



# Optimal timing of exercise for influencing energy intake in children during school lunch



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## ABSTRACT

**Introduction:** Laboratory studies have shown that exercise can reduce energy intake, with a benefit to moderate-to-vigorous physical activity (MVPA) in individuals. The aim of the current study was to identify the impact of MVPA before lunch on *ad libitum* energy intake in very young children in a natural setting.

**Methods:** Three conditions were tested on three occasions, each using a counterbalance testing sequence as follows: A) Meal\_MVPA: Meal at the beginning of the lunch period followed by a 40-min MVPA (reference condition); B) LPA\_meal: 40 min of light intensity exercise session followed by lunch; C) MVPA\_meal: MVPA followed by lunch. Children were instructed to eat their *ad libitum* lunch box (7–9 items) to reach 4/5 on the satiety visual analogue scale.

**Results:** 21 participants [8 boys and 13 girls; 80% normal weight; mean age: 5.6 (standard deviation: 0.5) years] participated in the study. Energy intake was significantly greater in the LPA\_Meal condition [509 kcal (95% confidence interval: 448–570)] than in Meal\_MVPA [442 kcal (380–504)] ( $p = 0.011$ ) and MVPA\_Meal [432 kcal (371–494)] ( $p < 0.001$ ) conditions ( $p < 0.05$ ). The energy from lipids was significantly greater in the LPA\_Meal [154 kcal (130–177)] than in Meal\_MVPA conditions [120 kcal (97–144)] ( $p = 0.016$ ).

**Conclusion:** The current study may indicate that it is possible for young school children to benefit from anorexigenic exercise in real-life settings. In addition, it was possible to delay mealtime without increasing energy intake when MVPA was provided during the delay period. Finally, the introduction of MVPA prevented an increase in lipid consumption observed for LPA.

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## 1. Introduction

Worldwide obesity rates are of great concern to many, including health and education professionals (World Health Organisation, 2017). They have attempted to identify solutions to prevent increased excess body weight in young individuals as early as possible (World Health Organisation, 2017). To do so, eating and exercise habits have been targeted as well as the environments

where children evolve (Centers for Disease Control and Prevention, 2015; Sturm, 2005).

For many reasons, schools are settings of interest including the significant amount of time children spend in these environments (Sturm, 2005). However, unhealthy school environments are frequently found: for example, many schools offer sweetened beverages and unhealthy foods (Center for Disease Control and Prevention, 2011; Sturm, 2005). This can contribute to unhealthy eating habits in which up to 25% of children have food intakes high in lipids, sugar and salt, and 33% surpass daily recommended energy intake guidelines (Ministère de l'éducation, 2007). As to physical activity, a small percentage of students are sufficiently active on a daily basis; however, physical

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education classes are not frequent enough and children are not always active during the duration of those classes (Direction de la santé publique, 2000).

Policies and programs in the school system aim to modify unhealthy behaviours and environments in favor of nutritional and physical activity (Centers for Disease Control and Prevention, 2015; White House Task Force on Childhood Obesity Report to the President, 2010; World Health Organisation, 2015a, b). A characteristic of these approaches is that they attempt on one hand to have an impact on nutrition habits (limiting food with high levels of added sugar) (US Department of Agriculture and US Department of Health and Human Services, 2010; World Health Organisation, 2015a, b), and on the other hand, enhance a physically active lifestyle (increased physical education classes (World Health Organisation, 2015a, b) and schoolyard improvements (Québec eb Forme, 2013; World Health Organisation, 2015a, b)). Numerous programs target both lifestyles and produce interesting results: improved nutrition, increased physical activity and reduced overweightness and obesity rates (Fung et al., 2012; Veugelers & Fitzgerald, 2005). Nevertheless, the implementation of these programs often requires many resources (time, money) and the synergy between exercise and eating habits (Varley-Campbell, Moore, & Williams, 2015) as well as exercise intensities are overlooked.

The anorexigenic effect of exercise is a concept where energy intake is reduced when the meal takes place during the post-exercise period (Thivel et al., 2012). In children, the use of exercise-induced anorexia could have a direct impact on the energy balance through increased energy expenditure but also indirectly through reduced energy intake (Moore et al., 2004). Exercise is now known for its acute impact on appetite and food choices (Dodd, Welsman, & Armstrong, 2008; Thivel et al., 2011). Recently, our group showed the short-lasting action of the anorexigenic effect of exercise (Albert, Drapeau, & Mathieu, 2015), supporting the view that optimal timing (exercise immediately prior to the meal) is present. An effective approach using the anorexigenic effect of exercise is also time- and resource-efficient, given that more exercise is not performed; it is just done at a more strategic time.

The current study aimed to test, outside the laboratory and within a school setting, whether optimal timing of exercise around the meal, which takes advantage of the anorexigenic effect, can impact eating outcomes in children in a way that favors obesity prevention. The hypothesis is that the introduction of exercise performed at higher intensity immediately before the meal would lead to lower energy intake at lunch time than if low intensity exercise is performed and to similar energy intake to the condition where the meal is taken prior to the exercise.

## 2. Materials and methods

### 2.1. Participants

Children from one kindergarten class (Jacques-Barclay School, St-Mathieu, QC, Canada) were recruited to participate in this study. Inclusion criteria were: 1) no allergies, 2) not currently following diets, 3) no diagnosis of diabetes, 4) no medication that might influence the study outcomes, and 5) no handicaps, limitations or injuries preventing the child to walk, run or take part in physical activity. The child's condition was to be considered stable during the duration of the study. The University of Montreal Health Research Ethics Committee approved the project and a consent form was signed by all participants and their parents.

### 2.2. Protocol

Children participated in the protocol, which included; one practice day (Day 1, Table 2) followed by three consecutive weeks with three testing days a week. The practice day aimed to expose children to tools [e.g. visual analogue scales (VAS)] and procedures (e.g. individual *ad libitum* meal and exercise sessions). In all cases, children ate only the food provided by the study between breakfast (*ad libitum* lunchbox composed of 4 items) and lunch (*ad libitum* lunchbox of 8–9 items) (Table 1). Three different menus were served alternately to children, one as per experimental conditions, in order to prevent boredom during the month of testing. The amounts were provided for the children, with an extra 50% of basic nutritional requirements so as to obtain an *ad libitum* lunch structure for the meal (Health Canada, 2017).

Children arrived at school at 7:45 a.m. Breakfast was served between 7:55 and 8:15 a.m. The objective of the breakfast was to normalize satiety in children at a satiety score of 4/5 on the illustrated VAS (Fig. 1). To ensure that each child had eaten enough, an evaluation of satiety was performed and data were compiled following breakfast by the same evaluator on all testing days. Regular classes under the responsibility of the teacher occurred after breakfast. Between 11:15 a.m. and 12:45 p.m., three conditions over the three-week protocol were offered: 1) Meal\_MVPA = 50 min for eating lunch, followed by 40 min of moderate to vigorous physical activity (MVPA) (reference condition), 2) LPA\_Meal = 40 min of low intensity physical activity, followed by 50 min for eating lunch, and 3) MVPA\_Meal = 40 min of MVPA followed by 50 min for eating lunch (Fig. 2). Each session was done three times, on day 1, 2 and 3 of weeks 1, 2 and 3 (Fig. 3). These conditions were developed according to meals and exercise sessions were structured within the school structure (no change in teaching schedule).

Each of the three conditions was assessed according to the three different meals during the 9 experimental days (Table 3). This procedure was chosen to avoid boredom towards the meals offered over a short period of time. The MVPA session was composed of different ball games, racing and chasing games. The games were borrowed from the kit "My school yard: a world of fun!" (Kino-Québec, 2017). Before beginning activities, a researcher showed the children the scale of perceived exertion (Robertson et al., 2000) and asked the children to reach 7–8 of 10. The LPA session aimed to reach a score of 1–2 on the perceived exertion scales. To do so, breathing, massages and yoga activities were used.

### 2.3. Measurements

During practice day, anthropometric measures (body weight and height) were taken for each child (BF350 bioimpedance balance, TANITA Corporation, Tokyo, Japan; Seca portable stadiometer, Hambourg, Germany) and interpreted using Canadian guidelines (Lau et al., 2007). A health readiness questionnaire was pre-answered by the parents to confirm that there were no contraindications to participation based on inclusion and exclusion criteria (Zimmerman & Bell, 2010). During physical activity, children wore a pedometer (SW200, Digiwalker, Japan). This system enabled the capture of the number of steps between breakfast and lunch.

During lunch, children ate what they wanted from the provided meals and left leftovers with the objective of reaching 4/5 on the satiety scale. At the end of each meal, a designated researcher asked children what their level of satiety was on the scale (Fig. 1). The food was previously weighed using a laboratory balance (Ohaus SE3001FS, Fisher Science Education) and then served in class. The lunch boxes were filled with different products according to Canada's Food Guide (Health Canada, 2017) and children neither shared

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