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Gender-specific effects of physical activity on children's academic performance: The Active Smarter Kids cluster randomized controlled trial

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ABSTRACT

Active learning combines academic content with physical activity (PA) to increase child PA and academic performance, but the impact of active learning is mixed. It may be that this is a moderated relationship in which active learning is beneficial for only some children. This paper examine the impact of baseline academic performance and gender as moderators for the effects of active learning on children's academic performance.

In the ASK-study, 1129 fifth-graders from 57 Norwegian elementary schools were randomized by school to intervention or control in a physical activity intervention between November 2014 and June 2015. Academic performance in numeracy, reading, and English was measured and a composite score was calculated. Children were split into low, middle and high academic performing tertiles. 3-way-interactions for group (intervention, control) * gender (boys, girls) * academic performance (tertiles) were investigated using mixed model regression.

There was a significant, 3-way-interaction ($p = 0.044$). Both boys (ES = 0.11) and girls (ES = 0.18) in the low performing tertile had a similar beneficial trend. In contrast, middle (ES = 0.03) and high performing boys (ES = 0.09) responded with small beneficial trends, while middle (ES = −0.11) and high performing girls (ES = −0.06) responded with negative trends.

ASK was associated with a significant increase in academic performance for low performing children. It is likely that active learning benefited children most in need of adapted education but it may have a null or negative effect for those girls who are already performing well in the sedentary classroom. Differences in gendered responses are discussed as a possible explanation for these results.

Trial registration: Clinicaltrials.gov registry, trial registration number: NCT02132494.

1. Introduction

In the Active Smarter Kids (ASK) study, 57 elementary schools in Norway were randomized by school to either intervention or control. Academic performance in numeracy, reading and English was measured using standardized Norwegian national tests (Resaland et al., 2015). Results indicated a significant increase in numeracy for low performing children in academic performance, with similar results across boys and girls (Resaland et al., 2016). The demonstrated benefit for academic low performing children is not surprising, as these children might be struggling in the traditional, sedentary classroom. PA enhances enjoyment of academic lessons, academic motivation (Vazou and Smiley-Oyen, 2014) and engagement with academic materials (Grieco et al., 2016). As such, it was expected that active learning, especially when conducted mainly in the school yard, as was the case in the ASK study, is likely to appeal to these children. There is, of course, a downside to this outcome. It may be that active learning has a null or a negative academic effect in children who perform well in the traditional sedentary classroom. Thus, for high performing children, active lessons might not provide a better learning environment.

Differences in the response to active learning may be especially pronounced in children who differ in their gendered response to the school environments. The World Health Organization (2017) defines the terms “gender” and “sex” as follows: “sex” refers to the biological and physiological characteristics that define men and women, and “gender” refers to the socially constructed roles, behaviors, activities,

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and attributes that a given society considers appropriate for men and women. In the present paper, we use the term "gender" to cover both terms.

The evidence for a beneficial effect of active learning on academic outcomes is scarce (Martin and Murtagh, 2017; Norris et al., 2015). None of the papers included in two recent reviews (Martin and Murtagh, 2017; Norris et al., 2015) examined whether effects on academic outcomes were moderated by gender. Despite lower levels of PA, on average, elementary school-aged girls generally outperform boys in most school subjects, including core numeracy and literacy (OECD, 2011; Voyer and Voyer, 2014). In general, this difference might emerge mainly from gendered responses to the learning environment. Specifically, more feminine responses are associated with classroom behavior that is verbal-emotive and marked by the ability to sit still for long durations and multitask, while more masculine responses are less open to sharing and are more 'restless' (Carrier, 2009). Moreover, elementary schools in many countries record an unequal representation of male and female teachers with female teachers as a large majority (Burusic et al., 2011). Therefore, instruction in today's elementary school might reside on the feminine side of the gender dimension. Thus, the traditional classroom environment might be a better fit for most girls compared to most boys (Evans, 2017; Renold, 2001). Furthermore, boys' higher level of PA compared with girls (Cooper et al., 2015) may reflect a restless inclination to move, which has been associated with masculinity, suggests that boys may be more responsive to PA learning environments than girls.

Because we do not have a direct measure of gender perceptions or responses in the ASK study, we will, instead, examine differences between boys and girls on academic performance. Data will be drawn from a seven-month PA cluster-randomized controlled trial (cluster RCT) on fifth-graders academic performance (Resaland et al., 2016). This secondary analysis test the moderating role of both baseline academic performance and gender on the effect of active learning on academic performance in children. We are especially interested in the 3-way interaction, as this will investigate differences in effect as a function of gender and baseline academic performance. As such, it provides the most complete indication to date of the subgroups that may be most and least responsive to an active learning intervention.

2. Methods

We previously published a detailed description of the ASK study sample, methodology, and main effects (Resaland et al., 2016; Resaland et al., 2015). Therefore, only a brief description is provided below.

ASK was a seven-month cluster RCT investigating the effect of school-based PA on academic performance. Sixty schools (1202 children) in Sogn and Fjordane County, Norway were invited. Of these 57 schools and 1145 children volunteered to participate. All children signed informed consent (recruitment success of 95% of schools, 97% of children (see Fig. 1). Data were obtained from 1129 children; 81% of all 10-year-olds who reside in the county.

2.1. The intervention

The ASK intervention is designed to increase PA (165 min/week above normal activity curriculum) and was comprised of three components:1) PA educational lessons (3 × 30 min each week); academic lessons in the core subjects, Norwegian, mathematics and English (second language) carried out mostly in the school playground; 2) PA breaks during classroom lessons (5 min × 5 days each week); 3) PA homework prepared by the teachers (10 min daily; 5 × 10 min each week). To optimize adherence, all components were included as part of the mandatory school curriculum for children attending I-schools. Additionally, as a part of the mandatory school curriculum in Norway, children from I-schools and C-schools participated in the curriculum-prescribed 90 min/week of PE and 45 min/week of PA (135 min/week).

The three PA components in the ASK intervention were planned so that activities were varied and enjoyable for the children. It was emphasized to ASK-teachers that all activities should include all children, especially those who were not particularly fit or enthusiastic about PA. Special attention was given to creating an encouraging and motivating atmosphere during lessons. The intention was that approximately 25% of daily PA in the ASK intervention was of vigorous intensity (i.e. children would be sweating and out of breath). Vigorous activity was achieved by selecting a variety of high intensity activities such as running, relay racing and obstacle courses. The ASK study is embedded in a socio-ecological conceptual framework that focuses on positive PA behaviors (McLeroy et al., 1988). To address individual and social determinants specific theoretical frameworks including Harter's Competence Motivation Theory (Harter, 1978), Achievement Goal Theory (Nicholls, 1989) and Ryan & Deci's Self-determination Theory (Ryan, 2002) were adopted. Thus, the ASK intervention emphasizes creating autonomy and supporting mastery oriented teacher-child interaction to enhance children's PA behavior. Our approach achieves this by positively influencing children's perception of competence, self-efficacy, and intrinsic motivation for PA.

2.2. Procedures

Children were assessed at baseline and after a seven months intervention. Children's academic performance in numeracy (often referred to as mathematic), reading and English were measured using standardized Norwegian national tests. These were designed and administered by The Norwegian Directorate for Education and Training. The numeracy test measures children's ability to understand numbers, measurements, and statistics. The reading test measured children's basic Norwegian reading skills such as finding information in a text, interpreting and understanding the text, and reflecting on and considering text form and content. The English test measured children's ability to find information and understand the main content and some details in simple text. The score was standardized to a mean of 50 scale points for each test, with a standard deviation of 10 (Norwegian Ministry of Education, 2013). Individual scores from each test were further standardized to standard deviation (SD) units and summed to derive a composite score for academic performance.

PA and sedentary time were measured by ActiGraph accelerometers (ActiGraph GT3X, LLC, Pensacola, Florida, USA), which are valid and reliable for measuring these parameters in children and youth (De Vries et al., 2009). Children were instructed to wear an accelerometer on the right hip for seven consecutive days at all times, except during water activities or while sleeping. A wear-time of 480 min/day for minimum four days (out of seven) and 180 min/day (between 09:00 and 14:00) for minimum three days (out of five weekdays) was used as criteria for valid measurements of overall PA and school PA, respectively. Periods of 20 min of zero counts were defined as non-wear time (Esliger et al., 2005). Outcomes for PA were moderate to vigorous PA (MVPA) (cut-point 2296 counts per minute (cpm)) and sedentary time (0–100 cpm) (Evenson et al., 2008; Trost et al., 2011). All analyses were based on the accumulation of data over 10 s' epochs.

Body mass was measured using an electronic scale (Seca 899, SECA GmbH, Hamburg, Germany). Height was measured with a portable Seca 217 (SECA GmbH, Hamburg, Germany). Parental education levels were obtained by questionnaire and categorized into three levels using the highest educational level obtained by the mother or father: i) upper or lower secondary school, ii) university < four years and iii) university ≥ four years.

2.3. Statistical analyses

Descriptive statistics are reported as means and SD. Differences between groups on categorical baseline variables were tested using