



School gardens and adolescent nutrition and BMI: Results from a national, multilevel study



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ABSTRACT

Objective: The aim of the current study was to determine the impact of school gardens on student eating behaviors, physical activity and BMI in New Zealand secondary schools. The current study also aimed to determine if school gardens could buffer the association between household poverty and adolescent BMI. **Methods:** Data were drawn from a national study of the health and wellbeing of New Zealand secondary school students ($n = 8500$) conducted in 2012. Multilevel regression models were used to determine the association between school gardens (school-level) and student nutrition behaviors, physical activity and measured BMI (student-level). **Results:** Approximately half of secondary schools had a fruit/vegetable garden for students to participate in. School gardens were associated with lower student BMI ($p = 0.01$) and lower prevalence of overweight ($p < 0.01$). **Conclusions:** School gardens appear to have a positive impact on student health. Future research may explore how school gardens are implemented to better understand their impact and to extend the benefits beyond the school community.

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School-based garden education programs are gaining in popularity as a strategy to address poor nutrition. Yet, the effectiveness of school garden programs is largely unknown as there are numerous methodological and practical difficulties in evaluating their impact. A review of garden-based youth nutrition interventions conducted in 2009 found that garden-based education programs conducted to date may contribute to positive improvements in fruit and vegetable intakes, willingness to try new fruits and vegetables, and preferences for fruits and vegetables (Robinson-O'Brien et al., 2009). However, the study designs of these interventions had many limitations. Many of the interventions were evaluated without a comparison group, all of the samples were convenience samples, and the implementation of gardening programs ranged widely in intensity and duration. Moreover, few studies have measured the potential impact of garden programs on a wider range of nutritional indicators, including BMI. Likewise, the potential role that school garden programs may play in improving food security has been largely ignored, yet many interventions have been implemented in communities experiencing high levels of deprivation (Evans et al., 2012; Meinen et al., 2012; Rowland Charbonneau et al., 2014; Wells et al., 2014).

Since the 2009 review, there have been at least two cluster randomized controlled trials examining the impact of school gardens on fruit and vegetable consumption and physical activity. Christian et al. (2014) randomly allocated 10 schools to receive the Royal Horticultural Society-led gardening intervention and 13 schools to receive the less-intense teacher-led intervention over one year. Results of this trial suggested that school gardening programs can improve fruit and vegetable consumption among children, but only when implemented at a high level. In a similar trial in New York, Wells et al. (2014) randomly allocated 12 schools to a one year school garden intervention and 6 schools to a wait list control. Findings from this trial suggest that students participating in school-based garden programs significantly reduced the amount of time spent in sedentary activity and increased their moderate-to-vigorous physical activity. Though these two cluster randomized trials currently provide the best level of evidence of the effects of school garden programs, both studies had limitations common to the design. These limitations include selection bias (of participating schools) and varying implementation of programs between schools.

Given the challenges in determining the impact of garden programs on health through well-designed intervention trials, multilevel observational studies may make a unique contribution to the evidence base. By accounting for the differences in socioeconomic conditions between schools (or communities), the un-biased association between school/community gardens and the nutritional wellbeing of individuals can be estimated. We are unaware of any multilevel observational studies

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that describe the relationship between school gardens and student nutrition, physical activity or body size.

The aim of the current research is to determine the impact of school gardens on student eating behaviors, physical activity and BMI in New Zealand secondary schools using advanced multilevel statistical techniques. The current study will also determine if school gardens can help to buffer the association between household poverty and nutritional indicators.

Methods

Data were drawn from the Youth'12 survey, a national study of the health and wellbeing of New Zealand secondary school students (school years 9–13) conducted in 2012 (Clark et al., 2013). In total, 8500 randomly selected students (of 12,503 invited) from 91 randomly selected secondary schools (of 125 invited) across New Zealand completed an anonymous survey about their health and wellbeing. Senior administrators in each school (80/91, 87.9%) completed a survey about the school environment, including whether the school had a garden.

Consent for participation was obtained from school principals on behalf of the Boards of Trustees. Students and parents were provided with information sheets about the survey. Parents were encouraged to discuss the survey with their child and could withdraw their child from participation (passive consent). Students consented themselves to participate in the survey at the time of the survey. The University of Auckland Human Participants Ethics Committee granted ethical approval for the study (ref 2011/206).

All data collection took place at school during the school day. On the day of the survey, small groups of students were asked to come to a designated room. Upon arrival students were given an anonymous login code to access the survey. Prior to the start of the survey, a member of the research team explained the survey and research procedures. The students then provided their own consent on the internet tablet before commencing the survey.

The survey included a 608 item multimedia questionnaire administered on an internet tablet. The survey was developed by a multi-disciplinary team of professionals as a means to collect timely information on the factors affecting the health and wellbeing of adolescents in New Zealand. The Youth'12 survey is the third in the series; most of the measures were tested for comprehension during the 2007 survey (Denny et al., 2008). After the student survey had been conducted in 2012, a letter was sent to all principals inviting them to participate in a school health survey. Principals provided consent and who to contact in their school regarding the school health services. These nominees were then contacted by phone and asked to fill in an on-line survey on the health services in their school.

Measures

The demographic variables, *age*, *sex*, *age* and *ethnicity*, were assessed by self-report. *Household poverty* was assessed by the self-reported presence of any two of the following nine indicators: household food insecurity (often/all the time), moving homes frequently (2 or more times in past year), not having working car at home, not having a telephone at home, not having a computer at home, overcrowding (more than 2 people per bedroom), both parents unemployed, use of rooms other than bedrooms for sleeping (e.g. living room, garage), and not going away on a family holiday during the past 12 months. This measure was based on the Family Affluence Scale (Currie et al., 2008) and its development is described elsewhere (Denny et al., Under review). In total, 19% of students met the criteria for household poverty. The proportion reporting each of the indicators was: household food insecurity 11%, moving homes frequently 7%, no car 2%, no telephone 6%, no computer 4%, overcrowding 5%, both parents unemployed 6%, use of rooms other than bedrooms for sleeping 16%, and no family holidays 22%.

Height and weight measurements were taken by research staff on portable scales and stadiometers. Research staff were trained to reliably collect height and weight. Height and weight measurements were made individually during the survey, behind privacy screens. Students wore light clothing and no shoes. Height and weight measurements were then used to calculate body mass index (BMI) as weight (kg)/height (m) squared. *Fruit and vegetable consumption* was assessed with a series

of questions asking about frequency of consumption of “fruit,” “potatoes, kumara, taro, etc.,” and “vegetables (not including potatoes, kumara, taro).” Students were categorized as meeting the recommendation for “5 + fruits and vegetables a day” if they responded that they consumed fruit twice a day or more often and vegetables or potatoes, kumara, or taro three times a day or more often. *Fast food/takeaway consumption* was assessed with two items asking about frequency of eat food from a fast food place (e.g. McDonald's, KFC, Burger King, Subway, Pizza Hut) or other takeaways or fast food shops (fish & chips, Chinese takeaways). Students were categorized as consuming fast food/takeaways “4 or more times a week” if they responded as such to either of the questions. *Physical activity* was assessed with a single question, “During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?” with responses ranging from 0 to 7 days.

Presence of a school garden was assessed with a single item on the school administrator survey, “Does your school have a garden (vegetable and/or fruit) that students participate in?” Information on the characteristics of the schools, such as *school funding*, *single sex or co-educational*, *school size* and *school socioeconomic ranking* is publicly available from New Zealand's Ministry of Education.

Analyses

Data were analyzed using multilevel regression models to determine the association between school gardens (school level) and student nutrition behaviors, physical activity and BMI (student level). All analyses accounted for student demographics and school characteristics that could potentially confound the results. Both the socio-demographic characteristics of students (Utter et al., 2011; Utter et al., 2007) and aspects of schools (Jaime and Lock, 2009) are associated with student nutrition, physical activity, and BMI. To determine if school gardens can modify the relationship between household poverty and nutrition behaviors, physical activity and BMI, separate multilevel regression models were run which included an interaction term (household poverty \times school garden), controlling for student demographics and school characteristics. All analyses were conducted using the SAS statistical software package (v9.3, Cary, NC) and results were considered statistically significant at $p < 0.05$.

Results

Approximately half (55%) of secondary schools had a fruit/vegetable garden for students to participate in (Table 1) and approximately 54% of students attended a school with a school garden (data not shown). There were few or no differences in the presence of a school garden by school characteristics (school funding source, single sex or co-educational, school size, or socioeconomic ranking of the school).

Results from the multilevel analyses demonstrate that school gardens were associated with lower student measured BMI ($p = 0.01$) and less frequent fast food consumption ($p = 0.04$), controlling for student- and school-level covariates (Table 2). There were no associations between school gardens and student fruit or vegetable consumption or physical activity. Finally, school gardens appeared to buffer the effect of household poverty on student BMI ($p = 0.04$), such that students experiencing household poverty observed the greatest benefit from school gardens (Fig. 1). There were no moderating effects of school gardens on any other nutritional indicator or physical activity.

Discussion

Findings from the current study suggest that approximately half of secondary schools in New Zealand have a fruit or vegetable garden that students can participate in. The presence of a school garden was associated with lower student BMI values and less frequent consumption of fast food by students. Moreover, the relationship between school

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