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HYPERACTIVITY AND INATTENTION OF CHILDREN IN THE ASSESSMENT OF TEACHERS AND THE RESULTS OF THE ADSCANER SYSTEM TEST

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Summary. This study attempts to examine relations between ADScaner results (hyperactivity and inattention) and symptoms of ADHD of children assessed by their teachers. It was a screening study. Teachers selected children who were hyperactive, then ADHD Questionnaire were conducted with teachers to obtain ADHD symptoms of hyperactive and control children. All children were assessed by ADScanner system. It is a device for evaluating motor activity (Doppler radar) and attention

(Continuous Performance Test). Children assessed as hyperactive by their teachers performed worse in the attention task and had higher level of motor hyperactivity than the control group. In the entire group, overall performance on the ADScanner tasks was low but significant related to ADHD domains evaluated by ADHD Questionnaire. In separated hyperactive and control groups, there were no significant correlations. Teachers assessed students rather accurately. But the objective measures of hyperactivity and inattention are useful in a screening diagnosis of ADHD. Key words: motor hyperactivity, inattention, screening, ADHD

Introduction

Attention deficit hyperactivity syndrome is one of the most common neurodevelopmental disorders, its incidence is estimated at 3 to 5% of the population of children and adolescents of school age. This means that at least one hyperactive child may appear in each 30-person class (Namysłowska, Wolańczyk, 2010). The majority of

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treated children are aged 6-9 years, because the beginning of school education shows the child's difficulties resulting from axial symptoms, i.e. motor hyperactivity, impulsiveness and inattention. Symptoms of the disorder make children unable to function within the educational system (Namysłowska, Wolańczyk, 2010).

Nosological diagnosis is based on symptomatic criteria according to DSM-5 and ICD-10, and the source of knowledge about symptoms should be teachers, parents and the child itself (Namysłowska, Wolańczyk, 2010; Pawłowska, Kalka, 2012). Therefore, the identification of symptoms of inattention and hyperactivity in children with ADHD is based on evaluation by parents and teachers. Questionnaire tools for this purpose are useful, but they are exposed to subjective assessments and the influence of various factors, e.g. motivational or specificity of the environment in which observation is carried out. In order to increase the accuracy of the diagnosis, a "multi-tool" approach is introduced to supplement subjective information obtained from informants from the child's environment with objective data (Biederman et al., 2004).

Attempts to objectivise symptoms are also made due to the lack of consistency in the results of subjective assessments of children's behaviour by parents and teachers. The results of the study of school-age children indicate either a high correlation between the assessments of parents and teachers (Borkowska, 2008), or a lack of any interdependence (Glass et al., 2014). Observations of parents and teachers are carried out under specific environmental conditions, which may be important for the way the symptoms of the disorder are expressed (Lee, Lammers, Witruk, 2015). Therefore, the search for objective measures may facilitate the assessment of a child's behaviour.

The studies published so far have used various measures of objective behavioural assessment of symptomatology in children. These were mainly computer-controlled Continuous Performance Tests (CPT) for attention assessment and portable devices monitoring motor activity, the so-called actigraphs for assessment of motor activity (Sims, Lonigan, 2012; Borkowska, 2016). Continuous performance tests are a well-known and frequently used measure of attention processes (McGee, Clark, Symons, 2000; Advokat et al. 2007; Edwards et al., 2007; Conners, Sitarenios, 2011). Actigraphy is an objective, non-invasive, quantitative method of assessing hyperactivity, which has been popular for 20 years (Meltzer et al., 2012). It is a device placed on the child's body, monitoring its motor activity. Actigraphs have been used in the study of children with various developmental problems, including ADHD and FASD (Glass et al., 2014). Due to the high costs of their use, they are currently used mainly in the diagnosis of problems in which the assessment of mobility is

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important for a full understanding of the disease, such as sleep disorders (Wiggs, Stores, 2004; Marino et al., 2013).

The use of additional measures of symptoms in ADHD, including hyperactivity, began to be introduced in the 1990s. The Data and Co-workers (2000) study used the actigraph to assess the level of motor activity in children with ADHD diagnosis. Children were examined during two-hour sessions: morning and afternoon. Two main subtypes of ADHD were compared: mixed and careless with typical developing children. There were no differences between children with ADHD, regardless of subtype, and the control group in the morning session. Differences in the form of increased activity in hyperactive children appeared only in the afternoon session. In the conclusions the authors emphasized the importance of the results obtained in the context of the need to take into account the temporal dimension and the influence of environmental factors on the level of motor activity of children with ADHD. An interesting result was also to obtain data on a similar level of motor hyperactivity in children with ADHD regardless of subtype, which is in some way inconsistent with the symptomatic diagnosis according to the DSM classification.

Another method used to objectively assess hyperactivity was infrared motion analysis systems. In studies using this type of measure, it was shown that children with ADHD presented 25-30% higher motor activity than their peers during the lesson, i.e. in the child's natural life situation and in specific conditions, during psychological examination in the office (Teicher et al., 2004).

In the search for methods that objectify symptoms, tools combining the advantages of both CPT and motion analysis systems were developed. The essence of these methods was the analysis of motor activity during CPT. 8- and 9-year-old children participated in the study by Teicher and colleagues (1996). The study included 4 markers registered 50 times per second in space every 0.04 millimetre. Children with ADHD moved their heads 2.3 times more often than typically developing ones, 3.4 times more often moved, turned 3.8 times more often and showed more linear and less complex patterns of movement. They reacted more slowly and with a greater variety of reaction times. The level of complexity of movements and differentiation of reaction latency significantly correlated with the behavioural assessments formulated by teachers. This objectively confirmed the difficulty of children with ADHD in sitting still, and the so-called drilling turned out to include frequent, high amplitude movements of the whole body.

Also in Poland, already in the 90's, there were attempts to objectivise the assessment of

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symptoms of motor hyperactivity. Due to the high costs of using the actigraph, there were attempts to use a much cheaper and simpler method of filming motor behaviour of children sitting in a forced position for 15 minutes with a camera. After recording two independent judges, competent judges evaluated the movements of the head, limbs and the whole body. The usefulness of this method of monitoring the mobility of children aged 8-12 years with the diagnosis of ADHD was confirmed (Kolakowski, Liwska, Wolańczyk, 1998).

Nowadays, it is emphasized the need to conduct physical activity tests (Physical Activity - PA) of children over a period longer than just a dozen or so minutes in the laboratory. According to Lin and co-workers (2013), the optimal time to monitor children's activity is one week. Actigraphic studies confirmed that children with ADHD show a higher level of motor activity than healthy peers, but only a thorough analysis of detailed time periods showed the existence of factors modifying children's motor activity. The Lin and colleagues (2013) study compared children with ADHD and their peers in Moderate to Vigorus Physical Activity (MVPA) indices per week and its metobolic equivalents recorded in minute intervals (METs). Children with ADHD generally showed higher levels of motor activity, both in MVPA and METs metabolism, both on weekdays and weekends. However, if hourly activity was analyzed, it turned out that intergroup differences were visible only in unstructured situations, i.e. free time (Lin, Yang, Su, 2013). Other studies showed differences at certain times of the day. Children wore a monitor for 5 days, which recorded their activity throughout the day, both in structured situations, i.e. during school classes and during their free time (Imeraj et al., 2013). The results showed a variation in the intensity of hyperactivity in the ADHD group during the day, especially in the early afternoon.

As it results from the above mentioned studies, the previously published work on the assessment of symptoms of hyperactivity and inattention, confirming the importance of objective data, was carried out with the participation of children with already diagnosed ADHD. However, there is no examination of children at the initial, screening stage of the diagnosis. The aspect of behavioural dynamics over specific periods of time is also important.

Objectives and test method

Research objectives

The first stage of diagnosing a child with developmental disorders is to recognize its difficulties and decide on further clinical diagnosis procedures. Diagnosis towards ADHD is labor- and time-consuming, requires the cooperation of many specialists and obtaining information and data from at least three sources: school / kindergarten, home and the child

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itself. ADHD is a non-pathognomonic disorder and it is therefore necessary to indicate a cut-off point related to the severity of axial symptoms. For this purpose, questionnaires based on criterion symptoms, filled in by parents, carers and teachers, are currently being used. However, they are subjective in nature. The aim of the study was to verify whether the results of hyperactivity and inattention obtained as a result of the ADScaner system provide significant additional data compared to the behavioural characteristics of the child as formulated by the teachers. This will allow us to conclude on the possibility of using more objective ways of obtaining information about symptoms of hyperactivity in children during the screening diagnosis stage.

The course of examinations and persons examined

The research presented in this article is a part of a project carried out in schools in Lubelskie Voivodeship. Invitations have been sent to schools all over the province with a proposal to carry out screening tests for ADHD of primary school students. Responses were received from 26 schools. In most cases, the tests were carried out on the premises of the institutions attended by children. Parents agreed in writing to the child's participation in the research. The first stage of qualification was the identification by teachers of students who, in their opinion, showed symptoms suggesting the presence of ADHD syndrome. Then the teachers, in cooperation with teachers and educators, filled in a questionnaire of symptoms. The group of children assessed as hyperactive included 83 children aged 7 to 9 years. Qualification to the control group consisted in random selection of children from the same classes attended by children identified by teachers as hyperactive. The children moved on to the next stage of the examination on condition that they obtained a written consent of their parents to take part in the examination. In such a case, teachers filled in a questionnaire of symptoms for those children from the control group. The control group consisted of 45 children aged 7-9 years. In the following part of the study, the children were examined in terms of the level of motor hyperactivity and, in addition, in terms of the severity of observation problems, using the ADScaner system.

Test methods

The research used the ADScaner system developed as a tool for diagnosing children with ADHD by the German company Meditech in cooperation with the Charité University of Berlin and the University Clinic in Mainz. It consists of a structured interview and an appropriate ADScanner to study attention and motor hyperactivity. In this study, the questionnaire was completed on the basis of an interview with teachers in schools. It was based on ADHD

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diagnostic criteria according to DSM-IV. It consisted of 18 statements (9 for symptoms of inattention and 9 for symptoms of hyperactivity/impulsiveness), the severity of which was assessed on a 4-stage scale (0 - never occurring or rarely; 1 - sometimes; 2 - frequently; 3 - very often). The ADScaner is a device that measures a person's motor activity (frequency and intensity) and attention by activating the Continuous Performance Test (CPT). The ADScaner measures the intensity of movement of the test person using Doppler radar. The radar produces a sinusoidal signal using an oscillator. Movements of the object change the wavelength of the reflected radar signal. This means that the signal received by the radar has a different frequency from the signal transmitted. The combination of transmitted and reflected signals gives the desired signal. Signal values are scanned at 1000Hz. The eigennoise is so low that it does not have to be taken into account in the analysis. The obtained values are saved and then transferred to the ADScanalyzer program on a computer connected to the scanner (data obtained from the manufacturer, i.e. MediTech). The measurement is carried out in a closed room and there must be no moving objects in the test area. The scanner is placed on a stand in front of the test person who is sitting on a comfortable chair with a footrest, approximately 2.5 metres from the scanner so that the entire body surface is covered by the scan. The test results in motion rates of 0.001 seconds per second. These factors are then averaged over each second. During the study, the respondent performs the CPT test at the same time (a typical ADScaneer test also includes an assessment of movement during the so-called rest session, which will not be analyzed in this article). It consists of 300 stimuli, 50 of which are stimuli that require a response in the form of pressing a button ball held in the dominant hand. Indicators in the CPT test are the number of correct reactions, i.e. proper reactions to a target stimulus appearing on the scanner screen. The maximum number of correct reactions is 50. The second indicator in the assessment of attention is the number of redundant reactions, defined as incorrect reactions to a false stimulus. The possible number of redundant reactions is 250. The test lasted 10 minutes.

Test results

A group of children perceived by teachers as hyperactive and their peers, as assumed, did not differ in terms of age. Hyperactive children were 8;01 years old on average, while the control group was 8;03 years old (t = -1,07 n.i.).

The results of behavioural descriptions of children from both groups, in terms of symptoms consistent with the diagnostic criteria for ADHD, obtained in the questionnaire filled in by the teacher and the summary indicators from the whole 10-minute ADScan study are presented in Table 1. The groups were compared with the Student's t test for independent groups.

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Table 1: Descriptive statistics of indicator values obtained in questionnaire measures and during the ADScan study

Variable	Hyperactive group $N = 83$ M (SD)	Inspection group $N = 45$ M (SD)	t	p	d Cohen
ADScaneer test results					
Correct reactions during CPT	38,191 (11,480)	45,933 (3,033)	-4,433	0,000	0,921
Redundant reactions during CPT	19,975 (32,160)	7,022 (12,454)	2,595	0,011	0,531
Movement during CPT	20,950 (22,7192)	9,720 (6,629)	3,237	0,011	0,671
Results of the symptoms questionnaire for ADHD					
Note	19,602 (5,082)	10,977 (4,779)	9,358	0,0001	1,750
Hyperactivity/ impulsivity	19,554 (5,790)	9,000 (4,730)	10,472	0,0001	1,995
Overactivity	11,012 (3,117)	4,866 (2,873)	10,940	0,0001	2,050
Impulsiveness	8,542 (3,306)	4,133 (2,974)	7,455	0,0001	1,423

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As can be seen from Table 1, the groups differ significantly in all the indicators obtained, both in the questionnaire data and in the ADScaner study.

In the next stage of analysis, both groups of respondents, defined on the basis of subjective observation of teachers, were compared in terms of dynamics of symptoms in terms of attention and hyperactivity during the ADScaneer study. Analyses were carried out in order to determine the significance of the time factor (individual minutes) and the group (hyperactive group and control group) in the results of hyperactivity and attention assessment.

In the General Linear Model (GLM) for repeated measurements, for variable motion indicators, in individual minutes, a significant main effect of the intraobject factor $F(3.11; 392) = 11.014$, $p < 0.0001$, Stage square = 0.08 and significant for the extraobjective factor $F(1; 126) = 10.477$, $p = 0.002$, Stage square = 0.077 was found. Also the interaction of time factor and factor group turned out to be significant $F(3.11; 392) = 2.678$, $p = 0.045$, Stage square = 0.021. Since Mauchly's sphericity test turned out to be important, Greenhouse-Geisser's test was used in the above analyses. Diagram 1 shows the dynamics of motor behaviour of children from both groups in individual 10 minutes of the study.

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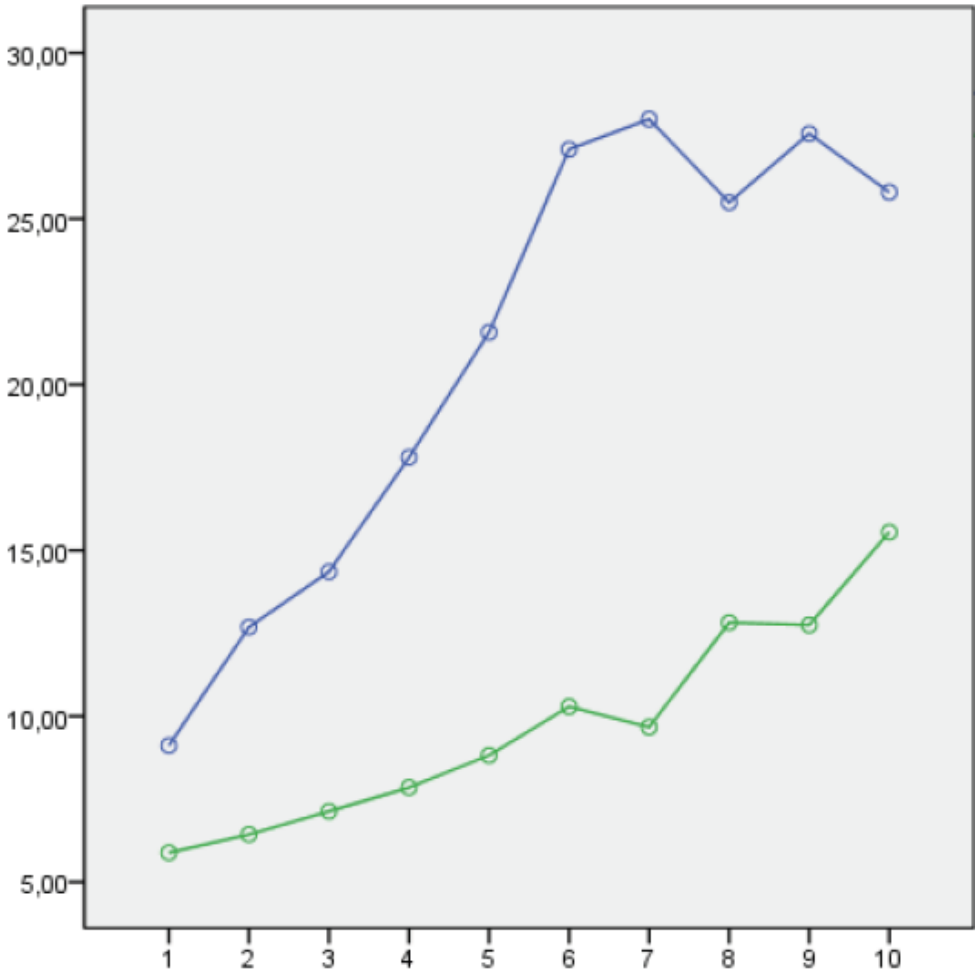

Chart 1: Variability of motion indices in the ADScaneer study in groups of children with hyperactivity and peers

The results show that mobility of children qualified by teachers as hyperactive significantly differentiates this group from their peers. At the same time, the effect of time is visible, which means that in the group of children with hyperactivity, hyperactivity significantly increases with the passing of successive minutes. In the control group this tendency is visible to a lesser extent.

The first indicator of the variable attention was the number of excess reactions. As in the case of motion indicators, the importance of the time factor (individual minutes) and the group (hyperactive group and control group) for the variability of results in the number of redundant reactions was also checked in the case of attention indicators. In the General Linear Model (GLM) for repeatable measurements, for the index of variable attention, i.e. the number of excess reactions in individual minutes, it was found that the effect of the

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main intraobjective factor F(4.97; 627) = 0.545, n.i.i. was irrelevant, The interobject factor effect was significant F(1; 126) = 6.732, p = 0.011, Eta square = 0.051. The interaction of time factor and factor group was not significant F(4.97; 627) = 0.824, n.i. Since Mauchly's sphericity test was significant, the Greenhouse-Geisser's test was applied. Figure 2 shows the results in both groups in relation to the number of excess reactions with CPT.

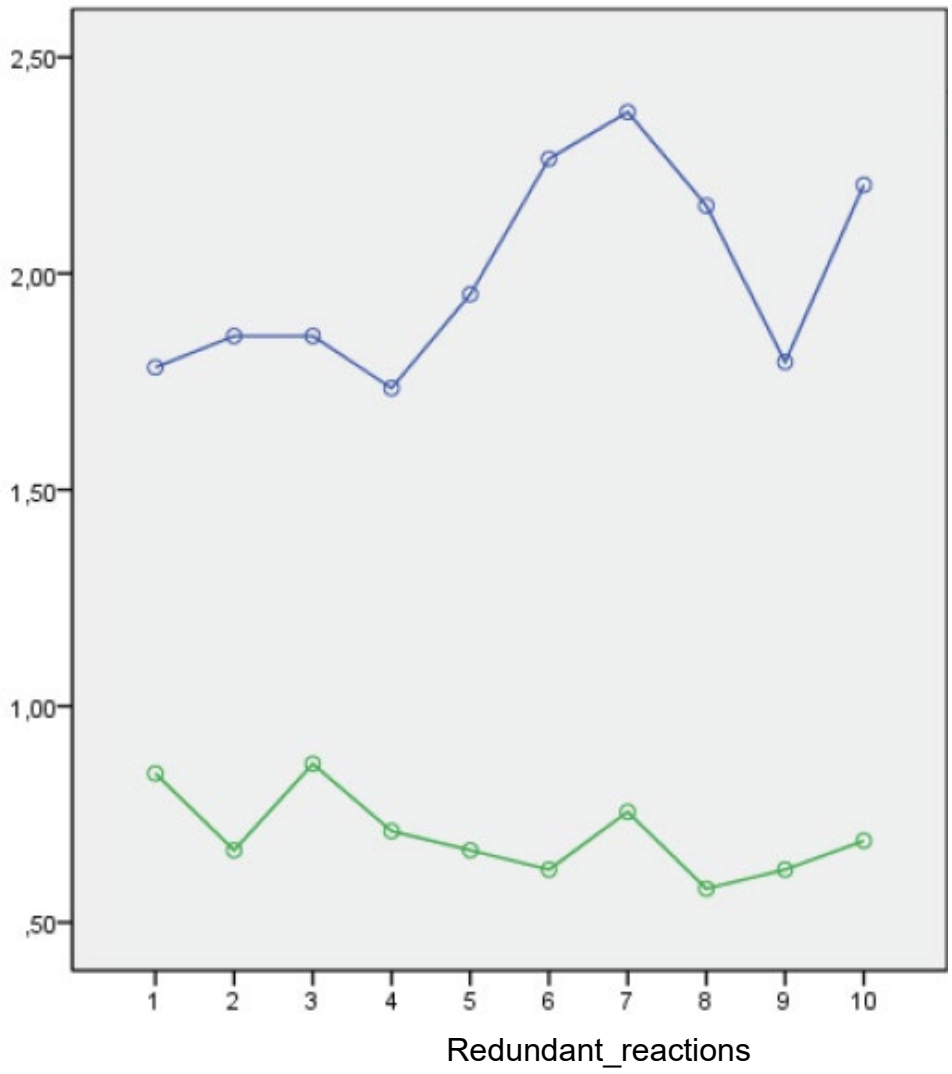

Figure 2: Variation in the number of excess reactions in CPT, in groups of children with hyperactivity and peers, in individual 10 minutes of the test

The obtained data indicate that the number of excessive reactions differentiated both groups of children, but did not depend on the time elapsed.

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The last indicator of the attention process was the number of correct reactions. The importance of time factor (individual minutes) and group (hyperactive group and control group) for variability in the number of correct reactions in the CPT test was analyzed again.

In the General Linear Model (GLM) for repeated measurements of the variable index attention, i.e. the number of correct reactions in individual minutes, the significance of the main intraobject factor effect $F(7.98; 998) = 6.07$, $p < 0.0001$, Stage square = 0.046, and the relevance of the interobject factor $F(1; 126) = 19.648$, $p < 0.0001$, Stage square = 0.135 was found. The interaction of time factor and factor group proved to be insignificant $F(7,98; 998) = 1,546$, n.i.i. Since Mauchly's sphericity test turned out to be significant, Greenhouse-Geisser's test was applied. Figure 3 shows the results concerning the number of correct reactions in CPT in both groups.

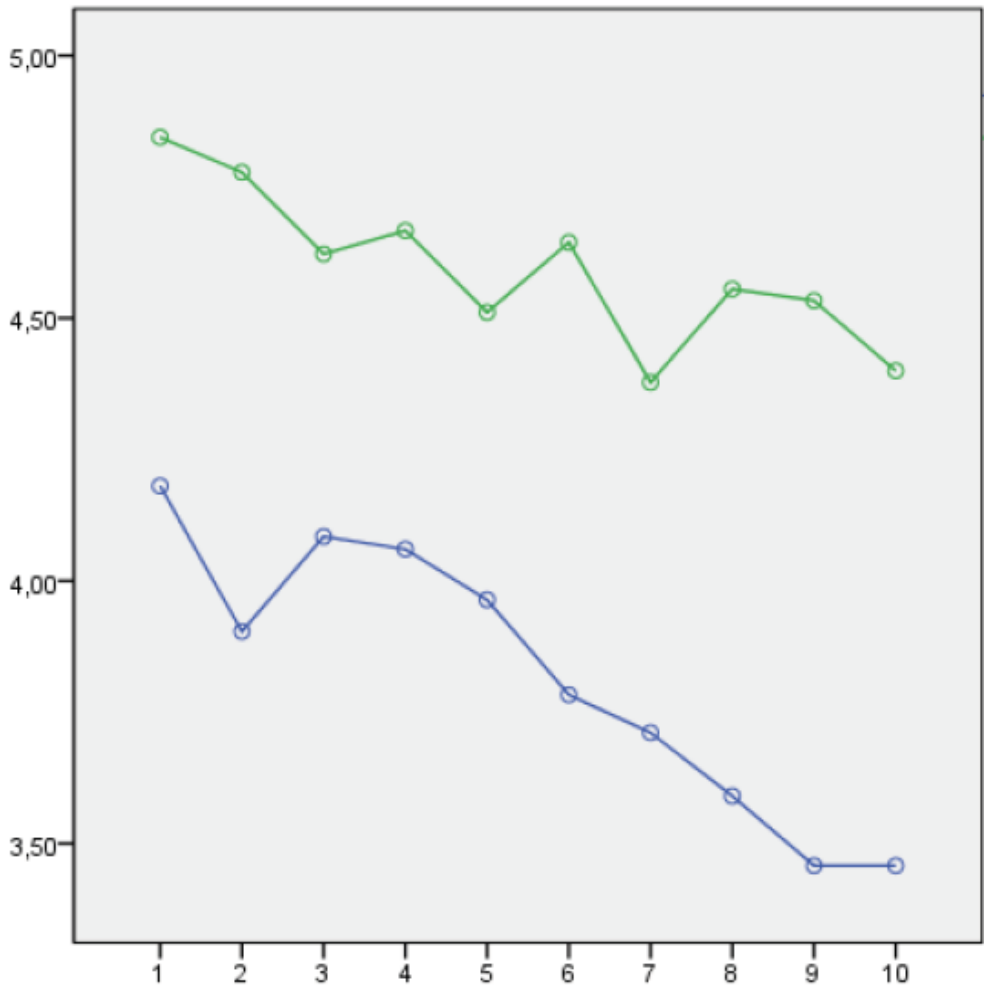

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Chart 3: Variation in the number of correct reactions in CPT, in children with hyperactivity and peers, in individual 10 minutes of the test

According to statistical analyses and the graph, children with hyperactivity showed a significant deterioration in performance, measured by the number of correct reactions falling in subsequent minutes. The difference between the two groups in this index was significant.

In the last stage of the analysis, a correlation between the severity of symptoms assessed in the questionnaire studies and measures from the ADScaner study was sought. The Pearson correlation indices between the attention, motor overactivity and impulsivity indices in the questionnaire study and the attention and motion process indices in the ADScaner study revealed several important correlations. In the whole study group, movement during cognitive activity (CPT test) correlated with the hyperactivity index in the questionnaire $r = 0.261^{**}$, $p = 0.01$, with attention $r = 0.280^{**}$, $p < 0.001$, hyperactivity and impulsivity $r = 0.207^{*}$, $p = 0.019$, hyperactivity $r = 0.261^{**}$, $p = 0.003$, and not with impulsivity. In the whole study group, normal reactions correlated negatively with impulsivity $r = -0.209^{*}$, $p = 0.018$, with attention $r = -0.323^{**}$, $p = 0.000$, hyperactivity/impulsiveness $r = -0.275^{**}$, $p = 0.002$ and excessive activity $r = -0.294^{**}$, $p = 0.001$. In the whole study group, the number of redundant reactions did not correlate with any questionnaire measure.

However, the interdependence analyses of the same variables, separately in the clinical and control group, showed that none of the correlations is significant.

Discussion of results

Hyperactivity in children, regardless of its etiology and mechanisms, is associated with behavioural and school problems. The attitude of teachers, as an important part of the school environment, towards a child with hyperactivity, including their beliefs, attitudes and attitudes, can influence children's school performance and behaviour (Sherman, Rasmussen, Baydale, 2008). This impact may also be visible during the assessment of the child's behaviour and possible qualification for further diagnosis towards ADHD. Therefore,

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this study examines how teachers characterise children with, in their opinion, unwanted behaviours suggesting the need for further diagnosis for attention deficit hyperactivity syndrome.

These children, in the questionnaire results on hyperactivity and inattention, differed significantly from the group of randomly selected children (control group) from the same schools, which was predicted due to the adopted test procedure. The first main objective of the study was to determine whether ADScaner is a useful tool as an additional, objective source of data in the assessment of hyperactivity and inattention symptoms in children perceived as hyperactive. The first important conclusion of the study is that children perceived by teachers as hyperactive differ from their peers in the objective measures obtained during the use of ADScaner, i.e. attention in the form of the number of correct reactions in the CPT test and the number of excess reactions and in the coefficient of motor hyperactivity measured by the doppler scanner. This means that these students did indeed have significantly weaker attentional skills and significantly more need for overexcitability. Correlation analyses carried out in the whole study group, i.e. regardless of the group to which they were qualified on the basis of teachers' assessments, confirmed that inattention and hyperactivity indicators obtained in subjective assessments of teachers are correlated with objective measures of these processes obtained in the ADScaneer study, which proves the reliability of data from ADScanera.

However, after conducting correlation analyses in separate groups, they turned out to be insignificant. The conclusion from this is that the diversity of results obtained in objective measures of inattention and hyperactivity, in a separate group of children assessed as hyperactive, was so large that the interdependence effect was abolished. A similar situation was observed in the group treated by teachers as not showing symptoms of hyperactivity. In this group, the differences in ADScanera results were so significant that they contributed to the elimination of interdependence.

It seems that subjective teacher assessments are not a sufficient source of data on symptoms of hyperactivity and inattention in children, and data from ADScanera can provide additional, precise information. The results of correlations between behavioural indicators in ADHD and objective measures are ambiguous, both low but significant correlation indicators are given (Epstein et al., 2003; Borkowska, 2008; Glass et al., 2014), as well as lack thereof (McGee, Clark, Symons, 2000; Advokat et al., 2007; Edwards et al.,

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2007). In the light of the results, it can be concluded that the reliability and accuracy of the questionnaire-based assessment of the child's symptoms may or may not be an important factor influencing the existence of correlation.

Thus, generally speaking, the results of objective measures obtained in ADScaner correlate with the diagnostic criteria for ADHD, while the high rates of hyperactivity in the subjective assessment of teachers do not correlate with the objectively assessed processes of attention and hyperactivity. This means that only a subjective characterisation of a child's behaviour should not be the basis for assessing the level of axial symptoms of children suspected of ADHD (Rapport et al., 2008).

The presented studies show that the assessment of the severity of axial symptoms should also take into account the dynamics of symptoms over time. This was particularly visible in the case of hyperactivity, whose indices in the group of hyperactive children increased, and the correctness of the reaction in the commentary task, whose indices worsened with time. The dynamics of changes in hyperactivity has already been pointed out by the authors studying this dimension of functioning of children with ADHD with the use of actigraph, on a daily or weekly basis (Imeraj et al., 2013; Lin, Yang, Su, 2013), emphasizing the differences between children with ADHD and those typically developing depending on the time of day (afternoon) or type of activity (free time). Although only the 10-minute variability was taken into account in this study, it also proved to be important for hyperactivity and correct response in CPT.

In conclusion, it can be concluded that teachers assessed their students quite accurately, as the group of children with hyperactivity differed significantly from the control group in objective measures of motor hyperactivity and inattention. At the same time it turned out that this group and the control group were not homogeneous in terms of attention deficits and excessive need for exercise, as demonstrated by the data from ADScanera and confirmed by the lack of correlation between the symptoms and ADScanera indices. It seems that ADScaner is a device that differentiates hyperactive children from children with no behavioral problems, and the objective data obtained through this study may be useful in diagnosing children with ADHD.

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Summary. The aim of the study was to assess the relationship between the results of the ADScaneren study (hyperactivity and inattention) and the symptoms of ADHD in the assessment of teachers. The study was screening in nature. Teachers indicated hyperactive children among their students. Then, on the basis of the ADHD symptoms questionnaire, the teachers evaluated children previously selected as hyperactive and from the control group. Both groups were examined by ADScaneer, which provides data on motor hyperactivity (Doppler radar) and remarks (Continuous Execution Test). Children assessed as hyperactive had a worse commentary task and a higher level of motor

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hyperactivity than the control group. In the whole study group ADScaneer performance indicators correlated low, but significantly with ADHD indicators from the questionnaire. In the analyses conducted separately in the hyperactive and control groups, no correlation was found. Teachers assessed students quite correctly. However, objective measures of hyperactivity and inattention are useful in screening diagnosis for ADHD.

Key words:

motor hyperactivity, inattention, screening, ADHD

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