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Home gardening and the health and wellbeing of adolescents

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ABSTRACT

Background: The current paper explores the associations between home gardening and dietary behaviours, physical activity, mental health and social relationships among secondary school students in New Zealand.

Methods: Data were drawn from a national youth health and wellbeing survey, conducted in 2012. In total, 8500 randomly selected students from 91 randomly selected secondary schools completed the survey.

Results: Two thirds of students had a vegetable garden at home and one quarter of all students participated in home gardening. Students participating in gardening were most likely to be male, of a Pacific Island ethnicity, of younger age, and living in a rural area. Gardening was positively associated with healthy dietary habits among students, such as greater fruit and vegetable consumption. Gardening was also positively associated with physical activity and improved mental health and wellbeing. Students who participate in gardening reported slightly lower levels of depressive symptoms, enhanced emotional wellbeing and experience higher family connection than students who do not participate in gardening.

Conclusions: Gardening may make a difference for health and nutrition behaviours and may contribute to adolescents' health and wellbeing in a positive manner. Health promoters should be encouraged to include gardening in future interventions for young people.

Keywords adolescent, gardening, mental health, nutrition

INTRODUCTION

Gardening can be seen as a promising health promotion tool due to its potential to influence multiple aspects of health. Gardening is an appealing activity particularly in programs for children and adolescents, as it is hands-on and interactive in nature. Moreover, gardening has been at the core of interventions to improve multiple aspects of health, including nutrition (Bukhari, Fredericks, & Wylie-Rosett, 2011; Davis, Ventura, Cook, Gyllenhammer, & Gatto, 2011; Evans et al., 2012; Heim, Stang, & Ireland, 2009; Lautenschlager & Smith, 2007; McAleese & Rankin, 2007; Morgan et al., 2010; Poston, Shoemaker, & Dzewaltowski, 2005; Ratcliffe, Merrigan, Rogers, & Goldberg, 2011; Robinson-O'Brien, Story, & Heim, 2009; Wang et al., 2010; Wright & Rowell, 2010), educational outcomes (Blair, 2009; Block et al., 2012), mental health (Chawla, Keena, Pevec, & Stanley, 2014; Pitt, 2014; Van Den Berg & Custers, 2011; Wakefield, Yeudall, Taron, Reynolds, & Skinner, 2007) and physical activity (Hermann et al., 2006; Kien & Chiodo, 2003; van den Berg, van Winsum-Westra, de Vries, & van Dillen, 2010).

BACKGROUND

Determining the true effect of gardening on health is difficult. Well-designed interventions require multiple sites (schools or communities) to implement gardens and randomization of those sites. Furthermore 'real world' conditions may make it hard to implement programs as intended. Many of the interventions have focused on single communities or populations and few studies have measured a broad range of health indicators (other than nutrition).

The two most notable gardening interventions conducted to date are the cluster randomized trials conducted by Christian and colleagues (Christian, Evans, Nykjaer, Hancock, & Cade, 2014) and Wells and colleagues (Wells, Myers, & Henderson, 2014). The trial conducted by Christian et al. (Christian et al., 2014) evaluated the effect of a school-based Royal

Horticulture Society (RHS) intervention on the fruit and vegetable intake of 7 to 11 year olds from 22 London primary schools. Ten schools were randomly assigned to the RHS-led intervention, while the remaining schools were allocated to a less involved teacher-led intervention. There was no true comparison group in this study because of the mandate of the RHS signalling that any school interested in their programme would receive it. This study highlights challenges in the real world that cannot be ignored in this type of research. Despite the strong study design, the findings were limited. Differences in fruit and vegetable consumption between the two intervention groups were only observed in schools where high levels of implementation were reached.

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.

Smaller scale studies have also suggested that participation in gardening can positively influence the nutrition and physical activity behaviours of children and adolescents. A systematic review (Robinson-O'Brien et al., 2009), as well as studies published after the review (Castro, Samuels, & Harman, 2013; Ratcliffe et al., 2011; Wang et al., 2010; Wright & Rowell, 2010), have suggested that participation in gardening programmes may increase the amount of fruits and vegetables consumed by children. With regards to physical activity, Hermann et al. (Hermann et al., 2006) reported a significant increase in daily physical activity levels among third- to eighth- grade students who participated in an afterschool programme which included gardening. Another trial reported similar findings, suggesting that children who previously participated in gardening and adventure education during a summer and autumn programme showed significant improvements associated with physical movement and relative energy expenditure compared to children who watched a videotape at home (Kien & Chiodo, 2003).

Researchers have reported significant associations with regard to gardening activity and body mass index (BMI) (Castro et al., 2013; Davis et al., 2011). For example, the 'LA Sprouts' programme, which was an afterschool gardening, nutrition and cooking programme used among predominantly Hispanic youth aged 9-11 years old in Los Angeles (Davis et al., 2011). Findings from the 'LA Sprouts' programme reported a reduction in participant BMI and less weight gain among overweight participants compared to controls. Moreover, an increase in dietary fibre intake and a decrease in diastolic blood pressure were also observed among 'LA Sprouts' participants.

There is limited evidence from previous intervention studies regarding gardening, social relationships and mental health in young people. However, qualitative studies of children, and a handful of studies in adults, (Armstrong, 2000; Pitt, 2014; Van Den Berg & Custers, 2011; Wakefield et al., 2007) have suggested such a relationship could exist. For example, in a qualitative case study Chawla et al. (Chawla et al., 2014) conducted interviews with 52 American adolescents involved in three different gardening programmes. Adolescents commented that working in the garden gave them time to reflect, feel centered and let go of school stress. Moreover, almost all of the youth indicated that their capacity to pay attention improved and that they were better able to do their schoolwork after gardening. A study conducted with Dutch adults found that their cortisol levels significantly decreased after 30 minutes of gardening (Van Den Berg & Custers, 2011).

Despite the many gardening programs that have been implemented to date, there is a dearth of information on the gardening behaviours of young people. To our knowledge, there have been no population-based studies to determine the prevalence of gardening participation for children or adolescents. Moreover, the majority of research conducted has focused on school

and community gardening leaving researchers to recommend a future focus on home gardening (Blair, 2009; Robinson-O'Brien et al., 2009). The current study aims to address some of these gaps by exploring the relationships between home vegetable gardening and dietary behaviours, physical activity, mental health and social relationships among a representative sample of high school students in New Zealand. The aims of the current research are informed by theories of youth development (Catalano, Berglund, Ryan, Lonczak, & Hawkins, 1998) which posit that the healthy development of adolescents is achieved through creating opportunities for skill development, meaningful relationships, and young people being able to contribute to their family and community. Gardening is an activity that may provide young people with such opportunities. The current research is also informed by the Attention Restoration Theory, which describes the restorative benefits of natural environments (Kaplan, 1995).

METHODS

Data for the current study were collected as part of the Youth2000 survey series (Clark et al., 2013). Specifically, Youth12 was a national health and wellbeing survey of New Zealand secondary school students and it was conducted in 2012. The final sample included 8500 students (12 to 18 years old) from 91 secondary schools across New Zealand.

One hundred and twenty-five randomly selected secondary schools throughout New Zealand were invited to participate in the survey, and 91 schools took part (73%). In total 12,503 students were selected and 8500 (68%) students took part in the survey representing 3% of the New Zealand secondary school roll.

Information sheets about the survey were sent to parents and schools before the start of the survey. Individual school principals gave consent for their school to participate and students personally consented to take part. Parents were given the opportunity to exclude their child from the survey. Ethical approval for the study was granted by the University of Auckland Human Participant Ethics Committee.

On the survey day, students were provided with an anonymous login code to access the survey. The survey included a 608-item health and wellbeing questionnaire administered on a handheld internet tablet. Additionally height and weight measurements were taken by trained research staff. Students provided their address so census meshblock numbers could be ascertained to determine the extent of their neighbourhood deprivation according to the New Zealand Deprivation Index (Atkinson, Salmond, & Crampton, 2014) and the urbanity of their household residence.

Measures

Student's gardening activity was assessed with one item; “Do you or your family grow any of your own vegetables?” and there were three response options “yes, and I help out with the garden”, “yes, but I don't help out with the garden” and “we don't grow vegetables”.

Age, sex and ethnicity were based on self-report. Ethnicity was assessed using the standard New Zealand Census ethnicity question where students could select all of the ethnic groups they identified with. Approximately 42% of students identified with more than one ethnic group. To facilitate analyses, discrete ethnic groups were created using the New Zealand census prioritization method by assigning students to one ethnic group in the following prioritized order: Māori, Pacific, Asian, other ethnic groups and New Zealand European (Statistics New Zealand, 2005).

Area deprivation was determined using the 2006 New Zealand Deprivation Index (Lang, 2002). This measure works with census meshblock numbers derived from the student's address and are a proxy of the geographical location of the small area the student lives in. Deprivation is classified on a scale from 1 to 10. Index deciles were categorized into 3 groups indicating low (1-3), medium (4-7) and high (8-10) levels of deprivation.

Student's height and weight were measured using a portable stadiometer (Seca model 214) and a digital scale (Health-o-Meter model 349KLX) by trained research staff. Height was recorded to the nearest 0.1 cm and weight was recorded to 0.1 kg. *BMI* values were calculated as weight in kilograms divided by height in meters squared.

Household poverty was assessed by the presence of any two of 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.

Family meals was assessed with one item; "During the past 7 days, how many times did all, or most, of your family living in your house eat a meal together?" with four response options ranging from "never" to "7 or more times". Responses were dichotomized by combining levels "never", "1-2 times", "3-4 times" in an 'infrequent' category and levels "5-6 times" and "7 or more times" in a 'frequent' category.

Fruit and vegetable consumption was assessed with one item; "During the last 7 days, how often did you eat any of the following? Fruit, potatoes, kumara, taro etc. or vegetables (not including potatoes, kumara, taro)?" with response options ranging from "less than once a day"

to “five or more times a day”. For fruits, responses were dichotomized for analyses by combining levels “twice a day”, “3 or 4 times a day” and “5 or more times a day” into a ‘yes’ category (twice a day or more), and levels “less than once a day” and “once a day” into a ‘no’ category. For vegetables, responses were dichotomized by combining “3 or 4 times a day” and “5 or more times a day” into a ‘yes’ category (≥ 3 times a day), and levels “less than once a day”, “once a day” and “twice a day” into a ‘no’ category.

Fast food consumption was assessed with one item; “During the last 7 days, how often did you eat food from any of these places?” including a fast food place, other takeaways or fast-food shops, dairies or petrol stations. Students could choose one out of four response options ranging from “none in the last 7 days” to “2 or more times a day”. Responses were then dichotomized for analyses by combining levels “4 to 6 times a week”, “once a day” and “2 or more times a day” into a category ‘yes’ (≥ 4 times a day) and levels “1 to 3 times a week” and “none in the last 7 days” into a ‘no’ category.

Home availability of fruits and vegetables and junk food were assessed with the following item; “How often are the following foods available to eat at home?” including fresh fruit or vegetables and junk food. Students could choose one of four response options (never, sometimes, usually, always). For fresh fruit and vegetables, responses were dichotomized to “always” vs. the other 3 categories combined. For junk food, responses were dichotomized to “always” and “usually” vs. “never” and “sometimes”.

Student’s physical activity engagement was assessed with the question, “During the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day? (Add up all the time you spend in any kind of physical activity that increases your heart rate and

makes you breathe hard some of the time)” with eight response options ranging from 0 to 7 days. *Student’s vigorous physical activity* was assessed with two items; “In the last 7 days, how many times have you done any exercise or activity that makes you sweat or breathe hard, or gets your heart rate up (such as soccer or rugby, running, swimming laps, fast bicycling, etc.)?” and “The last time you did this, how long did you do this physical activity for?”. Responses from the last two items were dichotomized and combined together for analyses by combining levels “3 times”, “4 times”, “5 times”, “6 times” and “7 or more times” (for frequency item 2), plus the levels “21-30 min”, “31-40 min”, “41-50 min”, “51-60 min” (for duration item 3), respectively into a ‘yes’ category and the levels “I don’t exercise”, “not in the last 7 days”, “1 time” and “2 times” (for item 2) and “up to 10 min” and “11-20 min” (for item 3) respectively into a ‘no’ category.

Family connection was assessed with a nine-item standardized scale assessing if the family has fun together, gets along and if the student feels close to mum/dad, spends enough time with mum/dad and feels mum/dad are warm/loving. Responses were standardized and averaged resulting in a possible score ranging between -1 and 1. Higher scores indicate greater family connection. The Cronbach’s α for the scale was 0.84.

Neighbourhood connection was assessed with five items: “Do you trust the people in your neighbourhood?”; “Do you feel you really belong in your neighbourhood?”; “Do the people in your neighbourhood help each other?”; “Are people in your neighbourhood friendly?” and “Do you like your neighbourhood?”. Students could choose either one of four response options (1. all the time, 2. sometimes, 3. not often, 4. never). Responses to the five items were averaged for analyses resulting in a range from 1 to 4, with higher scores indicating better neighbourhood connection.

Student's mental wellbeing was assessed by using the WHO Wellbeing Index (Bech, Olsen, Kjoller, & Rasmussen, 2003). This index developed by the WHO (World Health Organization) measures three underlying factors; positive mood, vitality, and general interests and rates 5 items on a 6-point Likert scale from 0 (at no time) to 5 (all the times). Responses are summed to obtain an overall score ranging from 0 to 25, with higher scores indicating better wellbeing. *Student's depressive symptoms* were assessed with the Reynolds Adolescents Depression Scale - short form (RADS-SF) (Reynolds, 2004). The scale includes 10 items with 4 point Likert response options with higher scores indicating more depressive symptoms.

Analysis

All analyses were conducted with the SAS version 9.3 using the survey procedures to account for the clustering and weighting of the data. Percentages with 95% confidence intervals were used to describe the prevalence of gardening behaviours. Gardening by student sociodemographic characteristics are presented as percentages with 95% confidence intervals. Associations between gardening behaviours and diet, BMI, physical activity, social relationships and emotional wellbeing were examined using multiple regression models which controlled for age, sex, ethnicity and household poverty as potential confounders. The significance level was set at $p < 0.05$.

RESULTS

Approximately two thirds of students had a vegetable garden at home (Table 1). Home vegetable gardens were more common among New Zealand (NZ) European students than students of other ethnicities. Close to 80% of rural students reported having a vegetable garden

versus nearly 65% and 70% of students living in major urban and minor urban areas, respectively. Home vegetable gardens were more common in households not experiencing poverty: approximately 70% of students who did not live with household poverty reported a household garden compared with nearly 60% of students living with household poverty. There were no differences in home vegetable gardens by sex, age, or area deprivation.

Insert Table 1 here

Approximately one quarter of all students have a home garden and participate in gardening. Students who participate in gardening were most likely to be male, younger (<13 years), identify with a Pacific ethnicity and live in a rural area. There were no differences in participating in gardening by household poverty, but students living in high deprivation areas were more likely to participate in gardening than students living in low deprivation areas.

Insert Table 2 here

Gardening activity was positively associated with overall healthy eating habits among students (Table 2). Students who participate in gardening were more likely to share frequent meals with their family than students without a garden. ($p < 0.001$) Furthermore, fruit and vegetable consumption and home availability of fruits and vegetables were significantly associated with gardening activity. Students who participate in gardening are twice as likely to meet the recommendation for fruit and vegetable consumption compared to students who do not have a garden (OR 2.0, 95% CI 1.8-2.3). Likewise, students who participate in gardening and students who have a garden but do not participate were significantly more likely to always have fruits and vegetables available at home compared to students without a garden ($p < 0.001$). Furthermore, home availability of fast food was significantly lower among student who participate in gardening. A significant, but weak, association between gardening and fast food consumption and BMI was observed.

Insert Table 3 here

Gardening activity was positively associated with physical activity among students (Table 3). Students who participated in gardening reported a greater engagement in physical activity. Students who participated in gardening also reported an average of 4.4 days of being active at least sixty minutes or more versus a reported average of 3.8 days for the two remaining groups ($p < .0001$). Similar relationships were observed for vigorous activity.

Insert Table 4 here

Gardening activity was associated with better social relationships and emotional wellbeing (Table 4). Students who participated in gardening reported higher family connection (mean 0.004) than students who did not participate in gardening (mean -0.14) and students without a garden (mean -0.19) ($p < .0001$). Students who participated in gardening reported significantly better mental wellbeing ($p < 0.001$) and significantly lower levels of depressive symptoms ($p < 0.001$). Participation in gardening was also associated with better neighbourhood connection ($p < 0.001$).

DISCUSSION

Home gardening is common for students in New Zealand; approximately two thirds reported having a vegetable garden at home, and one quarter reported participating in gardening. Findings from the current study suggest that gardening is positively associated with healthier eating habits and physical activity, but the observed relationship with BMI was less convincing. It was of interest that we observed that students involved with gardening also reported better social relationships, neighbourhood connection, and emotional wellbeing.

To date, we are not aware of any studies that describe the prevalence of gardening behaviours among adolescents in New Zealand, or internationally. In a previous study utilising the same

dataset, it was reported that approximately 50% of secondary schools in New Zealand have a fruit or vegetable garden that students can participate in (Utter, Denny, & Dyson, 2016). Taken together, these findings may suggest that gardening is a valued activity within New Zealand culture, and/ or the growing conditions of New Zealand are conducive to fruit and vegetable gardening.

Overall, findings from the current study suggest that participation in gardening was associated with a wide range of nutrition, health and social indicators for adolescents. With regard to the nutrition and physical activity indicators, results from the current study are largely consistent with previous school- and community-based interventions demonstrating an associated increase in fruit and vegetable consumption (Castro et al., 2013; Christian et al., 2014; Ratcliffe et al., 2011; Robinson-O'Brien et al., 2009; Wang et al., 2010; Wright & Rowell, 2010) and overall physical activity levels (Hermann et al., 2006; Wells et al., 2014). With regards to social relationships and emotional wellbeing and gardening, findings from the current study contribute further results to the growing body of literature in this area (Chawla et al., 2014; Pitt, 2014; van den Berg et al., 2010; Wakefield et al., 2007).

Findings of the current study are unique in that focus was on the gardening behaviours of adolescents at home, rather than evaluating the impact of a school- or community-gardens. With that in mind, it is difficult to directly compare the findings of the current study with those of other researchers. School-based gardening programmes may differ from home-based gardening in that they may be required as part of school curriculum, may offer more opportunity for developing peer-relationships, and may be more easily integrated with cooking programmes designed to develop adolescent cooking skills. Home-based gardening may be more relaxed and voluntary in nature, may involve just family members, and may or may not

lead to adolescent involvement in home cooking. Nonetheless, gardening (in any location) offers young people the opportunity to develop skills, spend quality time with adults (e.g. parents, teachers), and contribute something valuable to their families or local community. Gardening also provides an opportunity for young people to be outside and interact with nature. Previous studies have shown that being outside is associated with less stress and better wellbeing (Berman et al., 2012; Roe et al., 2013).

A major strength of the current study lies in its large and nationally representative sample. However a few limitations should be considered when interpreting the findings. First, the cross-sectional nature of this study does not allow for causal inference about the impact of gardening on health and wellbeing of young people to be made. It is possible that, for example, students who are feeling down may be less inclined to participate in gardening. However, we found that participating in gardening was positively associated with a wide range of positive health indicators, so it seems less likely that reverse causation is a major threat. Second, our measure asked specifically about home gardens and in prior research many gardening interventions appear to be implemented around schools or communities. As such, students who are involved in school- or community-gardens may be overlooked. Likewise, our measure of home-gardening included only one-item. Future research may wish to explore the extent, nature and quality of gardening that adolescents engage in.

Findings from the current study suggest that gardening may be an enjoyable and effective activity for improving nutrition, physical activity and the mental health of young people. Particularly, gardening may be a tangible activity that families can do together and in a meaningful way. Those working in health promotion may look for ways to enable families with the resources and opportunities to engage in gardening. The current study provides

epidemiological data on the prevalence of home gardening by adolescents and suggests that gardening, as an activity at home, may be associated with a wide range of positive health outcomes for young people.

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Table 1: Gardening and demographics

Gardening activity	"Do you or your family grow any of your own vegetables?"								
	Yes, and I help out			Yes, but I don't help out			No, we don't grow vegetables		
	n	%	95% CI	n	%	95% CI	n	%	95% CI
Total	2233	26.8		3291	39.6		2791	33.6	
Sex									
Male	1133	30.1	27.7-32.5	1375	36.9	34.9-38.8	1242	33.1	30.9-35.3
Female	1099	24.1	22.3-25.9	1916	41.9	39.7-44.1	1548	34.0	31.7-36.3
Age (years)									
<13	563	31.3	28.7-33.9	638	35.7	33.1-38.3	589	33.0	30.7-35.3
14	561	30.2	27.8-32.5	696	37.5	35.2-39.8	603	32.4	29.9-34.8
15	446	26.0	23.3-28.6	712	41.5	39.0-44.1	556	32.5	30.1-35.0
16	351	22.7	20.2-25.1	659	42.6	39.7-45.5	536	34.7	32.1-37.3
17>	309	22.2	19.3-25.1	583	41.8	38.3-45.3	503	36.0	32.8-39.2
Ethnicity									
Asian	241	23.2	19.8-26.7	397	38.5	35.2-41.8	395	38.3	33.8-42.8
European	1028	25.6	23.8-27.5	1760	44.2	42.6-45.8	1196	30.1	28.0-32.2
Maori	422	25.8	23.2-28.1	590	35.9	33.8-38.1	631	38.3	35.5-41.1
Other	139	27.8	23.2-32.5	193	39.0	34.2-43.8	165	33.1	27.6-38.7
Pacific	399	34.8	31.0-38.5	349	30.4	27.4-33.4	401	34.9	31.2-38.5
Area deprivation									
Low levels	584	23.8	21.6-26.1	1082	44.4	42.1-46.6	777	31.8	28.8-34.8
Middle levels	812	26.3	24.2-28.3	1267	41.2	38.8-43.6	999	32.5	30.1-35.0
High levels	786	29.9	26.8-32.9	886	33.6	31.0-36.2	964	36.6	34.1-39.0
Household poverty									
Yes	422	27.4	23.9-30.9	490	31.7	28.9-34.2	632	41.0	37.6-44.3
No	1811	26.7	24.9-28.4	2801	41.4	39.8-43.1	2159	31.9	30.0-33.8
Urbanicity									
Urban (major city)	1549	25.1	22.9-27.4	2405	38.9	36.8-41.0	2223	36.0	34.2-37.8
Urban (small city)	245	26.2	23.1-29.4	390	42.2	38.2-46.3	292	31.5	27.4-35.6
Rural	439	35.9	33.2-38.7	496	41.3	38.1-44.5	276	22.7	19.4-26.0

Major city: ≥30,000; Small city: minor urban areas 1,00 to 9,999 and secondary urban areas 10,00- 29,999

n: frequency; CI: 95% confidence interval

Table 2: Gardening and nutrition

<i>Gardening activity</i>	“Do you or your family grow any of your own vegetables?”				p-value
		Yes, and I help out	Yes, but I don’t help out	No, we don’t grow vegetables	
Family meals, frequent (≥ 5 times a week)	n (%)	1563 (70.3)	2021 (61.2)	1590 (57.1)	
	OR	1.7	1.1	1.0	
	95% CI	1.5-2.0	1.0-1.3	-	<.0001
Fast food consumption, ≥ 4 times a week	n (%)	341 (15.5)	347 (10.6)	365 (13.2)	
	OR	1.2	1.0	1.0	
	95% CI	1.0-1.4	0.9-1.2	-	.021
Vegetable consumption, ≥ 3 times a day	n (%)	1274 (57.6)	915 (28.1)	752 (27.3)	
	OR	2.0	1.1	1.0	
	95% CI	1.8-2.3	1.0-1.2	-	<.0001
Fruit consumption, ≥ twice a day	n (%)	1408 (63.7)	1587 (48.6)	1285 (46.5)	
	OR	2.0	1.1	1.0	
	95% CI	1.8-2.3	1.0-1.2	-	<.0001
Fruits and vegetables available at home, always	n (%)	1658 (74.9)	2248 (68.5)	1650 (59.4)	
	OR	2.1	1.4	1.0	
	95% CI	1.8-2.4	1.2-1.6	-	<.0001
Fast food available at home, always and usually	n (%)	882 (40)	1566 (47.8)	1393 (50.1)	
	OR	0.7	0.9	1.0	
	95% CI	0.6-0.7	0.8-1.0	-	<.0001
Body Mass Index	Mean ¹	23.7	23.4	23.8	.012
	SE	0.2	0.1	0.2	

OR: Odds Ratio; CI: 95% confidence interval; SE: Standard Error

¹Means adjusted for age, sex, ethnicity and household poverty

Table 3: Gardening and physical activity

“Do you or your family grow any of your own vegetables?”

Gardening activity

Yes, and I help out **Yes, but I don't help out** **No, we don't grow vegetables**

p-value

Physical activity engagement

# of days doing at least 60 min of physical activity	Mean ¹	4.4	3.8	3.8	
	SE	0.06	0.06	0.05	<.0001

Vigorous activity

at least 20 min of vigorous activity for 3 days a week	n (%)	1568 (71.0)	1924 (59.0)	1599 (58.1)	
	OR	1.6	0.9	1.0	
	95% CI	1.4,1.8	0.8,1.1	-	<.0001

SE: Standard Error

¹Means adjusted for age, sex, ethnicity and household poverty

Table 4: Gardening and emotional health**“Do you or your family grow any of your own vegetables?”***Gardening activity*

	Yes, and I help out	Yes, but I don't help out	No, we don't grow vegetables
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p-value**Family connection**

Mean ¹	0.004	-0.14	-0.19
SE	0.02	0.02	0.02

<.0001

Neighbourhood connection

Mean ¹	3.3	3.2	3.1
SE	0.02	0.02	0.02

<.0001

Depressive symptoms

Reynolds Adolescent Depression Scale

Mean ¹	19.9	21.0	20.8
SE	0.2	0.2	0.2

<.0001

Mental wellbeing

WHO Wellbeing Index

Mean ¹	16.8	15.3	15.3
SE	0.2	0.2	0.2

<.0001

WHO: World Health Organisation; SE: Standard Error

¹Means adjusted for age, sex, ethnicity and household poverty