Observational Study

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Body posture and physical activity in children diagnosed with asthma and allergies symptoms

A report from randomized observational studies

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Abstract

Asthma and body posture abnormalities in children and young people are major epidemiological problems worldwide. Asthma among children and adolescents, its relations with physical activity (PA) and PA relations with body posture were and are still being investigated.

The aim of this study was to investigate how body posture is shaped in children diagnosed with asthma symptoms and whether body posture is associated with PA. The study involved 192 children. The main group consisted of 90 children diagnosed with asthma and allergies symptoms age 9 to 12 years old ($x = 10.75 \pm 1.08$). The control group included 102 healthy children at the similar age ($x = 10.64 \pm 1.1$). The level of activity has been assessed on the basis of a questionnaire and body posture assessments were done using a plumb line, pediscoliometer, digital inclinometer.

Comparison of percentage of respondents fitting into body posture norms clearly indicates higher value in the group classified as active. In the group of participants diagnosed with asthma, percentage differences of participants with good body posture (without postural defects) were statistically significant. Among healthy children, percentages of the participants were higher in active children than in inactive children.

Body posture is directly related to PA and the lack of activity affects disturbances within posturometric parameters. Prevention of body posture abnormalities is worth promoting in groups of children, also with various diseases including asthma and allergies symptoms.

Abbreviations: ATR = angle of trunk rotation, BMI = body mass index, C7 = 7th cervical vertebra, PA = physical activity, SOSORT = Society of Scoliosis Orthopaedic and Rehabilitation Treatment, THL/L = thoraco-lumbar spine, WHO = World Health Organization.

Keywords: body posture, physical activity, SHS, symptoms of asthma and allergies

1. Introduction

Nowadays allergic diseases are a huge epidemiological problem worldwide.[1,2] According to the World Health Organization (WHO) estimations, the world's problems of allergies combined with rhinitis affect hundreds of millions of people, and the population of people with asthma is estimated to be approximately 300 million.[3] According to the American Lung Association, asthma occurs more frequently in adults than in children.[4] Among children, it is more common in boys than in girls, although after puberty it occurs more frequently in women than in men.[4] It is considered the most common cause of morbidity of children and adults up to 40 years of age.[5] Epidemiological importance of this problem is being highlighted by conducting global studies on its dynamics and causes.[6]

Another major epidemiological problem concerning a significant proportion of children and young people are postural problems of the body, of which 5% are severe deformities.[7–8] The latitude has effect on occurrence rates of body posture defects.[9] In the modern world of development of computerization and electronics, children and teenagers from the youngest years choose sitting forms of spending free time (in front of a computer, TV). Passive mobility becomes the cause of muscular disbalance, which may be a risk factor for abnormalities in body posture.[10–12]

The diagnosis of postural defects of the body becomes a broader problem requiring further improvement.[13] This proceeding is directly related to the controlled physical activity (PA), same as diagnosed allergies and asthma.[14] In the case of asthma, the fear of the occurrence of breathlessness attacks may lead to restrictions in participation in various forms of PA, including sport.[14] Empirical studies indicating lower than average level of PA in young asthmatics seem to confirm this hypothesis.[15] Other reasons for restricting PA by children and young people suffering from asthma are health convictions of children and parents and a wealth of leisure activities in the company of electronic gadgets.[16–19] The problem of movement passiveness, its consequence—hypokinesis and their impact have been the subject of many studies.[20] From the body posture point

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of view, negative influence on the development of postural patterns during posturogenesis has been found.[7,8]

The problems of asthma in children and adolescents, its relations with the PA and the PA relations with body posture were and are still being investigated. However, no study explains the importance of PA in children and adolescents with asthma for the quality of body posture. Epidemiological importance of asthma and the prevalence of postural defects seem to fully justify exploration in this direction.

The aim of this study was to investigate how body posture is shaped in children diagnosed with asthma symptoms and whether or not body posture is associated with PA. The differences between the quality of body posture between children with asthma and allergies and healthy children considering the level of PA were shown. In addition, an attempt was made to describe how PA can be a predictor of correct body posture in children diagnosed with asthma symptoms and allergies.

2. Material and methods

2.1. Ethical statement

The study has been approved by the Bioethical Committee of the Medical University of Silesia in Katowice under resolution No. KNW/0022/KB1/162/10 and No. KNW/0022/KB1/100/16. It is conformed to the Helsinki Declaration. All of the children and their parents provided written informed consent before the study, including enrolment and data collection.

2.2. Participants

Examined persons were participants of the program "Prevention of body posture abnormalities among students of primary school". Participation in the program has been proposed to directors of 9 primary schools in the Silesia region in Poland. Positive responses regarding the desire to participate in this program were received from 5 institutions. Research was multifaceted and conducted in collaboration with parents, teachers, school nurses, and doctors. The object of the study was the epidemiology of body posture defects occurrence, involving hypothetical risk factors concerning morphology, concomitant diseases, and lifestyle elements—with particular emphasis on PA.

Recruitment for the study involved following steps:

2.2.1. The first stage of recruitment. Data concerning health status of respondents, the prevalence of any chronic conditions and lifestyle of children was collected using a questionnaire filled in by parents. Questionnaires were distributed during meetings with parents, where all the information concerning design of studies and anticipated procedures was provided. At this stage, information involving more than 1500 children and adolescents was obtained.

Considering the topic of the present study, the following selection criteria were adopted: age: 9 to 12 years and systematic participation in the compulsory physical education classes throughout the school year.

2.2.1.1. Exclusion criteria. A history of earlier serious injuries within the musculoskeletal system, which may result in disturbances of body posture, appearance of a growth spurt associated with puberty, the occurrence of menstruation in girls in less than 1 year, the occurrence of defects or chronic diseases resulting in contraindications to PA and participation in physiotherapy aimed at correcting body posture abnormalities.

2.2.1.2. Randomization. On the basis of the performed analysis (met adopted criteria and completeness of data) 1165 potential participants were selected. Due to incomplete or incorrectly filled documentation, 213 potential candidates have been removed. Subsequently, 218 candidates were excluded due to restrictive criteria concerning body posture due to serious spinal deformities or chronic diseases, heart and chest defects, and motor organ dysfunctions. 1124 people were subjected to screening and 1103 candidates who met the criteria were finally selected for the study (Fig. 1).

2.2.2. The second stage of recruitment. Collected questionnaires were analyzed for the presence of diagnosed allergies and asthma symptoms treated for at least 1 year. 105 such persons were classified to the basic group (A). Children with asthma and allergies symptoms were treated for at least 1 year in specialist clinics. Parents indicated this information in the questionnaire. Authors did not diagnose asthma. The aim of the work was not to diagnose asthma or allergies but only to assess the body posture in this group, therefore the criterion of inclusion in this group was the diagnosis and systematic treatment of asthma or allergies for a minimum period of 1 year. A questionnaire completed by parents and confirmation of diagnosis resulting from medical records served to verify these data.

The child's condition was controlled systematically by the supervising doctor. None of the examined children was severely ill or in phase of exacerbation during the study. Children who had contraindications to PA were excluded from the study. Other 998 were healthy children, among whom the draw was made as to identify the control group (B). It was assumed that the size of this group should be similar to the basic group. Therefore, 10% of healthy children were drawn to the third stage of the study. The children in group A (n = 105) and B (n = 102) received an offer to be included in the study. 15 candidates withdrew from the group A after randomization. Finally, the main group included children diagnosed with allergies and asthma (n = 90) and the control group included children without these symptoms (n = 102). In addition, these groups were divided into subgroups: active and inactive children. The criterion for this division was based on the WHO guidelines:

(1) Children and youth aged 5 to 17 should accumulate at least 60 minutes of moderate—to vigorous intensity PA daily;
(2) Most of the daily PA should be aerobic;
(3) Vigorous-intensity activities should be incorporated, including those that strengthen muscle and bone, at least 3 times per week.[21]

The level of activity of examined children has been assessed on the basis of a questionnaire filled out by their parents. Included questions related to lifestyle elements (PA includes play, games, sports, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities), especially leisure activities weekly and during weekends. According to the level of PA in leisure time, specified by parents, all respondents were divided into 2 groups:

(i) moderate-to-vigorous physical activity (MVPA) and
(ii) sedentary time (ST).

This classification concerned both asthmatic and healthy participants.

In the active group, there were 44 children with symptoms of asthma and allergies (24 girls and 20 boys) and 48 healthy children (24 girls and 24 boys). In the passive group, there were 46 children with symptoms of asthma and allergies (24 girls and 22 boys) and 54 healthy children (23 girls and 31 boys) [Fig. 1].

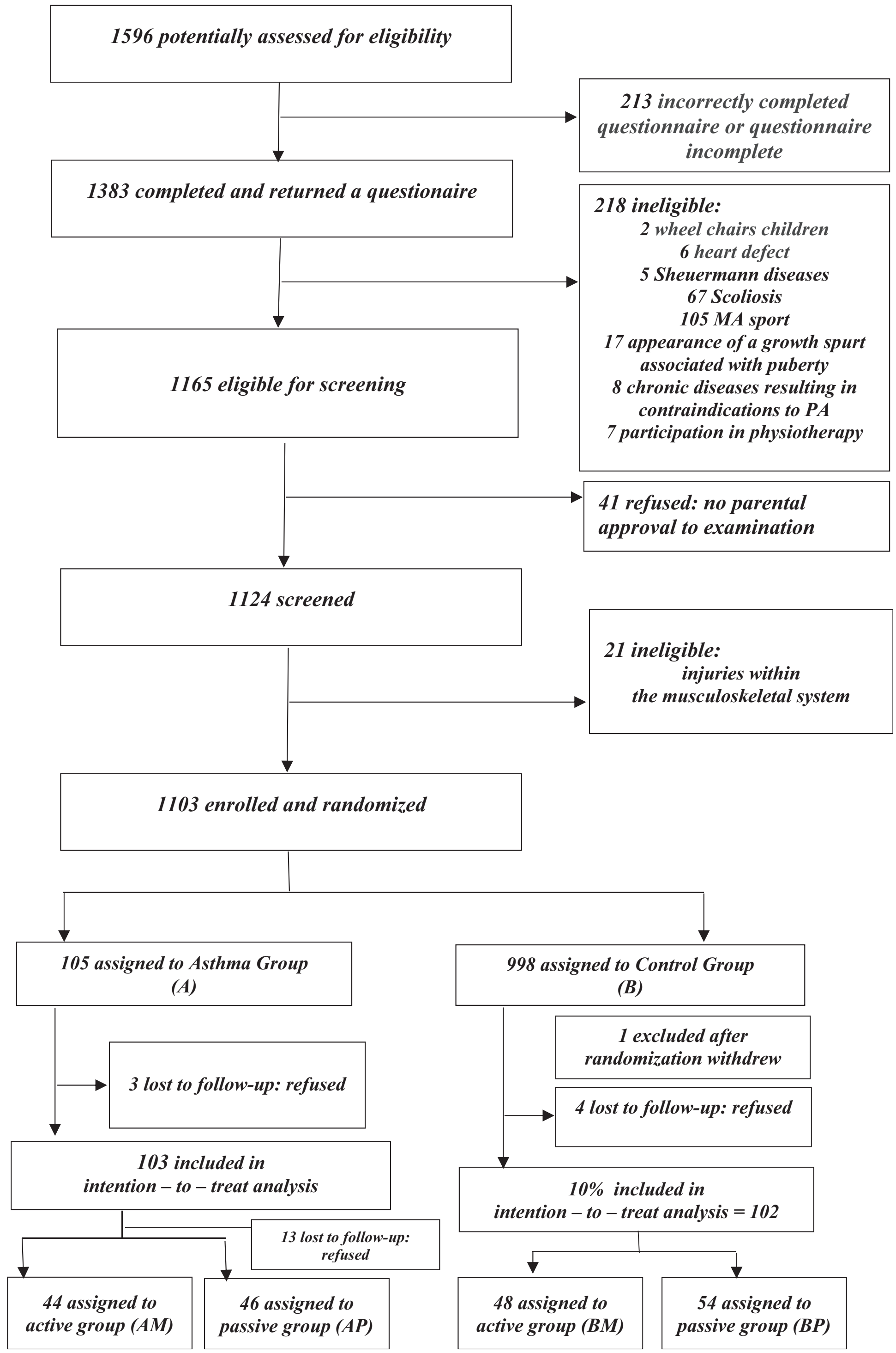

Figure 1. Visual insight in the selection procedure of participants (A—children with symptoms of asthma and allergies, B—healthy children): AM = MVPA group A; BM = MVPA group B; AP = passive group A; BP = passive group B; MVPA = moderate-to-vigorous physical activity).

3. Methods

Measurements of height and weight of respondents were done. Subsequently, based on these measurements, body mass index (BMI) in percentiles was calculated.[21]

All of the measurements were conducted by an experienced and qualified researcher.

The assessment of body posture quality was carried out using classic tools and tests for body posture evaluation suggested for use by Society of Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) based on scoliometer, digital inclinometer or Sunders plurimeter TMX-127 and plumb line (all of the appliances are certified).

Norms of body posture described using the following parameters were taken into account:

1. Torso rotation angle with the use of pediscoliometer during Adams' test in standing position on 3 levels: on the peak of cervical kyphosis, in thoracolumbar junction and on the peak of lumbar lordosis. Angle of trunk rotation (ATR) was measured with scoliometer ≤3° for each spine segment.
2. Suzuki Hump Sum indicator (SHS) was calculated in order to avoid erroneous overdiagnosis of body posture abnormalities.[22] The norm values ranged between 0° to 3°, 4° to 6° value inclined to make observations of examined children and to perform re-study within 6 months, the value of above 7° indicated the need for orthopedic consultations.
3. The plumb line (projected from external occipital protuberance) falling down on gluteal sulcus—the distance from gluteal cleft ≤0,5 cm.
4. Thoracic kyphosis and lumbar lordosis in median plane measured using digital inclinometer, included in the range of values 24° to 36° described by Dobosiewicz.[23]
5. The level of shoulder blades position measured using a ruler and scoliometer ≤2°.
6. Mathias test of postural muscle endurance in standing positions with arms bent to 90° for a time period of ≥30 seconds.

3.1. Statistical analysis

For missing data, the last observation carried forward (LOCF) method was used. This analysis imputes the last value observed before dropout, regardless of when it has occurred. Quantitative data were described using mean values and standard deviation. Homogeneity between samples was examined using the Kolmogorov–Smirnov 2-sample test. The analysis showed that the majority of measured parameters had normal distribution compatibility. Baseline characteristics of 2 groups were compared using 2-sample *t* tests for continuous variables and chi-square tests for categorical variables. 95% confidence intervals (CIs) were calculated. The following statistics methods were used for data analysis: Mann–Whitney *U* test for continuous variables with non- normal distribution, Student *t* test for continuous variables with normal distribution—to assess relations between examinations and non-parametric characteristics test χ2 and Spearman's Rank test.

Relations between particular results were searched sequentially. Subsequently, differences between parameters obtained in both groups were described. Weighted Kappa Statistic was used as a measure of intra-examiner reliability. Intra-class correlation coefficients were used as a measure of inter-examiner reliability for each method. Comparison analysis was performed to determine the 95% limits of agreement for all examiners. To avoid inter-tester variation, the same tester carried out all tests in the same participant. All statistical tests were performed at the 2-tailed 5% level of significance.

4. Results

Among the most frequently declared forms of PA during leisure time in both active groups similarly have been mentioned: football, swimming, tennis, dancing, and basketball.

Compared groups were homogeneous in terms of morphological indicators. Children from inactive groups tended to achieve higher BMI (Table 1) as compared with active groups, but the

Table 1

Mean values, standard deviation (SD) and minimum/maximum values of anthropometric and posturometric parameters. Mathias test results in each group of the study in planes.

	Groups											
	Main A (n=90)						Control B (n=102)					
	AM (n=4)			AP (n=46)			BM (n=48)			BP (n=54)		
Parameters	Mean (SD)	95 CI	Me	Mean (SD)	95 CI	Me	Mean (SD)	95 CI	Me	Mean (SD)	95 CI	Me
Anthropometric parameters												
Age, Yr	10.93 (1.06)	10.6–11.26	10.93	10.58 (1.08)	10.26–10.9	10.59	10.75 (1.0)	10.46–11.04	10.75	10.55 (1.17)	10.23–10.87	10.55
Height, Centimeter	147.41 (10.87)	144.1–150.7	147.41	146.7 (9.68)	143.82–149.58	146.7	147.81 (10.09)	144.88–150.74	147.81	145.64 (9.09)	143.1–148.1	145.64
Weight, Kilogram	37.43 (7.42)	35.02–39.85	34.44	38.04 (5.87)	36.29–39.78	38.04	36.98 (7.12)	34.92–39.06	36.99	36.75 (6.18)	35.07–38.43	36.75
BMI, Percentile	34.84 (25.66)	27.04–42.64	34.84	46.43 (31.7)	31.01–55.86	46.43	32.66 (22.57)	26.11–39.23	32.66	38.98 (24.09)	32.4–45.55	38.98
Posturometric parameters												
Plumb-line anal cleft, cm	0.43 (0.26)	0.35–0.5	0.5	0.77 (0.52)	0.62–0.93	0.5	0.21 (0.25)	0.14–0.29	0	0.63 (0.42)	0.51–0.75	0.5
Scapulae level (°)	0.37 (0.72)	0.14–0.59	0	1.72 (0.99)	1.42–2.02	2	0.21 (0.4)	0.09–0.33	0	1.44 (1.1)	1.12–1.75	1
Kyphosis angle (°)	29.61 (2.81)	28.75 -30.46	29	39.08 (4.7)	37.69–40.48	39	32.63 (3.04)	31.74–33.5	33	35.2 (4.97)	33.78–36.63	36
Lordosis angle (°)	30.39 (3.87)	29.2–31.56	31	26.62 (4.61)	25.24–28.01	26	25.44 (2.52)	24.7–26.16	29.5	30.23 (3.88)	29.09–31.37	31
Angle of Trunk Rotation *C_7-Th_1 (°)*	1.15 (0.93)	0.87–1.44	1	1.05 (0.64)	0.86–1.24	1	0.8 (0.75)	0.58–1.02	1	0.92 (0.88)	0.79–1.42	1
Angle of Trunk Rotation *Th (°)*	2.16 (0.85)	2.09–2.72	2.5	3.26 (1.93)	2.95–3.96	4	1.85 (1.01)	1.56–2.14	2	2.47 (0.71)	2.65–3.18	3
Angle of Trunk Rotation *Th-L/L (°)*	2.32 (1.3)	1.92–2.71	2	2.02 (0.98)	1.72–2.32	2	1.89 (0.83)	1.65–2.13	2	2.08 (0.98)	1.8–2.36	2
Sum of Trunk Rotation *(HUMP SUM °)*	3.21 (0.85)	2.95–3.46	3	4.71 (1.31)	4.33–5.11	4	2.33 (0.88)	2.08–2.59	2	3.61 (0.8)	3.38–3.83	4
Mathias test	22.83 (6.97)	20.66–25.01	25	20.65 (7.96)	18.28–23.02	21.5	25.89 (6.05)	24.14–27.65	30	21.97 (6.42)	20.09–23.93	22

AM=MVPA group A, AP=passive group A, BM=MVPA group B, BP=passive group B, C=cervical spine, L=lumbar spine, Th-L=thoraco-lumbar spine, Th=thoracic spine.

Table 2

Comparison of percentages of participants with normative values of analyzed parameters*.

	Groups					
	Main A (n=90)			Control B (n=102)		
Parameters	AM (%)	AP (%)	*P*	BM (%)	BP (%)	*P*
Frontal plane						
Plumb-line anal cleft, cm	93.18	52.17	.0001	100	64.81	.0001
Scapulae level (°)	95.45	69.56	.0007	97.91	83.33	.005
Sagittal plane						
Kyphosis Angle (°)	100	39.13	.0001	100	59.26	.0001
Lordosis Angle (°)	93.18	65.21	.0006	100	83.33	.001
Transverse plane						
Angle of Trunk Rotation C_7-Th_1 (°)	100	100	1	100	88.89	.008
Angle of Trunk Rotation Th (°)	86.36	30.43	.0001	100	68.52	.0001
Angle of Trunk Rotation Th-L/L (°)	81.81	100	.001[1]	100	85.18	.002
Sum of Trunk Rotation (HUMP SUM °)						
Norm	70.45	10.86	.0001	95.83	46.29	.0001
Observation	29.54	76.08	.0001	4.17	48.15	.0001
Orthopedic consultation	0	13.04	.006	0	5.55	.04
Mathias test	34.09	34.78	.5	54.16	33.33	.007

P value according to * the test between 2 components of the structure.

differences were not statistically significant. The values of measured body posture parameters in each group are presented in Table 1.

Comparison of percentage of respondents fitting into norms clearly indicates higher value in the group classified as active. The exception is the value of trunk rotation in thoracic-lumbar spine in children with asthma, where all inactive children were in "normative" range and a percentage of active children amounted to less than 82%.

In the group of participants diagnosed with asthma, besides Mathias test and the assessment of rotation value at the level of 7th cervical vertebra (C7), percentage differences of "normative" participants, as shown by the test between 2 components of the structure, were statistically significant. Among healthy children in each case, percentages of "normative" participants were higher in active children and the differences were statistically significant (Table 2).

Most of deviations from proper normative values have been observed in the transverse plane. Most of abnormal values in the assessment of trunk rotation ATR (Adams Trunk Rotation) were in the PA group. In this group, HUMP values within the range 4° to 6°, which according to the SOSORT recommendations require re-examination and observation over 6 months, were found in 39.58% of all examined cases (respectively AM—29.54% BM—4.17% and BP—48.15%). Due to the values above 7°, urgent consultations with a specialist were advised in 6 cases among inactive children from the main group. Most of the differences between the groups have been observed in the transverse plane in thoracic spine (Table 3).

5. Discussion

Selection criteria justified treating all respondents as a homogeneous group—regardless of sex. Moreover, it is confirmed by

Table 3

Differences in evaluated body posture parameters between examined groups assessed by *U*-MW test.

	Groups					
Parameters	AM/AP	BM/BP	AM/BM	AP/BP	AM/BP	AP/BM
Frontal plane						
Plumb-line anal cleft, cm	3.34**	3.05**	1.81	1.08	2.4*	3.98**
Scapulae level (°)	2.11*	2.45*	0.64	1.61	1.87*	2.45*
Sagittal plane						
Kyphosis Angle (°)	6.19***	4.96**	0.003	1.99*	4.77**	6.41***
Lordosis Angle (°)	3.09*	2.29*	1.82	2.61*	0.63	4.33**
Transverse plane						
Angle of Trunk Rotation C_7-Th_1 (°)	0.12	1.96*	1.88	1.91*	1.87	0.003
Angle of Trunk Rotation Th (°)	5.33***	4.05**	2.62*	3.92**	1.82	7.07***
Angle of Trunk Rotation Th-L/L (°)	1.31	1.64	3.07*	0.6	1.95	2.07*
Sum of Trunk Rotation (HUMP SUM °)	1.19	2.96**	2.24*	1.01	0.69	3.34**
Mathias Test (sek)	0.22	0.003**	0.02*	0.38	0.48	0.0001***

AM=MVPA group A, AP=passive group A, BM=MVPA group B, BP=passive group B, C=cervical spine, L=lumbar spine, Th – L=thoraco-lumbar spine, Th=thoracic spine.
* Statistically significant differences between groups.
* $P<.05$.
** $P<.001$.
*** $P<.00001$.

percentage proportions in compared groups. Comparison of age and morphological parameters of participants—according to groups adopted in the methodology of the study, showed no statistically significant differences ($P > .05$), suggesting the relative homogeneity of participants. It also allows eliminating these variables as having direct relationships with the analyzed issue in further analysis.

Body posture is characterized by variability and individuality,[24] which has been confirmed in studies and given the relevant similar study references. The majority of assessed body posture indicators revealed relatively large variation in obtained results, regardless of adopted division into groups (Table 1).

Individual character of body posture is an expression of the stage and complexity of posturogenesis. This process is influenced by various biological, psychological and behavioral factors. It is believed that body posture is determined by genetic background (movement patterns encoded in CNS) and modified by these factors.[25] The early stage of development is extremely important since in this stage movement patterns are formed. Therefore, the key role of PA, which is a necessary stimulus for the proper development of children not only in terms of body posture but in all areas, is also a predictor of activity in adulthood. Accordingly, suggestions and recommendations of CDC/ACSM (Centers for Disease Control and Prevention/ American College of Sports Medicine) advise at least 30 minutes of moderate-intense PA 5 days a week or vigorously increased activity for at least 20 minutes 3 days a week.[26] It justifies division adopted in this study—due to PA. There are not many objective contraindications for PA. Most frequently they result from congenital defects or diseases, but also in this area opinions concerning PA are evolving.[27,28] In relation to the body posture development, these opinions most frequently concern large deformations of the spine.[29] However, there is no doubt that developing disease is often a factor which modifies functional and structural body state, usually limiting PA. This implies a number of risks which are related to the biological, functional, and psychological spheres. This also applies to allergies and asthma, which symptoms may adversely affect PA. In the case of PA, the efforts that stimulate the occurrence of these symptoms may be particularly critical.[30,31] Therefore, in asthmatic children, it is important to control the effort which is proper in terms of form, intensity and performance conditions. The risks associated with sedentary lifestyle may also relate to the area of nutrition and energy balance, while the lack of control over the quality of nutrition can foster intensification of symptoms, as noted by the authors in terms of BMI. Therefore, a sedentary lifestyle is mentioned on the list of demographic, developmental and lifestyle factors influencing progression of asthma. It constitutes a threat of "vicious circle" where physical passivity is not only a factor interfering with correct development, but it also fosters dynamic development irregularities, including those related to body posture.[32]

Presented research results seem to confirm the importance of PA for the quality of body posture, which significance for the functioning and quality of life was and still is the subject of interest of many researchers.[27,28] The analysis of results indicates higher percentages of people meeting SOSORT requirements among active participants in both groups—among asthmatic and healthy children. The exceptions are C7 and thoraco – lumbar spine (THL/L) in children diagnosed with asthma. In the case of C7, no differences were found—due to activity. Percentage differences of "normative" THL/L in asthmatic children—at the expense of active children can be explained by increased mobility of this segment relative to the other. Children in this group with ATR values above 3° have been secured and re-examined within 6 months, but the progression or regression of this component can be only found at the re-examination in the next year.

The coefficient of thoracic kyphosis depth is comparable in active asthmatic children and in healthy children, but it is significantly higher in passive asthmatic group. Probably it is related to the impact of the disease on the development of the chest. It can also be associated with time spent in a sitting position and the quality of posture while sitting. These are considered as modifiers of spine orientation in sagittal plane.[33] However, this requires further analysis in this regard.

Presented results are innovative and require further observation and analysis in the field of various other aspects and contrast data to healthy children. The promotion of healthy lifestyle including PA may be a factor influencing proper body posture and preventing from body posture abnormalities. It should be emphasized that the study of our authorship is the first randomized trial study in this field. The main limitation of the study is a relatively small sample size, which was caused by the exclusion of patients who had contraindications to PA, injuries within the musculoskeletal system, no parental approval to examination, participation in physiotherapy, as well as the fact that participants were controlled systematically by different supervising doctors from various centers.

6. Conclusion

Body posture is directly related to PA. The lack of activity affects disturbances within posturometric parameters in each plane in both groups. Most of deviations from proper normative values have been observed in the thoracic part of transverse plane in inactive asthmatic children. The coefficient of thoracic kyphosis depth is significantly higher in passive asthmatic group. Systematic, regular, and proper selection of its correct forms shapes its development.

7. Conclusion for practice

Due to the fact that PA can be perceived in the context of prevention of body posture abnormalities, it is worth promoting in different age groups of children and young people, also with various diseases including asthma and allergies symptoms. Since the body posture will change due to the physiological posturogenesis process regardless of the disease development, children with asthma and allergies symptoms should be perceived through its prism.

Author contributions

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