many as 43 children (42.57%) had an abnormal total cholesterol level (≥ 170 mg/dL). In these subjects, other lipid disorders were found: in three children (2.97%) hypertriglycerydemia (≥ 150 mg/dL) and in 14 children (13.86%) the level of LDL-cholesterol was elevated (> 130 mg/dL). Among the group of children with an abnormal lipid profile, 11 (11.5%) were accompanied by overweight, obesity and hypertension. However, comparing lipid disorders in children without additional risk factors to lipid disorders in children with overweight, obesity and hypertension, the difference was not statistically significant (Table 4, Table 5).

Drawing upon the responses to the questionnaire, it was found that the average daily duration of children's physical activity was 4.15 hours. Only 15 children (14.85%) were physically active for less than three hours during the day. On the other hand, analysis of the time spent by children in front of the television (TV), computer or tablet showed that for most of the studied population (67 children, *i.e.*: 66.34%) it was 1–2 hours per day. Moreover, several children used electronic devices for 4–5 hours a day. Detailed data is given in Table 6.

Asking parents about their children's poor dietary habits (*e.g.* fast food, crisps, coke) more than half admitted that their children ate this type of food (Table 7). Among children who occasionally or regularly ate these unhealthy products, half (50.91%) had an abnormal lipid profile. However, the difference in the lipid profile between children with a fast-food intake and children with a healthy diet was not statistically significant, although it neared the level of significance (50.91% vs 32.61%, $p = 0.064$).

Analysis of exposure to passive smoking revealed that 16 children (15.84%) lived with parents of whom one or both smoked cigarettes. Two children (1.98%) had occasional contact with tobacco smoke when they were with their grandparents. The remaining subjects (82.17%) were not exposed to tobacco smoke. A family history of cardiovascular diseases (ischaemic heart disease, infarction, hypertension, diabetes, overweight or obesity, stroke) was positive in 18 children (17.82%). Of these

Table 3. Laboratory test results

Parameter	Mean ± SD	Minimum	Maximum
RBC [mln/mL]	4.71 ± 0.35	4.02	5.88
Hb [g/dL]	12.62 ± 12.67	11.00	19.93
Htc [%]	36.99 ± 2.55	32.10	44.40
PLT [thousand/mL]	329.73 ± 80.33	186.00	626.00
WBC [thousand/mL]	6.25 ± 1.49	4.00	10.10
Fasting glucose level [g/dL]	83.00 ± 8.13	56.00	100.00
TSH [mIU/L]	2.13 ± 1.16	0.40	5.89
fT3 [nmol/L]	187.11 ± 28.37	132.30	293.00
fT4 [pmol/L]	9.27 ± 1.19	7.01	12.44
Cortisol [μg/mL]	12.35 ± 5.85	3.74	30.67
Uric acid [mg/dL]	3.15 ± 0.81	0.80	5.60
Urea [mg/dL]	24.69 ± 5.57	12.00	44.00
Creatinine [mg/dL]	0.38 ± 0.09	0.20	0.60
HbA_{1c} [%]	5.01 ± 0.27	4,17	5.61
CRP [mg/L]	0.19 ± 0.33	0,01	2.03

RBC — red blood count; Hb — haemoglobin; Htc — haematocrit; PLT — platelets; WBC — white blood count; TSH — thyreotropic hormone; fT3 — thriiodothyronine; fT4 — tetraiodothyronine; HbA_{1c} — glycated haemoglobin C; CRP — C-reactive protein

Table 4. Comparison of children with an abnormal lipid profile with overweight, obesity and hypertension, to those without these risk factors

Group without overweight, obesity and hypertension (N = 74)		Group with overweight, obesity and hypertension (N = 27)		p
Number	Percentage [%]	Number	Percentage [%]	
32	43.24	11	40.74	0.73

Table 5. Comparison of lipid profile in children with overweight, obesity and hypertension, to those without these risk factors

Parameter	Group without overweight, obesity and hypertension (N = 74)		Group with overweight, obesity and hypertension (N = 27)		p
	Mean	SD	Mean	SD	
Total cholesterol [mg/dL]	166.11	31.50	181.06	27.53	0.073
Triglycerides [mg/dL]	66.97	28.01	76.41	45.94	0.270
LDL-cholesterol [mg/dL]	99.94	29.27	112.37	28.72	0.114

SD — standard deviation; LDL — low-density lipoproteins

Table 6. Time spent in front of television, computer or tablet

Time	Number	Percentage [%]
< 1 h/day	15	14.85%
1–2 h/day	67	66.34%
> 2 h/day	19	18.81%

Table 7. Number of children eating fast food, chips, cola drinks

Frequency	Number	Percentage [%]
Never	42	41.58
Occasionally	47	46.53
Often	12	11.88

children, six (5.94%) had an abnormal lipid profile, four (3.96%) hypertension or pre-hypertension, and one child had both risk factors.

In the standard ECG, no significant abnormalities were recorded. On echocardiographic examination, all children had normal heart anatomy without structural defects. In 13 (12.87%) children a slight mitral insufficiency was observed, and in three (2.97%) this was accompanied by haemodynamically not significant aortic regurgitation, most likely postinfectious.

In three children (2.97%) haemodynamically insignificant persistent foramen ovale (PFO) was reported. In all children, systolic function [measured by ejection fraction (EF) and shortening fraction (SF)] was normal.

Discussion

Cardiovascular diseases remain a major problem in the adult population. Exposure to cardiovascular incident risk factors in the paediatric population is an important and growing problem in developed countries [1, 3].

Overweight and obesity are documented risk factors for developing CVD and increasing overall mortality. Over the last three decades, the proportion of children and adolescents who are overweight or obese has been gradually increasing. The primary cause of obesity in children and adolescents is excessive food intake in relation to expenditure of energy [4]. Kułaga et al. [4], analysing a group of 5,026 children aged 2 to 6 years, showed overweight in 12.2% of boys and 10% of girls, and obesity in 4.9% of boys and 3.4% of girls. In our study, we obtained a slightly higher percentage of boys overweight and slightly lower values in girls (13.86% vs 12.20% and 7.92% vs 10.00%, respectively). On the other hand, the proportion of obesity in our group was slightly higher among boys and girls (boys versus girls respectively: 6.93% vs 4.90% and 4.95% vs 3.40%). Hassapidou et al. [5] obtained comparable results to ours. They estimated in a group of 1,250 children aged 2 to 6 years an incidence of overweight and obesity at 21.20%. In our group, with the same criteria for diagnosing overweight and obesity, the percentage was 22.77%.

High arterial blood pressure is one of the major risk factors for many diseases. Although it has been proven that hypertension is more likely to occur in adulthood, elevated values of blood pressure are already seen in childhood [6]. According to different authors, hypertension affects 2–5% of the paediatric population of Poland [7]. This is consistent with our results, where hypertension was observed in 3.96% of our children.

Based on many clinical trials, hypercholesterolemia has been shown to play an important role in CVD aetiology. According to the American Heart Association recommendations, serum total cholesterol level in children aged 6–19 years should be below 170 mg/dL [3, 8]. Despite the fact that total cholesterol level remains the strongest risk factor for CVD development, more attention has been paid to mixed dyslipidemia (elevated triglyceride and LDL-cholesterol level) on CVD evolution [8].

Chrzanowska et al. in their study found that hypertriglyceridemia was the most common lipid disorder in obese children aged 10–18 years [9]. In our group, 42.57% of children had a cholesterol level ≥ 170 mg/dL. Silva et al. in 198 children from Angola aged 7–11 years also reported a high percentage of hypercholesterolemia — in 69.2% of participants [10]. In our group of children with abnormal lipid profile, a quarter were overweight, obese or hypertensive, but all were aged three years or over.

Hyperglycaemia is a proven risk factor for developing CVD [11]. According to the American Diabetes Association, the correct fasting glucose level among adolescents and children is below 100 mg/dL [3]. None of our patients had an elevated glucose level value.

In developed countries, children and adolescents engage in too little physical activity. This is due to a number of factors, including a lack of positive adult role models, the widespread availability of various forms of transport (from lifts to cars) resulting in limited walking, as well as the lack of an attractive infrastructure for various forms of physical activity. Regular, adequate physical activity reduces overall mortality and cardiovascular diseases by 20–30% [12, 13]. Lloyd et al. have shown that parental activity has a positive effect on physical activity and the promotion of a healthy diet in their children [14]. In our study group, the mean time spent on physical activity was 4.15 hours. Only 14.85% of children spent less than three hours a day on physical activity. However, among this group were overweight, obese and hypertensive children.

Furthermore, it largely depends on the parents whether a child spends his or her leisure time actively, or instead chooses a passive lifestyle in front of a computer or TV screen. Väistö et al. [15], studying 468 children aged 6–8, showed a significant positive correlation between an inactive lifestyle (including spending 3+ hours per day in front of a TV/computer screen) and an increased risk of developing CVD (greater fat content, elevated waist circumference, or higher systolic blood pressure values) compared to children who spend time more actively.

A healthy diet helps to lower cholesterol levels, maintain normal blood pressure and weight, and is beneficial for diabetes prevention [16–18].

In the study group, more than half of the parents stated that their child occasionally or regularly ate fast food, drank sugary drinks and ate crisps or sweets in excessive amounts.

Many studies and meta-analyses have found that the consumption of fast foods with limited healthy ingredients, negatively affects body weight and metabolic profile in adolescents and young adults [19–21].

The lack of influence on a child's body of tobacco smoke is one of four beneficial health behaviours. The negative impact on the circulatory system involves not only active smoking by older children, but also passive smoking, to which about 40% of children and young people worldwide are exposed [2, 22]. In our group, less than 18% of children were exposed to passive smoking daily or occasionally (such as when they were with their grandparents or other caregivers). The remainingchildren (82.17%) were not exposed to tobacco smoke at all.

Multigene inheritance is related to metabolic processes, the function of central nervous system hunger and satiety centres, as well as energy consumption. Inadequate nutrition and poor diets at home promote the development of obesity, hypertension, metabolic syndrome

in children and young adults. Such complications lead to a shortening of life expectancy in adulthood [23]. In our group, a family history of cardiovascular disease was positive in almost 20% of the children. In this group of children, 61% at the study time were already affected by one of the CVD risk factors, such as overweight, obesity or hypertension.

In our research we did not notice significant abnormalities in 12-lead ECG; cardiac anatomy in echocardiographic examination was also normal in all children. Haemodynamically insignificant mitral and aortic insufficiencies, observed in several children, were most likely due to frequent respiratory tract infections. Myocardial contractility disorders were not observed. Despite the good echocardiographic evaluation and no obvious evidence of myocardial failure, it is important to remember that the American Bogalusa Heart Study has shown that 5–7-year-olds who are overweight, obese or hypertensive die more often as a result of coronary heart disease at a young age, compared to those who do not have these risk factors in their childhood [23].

Conclusions

In summary, the health of Kutno district children is similar to that of children from other developed countries. Despite better physical activity and normal glucose values, other risk factors did not differ significantly from those of other paediatric populations. Therefore, prophylaxis of cardiovascular diseases in the Polish children's population is imperative in the quest to eliminate secondary changes in the circulatory system in the adult population.

Limitation of the study

The limitation of our study was a small group of patients, but it was part of the project 'You live for yourself and others — take care of your health', where the funds allowed for the evaluation of 900 adults and only 100 children.

Conflict of interest(s)

The authors do not declare any conflict of interest.

Streszczenie

Wstęp. Choroby układu sercowo-naczyniowego (CVD) są główną przyczyną chorobowości i śmiertelności w populacji osób dorosłych. Ich profilaktyka odgrywa ogromną rolę w wyeliminowaniu niekorzystnego wpływu czynników ryzyka już w okresie wczesnego dzieciństwa, co pozwala uniknąć wystąpienia wtórnych zdarzeń sercowo-naczyniowych. Celem pracy jest ocena wybranych wskaźników stanu zdrowia populacji dziecięcej powiatu kutnowskiego pod kątem ryzyka rozwoju CVD w ramach projektu „Żyjesz dla siebie i innych — zadbaj o zdrowie".

Materiał i metody. Badaniem objęto grupę 101 dzieci w wieku 1–11 lat. U wszystkich przeprowadzono badanie przedmiotowe. Ponadto przeprowadzono badanie ankietowe dotyczące: wywiadu okołoporodowego, aktywności fizycznej, czasu spędzanego przed telewizorem, nawyków żywieniowych, narażenia na bierne palenie tytoniu oraz występowania CVD w rodzinie. Wykonywano także badania laboratoryjne, w tym lipidogram oraz zapis spoczynkowego 12-odprowadzeniowego elektrokardiogramu (EKG) i przesiewowe badanie echokardiograficzne.

Wyniki. W badaniu przedmiotowym u 9,9% dzieci stwierdzano nadwagę, a u 12,87% dzieci — otyłość. W tej grupie pacjentów u 3,96% dzieci stwierdzano nieprawidłowe wartości ciśnienia tętniczego. W wykonanych badaniach laboratoryjnych istotne odchylenia obserwowano w zakresie lipidogramu. W grupie dzieci z nieprawidłowościami lipidogramu 11,5% towarzyszyły nadwaga, otyłość i nadciśnienie tętnicze. Na podstawie przeprowadzonego badania ankietowego ustalono, że średni czas spędzany przez dziecko na aktywności fizycznej to 4,15 godziny. Więcej niż połowa dzieci spożywała okazyjnie lub często pokarmy typu *fast-food*. Na bierne palenie tytoniu było narażonych 15,84% dzieci. Wywiad rodzinny w kierunku CVD był pozytywny u 17,82% dzieci. W standardowym zapisie EKG oraz w badaniu echokardiograficznym u nie stwierdzano istotnych odchyleń od normy.

Wnioski. Stan zdrowia dzieci powiatu kutnowskiego jest zbliżony do stanu zdrowia dzieci z innych krajów rozwiniętych. Mimo lepszych wyników w zakresie aktywności fizycznej oraz prawidłowych wartości glikemii, inne czynniki ryzyka nie odbiegały istotnie od wyników badań dotyczących innych populacji dziecięcych.

Słowa kluczowe: stan zdrowia, czynniki ryzyka, choroby układu sercowo-naczyniowego, dzieci

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