

Short Communication

The effects of stimulant medications on children's growth velocity

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Received – 11 July 2014

Initial Review – 7 August 2014

Published Online – 26 December 2014

Abstract

Objective: This study sought to determine whether relationships exist between stimulant medications and children's growth velocity. **Methods:** The investigators conducted a retrospective review of 280 charts of pre-pubertal children with attention-deficit hyperactivity disorder (ADHD) who were prescribed stimulant medications for a minimum of 1 year. The children were patients in a university child development/ADHD clinic. **Results:** The average growth velocity across all genders and ages was 5.72 cm/year (females 5.53 cm/year, males 5.28 cm/year). The majority of the children had growth velocities in the 25-50th percentiles for age. **Conclusion:** This study did not find evidence of significant effect on growth velocity in children with ADHD treated with stimulant medications. Our results concur with the majority of other studies of growth in children taking stimulant medications for ADHD management. It supports our continued prescription of stimulant medications without concern for slowed or stunted growth in our patients with ADHD.

Key words: Adolescent, Amphetamine, Attention-deficit hyperactivity disorder, Child, Clinical practice patterns, CNS stimulants, Growth velocity, Medication adverse effects, Methylphenidate, Retrospective studies, United States, Youth

Approximately 3-7% of all children are affected by attention-deficit hyperactivity disorder (ADHD) [1]. Stimulant medications frequently are prescribed to manage ADHD symptoms in children and adolescents. These medications improve the core symptoms of inattention, impulsivity, and hyperactivity [2]. Other problem behaviors, such as noncompliance with instructions, impulsive aggression, poor social interactions, academic performance, and family dynamics, also may improve with stimulant medications [3]. The multimodal treatment study of 600 children with ADHD compared the efficacy of four treatment modes (medications, behavior therapy, medications plus behavior therapy, and community care) in reducing ADHD symptoms. The study found that the responses of the children in two arms of the study (medication combined with behavior therapy and medication alone) were superior to intensive behavior therapy alone and to routine community care [4].

There are two major families of stimulant medications (methylphenidates, amphetamines) used to treat ADHD. Non-stimulant medications (alpha agonists, selective non-reuptake releasing inhibitors, antidepressants) are also prescribed, usually as adjuncts to stimulant medications [5-7]. Stimulants are commonly the first line of treatment, because they are well-tolerated, become effective quickly, and are rapidly eliminated from the body. Methylphenidate and dextroamphetamine preparations are equally effective [8]. Children may respond

to one stimulant, but not to another. Therefore, finding the right stimulant medication for a child is often a practice of trial and error. Stimulant dosages vary, based on tolerance of the compound, not body weight. Common side-effects of stimulants are appetite suppression and sleep disturbance, both of which can be dose-dependent [9]. Some children experience transient abdominal pain, headache, or a mild increase in heart rate and blood pressure. Less common side effects of stimulant medications are irritability, nervousness or jitteriness. Children on high dosages or those who are very medication sensitive may experience mental "dulling," mood disturbances, psychotic reactions, or being "over focused." Motor tics and rebound hyperactivity are not uncommon.

Although these medications are generally well-tolerated, questions have been raised about the effects of stimulant medications on children's growth velocity. Researchers have postulated that stimulants may adversely affect growth by their anorexic effect and by an increase in synaptic dopamine, which causes acute inhibition in growth hormone [10,11]. Poulton conducted an extensive review of published reports on growth concerns and ADHD treatment. He cited "clear evidence of an association between treatment with stimulant medication and attenuated growth in height in the better quality studies," although he did note methodological shortcomings in several studies [12]. In 1998, Spencer et al. proposed that differences in growth velocity could be attributed to ADHD itself,

rather than to the stimulant medications taken to manage the condition [13]. Ten years later, two researchers reported growth suppression in children with ADHD ages 9-14 years and also attributed the effect to the condition of ADHD itself rather than to its treatment with stimulant medications [14]. Biederman et al. found no significant difference in peak height velocity between stimulant-treated and stimulant-naïve children with ADHD [15]. An article published in the latter part of 2014 reported that a longitudinal, population-based study showed that neither childhood ADHD itself or stimulant treatment was associated with significant height deficits into adulthood [16].

Study Objective

This study was designed to contribute to the literature on growth in children with ADHD using a less common methodology, a retrospective chart review. The study objective was to determine whether relationships exist between stimulant medications and children's growth velocity. The data used were measurements of children whose stimulant medication regimens were consistent with commonly accepted treatment recommendations.

METHODS

Members of the research team conducted 280 chart reviews of pre-pubertal children who were prescribed stimulant medications for at least 1 year. These children had been diagnosed with ADHD using the standard diagnostic criteria established and published by the American Psychiatric Association in the *Diagnostic and Statistical Manual of Mental Disorders*, Fourth Edition [17] and from positive parent and teacher responses on standardized ADHD questionnaires. Most of the children were enrolled at age 4 years as new patients and began taking stimulants at the time of enrollment. None of the children took stimulant medications before age 4 years.

We excluded children with ADHD who were not taking stimulant medications, those who had fewer than two visits 6 months apart, and those who took medication holidays between the clinic visits. Female subjects who achieved menarche, children taking growth hormone injections, those with genetic syndromes, and those with other growth-limiting conditions (e.g., cerebral palsy) also were excluded.

The children's stimulant medications included both short-acting and long-acting amphetamine and methylphenidate preparations. Children were prescribed the lowest dosages that achieved adequate control of their ADHD symptoms.

We used height and weight measurements collected at clinic visits to calculate growth velocity and then compared these data to normed growth velocity for the general pediatric population. At each clinic visit, children's heights were measured upright, minus shoes, using a stadiometer. Weights were obtained using an approved clinic scale. The stadiometer and scale were

calibrated on a regularly scheduled basis. Children's heights and weights were plotted on standard growth charts provided by the United States Centers for Disease Control and Prevention (CDC) [18]. The CDC growth charts are a national reference representing how US children and adolescents grew during the 1970s, 1980s and 1990s. The CDC recommends using these references from ages 2 through 19 years to track weight, stature, and body mass index from childhood through age 19 years. We used these charts to represent the growth of the general pediatric population (Figures 1 and 2). Growth velocities were calculated using the charts from the Fels Longitudinal Study [19]. Our study was approved by the University Institutional Review Board.

RESULTS

The children were ages 4-15 years (mean = 8.92; standard deviation = 2.52). The majority (78%) of the children were males. Descriptive statistics (frequencies, measures of central tendency) were used to analyze the growth data. The average growth velocity across all ages and genders was 5.72 cm/year. Females averaged 5.53 cm/year and males 5.28 cm/year. Among the females, the greatest growth velocity (6.20 cm/year) was observed between 9 and 10 years of age. Among the males, the greatest growth velocity (6.65 cm/year) was observed at 15 years of age. Of the 280 children in the study, the majority achieved annual growth velocities at or above the 10th percentile for age.

DISCUSSION

We did not find evidence of a significant effect on growth velocity in children treated with stimulant medications. The average growth velocity within each gender and across all ages was comparable to the general pediatric population (Table 1).

Table 1: Study participant average semi-annual growth velocity (rounded age and sex)

Age	Sex (SD)	
	Male (n=218)	Female (n=62)
4	3.04 (0.49)	2.95 (1.27)
5	2.95 (0.43)	2.60 (0.56)
6	2.68 (0.62)	2.54 (0.50)
7	2.51 (0.70)	2.85 (1.04)
8	2.06 (0.67)	2.37 (0.76)
9	2.69 (0.75)	2.66 (1.37)
10	2.42 (0.53)	2.76 (0.85)
11	2.68 (0.88)	3.10 (0.50)
12	2.89 (0.76)	2.53 (0.60)
13	2.83 (0.70)	3.10* (na)
14	2.99 (1.10)	-
15	3.32 (0.25)	1.95* (na)

*n=1 for these age groups

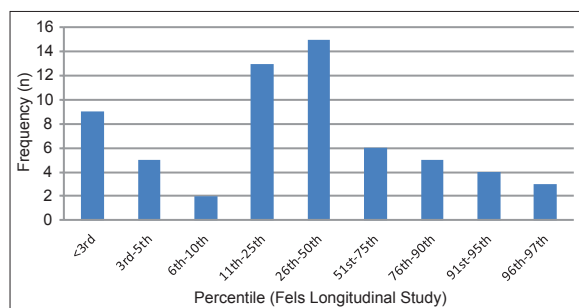


Figure 1: Growth velocities of 62 female study participants in observed percentile levels, using the Fels Longitudinal study as a reference set. A majority (n = 44, 70.97%) of study participants recorded growth velocities at or below the 50th percentile for their age

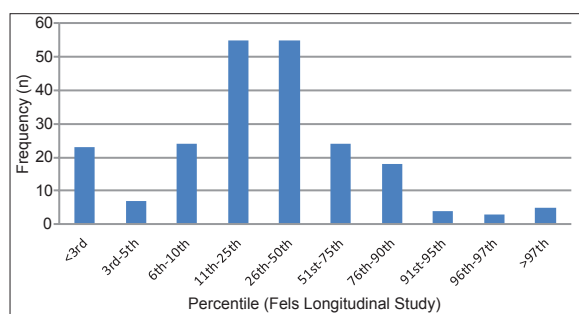


Figure 2: Growth velocities of 218 male study participants in observed percentile levels, using the Fels Longitudinal study as a reference set. A majority (n = 164, 75.23%) of study participants recorded growth velocities at or below the 50th percentile for their age

The effectiveness of stimulant medications is well-documented in numerous published studies. The dilemma of growth suppression effects of stimulants has been debated in the literature since the early 1970s. Our study was designed to answer the question about possible growth-suppressant effects of stimulant treatment in children with ADHD. Our study included patients who took stimulant medications for at least 12 months, but they had stable growth velocities for considerably longer periods. Our decision not to subgroup these children (e.g., by stimulant types or dosages) could be considered a limitation of the study. A detailed study that examines growth velocities in children grouped by type and dosage of stimulant medication would add to the body of knowledge on this subject.

CONCLUSION

Compared with the general pediatric population, there were no significant differences in growth velocities among children taking various types or doses of stimulant medications. Our study results are reassuring and encourage us to continue prescribing stimulant medications for children with ADHD.

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Funding: Nil; Conflict of Interest: None Stated

How to cite this article: Siddiqi S, Dedlow ER, Saliba H, Black EW, Giordano BP. The effects of stimulant medications on children's growth velocity. Indian J Child Health. 2014;1(3):136-9.