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Review article

When does it all go wrong? Longitudinal studies of changes in moderate-to-vigorous-intensity physical activity across childhood and adolescence

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Abstract

Objective/Background: There is a widespread belief that moderate-to-vigorous-intensity physical activity (MVPA) declines markedly in adolescence, particularly in girls. This belief has led to substantial research and policy effort aimed at reducing the perceived decline in MVPA during adolescence. The main aim of this review is to critically examine the belief that MVPA declines during adolescence.
Methods: Review of evidence from studies with objective measures of physical activity, systematic reviews of longitudinal studies, insights from recent longitudinal studies, and evidence from the International Children's Accelerometry Database (ICAD).
Results: Existing systematic review evidence, four recent longitudinal studies from England, and ICAD data all failed to support the hypothesis that MVPA declines particularly markedly during adolescence, or that an MVPA decline begins at adolescence, or that declines in MVPA during adolescence are greater in girls than in boys. Systematic reviews, longitudinal studies, and ICAD data in fact suggest that MVPA begins to decline, and sedentary behavior begins to increase, from around the age of school entry. Recent longitudinal studies also suggest that increasing sedentary behavior during adolescence displaces light-intensity physical activity. An emerging body of evidence from longitudinal studies that use trajectory analysis is providing important new insights into marked between-individual differences in the trajectories of MVPA across childhood and adolescence.
Conclusion: Although gaps in the evidence remain, particularly from low- to middle-income countries, and additional longitudinal studies are required, this review suggests that efforts to promote and/or maintain MVPA should begin well before adolescence.

Keywords: Adolescent; Child; Exercise; Longitudinal study; Physical activity; Sedentary behavior

Introduction

There is now a substantial amount of evidence, reviewed systematically and appraised critically, that physical activity influences health during childhood and adolescence.[1,2] Moreover, higher moderate-to-vigorous-intensity physical activity (MVPA) during childhood and adolescence has benefits beyond health. For example, recent evidence suggests that higher habitual MVPA can produce meaningful improvements in academic attainment in childhood and adolescence.[3–5]

Physical activity recommendations for school-age children and adolescents are evidence based and harmonized internationally (Appendix 1). The recommendation in relation to a minimum of 60 minutes of MVPA daily has received most attention, and is the focus of child and adolescent public health surveillance of physical activity. The other two physical activity recommendations are for vigorous-intensity physical activity (VPA), and for activities to promote muscle and bone health and flexibility (Appendix 1). Although these latter recommendations are important, they have generally received

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less attention (e.g., in research and in public health surveillance) than the recommendation for MVPA. Internationally, levels of MVPA among adolescents are typically much lower than recommended: as few as 20% of 13–15-year-olds globally appear to meet the MVPA recommendation.[6] Levels of adherence to the recommendations in relation to VPA and activities to promote muscle and bone health and flexibility are less well-known because of the lack of surveillance of these behaviors.[7,8]

It is generally accepted that there is a marked decline in MVPA during adolescence, and the decline is usually believed to be much more marked in girls than in boys. In the UK, for example, much policy and research efforts have been based on the concept that MVPA declines dramatically during adolescence, with the concept that adolescents, particularly adolescent girls, are a *high-risk* group for low MVPA.[9–11] Globally, international surveillance programs for MVPA also focus on adolescents.[6] There has been a tendency among researchers and policymakers in physical activity and health domains to assume that levels of MVPA among children are relatively high, or at least adequate, and that low MVPA is a problem that emerges in adolescence.[9–11]

The view that MVPA declines dramatically during adolescence has been extremely influential and is very well-established, but it is worth considering how evidence based the belief is. This work, a review of objectively measured evidence, aims to: (1) critique the belief that declines in MVPA begin in adolescence; (2) consider very recent evidence from longitudinal studies on the existence and extent of MVPA declines during adolescence; and (3) suggest new approaches to understanding the timing and magnitude of changes in MVPA across childhood and adolescence.

Methods

This work is a critique based on objectively measured physical activity evidence derived from recent systematic reviews of longitudinal studies of changes in MVPA and sedentary behavior, a synthesis of longitudinal studies published after the most recent systematic reviews, and a consideration of insights from the International Children's Accelerometry Database (ICAD).[12]

Results

Systematic review evidence on declines in MVPA during adolescence

The most recent systematic review of declines in physical activity (not specifically MVPA) during adolescence was carried out by Dumith et al.[13] Their work has been highly cited as evidence that MVPA declines during adolescence, and it reviewed 26 eligible longitudinal studies (with at least 2 measures of physical activity). Of the 26 eligible studies, 22 were based on questionnaire measures of change, three of which used pedometers, and only two were based on accelerometry. Most (16/26) of the eligible studies were from the United States, most (16/26) completed data collection before the year 2000, and the representativeness (or otherwise) of the samples in the eligible studies was usually unclear.[13]

Although the systematic review by Dumith et al[13] is a very useful and thorough summary of the evidence base in the area, numerous substantial limitations in the evidence base should be noted. First, the small number of accelerometer studies means that there was in fact almost no longitudinal evidence on the magnitude of declines in MVPA in that review, with accelerometry necessary to have high confidence in the amount and intensity of physical activity.[14] Second, the evidence base is arguably of limited generalizability globally given the dominance of studies from high-income countries, the United States in particular. Third, the dominance of studies with only two time points limits our understanding of the timing of changes in MVPA—an improved understanding of the timing and rate of changes in MVPA will require longitudinal studies with multiple measurement time points. In addition, the limited evidence across both childhood and adolescence revealed by Dumith et al[13] makes it impossible to determine whether age-related declines in MVPA either began during adolescence or increased during adolescence.

An additional difficulty with the review by Dumith et al[13] is that the evidence base is now so old that it may have reduced generalizability to contemporary populations. Recent and rapid societal changes, notably changes in transportation, in education, and in the technology now widely available to children and adolescents,[15] might have changed the timing and/or magnitude of declines in MVPA during adolescence quite markedly in recent years. For example, many new screen-based sedentary behaviors have become popular with young children, and exposure to screen-based sedentary behavior has probably increased substantially in early childhood.[16] Although the impact of these changes on physical activity is unclear, any increase in sedentary time must displace some combination of sleep, light-intensity physical activity, and/or MVPA. There is another difficulty with older evidence that applies particularly to settings where the environment has become more *obesogenic*: there is emerging, though not yet conclusive, evidence[17–19] that obesity, and possibly overweight, will reduce MVPA. Prevalence of overweight and obesity is generally higher than in the past, and the body fat content of nonoverweight and nonobese children appears to have been going up.[20,21] In addition, in recent longitudinal studies of children, body mass index z score tends to increase with age, across the distribution of body mass index z score, and not just in the overweight and obese children.[17] These population-wide changes in body composition predict that MVPA levels of children now will be lower than in even the recent past.

In summary, the lack of good evidence identified by Dumith et al[13] means that there can be little or no confidence in changes in either the amount or timing of MVPA across adolescence at present. The review also provides little or no confidence in the view that MVPA declines begin during adolescence. A brief review of more recent longitudinal