Anthropometric changes in non-medicated ADHD boys

Radek Ptacek, Hana Kuzelova, Ivo Paclt, Ilja Zukov, Slavomir Fischer

Department of Psychiatry, 1st Faculty of Medicine, Charles University, Prague.

Correspondence to: Radek Ptáček, Ph.D.
Department of Psychiatry, 1st Faculty of Medicine, Charles University
Ke Karlovu 11, 120 00 Prague 2, Czech Republic. ptacek@neuro.cz

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Abstract

OBJECTIVES: The aim of the study is to compare complex anthropometric characteristics in non medicated boys with ADHD and normal population.
METHODS: Complex anthropometric examination of non-medicated ADHD boys (n=46, average age 11.03 years), statistical and clinical comparison to the actual population growth norm. In contrast to the most of the previous studies, which analyzed mostly only BMI or basic signs of growth as height and weight, the presented study operates with a complex anthropometrical measurement and comparison with actual population norm.
RESULTS: The results of the study show significant differences in the signs of nutrition (percentage of fat) and growth indicators (lower values of height) between ADHD and non ADHD children. Further anthropometrical parameters show other possible but in the studied sample statistically non-significant differences.
CONCLUSION: Many studies analyzed growth relation to medication of ADHD children, but did not consider that the changes could appear also in non-medicated children and thus they might not be only a side effect of the treatment but a manifestation of the disorder itself. Growth changes in non-medicated children are not described well enough, so the presented study was performed to compare anthropometrics characteristics in ADHD boys with norm of nonclinical population and specify the differences. The results points to hypothesis that the growth changes are primarily caused by the disorder itself.

INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) constitutes a group of developmental disorders, which are characterized by inadequate level of attention, excessive activity and impulsivity (Cormier 2008; Spencer *et al.* 2008) and which are manifested in every part of children's behavior (Barkley *et al.* 1999; Matejcek 2003). ADHD is characterized by various symptomatology, etiology and heterogeneous development (Barkley *et al.* 1999; Kariyawasam *et al.* 2002; Barkley & Macias 2005; Paclt 2008; Geier *et al.* 2008) with a strong genetical binding (Crawford & Salmon 2000; Paclt *et al.* 2005; Drtilkova *et al.* 2008; Kopeckova *et al.* 2006, 2008; Sery *et al.* 2006). The disorder is represented by a multiple loci of pathology with respect to atypical functional anatomy and pathophysiology. Cognitive deficits extend beyond executive functioning to include spatial, temporal, and lower-level „nonexecutive" functions. Atypical functional anatomy extends beyond frontostriatal circuits to include posterior cortices, limbic regions, and the cerebellum and pathophysiology includes dopaminergic as well as noradrenergic neurotransmitter systems (Vaidya & Stollstorff

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2008; Fassbender & Schweitzer 2006; Roth & Saykin 2004) and perhaps the serotonergic and adrenergic systems (e.g. Comings *et al.* 2000).

In this connection and according to the current studies, children with ADHD show changes in growth and development (Paclt *et al.* 2000; Paclt *et al.* 2005; Ptacek *et al.* 2008; Ptacek *et al.* 2009), however these changes are not well described. The current studies mention that in the group of ADHD children a lower tendency to obesity can be supposed, due to the higher body activities and in consequence to neurological and endocrinological disorders (McGee *et al.* 1985) and in this relation late growth is supposed as well (Spencer *et al.* 1998). However this hypothesis of late development and growth was not significantly evaluated. On the contrary other studies show higher values of indexes of nutrition (BMI) in children with ADHD (Altafas 2002; Curtin *et al.* 2005; Mustillo *et al.* 2003; Ptacek *et al.* 2008) or more frequent obesity (Holtkamp *et al.* 2004; Altafas 2002). According to the studies which estimated the prevalence of overweight in children and adolescents, obesity and ADHD demonstrates significant co-morbidity (Waring & Lapane 2008), but it is also possible that obese people can have more serious problem with losing weight (Curtin *et al.* 2005). However these differences are still not definitely confirmed. One of the reasons is that literature on growth in ADHD children is sparse and historically has focused mainly on the potential for growth suppression associated with the use of stimulant medication (Faraone *et al.* 2001; Zachor *et al.* 2006). The relation of growth and/or obesity with use psychiatric medication is frequently discussed theme (Hrdlicka *et al.* 2009). But very important fact for understanding the disorder is that growth and weight changes can be a manifestation of this disorder itself and not only a manifestation of the secondary effect of the treatment (Spencer 1998; Ptacek *et al.* 2008). Numerous studies dealt with questions of growth and weight in connection to medication but the question of growth and weight changes connected with the disorder itself is uncared (Ptacek *et al.* 2009).

Most of the previous studies focused on the theme of growth and development in non-medicated ADHD children is very heterogeneous. Different and insufficient number of anthropometric parameters was used in all analyzed and presented studies and also the age range of subjects is not optimal. None of the studies brought significant results or clearer insight into the question. So further studies with a complex design and proper psychiatric and anthropometric methodology is needed (Ptacek *et al.* 2009).

In the context of above mentioned contradictory and insufficient findings, we designed the presented study. The aim of the study was to compare anthropometric characteristics of ADHD children group with the norms of the Czech population and to evaluate the differences.

MATERIALS AND METHODS

For empirical examination of suggested research question sample of 46 ADHD boys in average age 11.03 years (S.D. 2,68) was collected for evaluation of complex anthropometric parameters. Exclusion criteria for the group were organic illnesses involving the central nervous system, heart disease, any form of epilepsy and mental retardation (IQ WISC higher than 90), mental or developmental disorder (other than ADHD) of any kind. The reasons for including were ADHD diagnosis according to DSM-IV, full mental and somatic health, absence of medication, absence of any serious metabolic, endocrinous or mental disorder in family history. All criteria in the selected subjects were evaluated by a certified pshysician and a psychologist upon results of thorough examination.

Evaluation included psychological/psychiatrical methods and anthropometrical measurement. Psychological/psychiatrical methods included total score of Conners Parents Questionaire ("CPQ") (Conners, 1998). CPQ is an informant-rated self-report scale used as a screening tool for assessment of attention deficit hyperactivity disorder in children and adolescents. The questionnaire consists of 80 items, to produce 13 subscales. Since its introduction the psychometric properties of the CPQ have been well studied and proved good validity and reliability (Conners 1998).

Anthropometrics methods included height, weight, BMI, 10 altitudinal proportions, 11 widths proportions 13 circumferences proportions, 14 skin folds. All parameters were compared to growth norms of the Czech population (Viegnerova *et al.* 2005; Blaha *et al.* 2003; Blaha 1990; Blaha *et al.* 1999; Blaha, 1986).

RESULTS

Statistica 6 was used for statistical analysis (t-tests, correlation analysis and nonparametric tests). SD score which expresses the deviation of measured parameter from the value of the 50th percentile of the norm were used for evaluation of every parameter. Values of SD scores of anthropometrical parameters were compared with norms for Czech population through programs Antropo and Rust CZ programs. Dates were compared by means of parametrical and non-parametrical methods with hypothetical average 0 and S.D. 1 and then dates were correlated with CPQ questionnaire.

As the Table 1. shows, the significant differences were detected by a statistical analysis in the following signs: percentage of fat, height, abdominal circumference, middle thigh circumference, shoulders width, pelvis width, thoracic width, humeral epiphysis, femoral epiphysis.

According to the results of the study children with ADHD show specific anthropometrical differences from the norm, especially in body height and indicators of nutrition. Children with ADHD in measured group

Table 1: Differences of selected anthropometric parameters ADHD boys from the norm.

	Mean ±	S.D.	Min	Max	*t*-test	*p*
age	11.03	±2.68	6.67	15.92	–	–
CPQ	70	±17.99	33	102	–	–
shoulders width	**0.72**	**±1.28**	**–2.5**	**2.65**	**3.81**	**0.000**
pelvis width	**0.65**	**±1.66**	**–2.5**	**4.11**	**2.63**	**0.012**
thoracic width	**0.62**	**±1.32**	**–2.3**	**2.75**	**3.17**	**0.003**
thoracic circumference	–0.16	±1.49	–2.8	3.66	–0.72	0.474
abdominal circumference	**0.6**	**±1.46**	**–2.4**	**3.83**	**2.78**	**0.008**
glutei circumference	0.12	±1.54	–3.6	2.89	0.53	0.599
arm circumference	0.1	±1.36	–2.8	2.54	0.52	0.605
glutei thigh circumference	–0.08	±1.2	–2.5	2.19	–0.45	0.655
middle thigh circumference	**–0.41**	**±1.27**	**–4.1**	**1.21**	**–2.20**	**0.033**
max calf circumference	0.01	±1.43	–3.5	2.92	0.03	0.977
humeral epiphysis	**0.73**	**±1.47**	**–2.5**	**2.68**	**3.40**	**0.001**
femoral epiphysis	**0.45**	**±1.24**	**–2**	**2.77**	**2.45**	**0.018**
sole length	–0.13	±1.27	–3.6	1.58	–0.70	0.485
% skeleton	0.08	±1.27	–3.4	1.72	0.41	0.682
% muscle	–0.25	±1.42	–3.3	3.16	–1.18	0.243
% fat	**0.51**	**±0.86**	**–1**	**2.19**	**3.98**	**0.000**
weight	–0.21	±1.59	–3.9	2.65	–0.91	0.370
height	**–0.76**	**±1.45**	**–4**	**1.47**	**–3.56**	**0.001**
BMI	0.19	±1.3	–2.3	2.54	1.01	0.319
head circumference	–0.4	±1.48	–4	1.49	–1.83	0.074

Statistically significant on the minimum level $p<0.05$ are in boldface.

were significantly smaller than the normative population. This is in conformity with the hypothesis of late growth or lower value of height in children with ADHD (Spencer *et al.* 1998) but as it was mentioned earlier this finding was not definitely confirmed in previous studies.

Further higher values of indicators of nutrition as percentage of fat and abdominal circumference were found. These results are in contradiction to the hypothesis that children with ADHD can be thinner due to their higher activity, but confirm other studies which found higher occurrence of obesity among children with ADHD (e.g. Waring & Lapane 2008). Higher abdominal circumference can be associated with higher percentage of fat as well as femur circumference can be by contrast associated with development of muscles. Higher values of BMI are supported by other studies (Altafas 2002; Holtkamp *et al.* 2004), however, in this study BMI does not statistically differ from the norm. Generally BMI is not very predicative parameter in children and it is necessary to provide complex measurement as e.g. measurement of skin folds to assess if a child is overweight or not.

Very interesting findings which have not been published yet are different values of widths. Higher values of width of shoulders, width of pelvis and width of thoracic were found and these parameters may be connected with more robust skeleton. These findings do not have any support in other studies but these parameters also were not measured in most of them, for that reason they should be investigated more in further researches. There was not found correlation between a level of improper behavior evaluated by CPQ and anthropometrics characteristics which means that the anthropometrics changes do not correlate with a level of hyperactivity.

Figure 1. shows relation between height and weight of the studied group. The majority of the values of height are under the average and extreme values appear more in values of height. The observed tendency confirms usual presumption of body height and weight relation.

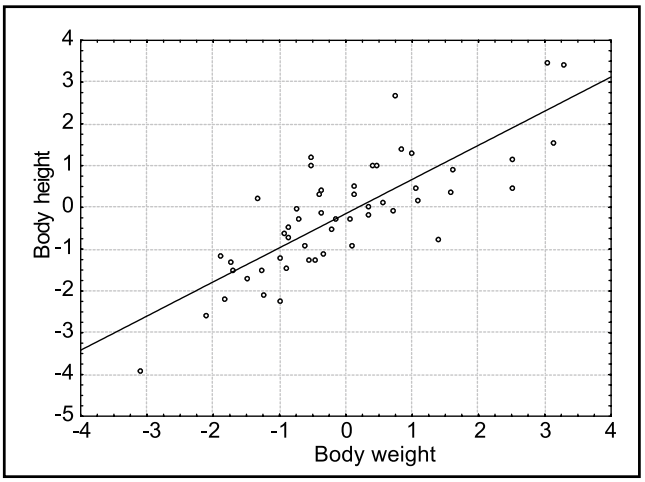

Figure 1: Dependency graph of body height and weight in ADHD boys.

DISCUSSION

ADHD is a group of disorders which intervenes into almost every part of child's life and for that reason interdisciplinary approach is necessary. This study brings anthropometric view to the disorder and provides analysis of growth changes in non-medicated ADHD children.

According to current studies specific changes in development and statue, especially BMI, may appear in children with ADHD, however available studies have many methodological insufficiencies and do not bring definite results. The most serious insufficiency we consider as very reduced number of anthropometrical parameters, usually only BMI, height and weight were used. Very low number of studies on this topic was published. The reason could be that many authors deal only with the question of changes in growth and weight during or after the using medication, however it should be considered before that these changes can be disorder specific.

The results of the presented study point to specific changes in growth and physique in children with ADHD. Although late growth or lower values of body height have not been definitely confirmed in previous studies yet, which can be also caused by the fact that most of previous studies monitored changes associated with medication, in our study statistically significant lower values of height were found in ADHD children in comparison to the population norms. Lower growth may be connected with neuroendocrinological changes which appear in ADHD children. Our results confirm the presumptions that changes in growth are manifestation of ADHD and have much wider connections than it was expected.

One of the most significant sign of measured group is higher percentage of body fat which is also supported by higher values of abdominal circumference, because fat is usually concentrated in abdominal area in children and also men. This finding is in contradiction to hypothesis that higher activity can influence proportions of children. Increased activity of children with ADHD does not have to be necessarily active motion, but lower level of attention, concentration, lower ability of controlling of behavior, impulsivity may be more characteristic signs for some groups of ADHD children than hyperactive behavior itself. Therefore children with ADHD do not have to have higher expenditure of energy than other children.

Higher values of widths have no support in other studies and neither definite explication, however it can also be caused by the fact that many studies do not evaluate these parameters and usually work only with height, weight and BMI. There is no theoretic and clinic explanation for these findings but it can be suspended that it could be a specific characteristic of ADHD. As higher values of percentage of body fat, abdominal circumference show state of nutrition and higher values of shoulders, pelvis, thoracic and epiphysis widths can show more robust skeleton. Lower value of thigh circumference may show weaker muscles on the contrary, however percentage of part of muscles was not statistically significant, despite it was lower than part of fat. Undoubtedly these parameters will be observed in further research.

Many studies observed changes in growth and weight during the medication. That can detect an effect of medication and secondary effect of medication but does not say anything about the diagnosis and its relations. According to this study, children with ADHD show specific changes in statue, growth and development. These characteristics may be more typical for this disorder than for the treatment. Before we investigate changes in growth in medicated ADHD children and relations between medication and growth changes, it is necessary to deal with the question of manifestation on development of ADHD itself.

CONCLUSION

ADHD is more than a diagnosis, it is a disorder in neuro-endocrinological system which expresses itself in psychological, sociological levels as unwelcome behavior in social contacts and influences not only the child but as well as child's surroundings. This disorder expresses itself in somatic and mental level in general and according to the several studies and the presented study it may influence growth and weight.

The results of the study point to higher values of percentage of body fat and lower values of height in ADHD children. This is very important finding which confirms that ADHD may be connected with changes in somatic development. Detailed research and analysis which can bring new information about connection of neuroendocrinological growth control and its disorders could be a breakthrough for life perspectives of ADHD individuals.

The presented study also confirms that it is essential to deal with ADHD and changes in development because changes do not appear only in connection with medication as it has been published many times. Researches observe these connections but do not consider possible changes in development as symptoms of ADHD itself.

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