Methylphenidate and growth in ADHD children

Radek Ptacek 1, Hana Kuzelova 1,2

1 Department of Psychiatry, 1st Faculty of Medicine, Charles University, Prague, Czech Republic; 2 Institute of Biology and Medical Genetics, 2nd Faculty of Medicine, Charles University, Prague, Czech Republic.

Correspondence to: PhDr. Radek Ptacek, PhD., Department of Psychiatry, 1st Faculty of Medicine, Charles University, Ke Karlovu 11, 120 00 Prague 2, Czech Republic; e-mail: ptacek@neuro.cz

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Abstract

Attention deficit hyperactivity disorder (ADHD) is a group of developmental disorder characterized by developmentally inappropriate levels of over activity, inattention and impulsivity. The most common treatment of ADHD is medication with stimulants, by specific methylphenidate which has been shown to improve attention and behavior. The treatment by stimulants may be accompanied by side effects from among decrease of appetite or changes in body development as growth suppression and loss of weight. Many studies describe growth or weight changes only associated with medical treatment of children ADHD. However changes in development and growth can also appear independently on medication. The authors of this paper review the relation of methylphenidate and growth in ADHD children in the current scientific literature.

INTRODUCTION

Attention-Deficit Hyperactivity Disorder ADHD is one of the most common disorders among school-aged children, with a prevalence of 3–7% in the general population (Paclt 2008). It is a group of disorders characterized by developmentally inappropriate inattention, concentration, excessive activity and impulsivity. These symptoms appear early in a child's life, some of them persist to the adult age.

ADHD is a complex disorder influenced by genetic and environmental factors, characterized by various symptomatology, etiology and heterogeneous development (Barkley et al 1999; Barkley & Macias 2005; Foltinova et al 2007, 2010; Geier et al 2008; Matejcek 2003; Paclt 2008). Genetic researches of candidate genes (DRD4, DAT, DRD5, DBH, 5HTT, HTR1B and SNAP25) brought consistent results, confirming the heredity of ADHD syndrome (Crawford & Salmon 2002; Drtilkova et al 2008; Kopeckova et al 2006, 2008; Paclt et al 2009, 2010; Sery et al 2006). Biochemical (Bulut et al 2007; Paclt et al 2005, 2006), endocrinological, neurological (Cormier 2008; Schubiner & Katragadda 2008; Kariyawasam et al 2002) and even neuroanatomical changes (Garrett et al 2008; Uhlikova et al 2007) often appear in children with ADHD. Specific changes in brain development of ADHD children may be caused by the disorder itself, or it can be caused by other non-related factors. In this connection and according to current studies, children with ADHD show probable changes in growth and development (Lam & Yang 2007; Ptacek et al 2008, 2009a, 2009b; Waring & Lapane 2008).

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 (Zachor et al 2006).

The most common treatment of ADHD is psychosocial treatment (behavioral or cognitive-behavioral treatment), stimulant treatment (mostly methylphenidate) and their combination, which seems to be the most effective (Jensen 2009). However single use
of stimulants is the most frequent treatment method in common clinical practice (Barkley & Macias 2005; Poulton 2005). Positive effects of methylphenidate are supported by numerous studies (e.g. Poulton 2005; Poulton & Nanan 2008) and the improvement appears to influence most of the core symptoms (Paclt 2008, Poulton & Nanan 2008). Although positive effects are well documented the treatment by stimulants may be also accompanied by different side effects – i.e. decrease of appetite (Kramer et al 2000; Paclt et al 2005; Poulton & Nanan 2008, McAfee et al 2008), insomnia, irritability, sadness (Prihodova & Nevsimalova 2006) and also serious neurological problems (Altafas 2002; Barkley et al 1999; Barkley & Macias 2005; Lam & Yang 2007). It was also reported that long period use of stimulants can seriously influence growth (Setoodeh & Teleffson 2007). In this context, most of the available studies confirmed high initiatory growth deficit after beginning of the treatment (Poulton & Nanan 2008).

Early and recent studies reported that methylphenidate may influence decrease of growth hormone secretion (Paclt 2008), but due to the fast metabolic elimination, the influence may not be considered as significant. These conclusions have not been definitely confirmed yet because not many longitudinal studies were done to describe properly this problematic.

**Growth changes in methylphenidate treated children**

It is known that methylphenidate may cause short time growth retardation and weight loss. Although many studies have been done, the methodology and observed variables are very heterogeneous and inconsistent. The studies do not lead to definite conclusions. They found that the treatment with methylphenidate in childhood may reduce expected height and weight. Although these effects attenuate over time, ultimate adult growth parameters are according to current opinions probably not affected. In correspondence to findings in following studies, changes of height are approximately 1cm/year less than norms (Poulton 2005).

**Tab. 1.** reviews effect of methylphenidate on growth and weight. The results of the compared studies show that the treatment with methylphenidate in childhood may cause growth suppression. However the results do not lead to definite conclusions.

<table>
<thead>
<tr>
<th>Study</th>
<th>Dose of methylphenidate (mg/day)</th>
<th>Growth/Values of Body Height</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safer et al 1972</td>
<td>±20</td>
<td>growth suppression</td>
<td>weight loss</td>
</tr>
<tr>
<td>Millichap &amp; Millichap 1975</td>
<td>10-20</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Kalachnik et al 1982</td>
<td>18.4</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Klein et al 1988</td>
<td>&lt; 60</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Vincent et al 1990</td>
<td>NS</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Schertz et al 1996</td>
<td>NS</td>
<td>NSD</td>
<td>weight loss</td>
</tr>
<tr>
<td>Swanson et al 1998</td>
<td>14.2</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>Spencer et al 1998</td>
<td>19.8</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>Sund &amp; Zeiner 2002</td>
<td>23.9</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Biederman et al 2003</td>
<td>NS</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Lisska &amp; Rivkees 2003</td>
<td>10-80</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>Poulton &amp; Cowell 2003</td>
<td>27 mg</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>MTA cooperative group 2004</td>
<td>34.4</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>Zhang et al 2005</td>
<td>27-64</td>
<td>growth suppression</td>
<td>NSD</td>
</tr>
<tr>
<td>Charach et al 2006</td>
<td>NS</td>
<td>NSD</td>
<td>weight loss</td>
</tr>
<tr>
<td>Zachor et al 2006</td>
<td>NS</td>
<td>NSD</td>
<td>weight loss</td>
</tr>
<tr>
<td>Pliszka et al 2006</td>
<td>NS</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Faraone &amp; Giefer 2007</td>
<td>NS</td>
<td>NSD</td>
<td>NSD</td>
</tr>
<tr>
<td>Swanson et al 2006</td>
<td>NS</td>
<td>growth suppression</td>
<td>weight loss</td>
</tr>
<tr>
<td>Ptacek et al 2008</td>
<td>NS</td>
<td>NSD</td>
<td>NSD</td>
</tr>
</tbody>
</table>

**NSD - no significant differences:** the study showed no effect of the treatment on growth parameters; **weight loss:** the study showed statistically significant weight loss after medication; **growth suppression:** the study showed statistically significant growth suppression in medicated children; **NS:** nonspecified or not available.
According to other studies, children with ADHD show some changes in stature, growth and development independently on medication (Ptacek et al 2009a). It is possible that there are specific and in some cases significant differences in development and stature, especially height and weight, in children with ADHD but these characteristics may be more typical for the disorder than for the treatment as Tab. 2 shows.

Differences have been found especially in weight and body mass index (BMI). According to studies compared in Tab. 2, non-medicated children with ADHD have higher BMI than norms. However the studies usually analyzed only BMI despite the fact that this is not very informative parameter in children. Connections between weight loss or growth suppression are not so clear and can not be explained only as a result of treatment. Some authors point on changes in eating behavior, such as binge eating or impulsive eating (Davis et al 2008; Strimas et al 2008). Treatment in children is also commonly associated with loss of weight that may be connected to the decrease of appetite (Paclt 2008) or decrease of impulsivity in eating. It means that the weight loss does not have to be direct result of a lower energy intake but also improvement of behavior.

Eating behavior may be some of the most important factors which cause weight changes in ADHD children. However none of the studies brought significant results or clearer insight into the question yet. So further studies with a complex design and proper psychiatric and anthropometric methodology are needed.

CONCLUSION AND 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. In ADHD children can appear not only psychical changes but also changes in body growth and development. These changes are mainly reported to using stimulants. According to studies medication causes growth suppression and weight loss due to decreasing of appetite as one of side effects of using stimulants. However present studies show that these changes are independent on medication. Reasons and the seriousness of these changes remain unclear.

It is very difficult to make conclusions because not many studies on changes in non medicated children have been done and their methodic is very heterogeneous. However it is clear that methylphenidate do not have such a serious effect on growth as it has been reported many times.

Further studies should include both medicated and non medicated children and compare them with population norms. Except of complex anthropometrical measurement they should include also important factor as socioeconomic status, feeding customs (Schubiner & Katragadda 2008). For further research is essential to include mentioned factors and to monitor possible long-term growth changes.

### REFERENCES


### Tab. 2. Comparison of the studies measuring body mass index (BMI) independently on medication.

<table>
<thead>
<tr>
<th>Study</th>
<th>value of body mass index (in comparison to norms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>McGee et al 1985</td>
<td>lower</td>
</tr>
<tr>
<td>Holtkamp et al 2004</td>
<td>higher</td>
</tr>
<tr>
<td>Altafas 2002</td>
<td>higher</td>
</tr>
<tr>
<td>Mustillo et al 2003</td>
<td>not significantly higher</td>
</tr>
<tr>
<td>Curtis et al 2005</td>
<td>not significantly higher</td>
</tr>
<tr>
<td>Lam &amp; Yang 2007</td>
<td>no significantly higher</td>
</tr>
<tr>
<td>Waring et al 2008</td>
<td>higher</td>
</tr>
<tr>
<td>Hubel et al 2006</td>
<td>higher</td>
</tr>
<tr>
<td>Ptacek et al 2008</td>
<td>higher</td>
</tr>
</tbody>
</table>


