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Why garden? – Attitudes and the perceived health benefits of home gardening

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ABSTRACT

Domestic (home) gardens provide opportunities for psychological and physical health benefits, yet these environments have received less attention in terms of their therapeutic value compared to other urban green spaces. This is despite their ubiquity and the popularity of gardening as a pastime. This research explored why residents engaged with gardening and the extent to which they recognised any health benefits from the activity. A questionnaire was distributed electronically within the UK, with 5766 gardeners and 249 non-gardeners responding. Data were collated on factors including garden typology, frequency of gardening and individual perceptions of health and well-being. Significant associations were found between improvements in well-being, perceived stress and physical activity and more frequent gardening. Gardening on a frequent basis i.e. at least 2–3 times a week, corresponded with greatest perceived health benefits. Improving health, however, was not the prime motivator to garden, but rather the direct pleasure gardening brought to the participants. There was evidence that satisfaction with one's front garden and the time spent in it increased as the proportion of vegetation was enhanced. The data supports the notion that domestic gardens should be given greater prominence in urban planning debates, due to the role they play in providing health benefits.

1. Introduction

'Gardening' is defined as the activity of working in a garden, growing and taking care of plants, and keeping the garden attractive (Gillard, 2001). Gardening is an extremely popular pastime in some cultures. In the UK for example, it is estimated that 49% of the adult population takes part in gardening activities (Department for Culture Media and Sport, 2017) and that there are 24 million domestic (home) gardens in the UK; a country with a population of 66 million people (Department for Culture Media and Sport, 2017; Office for National Statistics, 2015). Similarly, in the USA, it is estimated that 78% of home-owners take part in gardening on a regular basis (Kiesling & Manning, 2010). In any one city, gardens can exceed 20–25% of urban land area (Dewaelheyns et al., 2014; Mathieu et al., 2007) and are the most readily accessible green spaces for residents.

Gardening includes the cultivation of food crops for home

consumption, but also the growing of ornamental plants for aesthetic purposes. The relative popularity of these two main trends can vary based on culture and socio-economic background (Aguilar-Stoen et al., 2009; Bhatti & Church, 2000; Davoren et al., 2016; Maroyi, 2009; Reyes-García et al., 2012), but of course many individual gardens may comprise both areas for fruit/vegetable cultivation and aesthetic purposes. So why is gardening so popular and what reasons do people garden for? Gardening has been linked to improvements in human health and well-being, but it is not clear what aspects of gardening promote health, or indeed the extent to which any health benefits are recognised in the gardening community? The research presented here explores attitudes to domestic gardening and the extent to which gardening is seen as a health intervention.

Exploring nature and engaging with green space is now linked with health and well-being benefits (Cameron et al., 2020; Pritchard et al., 2020; Roslund et al., 2020; van den Bosch & Sang, 2017). For urban

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residents, parks (Razani et al., 2018), nature reserves (Bell et al., 2018), street trees (Guo et al., 2020) and gardens (Bitterman & Simonov, 2017; Vujcic et al., 2017) are important locations to relax, find restoration from stress, engage with physical activity and help restore a sense of balance in one's life (Tidball et al., 2019). Such aspects may help offset more serious mental and physiological health problems (Engemann et al., 2019). Community gardening has often been associated with health and social benefits (Soga et al., 2017; Wang & MacMillan, 2013), but increasingly private domestic (also known as home or residential) gardens have also been linked to health and well-being improvements (Cameron & Hitchmough, 2016; Cervinka et al., 2016; Chalmin-Pui et al., 2020; de Bell et al., 2020).

In evaluating health levels within urban landscapes, recent studies using regression models (Brindley et al., 2018; Dennis & James, 2017) suggest that the presence of domestic gardens mitigate against health deprivation. Domestic gardens have been linked to reductions in social, emotional and behavioural difficulties in children (years 4–6) (Richardson et al., 2017), better physical and mental well-being in mid-aged and older people (Machida, 2019; Peeters et al., 2014), a reduction in the incidence of depression in older people (Rappe & Kivelä, 2005), the prevention of stress (Stigsdotter & Grahn, 2004) and the capacity to support stress regulation (Adevi & Mårtensson, 2013; Cervinka et al., 2016; Young et al., 2020). A study in Japan, showed that domestic gardening was beneficial to the elderly, with positive effects on subjective happiness and habits around physical exercise and diet (Machida, 2019). Increasing the frequency of gardening was not correlated with greater health benefits, however. Increasing the vegetation component of front gardens has been linked with lower self-reported stress in residents, data that coincides with improvements in physiological indicators of stress as captured by diurnal cortisol profiles, indicating less chronic stress (Chalmin-Pui et al., 2020). Physical access, alongside viewing a garden, improved well-being in older people, and increasing the proportion of greenery in a garden can boost the positive well-being effects (Burton et al., 2015). In addition to increasing the area of vegetation, diversity may also be important. Enhancing the number of plant taxa present has been linked to stronger restorative effects (Young et al., 2020).

In addition to proportion/volume/diversity of vegetation present, garden style may be important. Twedt et al. (2016) demonstrated that more informal and naturalistic gardens had stronger restorative potential than gardens of a formal style. Strong visual appeal, based on flower colour for example, was also an important element in enhancing restorative potential. Young et al. (2020), however, concluded that allotment gardens (i.e. primarily used for the cultivation of fruit and vegetables) had marginally more restorative capacity than domestic gardens in their studies in Zurich (Switzerland). Similarly, Ambrose et al. (2020) found higher well-being scores associated with the cultivation of vegetables over ornamentals, and attributed this to a strong sense of purpose linked to growing one's own food.

Domestic gardens are associated with a wide range of other ecosystem services (Cameron et al., 2012; Langemeyer et al., 2018), although the type and level of service can be influenced by scale, design and management of gardens (Cameron & Blanus, 2016). These include improving air quality, reducing surface water run-off and risk of flooding, providing resource and habitat for wildlife, noise abatement, urban cooling, reducing energy loss from domestic properties and providing inexpensive sources of high quality food and employment opportunities (Cameron & Hitchmough, 2016; King & Shackleton, 2020). Other services associated with private gardens include affording children's experiences of nature and allowing the development of eco-literacy (Hand et al., 2017; Raymond et al., 2019). Such aspects may also affect health directly or indirectly.

The extent to which improving one's health is a motivating factor to engage with gardening is less clear. Previous studies have investigated what motivates people to garden in a residential setting. These include seeking intellectual challenge, the opportunity for self-expression,

aesthetics, an escape from negative stimuli, a place for leisure, an opportunity to be creative, a chance to foster skill development and facilitate social relationships (Ashton-Shaeffer & Constant, 2006; Clayton, 2007; McFarland et al., 2018). Some gardeners acknowledge advantages to physical fitness (Ashton-Shaeffer & Constant, 2006), and others (Lewis et al., 2018; McFarland et al., 2018) cite therapeutic aspects and health/nutrition as promoting factors. When comparing attitudes to gardening across cultures, Home and Vieli (2020) found that health aspects (restoration from stress) was the strongest motivating factor in both Chile and Switzerland. Food production in the garden has been linked to better nutritional health (Kirkpatrick & Davison, 2018) as well as other factors including pleasure, the promotion of social change (e.g. pro-environmental behaviour) and access to fresh and affordable food. With the exception of providing resources and habitat for wildlife (Salisbury et al., 2017) and supplying an alternative way of producing food (Beavers et al., 2020), few other key urban environmental ecosystem services have been quoted in previous research as strong motivating factors (e.g. few people garden to improve local air quality).

In contrast to these points, not all motivations to garden are necessarily seen as positive factors. Some residents have felt 'the need to garden' to keep their residence tidy, fit in with conventions or address peer-pressure, and may see garden activities as a chore (Clayton, 2007). Gardens can induce stress as well as provide restoration from it, and Young et al. (2020) found 16% of their respondents considered their garden to cause them stress quite frequently. Not all the influences on gardening may emanate from the home-owners themselves, but relate to external pressures. Previous studies have related gardens to other aspects of residential environments including those affecting well-being (Burton et al., 2015; de Bell et al., 2020), children's mental health (Richardson et al., 2017) or engagement with nature (Hand et al., 2017). Further understanding of the relationships between gardens and the wider neighbourhood thus merits attention. A sub-component of the research presented here was to determine how views on the local neighbourhood might influence attitudes to the owner's garden or gardening activities.

Despite the increasing evidence around the value of domestic gardens for health and other ecosystem services, they are often not a priority for policy makers and planners (Breuste, 2010; de Bell et al., 2020; Haaland & Konijnendijk van den Bosch, 2015). Residential garden size is getting smaller. Some planners/developers now omit gardens in new housing schemes completely, especially where urban space is at a premium, while others prefer to invest in other forms of green space (Borsboom-van Beurden et al., 2013; Douglas et al., 2019; Haaland & Konijnendijk van den Bosch, 2015). Also, existing domestic gardens are vulnerable to infill (new houses inserted between existing residences) and development (Drilling et al., 2016; Sayce et al., 2012), that results in a net loss of vegetation and soil sealing e.g. greater space allocated to car-parking bays. City densification is occurring across the globe and loss of garden space (and corresponding key ecosystem services) has been reported for Austria (Breuste, 2010), Germany (Wellmann et al., 2020), Chile (Hernández-Moreno & Reyes-Paecke, 2018), Ecuador (Finerman & Sackett, 2003), India (Balooni et al., 2014), New Zealand, (Freeman et al., 2015), Romania (Badiu et al., 2019) and the UK (Ross, 2015). Thus we felt further research was warranted to give a better basis for how people, (and particularly gardeners) viewed and valued their gardens, and how this might inform future policy. In the UK, where gardeners represent approximately 50% of the population, we felt their opinions about gardens may have relevance to current debates around city densification. We were particularly interested in how gardeners viewed their gardens from a health perspective.

This study explored why people in the UK engaged with gardening and the extent to which any health and well-being benefits were acknowledged by gardeners. It also aimed to determine whether there was a relationship between frequency of gardening and any perceived health benefits. It should be noted the research was implemented before the global COVID-19 virus pandemic, and thus represents a 'normal

mode' relationship between citizens and their gardens, rather than that potentially influenced by a major public health crisis.

The research aimed to address four specific questions:

- 1) What were the personal reasons given by people for gardening?
- 2) Is gardening linked with improved health outcomes; and does increased gardening frequency correspond to greater health benefits (i.e. self-reported well-being, reduced stress, more physical activity)?
- 3) To what extent do neighbourhood factors also influence health and well-being benefits?
- 4) Are there certain factors that influence an individual's satisfaction with their garden? Specifically, we were interested in how the proportion of green space (vegetated area) might affect satisfaction levels?

2. Materials and methods

2.1. Questionnaire: gardening – activities, motivations and health

A questionnaire was designed to determine attitudes towards gardening with particular reference to motivations to garden and self-reported health. The questionnaire was presented on-line using a Qualtrics website platform, which was accessible by personal computers or mobile phone devices. The questionnaire was targeted primarily at self-declared 'gardeners', but we also wished to garner opinions of 'non-gardeners'. Thus these 'non-gardeners' could both act as 'control' group for some questions, yet also provide us with a gradient of responses with respect to attitudes and levels of activity that take place in gardens. As such a small proportion of responses (249 ≈ 4%) were derived from individuals who expressed no or little interest in gardening. To aid this selection respondents were asked to notify and encourage friends, who they considered non-gardeners to also complete the questionnaire. The data was restricted to individuals over 18 years old.

The full questionnaire (see Supplementary Appendix A1) was made available on-line between 26 November 2016 and 30th April 2017. Data from this questionnaire were used to determine relationships between frequency of gardening (i.e. 'daily' through to 'never') and self-reported health and well-being levels. (Table 1 provides the key categories, questions posed and scales used for health indices). Qualitative data requested related to self-reported health benefits of gardening, motivations for gardening, and health barriers to gardening. Responses to 'interest in gardening' and 'frequency of gardening' were used to categorise the respondents based on interest in gardening. Questions relating to wider aspects/views of neighbourhood ('area rating', 'community spirit rating' and frequency of doing neighbourly 'favours') were also asked to determine levels of social interaction.

The questionnaire was publicised through the Royal Horticultural Society (RHS) website and member communications (comprising mostly active gardeners) but also BBC News webpage, home/interior, health/well-being and psychology magazines/webpages, and mindfulness centres (to attract non-gardeners). The page on the RHS website received 5442 unique views during the period that the questionnaire was open. Responses to previous RHS member newsletters tend to suggest a 7–12% response rate of those who open the link. That would equate to 600–1100 respondents via this route and would suggest the contribution through the other routes were noteworthy. The RHS contacted the BBC Science news journalist directly and they featured the survey alongside an online article on their website, through social media and via regional BBC radio stations. Editors of lifestyle and well-being magazines were contacted by e-mail and also featured the survey in their pages. No financial or other incentives were used to encourage

Table 1

Categories assessed to determine relationships between interest/motivations to garden and health, and influence due to other socio-demographic variables. Respondents were provided with a range of options (e.g. Likert scales – L followed by the number of options available), or asked to provide their own answers to open questions (open question).

Category	Key question/s
Gender	What is your gender?
Age	How old are you?
Education	What is your highest level of education?
Income	Which of the following ranges of net income do you fit into?
Accommodation type	What type of accommodation are you currently living in?
Area rating	In general, how would you rate your area as a place to live? (L-5)
Community spirit rating	How would you rate the sense of community spirit in your area? (L-5)
Favours	How often do you and people in your neighbourhood do favours for each other? (L-4)
Interest in gardening	Which of these best describe your level of gardening interest and attitude to gardening?
Frequency of gardening	How regularly do you actually garden? (L-6)
Motivation to garden	Why do you garden? (open question)
Health issues that impede gardening	Do you have any health issues that prevent you from gardening or that make it difficult for you to garden? (open question)
Gardening location	Which areas do you garden? (front/back etc.)
Vegetation	Approximately what percentage of your front garden is planted?
Happiness (satisfaction) with front garden	How happy are you with your front garden currently? (L-5)
Happiness (satisfaction) with back garden	How happy are you with your back garden currently (L-5)
Health benefits	Have you any therapeutic benefits from your garden? (open question)
Well-being	Shortened Warwick and Edinburgh Mental Well Being Scale, SWEMWBS – scale 7 (low well-being)–35 (high well-being), (Tennant et al., 2007) (L-5)
Perceived stress	Perceived Stress Scale, PSS with scores from 0 (low stress)–40 (high stress), (Cohen et al., 1983) (L-5)
Physical activity	In the average week, on how many days do you do any physical activity (of sufficient exertion to raise breathing rate) for at least 30 min? (L-8)

respondents to complete the survey.

2.2. Data handling

Linear and ordinal logistic regression models were fitted to quantitative data within the R statistical package (R Core Team, 2020). These models enabled assessment of the significance of the relationship between our potential explanatory variables of interest (gardening frequency and views on the local neighbourhood) and our studied responses (well-being, perceived stress, physical activity, and happiness with front garden) while accounting for the potentially confounding demographic variables of income, gender, age, and accommodation type. Views on the local neighbourhood were assessed in terms of opinion on both area and sense of community spirit; and frequency of conducting neighbourhood favours.

For the three health metrics (well-being, perceived stress, physical activity), initial exploratory data analysis plotted health benefits by gender and gardening frequency. A formal linear model analysis was then conducted to control for socio-demographic variables. Initial fitted models were of the format, i.e.

Health benefit ~ Accommodation type + Gender + Age + Education + Income + Frequency of Gardening + Area rating + Community spirit rating + Favours

Stepwise model selection amongst the explanatory variables of interest (frequency of gardening and views on the local neighbourhood) was then performed by Akaike Information Criteria (AIC) whereby non-significant variables were dropped and the model rerun. Socio-demographic variables were kept in all models. Modelling assumptions were assessed by comparison of residuals and seen to be satisfactory.

Data on happiness with the front garden was fitted using ordinal logistic regression since responses lay on a five-point ordered Likert scale. The same initial explanatory variables were included, but with vegetation cover also added. A similar approach to model selection using AIC was then taken to assess the significance of the variables of interest (frequency of gardening, views on local neighbourhood, and vegetation cover).

Qualitative data analysis involved linguistics-based text analysis in the IBM SPSS Text Analytics for Surveys package. Textual data was transformed into quantitative data to discover relationships between concepts.

3. Results

A total of 6914 people responded, with 6015 responses used for analysis. Responses that were incomplete or from people under 18 were excluded. There were 5766 people who identified themselves as gardeners and 249 as non-gardeners. (Socio-demographic information and responses are summarised in Supplementary Appendix A2). Participants were more likely to be older adults, female, and house-owners.

3.1. Why garden?

The open-ended section of the questionnaire (5418 respondents) showed that most people gardened for pleasure and enjoyment, with similar aspects, i.e. ‘love of the activity’ and ‘seeing plants and/or flowers grow’ also scoring highly (Fig. 1). ‘Sensory reasons’, ‘expression and self-identity’ and ‘maintenance’ were common responses. ‘Health benefits’ (especially when ‘well-being’ and ‘calm and relaxation’ are added in) were also frequently cited. Engagement with food growing/nature/being outdoors were motivations for some.

3.2. Health benefits

3.2.1. Well-being

Initial plots suggested well-being scores decreased as gardening activity became less frequent (Fig. 2). On fitting our initial linear model there was no evidence that, accounting for other variables, the frequency of conducting neighbourhood favours affected well-being and so this was dropped from the model. A chi-squared test provided overwhelming evidence that the frequency of gardening had an effect on well-being ($P < 10^{13}$). Accounting for the local neighbourhood and other socio-demographic variables, an individual who gardened ‘daily’ had an expected well-being score higher than those who gardened less regularly. This was higher: by 0.68 vs gardened ‘2–3 times a week’ (95% CI [0.26, 1.10]), by 1.33 vs ‘once a week’ (95% CI [0.88, 1.77]), by 1.71 vs ‘2–3 times a month’ (95% CI [1.22, 2.20]), by 1.51 vs ‘once a month’ (95% CI [0.97, 2.05]) and by 1.84 points vs ‘never gardened’ (95% CI [1.16, 2.52]) (Table 2). This corresponds to a 6.6% increase in expected well-being from those who gardened ‘daily’ compared to those who ‘never gardened’.

There was very strong evidence that the area rating ($P < 0.004$) and sense of community spirit ($P < 10^{-5}$) had an effect on well-being. As the view of the area decreased from ‘excellent’ to ‘good’, expected well-being dropped by 0.39 (95% CI [0.09, 0.68]), to ‘average’ by 0.86 (95% CI [0.39, 1.33]) and to ‘poor’ by 0.71 (95% CI [−0.18, 1.53]). Expected well-being decreased uniformly as perception of community spirit decreased. Those with an ‘excellent’ sense of community spirit had expected well-being scores that were higher: by 0.42 vs ‘good’ (95% CI [0.03, 0.82]), by 0.80 vs ‘average’ (95% CI [0.36, 1.22]), by 1.30 vs ‘poor’ (95% CI [0.76, 1.85]) and by 2.26 vs those with a ‘very poor’ sense of community spirit (95% CI [1.13, 3.38]).

Neither education level nor gender appeared to have a significant effect on well-being. Accommodation type, age, and income had a statistically significant impact on well-being. Increases in well-being were particularly evident for people earning more than £70,000 per annum for whom expected well-being was 0.95 (95% CI [0.40, 1.50]) points higher than those with an income of less than £15,000. Well-being increased as individuals age, though with a sharp expected decrease for individuals older than 75. Expected well-being was higher by 0.47 points (95% CI [0.01, 0.94]) for individuals living in semi-detached or detached houses compared to those living in flats.

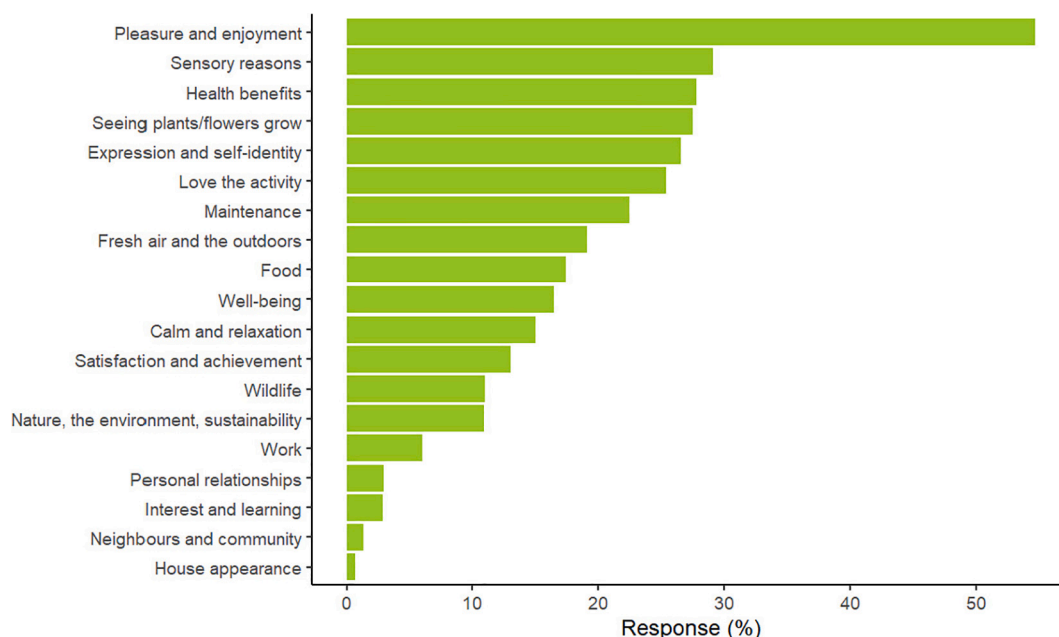


Fig. 1. Reasons to partake in gardening.

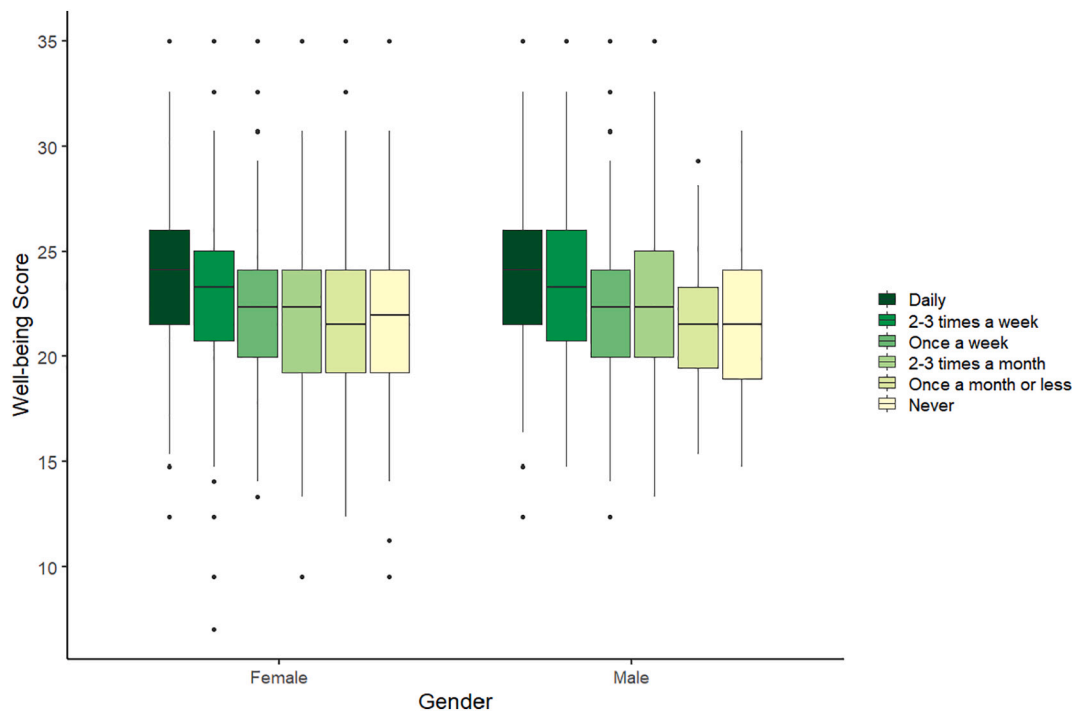


Fig. 2. Mental well-being score (SWEMWBS) and frequency of gardening – exploratory boxplots showing minimum, first quartile, median, third quartile, maximum and outlier scores.

Table 2

The expected decrease in well-being, increase in stress, and decrease in physical activity for individuals with varying gardening frequency compared to a baseline individual who gardens daily.

Frequency of gardening	Well-being (decrease in SWEMBS)		Perceived stress (increase in stress)		Physical activity (decrease in activity)	
	Estimate	95% CI	Estimate	95% CI	Estimate	95% CI
Daily	Baseline		Baseline		Baseline	
2–3 times a week	0.68	0.26–1.10	0.71	–0.09–1.51	1.03	0.80–1.27
Once a week	1.33	0.88–1.77	1.47	0.61–2.33	1.44	1.18–1.69
2–3 times a month	1.71	1.22–2.20	1.74	0.80–2.69	1.46	1.18–1.75
Once a month or less	1.51	0.97–2.05	1.90	0.86–2.94	1.66	1.35–1.98
Never	1.84	1.16–2.52	1.68	0.39–2.97	1.42	1.04–1.82

3.2.2. Perceived stress

Initial exploratory data analysis on perceived stress by gender and frequency of gardening suggested a clear increase as frequency of gardening dropped (Fig. 3). On fitting our linear model there was no evidence that the frequency of neighbourhood favours affected well-being and so this was dropped from the model. A subsequent chi-squared test again provided overwhelming evidence that frequency of gardening had an effect on perceived stress ($P < 3 \times 10^{-4}$). Accounting for the local neighbourhood and socio-demographic factors, an individual who gardened ‘daily’ had an expected perceived stress score lower than those who gardened less regularly. Stress scores for those who gardened ‘daily’ were reduced: by 0.71 vs ‘2–3 times a week’ (95% CI [–0.09, 1.51]), by 1.47 vs ‘once a week’ (95% CI [0.61, 2.33]), by 1.74 vs ‘2–3 times a month’ (95% CI [0.80, 2.69]), by 1.90 vs ‘once a month’ (95% CI [0.86, 2.94]) and by 1.68 compared to those who ‘never gardened’ (95% CI [0.39, 2.97]) (Table 2). This equates to a 4.2% decrease in relative stress levels from those who gardened ‘daily’ compared to those who ‘never gardened’.

There was very strong evidence that perception of both the area ($P < 10^{-4}$) and community spirit ($P < 0.004$) had an effect on perceived stress. As the sense of community spirit decreased then perceived stress increased, particularly amongst those who described the sense of community as ‘poor’ or ‘very poor’. Those who considered it ‘poor’ had an

expected stress score 1.34 (95% CI [0.31, 2.37]) higher; and those who considered it ‘very poor’ 3.13 (95% CI [1.00, 5.26]) points higher than those who described their sense of community as ‘excellent’. As the view on the area decreased, expected stress also uniformly increased. For those who saw their area as ‘excellent’, expected stress scores were: 0.91 lower vs those who saw it as ‘good’ (95% CI [0.33, 1.47]), 2.02 lower vs ‘average’ (95% CI [1.12, 2.92]), 2.27 lower vs ‘poor’ (95% CI [0.59, 3.96]) and 3.20 points lower vs those who saw their area as ‘very poor’ (95% CI [–1.22, 7.61]).

Considering the socio-demographic variables, there was limited evidence that education level had an effect on perceived stress. Accommodation type, age, gender, and income did however have a statistically significant impact, in particular age and income. Expected perceived stress was 1.47 (95% CI [0.41, 2.52]) points lower for people who had an income of more than £70,000 compared to those with an income of less than £15,000. Expected perceived stress decreased consistently as individuals aged up to the age of 65–74, but then rose again for those in the 75–84 year-old range. Perceived stress was expected to be lower by 1.08 points (95% CI [0.20, 1.96]) for individuals living in semi-detached or detached houses compared to those living in flats. Expected perceived stress was lower by 0.59 points (95% CI [0.02, 1.16]) for men compared to women.

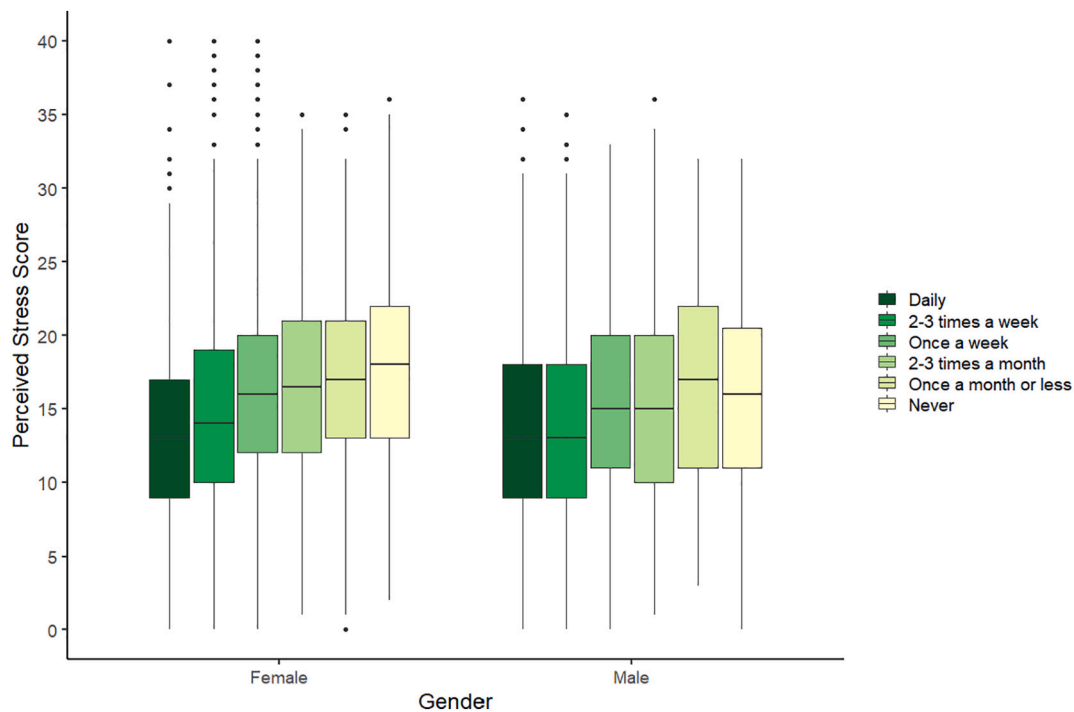


Fig. 3. Perceived stress score and frequency of gardening – exploratory boxplots showing minimum, first quartile, median, third quartile, maximum and outlier scores.

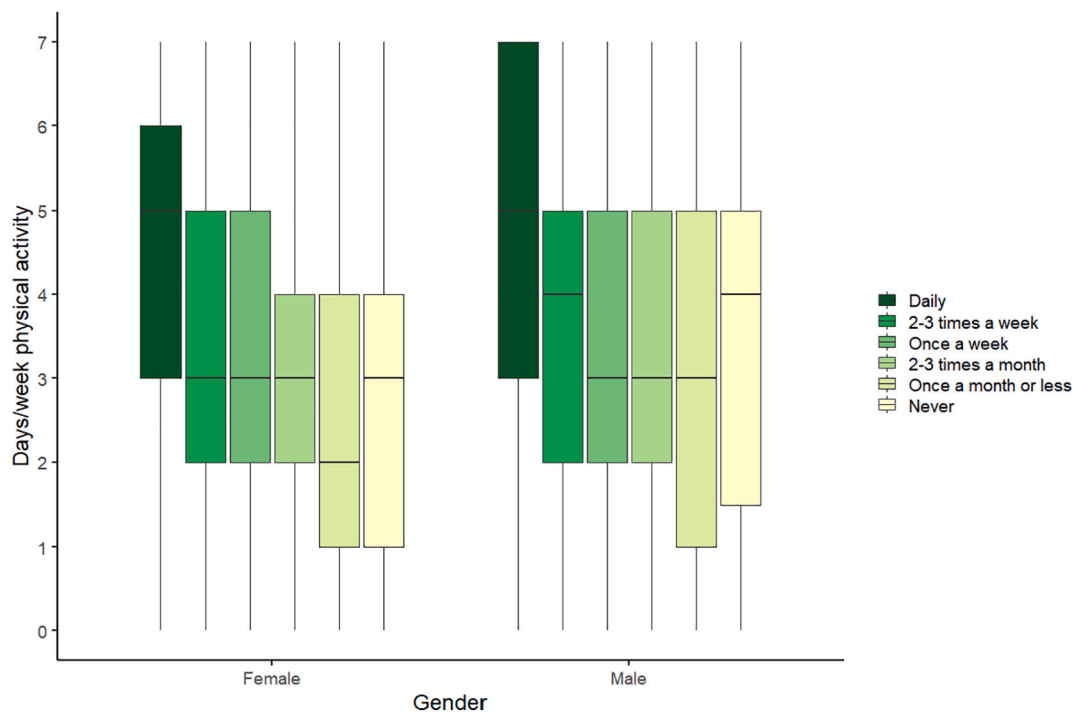


Fig. 4. Number of days per week with moderate physical activity and frequency of gardening – exploratory boxplots showing minimum, first quartile, median, third quartile and maximum scores.

3.2.3. Physical activity

Initial exploratory data analysis, illustrating days per week of moderate physical activity by gender and frequency of gardening showed a decrease in physical activity as gardening frequency dropped (Fig. 4). On accounting for the full range of explanatory variables, there was no evidence perception of community spirit had an effect on level of physical activity so this was dropped from the model. A chi-squared test

provided overwhelming evidence that frequency of gardening had an effect on physical activity ($P < 10^{-15}$). Perhaps, unsurprisingly, this was primarily seen amongst the individuals who gardened ‘daily’ suggesting those individuals who gardened less frequently did not make up the level of exercise in other forms. Individuals who gardened ‘daily’ were expected to be more active than those who gardened less regularly. Activity was expected to increase in the ‘daily’ category: by 1.03 days vs

gardened ‘2–3 times a week’ (95% CI [0.80, 1.27]), by 1.44 days vs ‘once a week’ (95% CI [1.18, 1.69]), by 1.46 days vs ‘2–3 times a month’ (95% CI [1.18, 1.75]), by 1.66 days vs ‘once a month’ (95% CI [1.35, 1.98]) and by 1.42 days vs those who ‘never gardened’ (95% CI [1.04, 1.82]) (Table 2).

There is some evidence that area rating ($P = 0.01$) and the frequency neighbour favours were carried out ($P = 0.047$) had a statistically significant effect on physical activity but these effects were small and only seen in individuals who saw their area as ‘excellent’ or frequently experienced/implemented neighbourhood favours, who were more active than others.

There was little evidence that income, education or accommodation type had significant effects on physical activity. Age and gender did however have a statistically significant impact. Accounting for the other explanatory variables, the highest expected level of physical activity was seen amongst individuals between 45 and 64. Physical activity was expected to be higher by 0.22 days (95% CI [0.05, 0.40]) per week for men compared to women.

3.3. Happiness (satisfaction) with garden areas

Gardeners were more satisfied with their garden areas, than those who considered themselves non-gardeners ($P < 2 \times 10^{-16}$). Gardeners ($n = 5766$) claimed to be ‘somewhat to extremely happy’ with their front (60%, 95% CI [58.9, 61.4]) and back (77%, 95% CI [75.6, 77.8]) gardens, while the percentages for non-gardeners ($n = 249$) was 26% (front, 95% CI [20.8, 32.0]) and 35% (back, 95% CI [29.4, 41.6]), respectively.

The reported levels of happiness with one’s front garden was split by frequency of gardening and area rating (Fig. 5). The data suggested that the view on the area, and potentially gardening frequency, had an effect on how happy people were with their front-garden.

Since the response was on a Likert scale, to quantify the effect of our

explanatory variables on the level of an individual’s happiness with their front garden, an ordinal logistic regression was performed and, as described earlier, vegetation cover was added as a potential explanatory variable. After initial model fitting, there was no evidence that sense of community spirit had an effect on happiness with front-garden so this was dropped from the model. A chi-squared test provided overwhelming evidence that vegetation cover had an effect on happiness with the front-garden ($P < 10^{-15}$) (Fig. 6). For each additional 10% of vegetation cover, the odds of being more happy with one’s garden is multiplied by 1.26, i.e. increases by 26% (95% CI [1.22, 1.30]).

There was strong evidence that area rating ($P < 10^{-5}$) had a significant effect on happiness with the front garden and weak evidence that the frequency of neighbour favours ($P = 0.042$) also did. For those who perceived their area as ‘excellent’, the odds they were more happy with their front garden increased: by 1.18 times vs ‘good’ (95% CI [0.98, 1.41]), by 1.58 times vs ‘average’ (95% CI [1.18, 2.11]), by 4.68 times vs ‘poor’ (95% CI [2.57, 8.50]) and by 2.77 times vs those in ‘very poor’ areas (95% CI [0.75, 10.24]). Individuals living in areas where favours were ‘frequently’ performed were 1.37 (95% CI [1.07, 1.75]) times more likely to be happy with their front garden than those living in areas where favours occurred rarely, i.e. an increase of 37%.

After accounting for the proportion of vegetation cover, frequency of gardening had a weak effect ($P = 0.10$) on happiness with one’s front garden. Those who gardened more frequently having greater odds of being happier with their front garden. For an individual who gardened ‘daily’, the odds of being more happy with their front garden was: 1.22 times greater vs gardened ‘2–3 times a week’ (95% CI [0.92, 1.61]), 1.23 times greater vs ‘once a week’ (95% CI [0.92, 1.66]), 1.39 times greater vs ‘2–3 times a month’ (95% CI [1.00, 1.93]), 1.54 times greater vs ‘once a month’ (95% CI [1.06, 2.23]) and 1.90 times greater than those who ‘never gardened’ at all. (95% CI [1.12, 3.20]). Accounting for vegetation cover, area rating and frequency of gardening, there was little evidence

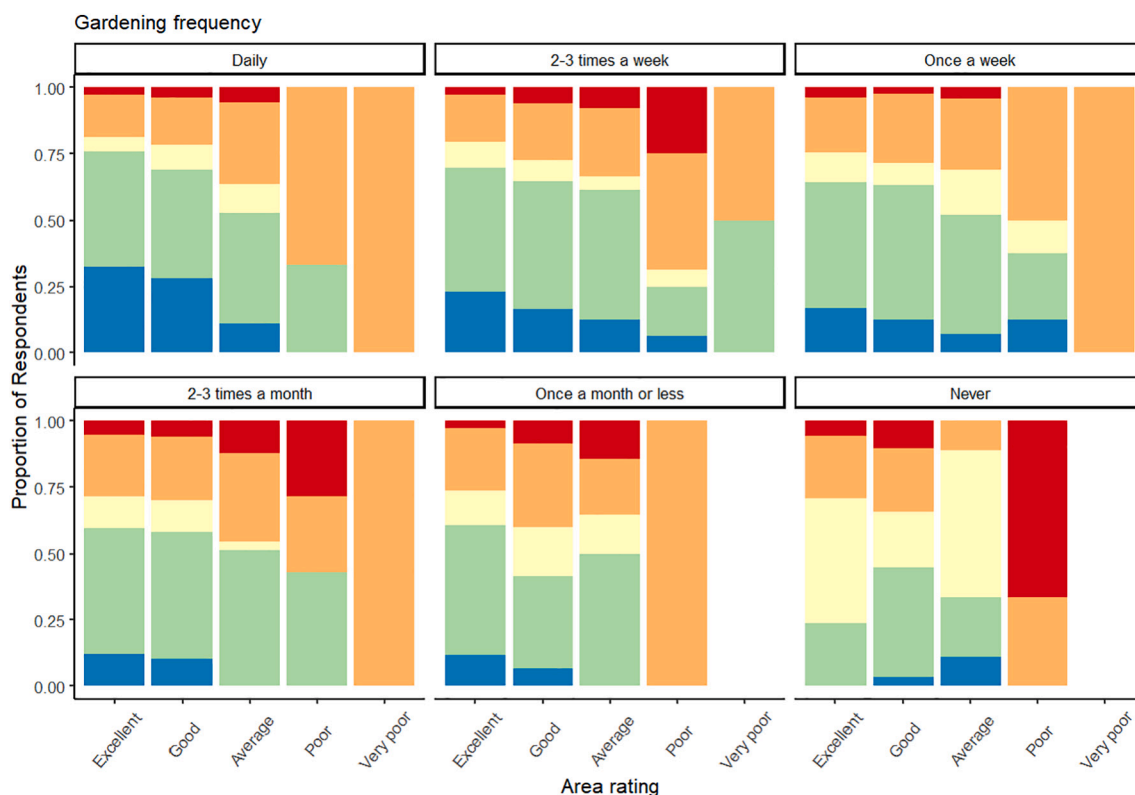


Fig. 5. Proportion of individuals in each category of front garden happiness (coloured bars) as affected by frequency of gardening and area rating. Colour of bars relate to level of happiness with front garden: Red (top bar) = extremely unhappy, orange = somewhat unhappy, cream = neither happy nor unhappy, green = somewhat happy and blue (bottom bar) = extremely happy. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

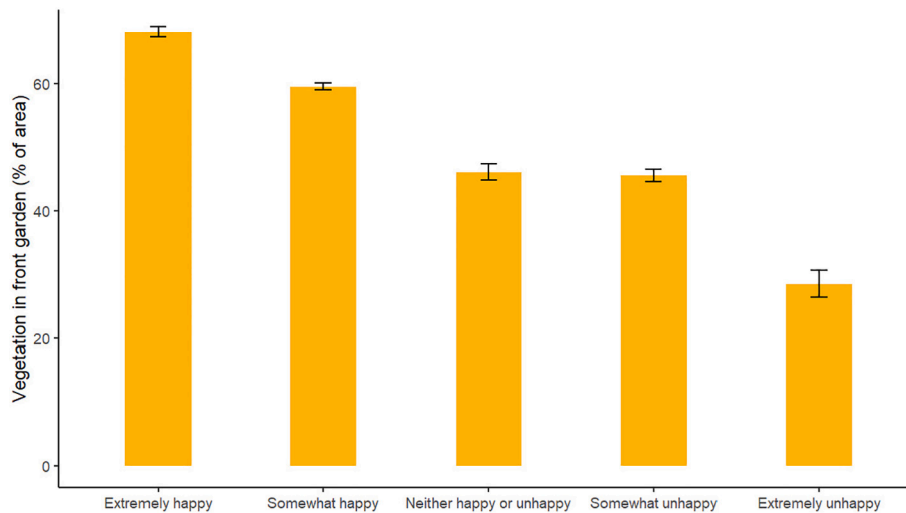


Fig. 6. Percentage of front garden vegetated and happiness rating for front garden. Bars = \pm standard error of mean.

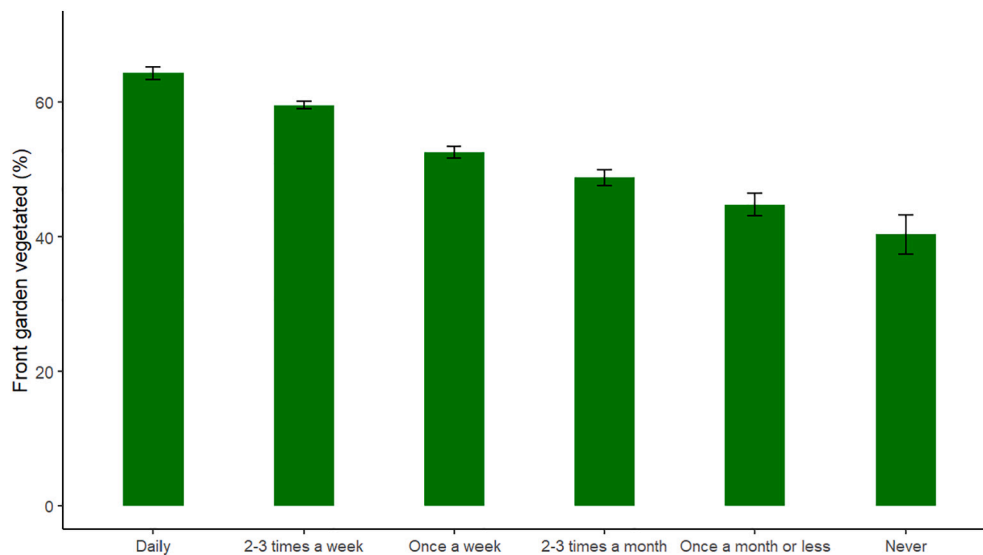


Fig. 7. Percentage of front garden that is vegetated and frequency of gardening. Bars = \pm standard error of mean.

that income, accommodation type, gender, or education had significant effects on how happy people felt about their front garden.

We noted that there was a relationship between frequency of gardening and the proportion of vegetation present in front gardens (Fig. 7) so these variables are somewhat co-linear. People who gardened more frequently tended to have more vegetation in their front garden; $F(5, 454.04) = 42.34, P < 0.01$, explanatory measure of effect size = 0.33. Significant increments in vegetation cover were recorded as frequency of gardening increased from ‘once a month’ (or less) to ‘2–3 times a month’ (5.64%, 95% CI [−3.24 to 14.52], $P = 0.04$); from ‘2–3 times a month’ to ‘once a week’ (4.58%, 95% CI [1.90, 11.07], $P = 0.03$), from ‘once a week’ to ‘2–3 times a week’ (7.67%, 95% CI [3.21, 12.13], $P < 0.01$) and finally from ‘2–3 times a week’ to ‘daily’ (7.08%, 95% CI [2.31, 11.85], $P < 0.01$).

3.4. Gardeners facing health barriers

One of the questions asked if health problems were a barrier to gardening and 40.5% of respondents (2436 people out of 6015) said health issues could impact on their ability to garden. A wide range of health issues were cited, but the most common were back-related,

arthritis and joint pain (Fig. 8). These same individuals were then asked whether conversely, they considered any aspects of gardening might be therapeutic. This population considered gardening was particularly good for providing; relaxation (20%), stress relief (16%), space for reflection (14%), help with episodes of depression (13%), physical exercise (13%), a sense of well-being (13%) and boosting energy levels (12%) (Fig. 9).

4. Discussion

4.1. Reasons to garden

The majority of participants were older adults, female, and they usually owned their own house (Appendix 2). Despite activities and attitudes to gardening sometimes being quoted as dividing down lines based on gender (Bhatti & Church, 2000), we saw few differences based on this, with perhaps the exception of men being more physically active. Pleasure and enjoyment were the most commonly quoted reason to garden (especially when ‘loving the activity’ and ‘enjoying seeing plants/flowers grow’ are added to this category – Fig. 1). Pleasure, joy and love of the activity have been identified as primary factors in other

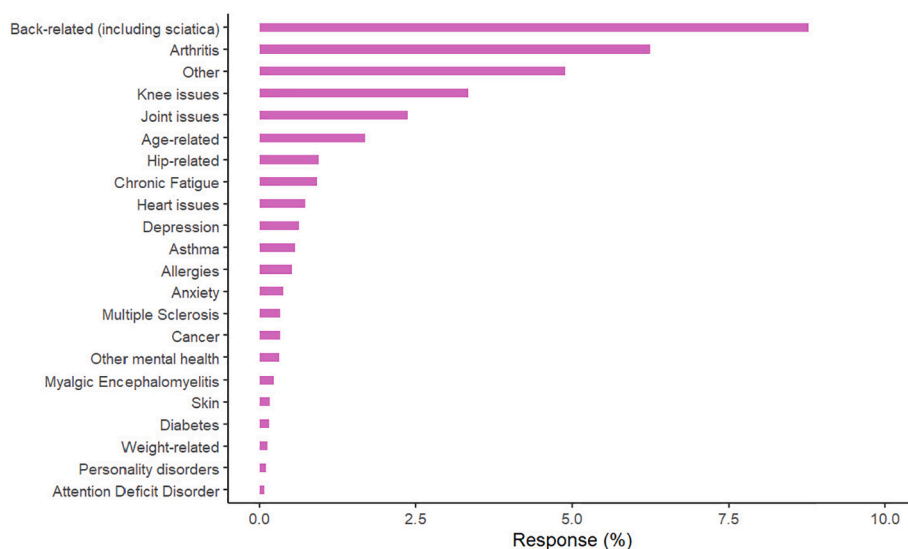


Fig. 8. Health-related barriers making it difficult to garden.

research, with the ability to view growing plants and flowers also being a notable motivator (Ashton-Shaeffer & Constant, 2006; McFarland et al., 2018). The data here indicated that being creative and having the opportunity for self-reflection was important to some people. There was also some evidence that the desire (or pressure) to keep the area well-maintained was a reason for others. Both these aspects support previous work by Clayton (2007).

Recent studies have suggested that health (as defined by restoration potential) could be a key motivator for gardening (Home & Vieli, 2020; Lewis et al., 2018). Home and Vieli (2020) ranked motivations in the order of restoration, socialization and food production and that these were consistent across two different contexts/cultures (Switzerland and Chile). Although health was not the primary motivating factors for people to garden in this study, many respondents recognised the health benefits of gardening. ‘Health benefits’ per se was a middle ranking factor, comparable to sensory reasons, expression of self-identity and the need to maintain the garden. It’s prominence as a reason to garden improves though if allied responses, i.e. ‘well-being’ and ‘calm and relaxing’ are included in as health benefits. Nevertheless, pleasure/joy seem to be the main reason people garden. These primary motivating factors may of course, have health benefits in themselves. Enjoying or loving your pastime is likely to lead to positive affect (Cervinka et al., 2016) and thus contribute to longer term health benefits, even if health per se is not the conscious reason for doing it.

Further work is required here, however, as the health benefits of green space can accrue for restorative processes (e.g. following the attention restoration theory; Kaplan & Kaplan, 1989; van den Berg & Custers, 2011) but also from positive affect (joy) (McMahan & Estes, 2015; Richardson, 2019) but the mechanisms differ somewhat. Previous studies on health benefits of domestic gardens (Home & Vieli, 2020; Lewis et al., 2018) have explained the response in terms of mental restoration (from stress or fatigue), but the data presented here aligns with recent work by Ambrose et al. (2020) and indicates that positive affect itself is acting as a prophylactic against poor health. In effect, you do not need to be stressed to gain a positive mental health benefit from gardening.

In contrast to the work of Home and Vieli (2020), social factors were not deemed a strong motivator factor in our study, perhaps reflecting some cultural difference or the way the gardens were being used in the UK. More likely, however, is that this relates to the way questions were presented, i.e. “why do you garden?” vs “what do you use your garden for?” The latter being more likely to elicit responses around recreation, play and socialising. A point Home and Vieli (2020) recognise:

“The social component is different to the other components in that it is not strictly dependant on the interaction with the garden itself but rather that the garden provides a location for the activity”.

With the possible exception of motivating factors such as enjoying fresh air/being outdoors, being close to/supporting nature or for sustainability reasons (middle ranking motivations) we saw no strong links between the wider environmental ecosystem services associated with gardens and health. In essence, people were not gardening to specifically protect their health from e.g. the impacts of flooding, excess heat or poor air quality. This may be due to a lack of awareness within the public around the benefits of gardens, gardening and garden plants in this regard (Breuste & Artmann, 2015; Cameron & Blanus, 2016; Langemeyer et al., 2016; Chalmin-Pui et al., 2019); or if such benefits are acknowledged, they are not primary drivers for people to engage with gardening.

4.2. Gardening and health outcomes

Our second question was to determine relationships between gardening and health benefits as expressed as self-reported data on well-being, perceived stress and physical activity. Significant improvements in well-being, reductions in perceived stress and greater physical activity were all strongly associated with more frequent gardening (Table 2, Figs. 2–4). For someone who gardened daily, compared to an individual who did not garden at all, well-being scores were 1.84 higher, stress scores 1.68 lower and they were more physically active by 1.42 days a week. Both the act of gardening (Adevi & Mårtensson, 2013; Cervinka et al., 2016; Stigsdotter & Grahn, 2004) and having a greater proportion of vegetation around the domestic property (Chalmin-Pui et al., 2020) have previously been linked with reduced stress in residents. Moreover, the data collected here indicates more frequent gardening is linked to greater physical activity (Fig. 4), supporting the notion that regular gardening supports physical/physiological health as well as benefits mental health. Gardening has been linked with greater physical fitness previously (Machida, 2019), but as far as we are aware this is the first report of a ‘dose-response’ with respect to frequency of gardening improving resident’s well-being and stress reduction. Increments on self-reported health were clearly evident as gardening increased to 2–3 times a week, and then again when frequency increased to daily (Table 2).

A number of health issues were seen as barriers to gardening, most notably pain relating to the back, knees, other joints and arthritis in general. A small number of correspondents cited depression and anxiety

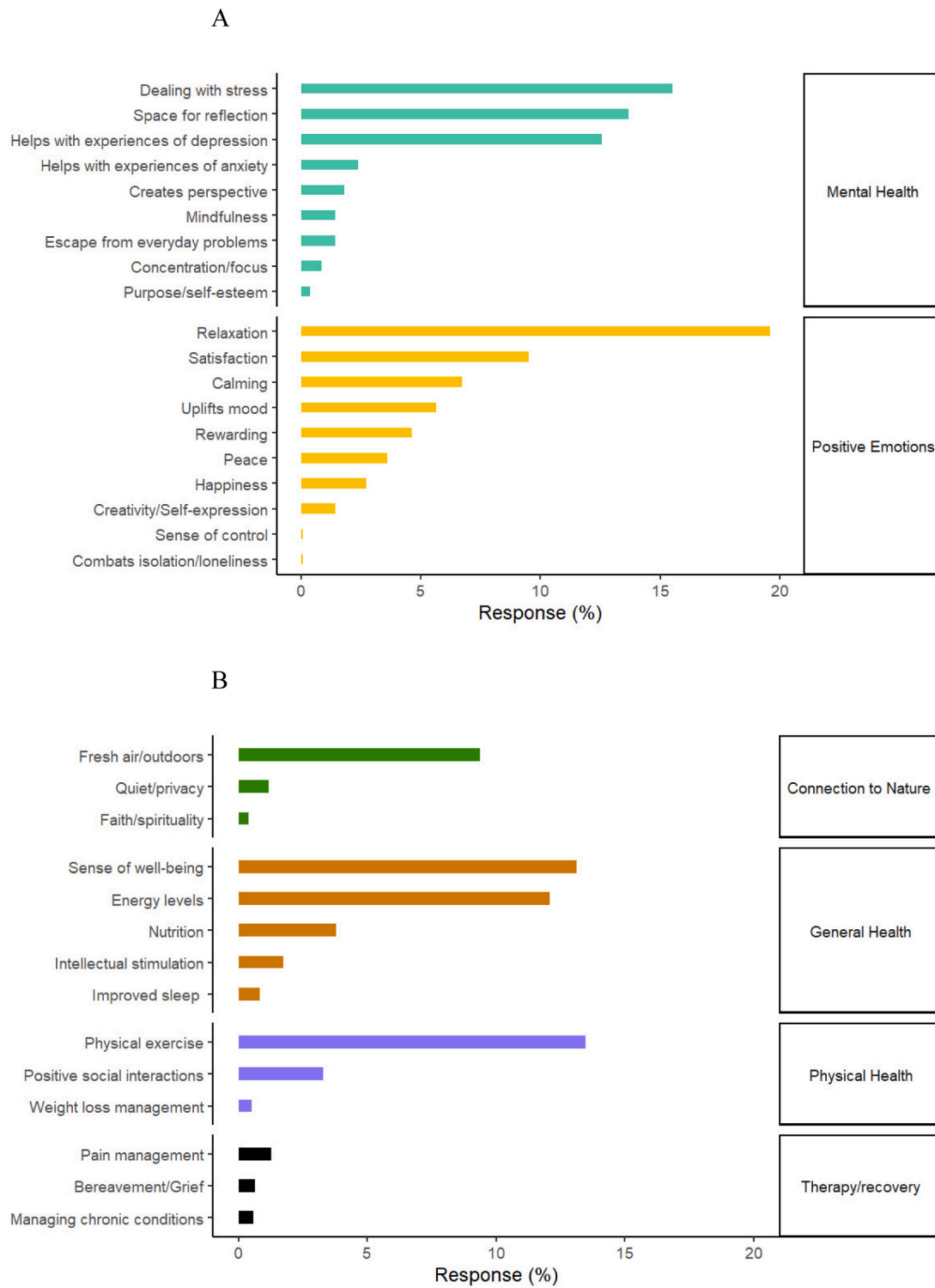


Fig. 9. People expressing health problems who also considered gardening as therapeutic (%). Specific points being grouped into larger categories of A = positive emotions, mental health and B = therapy and recovery, physical health, connections to nature and general health.

as inhibitors to gardening. Of gardeners who cited health problems, they also stated that gardening could help with health related issues. Gardening was again seen as a rewarding activity in terms of providing positive emotions, especially relaxation, calming effects and a degree of satisfaction. Strong responses were given for the benefits associated with dealing with stress and depression, and providing an opportunity for reflection and a sense of well-being. Its help in maintaining/promoting physical exercise was also noted by 14% of respondents. Ashton-Shaeffer and Constant (2006) and Wang and MacMillan (2013) also suggested that for people with health issues, the opportunity for physical exercise and keeping fit, was an important consideration to take up/maintain gardening.

4.3. Neighbourhood factors and health outcomes

Other factors associated with our sample population were also shown to be important to health. Both well-being and perceived stress scores were affected by perceptions of the local neighbourhood and community relations as well as influenced by accommodation type, age and income. Health benefits tended to decrease as participants had more negative ratings about both their neighbourhood and sense of community spirit. A very poor sense of community spirit was associated with large drops in well-being (2.26 points less) and increases in perceived stress (3.13 points more) compared to those who considered their location to have an excellent community spirit. Health scores tended to be lower for those living in flats, those on lower income and residents over 75 years of age. Much of this data reflects trends in the national population as a whole (Gardener & Lemes de Oliveira, 2020).

4.4. Proportion of green space and satisfaction with the front garden

Satisfaction (happiness rating) with the front garden increased markedly, as the proportion of vegetation increased. Burton et al. (2015) suggested that increasing the proportion of vegetation within a garden could improve well-being. We found an indirect link in this study to support this theory. As a greater proportion of front gardens were covered with plants, the frequency of gardening increased correspondingly. As discussed above, large improvements in well-being and reduced perceived stress were also associated with more frequent gardening. If greater green space is encouraging more frequent gardening, this may have a positive ancillary effect on physical fitness and other aspects of health. Alternatively, having views out of the front of the house which have a higher component of green space, may also be seen as providing greater mental restoration directly (Chang et al., 2020; Korpela et al., 2017).

There was an inter-relationship between satisfaction with the front garden and wider perceptions of the neighbourhood (this latter factor also being linked to health). People who viewed their neighbourhood in a positive way, also had greater satisfaction with their front garden. This inter-relationship between the private front garden and the public landscape out-with the properties' boundaries warrants further research attention. Gardens may be a component in determining wider place attachment (Korpela, 2012), or conversely, health and social benefits associated with carefully maintained front gardens may be undermined by poorly managed or non-welcoming neighbourhoods.

4.5. Gardens and planning policy

Data reported here (albeit from a population dominated by gardeners) indicates the strong value people place in their gardens and gardening – a major source of joy, engagement and opportunity for self-reflection. Moreover, although not necessarily a major motivating factor, the data suggests a clear indication that regular gardening can reduce stress and improve well-being. Thus this data challenges the concept that gardens should be given low priority when providing green space in new urban developments (Douglas et al., 2019; Haaland &

Konijnendijk van den Bosch, 2015), or that they can be sacrificed via infill with the increased densification of our cities (Ross, 2015; Wellmann et al., 2020). Furthermore, there is a relationship between front gardens and wider appreciation of the neighbourhood, including components relating to scale and type of green space (Twedt et al., 2016; van Dongen & Timmermans, 2019). This needs further exploration, but overall impacts on neighbourhood satisfaction, also relate to self-reporting on improved well-being and reduced stress. More research is required on how green space and their typologies (either private or public) within the proximity of the house, affects attitudes to the neighbourhood, and in turn can influence well-being.

4.6. Contextual components

Context may also be important in our study; our data was collected in 2016–2017 and was not correlated with any particular atypical health or societal concern. In contrast in 2020, a global pandemic caused by the COVID-19 virus, increased people's concern about health, and radically altered social behaviour. For example, social isolation policies in the UK and elsewhere, resulted in more citizens staying at, and working from, home. This corresponded in a rapid and wide-spread increase in interest in domestic gardening (Wood & Partridge, 2020). The precise motivations for this are unclear, but anecdotally have been linked to: enhancing positive affect and well-being (gardening was ranked third out of the 24 most popular activities; Lades et al., 2020), a desire to procure food (Walljasper & Polansec, 2020), the capacity to reduce anxiety and stress and residents 'having more time on their hands' (Sofo & Sofo, 2020). Thus further research is warranted to better understand how a major health concern (or social change) might impact on the motivations to garden.

4.7. Limitations to the study and recommendations for future research

The study drew in a large population of dedicated gardeners, and although the structure of the data and paper reflects this, it needs to be further acknowledged that such a population are likely to be more positive and vocal about the benefits of gardening from a health or social perspective. A response from a similarly sized cohort with only a limited or tangential interest in gardens would make a useful comparison. Interestingly though, the data does augment previous studies from this group which focussed on a largely non-gardening population yet also found health benefits associated with the presence of new garden plants (Chalmin-Pui et al., 2020). Demographics are also strongly skewed to older adults and women too, and further studies are merited on younger generations, for example those who have just purchased or started renting a house with a garden. The promotion of the questionnaire was largely restricted to UK based organisations (and the questionnaire was in English only). As such the results will tend to be representative of western industrialised countries only, where ornamental garden styles tend to be more common. Thus, further research is warranted in those locations and cultures where home food production is the main rationale and where interpretations and the links to health may differ (Davoren et al., 2016). For ethical reasons, we stated clearly what the questionnaire was about (Do gardens influence health and well-being?) but we acknowledge that the title itself might imply some positive link or *suggest/infer* cause and effect to the respondents. This may have lead some respondents to give more consideration to health aspects than they normally would, and perhaps cause some bias in the results. Finally, our data did not investigate duration of gardening on a daily basis, or how duration and frequency varied over the calendar year. This are also likely to impact on perceptions of health.

5. Conclusions

This research sampled a population of UK residents via targeted websites (e.g. RHS, BBC etc.), the majority of whom expressed some

interest in gardening, but also included non-gardeners. The data showed that more frequent gardening (i.e. 2–3 times per week) corresponded to reductions in perceived stress, increased subjective well-being and increased self-reported physical activity levels. The results are novel in that we observed a ‘dose’ effect with the perceived health benefits increasing in line with frequency of gardening activities. As gardening is undertaken by about 25–50% of adults in a wide range of countries (e.g. Home & Vieli, 2020; Kiesling & Manning, 2010; Reyes-Paecke & Meza, 2011), it has considerable implications for maintaining and improving health levels in an increasingly sedentary urban population. Policy makers and planners need to better appreciate the contribution of residential home gardens to citizen’s health, as well as other positive contributions to urban ecosystem services (Cameron & Blanusa, 2016; Camps-Calvet et al., 2016; Hand et al., 2017), when evaluating different typologies of green space. Based on this data some of the assumptions about future housing policy (which limits the extent of green space within the proximity of the domestic dwelling, Burton, 2002; Bibby et al., 2020) needs to be challenged. The data also supports the notion that home gardening, could have potential as a specific health intervention in its own right, for example, within eco-therapy or green/social prescription programmes (Robinson & Breed, 2019). Although health benefits are an important component of gardening, our data shows that health per se is not the main motivating factor for gardening, and that joy, pleasure and aesthetics are greater drivers to engage with this pastime. More information, is thus required on why people become interested in gardening and whether the benefits could be translated to other, currently less-engaged, sections of society.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Ethical considerations

The research project was compliant with the UK Data Protection Act (1998) and was approved by the University of Sheffield Research Ethics Committee.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cities.2021.103118>.

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