

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

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ABSTRACT

The aim of the current study was to determine the impact of school gardens on student eating behaviours, 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. Data were drawn from a national study of the health and wellbeing of New Zealand secondary school students (n=8,500) conducted in 2012. Multilevel regression models were used to determine the association between school gardens (school-level) and student nutrition behaviours, physical activity and measured BMI (student-level). Approximately half of secondary schools had a fruit/ vegetable garden for students to participate in. School gardens were associated with lower student BMI ($p=0.01$), lower prevalence of overweight ($p<0.01$) and less fast food consumption ($p=0.04$), controlling for student- and school-level covariates. School gardens buffered the effect of household poverty on student BMI ($p=0.04$), such that students experiencing household poverty observed the greatest benefit from school gardens. 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.

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 (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 (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 programmes 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 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 behaviours, 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, 8,500 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%, an 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 analysed using multilevel regression models to determine the association between school gardens (school level) and student nutrition behaviours, 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 behaviours, physical activity and BMI, separate multilevel regression models were run which included an interaction term (household poverty*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 (Figure 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 gardens and BMI was strongest for students living with household poverty. Interestingly, we found no relationship with fruit and vegetable consumption or physical activity.

The current study is unique in that we are unaware of any other multilevel studies examining the association between school gardens and student nutrition, physical activity or BMI. Of the interventions conducted to date, almost all measure fruit and vegetable consumption and preferences as primary outcome measures, while few or none include any wider health measures including BMI (Robinson-O'Brien et al., 2009). That said, the LA Sprouts study was able to report a significant reduction in BMI among participating students, though that study was conducted in only one site, with no randomization (Davis et al., 2011). In the current study we also found that the relationship between school gardens and BMI was most beneficial for students who live with household poverty. While many previous interventions have been developed in communities experiencing deprivation (Evans et al., 2012; Meinen et al., 2012; Rowland Charbonneau et al., 2014; Wells et al., 2014), little attention has been given to how diverse communities engage with and benefit by community-based gardens.

Numerous intervention studies have suggested that gardening can lead to improvements in student fruit and/or vegetable consumption (Lautenschlager and Smith, 2007; McAleese and Rankin, 2007; Ratcliffe et al., 2011). However, in their cluster randomized controlled trial, Christian et al. (Christian et al., 2014) found little evidence to support that school gardens alone could improve student fruit and vegetable intake. They did find that when implementation of school gardens was integrated within the curriculum and community, student daily fruit and vegetable consumption was significantly increased. In the current study, we did not observe a relationship between school gardens and fruit or vegetable consumption among students. This may reflect that our measure of school garden was binary and did not capture the level of involvement or engagement of students and the wider community in the school garden.

It is of interest that in the current study there was a significant (inverse) association between school gardens and student consumption of fast food and takeaway foods. We are aware of few, if any, previous studies which have found any relationship between gardening and consumption of fast foods. Though, in a qualitative study by Ober Allen, et al. (Ober Allen et al., 2008), young people who were involved with community gardens reported that their involvement in the garden resulted in a personal interest in eating more fruits and vegetables and less junk food.

The strengths of the current study lie in the large sample size and the representative nature of the data. However, the current study has a few limitations that should be considered when interpreting the findings. First, as mentioned above, the current study only assessed the presence of a school garden, but not how the garden was integrated into the school curriculum or the wider community. Better measures in these areas, such as how garden activities are integrated into the classroom activities, the extent and nature of student involvement in the garden, and how the produce is used, may help to explain the lack of association between school garden and fruit and vegetable consumption. For example, Christian et al. (Christian et al., 2014) measured extent of implementation of the school gardening program (through indicators such as variety of fruits and

vegetables grown and harvested, student participation in gardening, and success and failure stories for schools) and found that improvements in student fruit and vegetable consumption were only significant in schools with the greatest levels of implementation. The wider body of implementation science recognizes that implementation fidelity and process are important in understanding and explaining the outcomes of interventions (Hasson, 2010). Second, no data on seasonality was assessed in the current study. The data for the Youth'12 study were collected over one calendar year and different fruits and vegetables are abundant at different times of the year. While the climate in New Zealand is generally mild and most of the country can maintain vegetable gardens all-year, it is possible that some schools may have been surveyed during low production times for the garden. This would suggest that the true relationships between school gardens and nutrition, physical activity and BMI may have been underestimated for schools where data were collected during the winter months. Third, our measures of dietary indicators and physical activity have not been tested for validity or reliability. This likely explains our lack of relationship between school gardens and dietary indicators and physical activity, particularly in light of previous studies where validated tools were used to measure diet and physical activity (Christian et al., 2014; Wells et al., 2014). Last, the issue of selection bias may affect the results of the current study. It is possible that schools opting to maintain a vegetable garden may be generally more interested in creating a healthier school environment.

Findings from the current study suggest that school gardens are reasonably common in New Zealand secondary schools. Given the momentum building in this area (both in New Zealand and internationally), the current research raises important questions about the implementation and mediating pathways that school gardens can play in student health outcomes. Future research may explore how school gardens are implemented in schools and utilised by students to better understand their impact and to extend the benefits beyond the school community.

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Conflict of Interest

All authors declare that they have no conflicts of interest to disclose.

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