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A case–control study of the health and well-being benefits of allotment gardening

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ABSTRACT

Background Allotments in the UK are popular and waiting lists long. There is, however, little evidence on the health benefits of allotment gardening. The aims of this study were to determine the impacts of a session of allotment gardening on self-esteem and mood and to compare the mental well-being of allotment gardeners with non-gardeners.

Methods Self-esteem, mood and general health were measured in 136 allotment gardeners pre- and post- an allotment session, and 133 non-gardener controls. Allotment gardeners also detailed the time spent on their allotment in the current session and previous 7 days, and their length of tenure.

Results Paired *t*-tests revealed a significant improvement in self-esteem ($P < 0.05$) and mood ($P < 0.001$) as a result of one allotment session. Linear regression revealed that neither the time spent on the allotment in the current session, the previous 7 days or the length of tenure affected the impacts on self-esteem and mood ($P > 0.05$). One-way ANCOVA revealed that allotment gardeners had a significantly better self-esteem, total mood disturbance and general health ($P < 0.001$), experiencing less depression and fatigue and more vigour ($P < 0.0083$).

Conclusions Allotment gardening can play a key role in promoting mental well-being and could be used as a preventive health measure.

Keywords environment, health promotion, mental health

Introduction

There is increasing evidence to indicate that direct contact with natural environments has important positive health outcomes.[1] Engagement with both wild and cultivated natural places improves self-esteem and mood,[2–5] reduces stress and anxiety[6] and fosters mental well-being.[7,8] Furthermore, being physically active while exposed to nature ('green exercise') provides additive benefits for mental well-being above those received from contact with nature alone.[4,9,10] These benefits are derived from all types of natural environments and from durations of exposure from 5 min upwards.[9]

Over half of the world's population and more than 70% of those in Europe reside in urban areas.[11] Given the importance of nature for well-being, such changes in urbanization may be having a negative impact on health. Some urban living is associated with an increased prevalence of mental ill-health: one meta-analysis of 20 studies comparing mental illness in urban and rural areas found that urban dwellers were 38% more likely to develop a mental illness, 21% more likely to suffer from anxiety and 39% more likely to develop a mood disorder.[12] The quantity and quality of available green space close to the home is also correlated with longevity and a decreased risk of mental ill health.[13–16] People in urban areas with plentiful tree cover and green space have a lower prevalence of asthma, improved mental well-being, a reduction in stress, lower morbidity and cardiovascular disease risk, greater longevity of the elderly, improved cognitive function and healthier cortisol profiles.[9,13–15,17–20] Less green space typical of deprived communities produces higher stress and flattened cortisol profiles[21] and increased incidence of obesity.[22]

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Gardening provides an opportunity for people residing in urban and rural areas to have regular contact with nature, be physically active and engage in green exercise. Home gardens and allotments have long been important for domestic food production and consumption; and in the mid-20th century, half of the nation's vegetable needs were produced via vegetable gardens.[23] In addition, gardening can improve health; restoring physical, mental and spiritual health,[24] improving mood,[25,26] encouraging physical activity[27] and increasing life satisfaction.[28] Furthermore, Van den Berg and Custers[5] found that gardening leads to greater reductions in stress following a stress test than reading indoors.

Many people in the UK do not have access to a private garden.[29] There is also an increasing demand for allotment gardens. There are an estimated 3 million individual allotments gardens across Europe which are utilized by a variety of different populations and in the UK waiting lists for allotments are at a 40-year high having grown from 13 000 to 100 000 since the mid-1990s.[30–32] Allotment gardening is different from traditional gardening as it is an activity in a public space separated from the home, requiring the renting of a plot and is focused on food production as well the relationships between people and the land.[33–35] Recent studies have demonstrated that allotment gardening provides a number of environmental benefits including the support and regulation of ecosystem services.[36–39] Allotment gardening also results in more sustainably produced food, promotes healthy eating and acts as an educational resource.[30] Evidence also suggests that gardening on allotments improves general health, aids recovery from stress, increases life satisfaction, promotes social contact and provides opportunities for low to moderate–high intensity physical activity, all of which promote mental well-being.[25,26,40–47] Simply 'being' on an allotment garden can improve health and well-being;[48] with data from the European Quality of Life Survey indicating that people who grow their own food are happier than those who do not.[49] Furthermore, compared with an indoor exercise class, allotment gardening results in significantly lower levels of stress.[50] Allotment gardening might also play a key role in promoting health and well-being in the more vulnerable groups in society through the development of social support and cohesion.[49,51] However, much evidence regarding the health benefits of allotment gardening is descriptive[32] and little research has been conducted to assess the health benefits of allotment gardening specifically.

Additionally, there are few comparisons of the health of allotment gardeners with those who do not garden. A study by Van den Berg *et al.*[32] found that allotment gardeners had a higher life satisfaction, reduced loneliness, fewer health complaints and better overall health and well-being than non-allotment gardeners. However, the response rate of allotment gardeners was low and it is conceivable that only those people who believed that they received benefits from allotment gardening responded. The non-gardener group was also small, not well-matched in relation to their allotment gardener counterparts and 64% had access to a garden at home and may therefore have been active gardeners. Furthermore, not all outcome measures were assessed using a validated scale. The aim of our study was to determine the effect of allotment gardening on self-esteem and mood as two key indicators of mental well-being and long-term disease risk[9] and to compare the mental well-being of allotment gardeners with non-gardener controls.

Methodology

Participants

Two hundred and sixty-nine participants aged 55.6 ± 13.6 years volunteered to participate in the study, comprising 152 males (56%) and 117 females (44%). Participants consisted of both allotment gardeners ($n = 136$) and non-gardeners ($n = 133$) and were matched in terms of age and gender to within 10%. Participants were also closely matched in terms of main occupation, with the majority of participants in each group identifying themselves as employed.

Allotment gardeners were recruited from 10 allotment sites in North-Western England. All allotment gardeners were eligible for participation in the research; however, only one participant was permitted per allotment plot to prevent data duplication. The sites were predominantly situated within the Greater Manchester conurbation, in the South and West Manchester area. Two of the sites were in the towns of Glossop and Chapel-en-le-Frith, to the east of Manchester on the western edge of the Pennines, while one was also on the Southern edge of the Pennines. Non-gardeners were recruited from 10 local supermarkets and consisted of participants who did not partake in any gardening activities. These participants were identified by asking the question 'do you garden' and informing potential participants that the study required participants 'that do not do anything in the garden'. Supermarkets were recruited based upon their distance from each of the allotment sites, with the closest supermarkets being approached initially. Of the 10 supermarkets recruited for the research, six were the nearest store to the allotment sites.[52] The index of deprivation for the allotments and their surrounding areas ranged from 15.4 to 84.5%, indicating a large variation in participants in terms of income deprivation, employment deprivation, health and disability deprivation, education and skills training, barriers to housing, crime and living environment.[53] All participants provided individual consent to take part in the study. Institutional ethical approval was granted.

Procedure

In the spring–summer growing seasons of 2006–09, the allotment sites and supermarkets were visited. During the visits to the allotments, participants were asked to complete a questionnaire assessing self-esteem, mood and general health at the start of their allotment session. At the end of the allotment session, participants completed a further questionnaire assessing self-esteem and mood. Participants were also asked to identify how long they had spent on the allotment in that particular session, in the previous 7 days and their length of tenure on the allotment. Allotment gardeners were also asked to identify what they liked about gardening on their allotment. This question was open-ended allowing gardeners to identify as many things as they wanted to. During visits to the supermarkets, non-gardeners were asked to complete a one-off questionnaire assessing self-esteem, mood and general health. Descriptive data were collected from all participants including sex, age, height and weight. Body mass index was calculated from height and weight by dividing weight in kilogram by height in metre square. Self-esteem, mood and general health were assessed using standardized and validated scales.

Instrumentation

Self-esteem is defined as *a person's positive or negative attitude towards the self in totality*[54] and exhibits an inverse relationship with depression and anxiety[55,56] in addition to being a risk factor for mental ill health.[57,58] Self-esteem was assessed using the one-page 10-item Rosenberg self-esteem scale.[59] The Rosenberg self-esteem scale is the mostly widely used and popular self-esteem measure. The instrument provides a self-report one-dimensional measure of self-esteem and consists of 10 statements each of which are scored on a four-point Likert scale from strongly agree to strongly disagree. An overall self-esteem score ranging from 10 to 40 is calculated with a higher score representing a better self-esteem.

Mood is defined as a 'host of transient and fluctuating affective states that reflect how an individual feels in general, globally or at a particular moment in time'.[60] Moods can be positive or negative, persist for long periods of time without specific cause and influence feelings of happiness, quality of life and ability to cope with stress.[61,62] Mood was assessed using the 30-item Profile of Mood States (POMS) questionnaire.[63] The POMS questionnaire assesses mood under six subscale mood states: tension–anxiety, depression–dejection, anger–hostility, vigour–activity, fatigue–inertia and confusion–bewilderment. Each subscale is represented by five phrases, each of which is scored on a five-point Likert scale from 'not at all', to 'extremely'. Scores for each of the subscales are generated and converted into normative values. A total mood disturbance (TMD) score is also generated by summing the five negative subscales (tension, depression, anger, fatigue and confusion) and subtracting the positive subscale of vigour. A higher TMD score indicates a worsened mood.

The General health questionnaire (GHQ) is a screening instrument designed to identify individuals who have mental health problems and breaks in normal function.[64,65] The GHQ-12 was used to assess general health and consists of 12 questions categorizing healthy and abnormal functioning.[65] Participants respond to each question on a four-point Likert scale from 'not at all' to 'much more than usual'. An overall score from 0 to 36 is generated, with a higher score representing a greater level of psychological distress and abnormal functioning.[65]

Data analysis

To analyse the effects of an allotment gardening session on self-esteem and mood, one-way ANOVA was used to compare pre-self-esteem and TMD scores across the 10 different allotment sites, while one-way MANOVA was used to compare pre-subscale mood scores across the different sites. Paired samples *t*-tests compared self-esteem and TMD scores pre- and post- the allotment session. One-way MANOVA compared pre–post subscale mood scores. Linear regression was used to examine the relationship between the time spent on the allotment in the last 7 days, during the allotment session and the length of tenure with the change in self-esteem and mood scores. Participant responses regarding what they liked most about their allotment were categorized. The occurrence of each category was summed to give the total number of allotment gardeners who identified that particular category as being what they liked about their allotment.

For the comparison of allotment gardeners and non-gardeners, independent *t*-tests were used to compare descriptive data, including height, weight and BMI; while a χ^2 test was used to compare participants main occupation. Group differences in unadjusted mean scores for self-esteem, GHQ-12 and TMD were analysed using independent *t*-tests while group differences in unadjusted means for subscale mood were assessed using one-way MANOVA. The self-esteem, mood and GHQ-12 scores of allotment gardeners and non-gardeners were also compared using a covariate adjusted model (ANCOVA) controlling for participants' sex, age and occupation. Subscale mood scores were compared using one-way MANOVA with age, sex and occupation inserted as covariates. The pre-allotment session scores were used for allotment gardeners. IBM SPSS version 19.0 software was used for all statistical analysis[66] and significance was accepted as $P < 0.05$ throughout. Missing data were labelled as missing within the database to allow all collected data to be

included in the analysis. Data were only missing when a participant missed out a question on one of the scales within the questionnaire; preventing a score from being calculated. Of the 1079 data points collected in total for self-esteem, mood and general health, only 1.4% were missing; equating to 15 pieces of data. These 15 pieces of data were from eight different participants, the majority of which were gardeners ($n = 7$); and included self-esteem and mood measures.

Results

Health benefits of allotment gardening

There were no significant differences between the participants pre-session self-esteem, subscale mood or TMD scores across the different allotment sites ($P > 0.05$). All data were therefore grouped together. A paired samples t-test revealed a significant difference between the pre- and post-allotment session self-esteem score [$t(130) = 2.62$; $P < 0.05$]. Participants' self-esteem score increased from the start to the end of the allotment session, representing an improvement in self-esteem (Table 1).

One-way MANOVA revealed a significant difference between pre- and post-session subscale mood scores [$F(6,128) = 7.893$; $P < 0.001$], with a significant reduction in tension–anxiety ($P < 0.001$), depression–dejection ($P < 0.0083$), anger–hostility ($P < 0.001$) and confusion–bewilderment ($P < 0.001$) (Table 1). Paired samples t-test also revealed a significant difference between pre- and post-session TMD scores [$t(133) = 4.42$; $P < 0.001$]. The score decreased from the start to end of the allotment session, indicating an enhanced mood (Table 1).

Frequency and duration of allotment gardening

Allotment gardeners revealed that their average length of tenure on the allotment was 9.3 ± 11.9 years, ranging from <1 year to up to 60 years. In the last 7 days, participants had spent an average of 8.1 ± 6.2 h on their allotment plot (range from 0 to 40 h) and in the session monitored, spent 2.6 ± 1.7 h on their plot. The minimum time spent on the plot in the session of assessment was 0.33 h and the maximum was 8.1 h. Linear multiple regression revealed that neither the length of participants tenure (years) (SE: $\beta = -0.054$; $P = 0.588$; TMD: $\beta = -0.008$; $P = 0.939$), time spent on the allotment in the previous 7 days (SE: $\beta = -0.035$; $P = 0.737$; TMD: $\beta = -0.016$; $P = 0.881$) or time spent on the allotment in the current session (SE: $\beta = -0.034$; $P = 0.735$; TMD: $\beta = -0.029$; $P = 0.770$) significantly contributed to the variance in the change in self-esteem or TMD. Participants who had been gardening on their allotment over a long-term period experienced a similar magnitude of improvements in self-esteem and mood as participants who had been allotment gardening for a short time.

Enjoyment of allotment gardening

Participants identified six main themes related to what they enjoyed most about gardening on their allotment. The majority of participants (70%) reported that they enjoyed being outdoors and having contact with nature, followed by the sense of achievement derived from allotment gardening (50%) and the opportunity for restoration and stress relief (35%). Participants also reported enjoying the social interaction (31%), growing and eating the produce (19%) and the opportunities to be active (11%).

Comparison of allotment gardeners and non-gardeners

Table 2 contains descriptive data for allotment gardeners and non-gardeners. Independent t-tests revealed no significant differences between the allotment gardeners and non-gardeners in age or height ($P > 0.05$). However, the weight

Table 1 Mean ± SD (95% CI) subscale mood scores pre and post a single allotment session

	Pre-session score	*Post-session score*
Self-esteem	32.8 ± 3.9 (32.1–33.4)	33.4 ± 4.1 (32.6–34.0)[a]
Tension–anxiety	33.4 ± 3.2 (32.8–33.9)	32.4 ± 2.8 (31.9–32.9)[a]
Depression–dejection	38.1 ± 1.9 (37.8–38.4)	37.7 ± 1.7 (37.4–38.0)[a]
Anger–hostility	39.3 ± 3.8 (38.7–40.0)	38.1 ± 2.7 (37.7–38.6)[a]
Vigour–activity	41.6 ± 5.9 (40.6–42.6)	42.6 ± 6.9 (41.4–43.7)
Fatigue–inertia	38.8 ± 5.1 (37.9–39.6)	38.8 ± 5.2 (37.9–39.7)
Confusion–bewilderment	35.7 ± 3.8 (35.1–36.4)	34.2 ± 3.0 (33.7–34.7)[a]
Total mood disturbance	143.6 ± 16.9 (141.0–146.5)	138.7 ± 15.1 (136.0–141.2)[a]

[a]A significant difference between pre- and post-allotment session score ($P < 0.0083$).

[$t(267) = 2.14$; $P < 0.05$] and BMI [$t(259) = 2.80$; $P < 0.01$] of non-gardeners were significantly greater than those of allotment gardeners (Table 2). A χ^2 test also revealed no significant differences ($P > 0.05$) in the main occupation of non-gardeners and gardeners. In the non-gardener group, 57.9% of participants were employed (including self-employed), 33.8% retired, 3.8% did housework and 2.3% were both seeking employment or identified their employment status as 'other'. In the gardeners group, 55.1% were employed, 41.2% retired, 2.9% did housework and 0.7% were seeking work.

Independent *t*-tests revealed significant differences between allotment gardeners and non-gardeners in self-esteem [$t(262) = -2.82$; $P < 0.01$], GHQ-12 [$t(267) = 4.06$; $P < 0.001$] and TMD [$t(264) = 3.94$; $P < 0.001$] scores. Allotment gardeners had a better self-esteem, reduced mood disturbance and fewer breaks in normal psychological functioning than non-gardeners (Table 3). One-way MANOVA also revealed a significant difference between allotment gardeners and non-gardeners in subscale mood [$F(6,259) = 5.49$; $P < 0.001$], with allotment gardeners having a lower depression ($P < 0.0083$) and fatigue ($P < 0.0083$) and higher vigour ($P < 0.001$). These differences remained statistically significant after covariate adjustment for age, sex and occupation (Table 4).

Table 2 Mean ± SD descriptive data in allotment gardeners and non-gardeners

	Allotment gardeners (n = 136)	*Non-gardeners (n = 133)*
Age (years)	55.8 ± 13.7	55.4 ± 13.7
Height (m)	1.7 ± 0.2	1.7 ± .0.1
Weight (kg)	71.76 ± 17.74	76.83 ± 21.04[a]
Body mass index (kg m^2)	25.5 ± 3.5	27.0 ± 5.0[a]

[a]A significant difference between allotment gardeners and non-gardeners in weight ($P < 0.05$) and BMI ($P < 0.01$).

Discussion

Main findings of this study

The aim of this study was to determine the effect of allotment gardening on self-esteem and mood and to compare the mental well-being of allotment gardeners with non-gardener controls.

The findings first indicate that one session of allotment gardening can result in significant improvements in self-esteem and mood via reductions in tension, depression, anger and confusion. These findings are supported by previous research demonstrating the health and well-being benefits of participating in green exercise activities.[4,9,10] With an increasing number of people residing in urban areas, a decline in the number of homes with gardens,[29] and the increased risk for mental ill health associated with urban living;[11,12] these findings are particularly important and suggest that allotment gardening might play an important role in promoting mental well-being in people residing in urban areas.

In addition to the improvements in self-esteem and mood resulting from a single session of allotment gardening; the findings of this study highlighted that the length of time spent on the allotment during the session and in the previous 7 days; and the length of participants' tenure did not significantly contribute to changes in self-esteem or mood. Thus, participants who attend an allotment for a short period just once per week can experience a similar magnitude of improvements in self-esteem and mood as participants who attend more regularly for longer periods of time.

We found that <30 min of allotment gardening produces a measureable and beneficial health affect. This finding is encouraging as participants are more likely to be able to fit

Table 3 Unadjusted mean ± SD (95% confidence interval) mental health measures in allotment gardeners and non-gardeners

	Allotment gardeners (n = 136)	*Non-gardeners (n = 133)*
Self-esteem	32.8 ± 3.9 (32.0–33.4)	31.4 ± 4.2 (30.7–32.1)[a]
General health	9.0 ± 3.7 (8.3–9.8)	11.1 ± 4.9 (10.4–11.8)[a]
Tension	33.4 ± 3.2 (32.7–34.0)	34.1 ± 4.1 (33.5–34.8)
Depression	38.1 ± 1.9 (37.7–38.5)	39.1 ± 3.0 (38.6–39.5)[a]
Anger	39.3 ± 3.8 (38.7–40.0)	39.9 ± 4.1 (39.2–40.5)
Vigour	41.6 ± 5.9 (40.6–42.7)	38.1 ± 6.7 (37.0–39.1)[a]
Fatigue	38.8 ± 5.1 (37.8–39.7)	41.1 ± 6.2 (40.2–42.1)[a]
Confusion	35.7 ± 3.8 (35.0–36.4)	36.4 ± 4.4 (35.7–37.1)
Total mood disturbance	143.7 ± 16.9 (140.6–146.8)	152.4 ± 19.7 (149.3–155.6)[a]

[a]A significant difference between allotment and non-allotment gardeners.

Table 4 Adjusted mean ± SE mental health measures in allotment and non-allotment gardeners

	Allotment gardeners (n = 136)	*Non-gardeners (n = 133)*
Self-esteem	32.7 ± 0.4	31.4 ± 0.4[a]
General health	9.0 ± 0.4	11.1 ± 0.4[a]
Tension	33.3 ± 0.3	34.1 ± 0.3
Depression	38.1 ± 0.2	39.1 ± 0.2[a]
Anger	39.3 ± 0.3	39.9 ± 0.3
Vigour	41.6 ± 0.5	38.1 ± 0.6[a]
Fatigue	38.8 ± 0.5	41.1 ± 0.5[a]
Confusion	35.7 ± 0.4	36.4 ± 0.4
Total mood disturbance	143.7 ± 1.6	152.4 ± 1.6[a]

Means are adjusted for sex, age and occupation.
[a]A significant difference between allotment and non-allotment gardeners.

short, occasional allotment sessions into their daily routines. In addition, the findings of this study suggest that the health and well-being benefits of allotment gardening do not deteriorate over time. The length of time spent allotment gardening by participants in the current study ranged from <1 year up to 60 years, yet this did not impact upon the magnitude of changes in self-esteem and mood received from one allotment session. Thus, allotment gardening could be used as a long-term tool for promoting and improving mental well-being.

The findings of this study also indicate that allotment gardeners have better mental well-being than their non-gardener controls. Allotment gardeners reported significantly higher levels of self-esteem and mood, with reduced levels on the POMS subscales of fatigue and depression and greater feelings of vigour. In addition, allotment gardeners achieved better scores on the GHQ, indicating a reduced level of psychological distress and abnormal functioning. These differences remained statistically significant after adjustment for age, sex and occupation. Given the fact that ~1 in 4 adults suffer from a mental illness each year,[67] this finding is particularly important. Allotment gardening could play a key role in promoting mental well-being in the general population, regardless of circumstance; and could therefore be used as a preventive health measure. However, the lengthy waiting lists for allotment plots throughout the UK,[30] and the reduction in the availability of green spaces in urban areas are limiting the ability of people to have access to nature close to their homes. Community allotment plots might provide a feasible solution to this problem as they allow all people to access an allotment and to take part in green exercise; in addition to promoting social interaction, community inclusion and opportunities for healthy eating; all of which promote well-being.[33–35] Local public authorities should therefore seek to provide community allotment plots in order to improve the health and well-being of their residents.

While this study was primarily focused on mental well-being outcomes, descriptive analyses revealed that non-gardeners had a significantly higher BMI than allotment gardeners. The average BMI for non-gardeners was 27.0 kg m^2, compared with 25.5 kg m^2 in gardeners. While both of these scores fall into the overweight category (25.0–29.9 kg m^2); ~68% of participants in the non-gardening group were overweight or obese, compared with only 47% in the gardener group. Higher incidence of overweight and obesity is associated with coronary heart disease and increased risk of type II diabetes. Approximately 12% of people with a BMI of >27.0 kg m^2 have diabetes while hypertension is associated with a BMI of >25.0 kg m^2.[68] Thus, allotment gardening could help to reduce BMI and associated disease risk; promoting improved well-being. However, further research comparing measures of physical health and the physical health of gardeners when they take on an allotment would be required to confirm this hypothesis.

In addition to the questionnaires assessing health and well-being, allotment gardeners were asked what they enjoyed most about gardening on their allotment. The key themes were being outdoors; the sense of achievement; opportunities for restoration; social interaction; growing and eating produce and opportunities to be active. These are largely linked to the proposed health benefits of allotment gardening which include healthy eating, being active, improvements in physical and mental well-being and social interaction.[30,40–50] Thus, participants seem to enjoy the aspects of allotment gardening which contribute to their health. The opportunities for social interaction offered by allotment gardening might be particularly important as the development of relationships promotes social capital.[69] Social capital increases life expectancy, while a lack of social capital embodied by loneliness has the equivalent risk to health as consuming 15 cigarettes daily and is twice as harmful as obesity.[67,69] Allotment gardening could contribute to a greener and healthier economy focused on the prevention of ill-health. This preventive approach could result in substantial savings to the UK economy, particularly in the treatment of health conditions such as mental illness, obesity, cardiovascular disease and loneliness.[69]

What is already known

The findings of this study support the growing body of evidence indicating that contact with nature via gardening is beneficial for mental well-being[24–28,40–50] and that participation

in green exercise activities provides additive benefits for health.[4,9,10] The findings of this study also support those of Van den Berg *et al.*[32] who found that allotment gardeners had a better overall health and well-being than non-allotment gardeners. However, to date, evidence regarding the health benefits of gardening has been qualitative or descriptive and not specifically focused on allotment gardening. Furthermore, the findings of Van den Berg *et al.*[32] did not incorporate a well-matched non-gardener control group.

What this study adds

The study provides direct quantitative evidence of the health benefits of partaking in allotment gardening and the enhanced health of allotment gardeners compared with non-gardeners. We have demonstrated that as little as 30 min of allotment gardening can produce significant health gains and that these occur irrespective of previous participation in allotment gardening. This is the first known study to comprehensively evaluate the health benefits of allotment gardening using quantitative methods and matched non-gardener controls. The findings indicate that allotment gardening can play an important role in promoting and improving well-being and that it could therefore be used as a long-term tool for combatting ill-health.

Limitations

This study has a number of limitations. First, the questionnaires used are open to a ceiling and floor effect. Allotment participants may have rated themselves as having a high self-esteem or mood at the start of the allotment session, but felt better following the allotment session. As a high score has already been achieved; it may be difficult to quantify this improvement. It was also difficult to engage non-gardeners with poor health in the study. This may have introduced some degree of bias as the majority of non-gardeners were of good health, as evidenced by their questionnaire scores. There were also some missing data which might have impacted upon the study findings. However, these data were missing across a number of different participants and health measures and therefore appeared to be missing at random. Furthermore, despite these limitations, there were still significant differences between pre- and post-allotment session self-esteem and mood scores and between the mental health of allotment gardeners and non-gardeners. Following initial measurement of non-gardeners, it would have also been helpful to determine whether gardening on an allotment would have resulted in an improvement in their mental well-being. It would have also been beneficial to control for a range of socioeconomic variables such as income, housing, life-stage, education and marital status in addition to age, gender and occupation status. Future research should therefore analyse the effect of allotment gardening on non-gardeners and participants with a low level of mental well-being. It should also seek to differentiate between people who were suffering from mental illness when they took on the allotment to determine whether their health is also better than that of non-gardeners, despite their prior ill-health. The study would also benefit from measures of physical health in order to determine whether allotment gardening can benefit both physical and mental well-being.

Policy implications

This research evidencing the mental well-being benefits of allotment gardening has important policy implications. There are an increasing number of people in the UK who suffer from mental ill-health, in addition to experiencing poor physical health and loneliness, being overweight or obese and physically inactive; all of which are costly to the UK economy.[61] Allotment gardening could prevent many of these problems and thus could result in savings to the UK health services and economy at large. Opportunities for gardening therefore need to be provided to all people, including people with ill health, socially disadvantaged and those in urbanized areas. This could be achieved through improved provision and access to gardens, for example, community allotment plots. Policies concerned with improving health and well-being and preventing ill-health should include access to gardens as part of their future policies and strategies.

Conclusions

Overall, the findings of this study indicate that one single session of allotment gardening can improve both self-esteem and mood, irrespective of how long participants spend on the allotment, whether they have attended in the last 7 days and their overall length of tenure. Furthermore, allotment gardeners have a better level of self-esteem and mood and a reduced level of abnormal psychological functioning than non-gardeners. Thus, in order to improve health and well-being, people in the UK should be encouraged to take part in short bouts of allotment gardening. Health organizations and policy makers should consider the potential of allotment gardening as long-term tool for combatting the increasing prevalence of ill-health and local public authorities should seek to provide community allotment plots to allow residents to have regular opportunities to partake in gardening activities.

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References

1 Brown DK, Barton JL, Gladwell VF. Viewing nature scenes positively affects recovery of autonomic function following acute mental stress. *Environ Sci Technol* 2013;**47**:5562–9.

2 Barton JL, Hine R, Pretty J. The health benefits of walking in greenspaces of high natural and heritage value. *J Integr Environ Sci* 2009; **6**:1–18.

3 Barton JL, Griffin M, Pretty J. Exercise, nature and socially interactive based initiatives improve self-esteem and mood in the clinical population. *Perspect Public Health* 2012;**6**:261–78.

4 Pretty J, Peacock J, Hine R *et al*. Green exercise in the UK countryside: effects on health and psychological well-being. *J Environ Plann Manage* 2007;**50**:211–31.

5 Van den Berg A, Custers M. Gardening promotes neuro-endocrine and affective restoration from stress. *J Health Psychol* 2011;**16**:3–11.

6 Mackay G, Neill J. The effect of 'green exercise' on state anxiety and the role of exercise duration, intensity and greenness: a quasi-experimental study. *Psychol Sport Exercise* 2010;**11**:238–45.

7 Bowler DE, Buyung-Ali LM, Knight TM *et al*. A systematic review of the evidence for the added benefits to health of exposure to natural environments. *BMC Public Health* 2010;**10**:456–66.

8 Thompson Coon J, Boddy K, Stein K *et al*. Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental well-being than physical activity indoors? A systematic review. *Environ Sci Technol* 2011;**45**:1761–72.

9 Barton JL, Pretty J. What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environ Sci Technol* 2010;**10**:3947–55.

10 Pretty J, Peacock J, Sellens M *et al*. The mental and physical health outcomes of green exercise. *Int J Environ Health Res* 2005;**15**:319–37.

11 Dye C. Health and urban living. *Science* 1998;**319**:766–9.

12 Peen J, Schoevers RA, Beekman AT *et al*. The current status of urban–rural differences in psychiatric disorders. *Acta Psychiatr Scand* 2010;**121**:84–93.

13 Maas J, Verheij RA, De Vries A *et al*. Morbidity is related to a green living environment. *J Epidemiol Community Health* 2009;**63**:967–73.

14 Maas J, Verheij RA, Groenewagen PP *et al*. Green space, urbanity and health: how strong is the relation? *J Epidemiol Community Health* 2006; **60**:587–92.

15 Ward Thompson C, Roe J, Aspinall P *et al*. More green space is linked to less stress in deprived communities: evidence from salivary cortisol patterns. *Landsc Urban Plan* 2012;**105**:221–9.

16 White MP, Alcock I, Wheeler BW *et al*. Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. *Psychol Sci* 2013;**24**:920–8.

17 Bratman G, Hamilton P, Daily G. The impacts of nature experience on human cognitive function and health. *Ann NY Acad Sci* 2012; **1249**:118–36.

18 Hartig T. Green space, psychological restoration and health inequality. *Lancet* 2008;**372**:1614–5.

19 Mitchell R, Popham F. Effect of exposure to natural environment on health inequalities: an observational population study. *Lancet* 2008; **372**:1655–60.

20 Takano Y, Nakamura K, Watanabar M. Urban residential environments and senior citizens longevity in megacity areas: the important of walkable green spaces. *J Epidemiol Community Health* 2002;**56**:913–8.

21 Roe J, Ward Thompson C, Aspinall P *et al*. Green space and stress: evidence from cortisol measures in deprived urban communities. *Int J Environ Res Pub Health* 2013;**10**:4086–103.

22 Lachowycz K, Jones AP. Green space and obesity: a systematic review of the evidence. *Obes Rev* 2011;**12**:183–9.

23 Pretty J. *The Living Land: Agriculture, Food and Community Regeneration in Rural Europe*. London: Earthscan, 1998.

24 Milligan C, Gatrell A, Bingley A. 'Cultivating Health': therapeutic landscapes and older people in Northern England. *Soc Sci Med* 2004; **58**:1781–93.

25 Fieldhouse J. The impact of an allotment group on mental health clients' health, well-being and social networking. *Br J Occupther* 2003; **66**:286–96.

26 Hayashi N, Wada T, Hirai H *et al*. The effects of horticultural activity in a community garden on mood change. *Environ Control Biol* 2008; **46**:233–40.

27 Park SA, Shoemaker CA, Haub M. Can older gardeners meet the physical activity recommendations through gardening? *Horttechnology* 2008;**18**:639–43.

28 Waliczek TM, Zajicek JM, Lineberger RD. The influence of gardening activities on consumer perceptions of life satisfaction. *HortScience* 2005;**40**:1360–5.

29 Department for Communities and Local Government. 2010. *English Housing Survey*. London: Crown, 1999.

30 Campbell M, Campbell I. *Allotment Waiting Lists in England 2013*. Merseyside: Transition Town West Kirby and The National Allotment Society, 2013.

31 Stephan B, Carl F, Johan C. Social–ecological memory in urban gardens: retaining the capacity of management of ecosystem services. *Global Environ Change* 2010;**20**:255–65.

32 Van den Berg AE, van Winsum-Westra M, de Vries S *et al*. Allotment gardening and health: a comparative survey among allotment gardeners and their neighbours without an allotment. *Environ Health* 2010;**9**:74–85.

33 Crouch D. British allotments, landscapes of ordinary people. *Landscape* 1999;**31**:1–7.

34 Gross H, Lane N. Landscapes of the lifespan: exploring accounts of own gardens and gardening. *J Environ Psychol* 2007;**27**:225–41.

35 Wiltshire R, Burn D. *Growing in the Community: A Good Practice Guide for the Management of Allotments*, 2nd edn. London: Local Government Association, 2010.

36 Churkina G, Brown DG, Keoleian G. Carbon stored in human settlements: the conterminous United States. *Global Change Biol* 2010;**16**: 135–43.

37 Edmondson JL, Davies ZG, McCormack SA *et al*. Are soils in ecosystems compacted? A citywide analysis. *Biol Lett* 2011;**23**:771–4.

38 Edmondson JL, Davies ZG, McHugh N *et al*. Organic carbon hidden in urban ecosystems. *Sci Rep* 2012;**2**:963–70.

39 Edmondson JL, Davies ZG, Gaston KJ *et al*. Urban cultivation in allotments maintains soil qualities adversely affected by conventional agriculture. *J Appl Ecol* 2010;**51**:880–9.

40 Armstrong D. A survey of community gardens in upstate New York: implications for health promotion and community development. *Health Place* 2000;**6**:319–27.

41 Patel IC. Gardening's socioeconomic impacts: community gardening in an urban setting. *J Ext* 1991;**29**:7–8.

42 Perez-Vazquez A, Anderson S, Rogers AW. Assessing benefits from allotments as a component of urban agriculture in England. In: Mouget LJA (ed). *Agropolis: The Social Political and Environmental Dimensions of Urban Agriculture*. London: Earthscan and IDRC, 2005, 239–66.

43 Twiss J, Dickinson J, Duma S *et al*. Community gardens: lessons learned from California healthy cities and communities. *Am J Public Health* 2003;**93**:1435–8.

44 Wakefield S, Yeudall F, Taron C *et al*. Growing urban health: community gardening in South-East Toronto. *Health Promot Int* 2007;**22**: 92–101.

45 Hawkins J, Smith A, Backx K *et al*. Exercise intensities of gardening tasks within older adult allotment gardeners in Wales. *J Age Phys Act* 2015;**23**:161–8.

46 Wang D, Macmillan T. Benefits of gardening for older adults: systematic review of literature. *Act Adapt Aging* 2013;**37**:153–81.

47 Sempik J, Aldridge J, Becker S. *Growing Together—A Practice Guide to Promoting Social Inclusion Through Gardening and Horticulture*. Chicago: University of Chicago Press, 2005.

48 Hawkins J, Mercer J, Thirlaway K *et al*. 'Doing' gardening and 'being' at the allotment site: exploring the benefits of allotment gardening for stress reduction and healthy ageing. *Ecopsychology* 2013;**5**:110–25.

49 Church A, Mitchell R, Ravenscroft N *et al*. 'Growing your own': a multilevel modelling approach to understanding personal food growing trends and motivations in Europe. *Ecol Econ* 2015;**110**:71–80.

50 Hawkins J, Thirlaway K, Backx K *et al*. Allotment gardening and other leisure activities for stress reduction and healthy ageing. *Horttechnology* 2011;**21**:577–85.

51 Bishop R, Purcell E. The value of an allotment group for refugees. *Br J Occup Ther* 2013;**76**:264–9.

52 Ericcson Nolan M. Allotments, health and well-being. PhD Dissertation. Colchester, Essex: University of Essex, Colchester, 2012.

53 Department for Communities and Local Government. *The English Indices of Deprivation*, 2007. http://geoconvert.mimas.ac.uk/help/imd-2007-manual.pdf.

54 Bagley C. Normative data and mental health construct validity for the Rosenberg self-esteem scale in British adolescents. *Int J Adol Youth* 2001;**9**:117–26.

55 Boden JM, Fergusson DM, Horwood LJ. Does adolescent self-esteem predict later life outcomes? A test of the casual role of self-esteem. *Dev Psychopathol* 2008;**20**:319–39.

56 Orth U, Robins R, Meier LL. Disentangling the effects of low self-esteem and stressful life events on depression: findings from three longitudinal studies. *J Pers Soc Psychol* 2009;**97**:307–21.

57 Griffiths LJ, Parsons TJ, Hill AJ. Self-esteem and quality of life in obese children and adolescents: a systematic review. *Int J Pediatr Obes* 2010;**5**:282–304.

58 Xavier S, Mandal S. The psychosocial impacts of obesity in children and young people: a future health perspective. *Public Health Med* 2005;**6**:23–7.

59 Rosenberg M. *Society and the Adolescent Self-Image*. Princeton: Princeton University Press, 1965.

60 Berger BG, Motl RW. Exercise and mood: a selective review and synthesis of research employing the profile of mood states. *J App Sports Psychol* 2001;**12**:69–92.

61 Berger B, Pagman D, Weinberg RS. *Foundations of Exercise Psychology*. Morgantown: Fitness Information Technology, 2002.

62 Hull RB. Mood as a product of leisure: causes and consequences. In: Driver BL, Brown PJ, Peterson GL, (eds). *Benefits of Leisure*. State College, PA: Venture, 1991.

63 Mcnair DM, Lorr M, Droppleman LF. *Revised Manual for the Profile of Mood States*. San Diego: Educational and Industrial Testing Service, 1992.

64 Goldberg D. *General Health Questionnaire*. Berkshire: NFER-NELSON Publishing Company, 1978.

65 Goldberg D, Williams P. *A User's Guide to the General Health Questionnaire*. Berkshire: NFER-NELSON Publishing Company, 1998.

66 IBM Corp. *IBM SPSS Statistics for Windows*. Armonk, NY: IBM Corp, 2010.

67 Bolton M. *Loneliness—The State We're In*. London: Campaign to End Loneliness, 2012.

68 Haslam DW, James WP. Obesity. *Lancet* 2005;**366**:1197–209.

69 Pretty J, Barton J, Bharucha ZP *et al*. Improving health and well-being independently of GDP: dividends of greener and prosocial economies. *Int J Environ Health Res* 2015;**11**:1–26.