



Curricular activities and change in determinants of fruit and vegetable intake among adolescents: Results from the Boost intervention

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ABSTRACT

Knowledge of the association between implementation of different intervention components and the determinants they are tailored to change may contribute to evaluating the effects and working mechanisms of multi-component interventions. This study examined 1) the effect of a Danish multi-component school-based intervention (2010–2011) on key determinants of adolescents' fruit and vegetable intake and 2) if dose of curricular activities was positively associated with change in these determinants. Using multi-level linear and logistic regression analyses stratified by gender and socioeconomic position, we analyzed survey data from the cluster-randomized Boost study targeting Danish 13-year-olds' fruit and vegetable intake. We examined 1) differences in knowledge of recommendations, taste preferences and situational norms between students from 20 intervention ($n = 991$) and 20 control ($n = 915$) schools at follow-up; and 2) associations between curriculum dose received and delivered (student and teacher data aggregated to school- and class-level) and these determinants among students at intervention schools only. At follow-up, more students from intervention than control schools knew the recommendation for vegetable intake (OR 1.56, CI:1.18, 2.06) and number of fruits liked (taste preferences) increased by 0.22 (CI:0.04, 0.41). At class-level, curriculum dose received was positively associated with proportion of students knowing the recommendation for vegetable intake (OR 1.06, CI:1.002, 1.13). In stratified analyses, this association was only significant among students from high social class (OR 1.17, CI:1.04, 1.31). The Boost intervention succeeded in improving students' taste preferences for fruit and knowledge of recommendation for vegetable intake, but only the latter determinant was positively associated with curriculum dose.

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1. Introduction

Many schoolchildren do not reach the international recommendation of eating at least 400 g of fruit and vegetables (FV) daily (Currie et al., 2012; Pedersen et al., 2015). School-based multi-component interventions combining educational and environmental strategies have been shown to be effective in increasing children's FV intake (Evans et al., 2012; Knai et al., 2006; Van Cauwenberghe et al., 2010; Wang & Stewart, 2012). However, several studies report poor implementation (Christian et al., 2012; Lytle et al., 2004; Reinaerts et al., 2007; Wind et al., 2008), for example low implementation level of curricular

components delivered by teachers (Christian et al., 2012; Wind et al., 2008). To enable correct interpretation of intervention effects and develop effective intervention components, knowledge of the implementation of separate intervention components is important (Linnan and Steckler, 2002). Furthermore, assessment of the implementation may clarify whether lack of change in important determinants of FV intake is caused by low implementation of the components addressing these determinants or by lack of effect of the chosen intervention tools (Linnan and Steckler, 2002; Durlak and DuPre, 2008).

Curricular components in previous multi-component dietary interventions among children and adolescents (Wind et al., 2008; Bere et al., 2006; Lehto et al., 2014; Story et al., 2000; Anderson et al., 2005; Bessems et al., 2013) have targeted determinants such as taste preferences, dietary knowledge, awareness of national recommendations for FV intake, and practical skills. Two of these studies (Bere et al., 2006; Lehto et al., 2014; Story et al., 2000; Anderson et al., 2005) examined the impact of the entire intervention on changes in determinants of FV intake. Anderson et al. (2005) found a greater increase in children's

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(6–7 and 10–11 years old) knowledge and subjective norms (perceived social pressure from school nurse) in the intervention group compared to the control group, while taste preferences were unchanged. Bere et al. (2006) identified a significant difference between intervention and control groups for awareness of recommendations for FV intake, but not for home accessibility, modelling, intention to eat five-a-day, preferences and self-efficacy to eat five-a-day. We have not been able to identify multi-component intervention studies examining the association between implementation level of curricular components separately and change in determinants of FV intake among adolescents.

The aim of this study was therefore to evaluate if a curricular component worked through its intended theory- and evidence-based link (Baranowski and Jago, 2005; Aarestrup et al., 2014a; Cerin et al., 2009) by 1) examining the effect of the entire multi-component intervention on *three important determinants of adolescents' FV intake* addressed by the curricular component: *knowledge of recommendations, taste preferences and situational norms related to FV intake* (Krølner et al., 2011; Rasmussen et al., 2006; Sleddens et al., 2015). These determinants were identified in reviews of quantitative and qualitative studies of children's and adolescents' FV intake (Krølner et al., 2011; Rasmussen et al., 2006); and 2) examining if implementation level of this curricular component (dose delivered and received) was associated with change in these three determinants. The study has been pre-specified as a secondary analysis of Boost intervention data in the trial registry Current Controlled Trials ISRCTN11666034 (<http://www.isrctn.com/ISRCTN11666034>).

2. Methods

2.1. The Boost intervention

The Boost intervention aimed to increase adolescents' FV intake through curricular activities and free FV distribution at school, parental newsletters and fact sheets for sports- and youth clubs (Krølner et al., 2012). Development of the intervention was guided by the Intervention Mapping protocol (Krølner et al., 2012; Bartholomew et al., 2006).

The Boost intervention lasted nine months (September 2010–May 2011). It was tested in a school-randomized controlled trial among all seventh grade students (\approx 13-year-olds) from a random sample of 20 intervention and 20 control schools from 10 randomly selected municipalities in Denmark. Implementation of intervention components was monitored by a thorough quantitative and qualitative process evaluation (Aarestrup et al., 2014a; Jørgensen et al., 2014; Aarestrup et al., 2014b; Aarestrup et al., 2015). The Boost intervention is described in details elsewhere (Krølner et al., 2012).

2.2. The Boost curriculum

As specified in the Boost program theory, each intervention component was designed to change adolescents' FV intake (distal outcome) through changes in specific determinants of FV intake (proximal outcomes) (Krølner et al., 2012). Curricular activities specifically aimed at changing assessment of personal FV intake, FV intake in the class and family and personal goal setting (awareness, situational and social norms); analysis and production of food related advertisements (influence from media); study of how FV intake affects the body (short term outcome expectations); tasting different types of FV (taste preferences); cookery at school (skills and taste preferences), and discussing occasions and meals appropriate for eating FV (situational and social norms, influence from peers and family); field trips to local supermarkets or fruit orchards (awareness of availability) (Krølner et al., 2011; Rasmussen et al., 2006; Krølner et al., 2012). This study focuses on two known important determinants of adolescents' FV intake (Krølner et al., 2011; Rasmussen et al., 2006): Knowledge of recommendations and taste preferences, and on one potential determinant for adolescents' FV intake (Krølner et al., 2011): Situational norms related to FV intake

(perceived appropriate occasions and time for eating FV). Students' perceptions of whether it is appropriate to eat FV in school or at birthdays may influence their intake during these occasions.

The Boost curriculum was based on existing material from other interventions (Klepp et al., 2005; Lien et al., 2010) and consisted of four parts: 1) A detailed teacher manual including 12 compulsory, five optional, and eight additional activities, each to be carried out during 1–4 class lessons. A time schedule specified 1–3 activities which were to be implemented monthly to ensure regular exposure; 2) A teacher script for a project week (four compulsory and four optional activities); 3) A student workbook covering the activities presented in the teacher manuals; 4) A computer tailoring module tailored to students' FV intake, awareness level, taste preferences, and leisure time activities which students were expected to complete three times (Krølner et al., 2012).

The activities were designed to be integrated in different school subjects for example maths, home economics and physical education, and to comply with national learning objectives for these (Krølner et al., 2012). Teachers were to implement all compulsory activities in each of the seventh grade classes but were allowed adaptations to their local context. The teaching material is available in Danish (www.cirhp.dk).

2.3. Fruit and vegetable distribution and parental newsletters

Teachers were responsible for daily distribution of one free piece of fruit or vegetable to every student. To create a pleasant eating environment, teachers were encouraged to implement a FV break and to cut up the FV in appealing snacks. Boost coordinators at the schools were asked to post six Boost parental newsletters at the school's website for parents with ideas on how to increase adolescents' FV intake at home and in their leisure time.

2.4. Study sample and data collection

In this study, we combined data from students, teachers, parents and principals. Before intervention start (August 2010), 1121 students at intervention schools completed a baseline questionnaire (response rate of enrolled students: 95.4%). Of these, 991 students (84.3%) completed a follow-up questionnaire post intervention (May/June 2011). At control schools, 1035 students (response rate of enrolled students: 92.9%) completed the baseline questionnaire. Of these, 915 students (82.1%) completed the follow-up questionnaire.

Students completed web-based questionnaires during school hours and received paper questionnaires for their parents to complete. At intervention schools, parent data were received for 655 students (58.4% (655/1121)) at baseline and 368 students (37.1% (368/991)) at follow-up.

Web-based questionnaires were sent to principals and teachers by email. All principals ($n = 20$, 100%) completed baseline and follow-up surveys (October 2010 and July 2011). We received teacher data from all intervention schools post intervention. Number of seventh grade teachers involved in implementation of the curriculum at each intervention school differed from two to all (total number of teachers at seventh grade ranged from six to 21).

The Boost study adheres to all Danish ethical standards and the Declaration of Helsinki and is approved by the Danish Data Protection Agency (J.nr. 2010–54–0974). Parents could indicate in their questionnaire whether they wanted the project group to exclude their child's questionnaire from the database. Responses were treated anonymously and confidentially.

2.5. Measures

Table 1 summarizes study measures. Dependent variables: Determinants of FV intake (student data): 1) Correct knowledge of recommendations for FV intake. In Denmark, children > 10 years are recommended

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