

## Original article

# Urban organic community gardening to promote environmental sustainability practices and increase fruit, vegetables and organic food consumption



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## ABSTRACT

**Objective:** To describe the environmental practices of participants in an urban organic community garden at the beginning of their gardening experience and after a period of six months, and to discover their opinion about how this activity influenced the consumption of vegetables, fruits and organic food.

**Method:** Interviews using structured questionnaires were conducted twice with 115 city dwellers: when they started in the vegetable garden and about 6 months later. The questionnaire included questions related to environmental practices. The second evaluation also included questions related to the consumption of organic food, vegetables and fruit.

**Results:** This research showed significant behavioural transformation, including positive outcomes in environmental practices such as recycling and trying to persuade friends or family to recycle, compost leftovers or choose to walk/bike to save petrol. In the opinion of the participants, activities in the organic community garden helped to increase consumption of fruits, vegetables and organic food.

**Conclusion:** The study results reinforce the hypothesis that an organic community vegetable garden can induce significant, positive behavioural changes among its users. In particular this research suggests horticulture is associated with positive improvements in personal environmental behaviours, awareness of the environment's high social priority and increased consumption of organic food, fruit and vegetables.

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## Prácticas agrícolas ecológicas urbanas para promover la sostenibilidad ambiental y aumentar el consumo de frutas, verduras y alimentos orgánicos

## RESUMEN

**Objetivo:** Caracterizar las prácticas ambientales de los participantes de un jardín comunitario orgánico urbano al inicio de su experiencia en prácticas agrícolas y después de 6 meses, así como conocer su opinión sobre cómo esta actividad influyó en el consumo de verduras, frutas y alimentos orgánicos.

**Método:** Las entrevistas con cuestionarios estructurados se realizaron dos veces a 115 habitantes de la ciudad: cuando comenzaron en la huerta y unos 6 meses después. El cuestionario incluyó preguntas relacionadas con las prácticas ambientales. La segunda evaluación incluyó también preguntas sobre el consumo de alimentos orgánicos, verduras y frutas.

**Resultados:** Se observó una transformación conductual significativa, incluidos resultados positivos en prácticas ambientales como el reciclaje e intentar que amigos o familiares reciclen, la composta de sobras o elegir caminar o ir en bicicleta para ahorrar gasolina. En opinión de los participantes, las prácticas agrícolas de la comunidad orgánica contribuyeron a aumentar el consumo de frutas, verduras y alimentos orgánicos.

**Conclusión:** Los resultados del estudio refuerzan la hipótesis de que un huerto comunitario orgánico puede inducir cambios conductuales significativos entre sus usuarios. En particular, esta investigación sugiere que la horticultura se asocia con mejoras positivas en los comportamientos ambientales y la conciencia de la alta prioridad social del medio ambiente y un mayor consumo de alimentos orgánicos, frutas y verduras.

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### Palabras clave:

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## Introduction

The way in which most cities have grown, characterized by heavy air and water pollution, lack of green spaces, large energy consumption, unsustainable waste production, long distance industrialized food chains and an overall disproportionate footprint has led to a number of public health issues.<sup>1</sup> As such, measures ensuring improved urban environmental management have become imperative.<sup>2</sup>

The importance of appropriate urban green spaces was formally recognized for the first time at European level in 1990, when the European Commission published the *Green Paper on the Urban Environment*.<sup>3</sup> In this report the main environmental problems are pointed out and strategies outlined for the achievement of urban sustainability. Since then several agreements and documents (such as the United Nations' Agenda 21, the Aalborg Commitments and the Leipzig Charter) have advanced social reflection, particularly with regard to urban sustainability –where the planning of attractive and multifunctional public spaces takes center stage.<sup>4,5</sup>

Nevertheless, despite some progress, the much sought after urban sustainability is far from guaranteed.<sup>6</sup> Urban agriculture is one of the pieces in that puzzle that must not be underestimated, being a source of nearby healthy and diversified food.<sup>7</sup> In addition, it doubles as a green zone, contributing to the broader environmental and social balance. Green spaces help regulate greenhouse gases, promote noise reduction, balance rainwater drainage (preventing floods), lessen the organic waste going to landfills, preserve soil and biodiversity, regulate the local temperature and even impart cultural and green values.<sup>8</sup>

On another level, local agriculture brings additional food security to urban deserts where poverty, economic crisis or social instability lead to hunger or at least little access to fresh fruits and vegetables. Self-production can make the difference between life and death. Organic urban gardens can also increase the availability of fresh and natural food. This increase could be beneficial to public health since it naturally favors its consumption.<sup>9,10</sup>

This type of agriculture also has a pedagogical role in enabling the urban population to make contact with the basis of its survival influencing its practitioners to a greater importance of preserving the environment like carrying out practices more environmental friendly.<sup>11</sup>

In short, urban gardening enhances both the human and the ecological dimensions of cities across the world.<sup>7</sup> Recent projects across Europe are aiming at improving urban spaces by striking a balance between urban needs and sustainability, building bridges from food deserts to biodiversity through the green economy.<sup>12,13</sup>

Further, urban horticulture is a recent phenomenon in Portugal and its impact in different dimensions was not yet studied. In fact, this is the first study that aims to evaluate the impact of organic urban gardens in environmental practices and consumption of vegetables, fruit and organic food in the country. Research elsewhere shows promising results regarding the influence of urban gardens on several issues related with health, quality of life, education and environmental sustainability.<sup>14–20</sup> Promising results in Portugal would contribute to the reinforcement of the role these structures play in public health decisions and to their expansion along the urban territory.

The objectives of this study were to characterize the environmental practices of participants of an urban organic community garden at the beginning of their gardening experience, as well as to evaluate the impacts of the gardening activity on those dimensions and on opinions towards organic food and fruit and vegetables consumption after a six-month involvement.

## Methods

### Study design

This research was conducted in an urban organic community garden established right before the beginning of the study. The area is part of a mental hospital's larger grounds and sits right in the middle of Porto, Portugal's second largest city. This project was made possible by a private institution that aims to expand urban gardens across the country. Only a small annual fee is asked. The institution provided full access to the urban garden facilities and made easier the contact with the participants. The criteria for plot attribution were: being a hospital worker or a resident in the surrounding neighborhoods. All the participants received basic training on planting and composting and a composter was made available for each plot.

The first evaluation took place between July and October 2015, at the moment people were starting their horticultural activity. Follow-up occurred between May and August 2016. The interval between evaluations ranged between six and twelve months, with two thirds of respondents re-evaluated eight to ten months after the initial contact.

The Ethics Lab of Católica Porto Institute of Bioethics Committee and the Institutional review board approved this study (ERS number: 10/2015).

### Participants

All plots were visited and their users were invited to participate in the study. Contacts were attempted on at least three different days and on at least three different times of the day (morning, afternoon and evening). If gardeners were not available during these attempts they were contacted by phone, again at three different times of day and on three different days (contacts were supplied by the institution in charge of garden management, who is a partner in this study). Those that still were not reached after all these attempts were excluded. Of those contacted, one person declined to be enrolled in the study. Of the 116 users of the urban organic community garden a total of 115 people opted in.

Of the initial 115 participants, 102 (88.7%) were followed-up. The 13 participants who dropped out (five gave up horticulture and eight remained unavailable) were compared with the remaining regarding their sociodemographic characteristics (age, sex, educational level and professional status), experience in horticulture and motivation to start the garden care project. No statistically significant differences were found between the two groups for any of the variables considered.

### Data collection

Data was collected using semi-structured questionnaires. These were always applied by the same researcher and during face-to-face or phone call interviews. The initial questionnaire included socio-demographic parameters and improved environmental sustainability practices (inspired by the Portuguese version of New Ecological Paradigm Scale, with an added focus on urban living). Evaluation was carried out by presenting horticulturists with a list of environment related activities and asking how often they had engaged in such practices in the previous 12 months. Professional activity data were aggregated based on the Portuguese Job Classification by the National Statistics Institute.<sup>21</sup> The questionnaire applied at the second evaluation included all the parameters previously described (with the exception of personal data) and added a final chapter on perceived gardening impacts. It also assessed participants' opinions regarding savings in produce purchases, increased organic food use, increased fruit and vegetables

**Table 1**  
Environmental sustainability practices.

	Initial evaluation, n = 102 n (%)			Final evaluation, n = 102 n (%)			p
	Very often or often	Sometimes	Rarely or never	Very often or often	Sometimes	Rarely or never	
I looked for ways to reuse things	33 (32.4)	26 (25.5)	43 (42.2)	56 (54.9)	30 (29.4)	16 (15.7)	<0.001
I sorted paper for the recycling bin	31 (30.4)	34 (33.3)	37 (36.3)	72 (70.6)	17 (16.7)	13 (12.7)	<0.001
I sorted packages for the recycling bin	31 (30.4)	34 (33.3)	37 (36.3)	72 (70.6)	17 (16.7)	13 (12.7)	<0.001
I sorted glass for the recycling bin	31 (30.4)	34 (33.3)	37 (36.3)	67 (65.7)	22 (21.6)	13 (12.7)	<0.001
I tried to have friends / family sort materials for recycling	7 (6.9)	15 (14.7)	80 (78.4)	20 (19.6)	21 (20.6)	61 (59.8)	<0.001
I bought products in recyclable or reusable packaging	13 (12.7)	17 (16.7)	72 (70.6)	20 (19.6)	35 (34.3)	47 (46.1)	0.002
I picked trash from the ground that was not mine	3 (2.9)	22 (21.6)	77 (75.5)	16 (15.7)	11 (10.8)	75 (73.5)	0.038
I composted leftovers	3 (2.9)	13 (12.7)	86 (84.3)	101 (99)	1 (1.0)	0 (0.0)	<0.001
I choose to walk or bike to save gas	5 (4.9)	10 (9.8)	87 (85.3)	20 (19.6)	17 (16.7)	65 (63.7)	<0.001
I wrote a letter or signed a petition concerning an environmental issue	1 (1.0)	2 (2.0)	99 (97.1)	2 (2.0)	10 (9.8)	90 (88.2)	0.008
I voted for a candidate or party that supports the environment	0 (0.0)	0 (0.0)	102 (100)	7 (6.9)	6 (5.9)	89 (87.3)	0.001
I made a donation to an environmental group	0 (0.0)	4 (3.9)	98 (96.1)	1 (1.0)	9 (8.8)	92 (90.2)	0.717
I volunteered to help a green activity or environmental group	0 (0.0)	4 (3.9)	98 (96.1)	3 (2.6)	8 (7.0)	91 (89.2)	0.025

consumption and improved environmental sustainability practices. Both questionnaires were prepared specifically for this study.

#### Data analysis

Categorical variables were described by their absolute (n) and relative (%) frequencies. In order to evaluate the normality of the distribution of continuous variables the Kolmogorov-Smirnov test was used. For the comparison of the same variable between the two moments of evaluation, in cases where the variable did not follow the normal distribution, the Wilcoxon test was used for the comparison of ordinal and continuous variables or comparison between an ordinal and continuous variable. An analysis of the impact of exposure duration on environmental sustainability practices and participants perceptions was also performed. For this comparison we divided the participants into two distinct groups: those that invested up to 3 hours a week and those who gardened for more than 3 hours a week.

A significance level of 5% was used for all statistical tests.

Statistical analysis was performed using the IBM SPSS STATISTICS 23 software for Microsoft Windows.

## Results

#### Sample characterization

The sample consisted mainly of females (57.8%) and had a mean age of 53 years (minimum 24 and maximum 77 years). A large proportion of the participants was married or had live-in relationships and, in some cases, also had children. The educational level of the sample was high, with 52.0% of the participants holding higher education degrees and 23.5% secondary education degrees. The majority of the participants were from Porto (96.1%). The remainder resided in Matosinhos (2.9%) and Maia (1.0%), two cities very close to Porto.

Regarding occupation, the sample was mainly composed of “specialists in intellectual and scientific activities” (39.2%) and “technicians and professionals of intermediate level” (22.5%). Regarding the professional status, about half of sample was

employed (48.0%) and a high proportion was retired and/or disabled (38.2%). When interviewed about household income, an equal proportion of respondents stated that “current income is enough” or that “it is very difficult to live on current income” (31.4%) (options supplied in the questionnaire).

Only 36.3% of the participants reported having experience in horticulture prior to their start at the garden in question. At the moment of entering the study the majority of respondents (51.0%) had been gardening at the site for a maximum of three months. However, 25.5% had started just one week prior to the first interview.

#### Environmental sustainability practices

For all parameters related to environmental sustainability practices, with the exception of “I made a donation to an environmental group”, significant improvements were registered between the initial and final evaluations. In particular, regarding to composting and glass recycling, the proportion of participants who reported doing this often or very often more than doubles from the first to the second evaluation.

It is also important to note that 10 individuals who never had “looked for ways to reuse things”, 21 individuals who never had “tried to have friends/ family sort materials for recycling” or “bought products in recyclable or reusable packaging”, 17 individuals who never had “picked trash from the ground that was not mine”, 33 individuals who never had “choose to walk or bike to save gas” and 18 individuals who never had “volunteered to help a green activity or environmental group” started doing this practices during the period of time between both interviews. The results are shown in [Table 1](#).

#### Participants opinions regarding the benefits stemming from horticulture

The participants emphasized in a practically consensual way the influence of horticulture on increase of organic food use, increase fruits and vegetables consumption and improve environmental sustainability practices responding in the vast majority that perceived immense or a lot the influence of horticulture on these

**Table 2**  
Participants opinions regarding the benefits stemming from horticulture.

	Evaluation, n = 102 n (%)
<i>Savings in produce purchases</i>	
Immense or a lot	16 (15.7)
Moderately or little	62 (60.8)
Anything or cannot tell	24 (23.5)
<i>Increased organic food use</i>	
Immense or a lot	82 (82.4)
Moderately or little	20 (19.6)
Anything or cannot tell	0 (0.0)
<i>Increased fruit and vegetable use</i>	
Immense or a lot	97 (95.1)
Moderately or little	5 (4.9)
Anything or cannot tell	0 (0.0)
<i>Improved environmental sustainability practices</i>	
Immense or a lot	86 (84.4)
Moderately or little	16 (15.7)
Anything or cannot tell	0 (0.0)

aspects of their lives. With regard to savings in produce purchases the participants stated that they felt a moderately to little savings. The results are presented in [Table 2](#).

#### *Impact of exposure duration on environmental sustainability practices and participants perceptions*

In order to understand whether dedicating more time to vegetable gardening enhanced green practices, participants were divided into two distinct groups: those that invested up to 3 hours a week and those who gardened for more than 3 hours a week. The first group consisted of 42 gardeners (41.2%) and the second group of 60 (58.8%). Statistically significant differences were only found for the “I composted leftovers”, where the longer stays group doing it “very often” in 93.3% of cases, as opposed to 71.4% for those working lesser hours.

With regard to participants' perceptions, it was observed that those who spent more time on horticulture were able to save more and were more influenced in the consumption of organic foods. Regarding the other parameters, no significant differences were found. However, it is possible to observe higher frequency values in the group that spends more than 3 hours per week. The results are shown in [Table 3](#).

**Table 3**  
Impact of exposure duration on environmental sustainability practices and opinions towards aspects related to organic food, fruit and vegetables consumption.

	Up to 3 hours a week, n = 42 n (%)	More than 3 hours a week, n = 60 n (%)	p
<i>Savings in produce purchases</i>			
Immense or a lot	3 (7.5)	13 (22.0)	0.016
Moderately	12 (27.5)	21 (35.6)	
Little or anything	27 (65.0)	25 (42.4)	
<i>Increased organic food use</i>			
Immense or a lot	29 (69.0)	53 (88.3)	0.011
Moderately	9 (21.4)	7 (22.7)	
Little or anything	4 (9.5)	0 (0.0)	
<i>Increased fruit and vegetable use</i>			
Immense or a lot	41 (97.6)	56 (93.3)	0.345
Moderately	0 (0.0)	4 (6.7)	
Little or anything	1 (2.4)	0 (0.0)	
<i>Improved environmental sustainability practices</i>			
Immense or a lot	35 (83.3)	51 (85.0)	0.783
Moderately	6 (14.3)	9 (15.0)	
Little or anything	1 (2.4)	0 (0.0)	

## Discussion

The present study suggests that the practice of urban organic community gardening is associated with improvement in personal environmental behaviors and overall environmental awareness. Participant's consumption of organic food and fruits and vegetables also showed improvement. Interestingly, extra gardening time was not associated with better outcomes for most of the angles considered.

The study was carried out in an urban organic community garden where the majority participants were professionally active, educated, middle-aged women. This specific profile can be understood through the criteria used for allocating plots, which gives priority to those working at the hospital on whose grounds the garden is located. This proximity allows for increased presence and gardening effort.

The questionnaire focused on environmental practices commonly available in cities (such as sorting domestic waste for recycling). This approach proved effective as remarkably positive changes could be measured. To the best of the authors' knowledge this is the first time that urban gardening exposure has been shown to influence specific green practices of an adult sample.

Previous research suggests that “improving the environment” is a crucial aspect of participants towards horticultural activities, particularly as regards aesthetic and ecological values. Hence horticultural activities are beneficial not only for the participants but also for the environment.<sup>15</sup> Our research goes one step further, uncovering the positive impact on specific environmental practices such as recycling and trying to have friends or family recycle, compost leftovers or choose to walk/bike to save gas. It's also important to note that the production of organic food in community gardens increases its consumption among participants, which can positively impact on health of the population and the environment, due to the reduction in the use of pesticides.

A correlation between an increased connection with nature by environmental volunteers and improved green practices, environmental awareness and responsibility was previously described in the literature. Participants reported that they had not incorporated these practices previously mostly because of “never really having thought about it”.<sup>22</sup> Gardening being one way of (re)discovering nature, it is to be expected at least some level of influence. Our research shows the connection is in fact broad and encouraging. These results open new paths for public health since exposure to urban organic community gardens could boost citizen engagement in more environmental friendly practices.



From a public health perspective, it is equally noteworthy that research shows urban gardening seems to complement not just environmental education and conservation objectives but also health and wellbeing goals. The potential of urban and community biological gardens as an educational tool has been studied in children in a school environment and, similar to the present research, has registered positive results. Researchers have found an increase in consumption of fruits and vegetables as well as changes in behaviors and attitudes towards these foods in children exposed to gardening.<sup>14,23</sup> Other studies have associated the practice of horticulture by children with improvements in social interaction with interesting results. Gardening could promote positive outcomes in social inclusion with respect to gender, social class, race and ability and improve self-understanding, interpersonal and cooperative skills.<sup>24,25</sup> In addition, other studies have shown that children exposed to horticulture also improve their academic performance, exhibiting a more positive attitude towards learning and education.<sup>26</sup> Despite the differences in sociodemographic profile, these results also point to the fact that exposure to urban community gardening is an excellent multilevel educational tool.

Adult samples also show encouraging results. Several studies have detected improved outcomes in physical activity, food and nutrition intake, mental and physical health, social skills, pain and smoking habits.<sup>16–20,27</sup> In a world with so many physically and mentally debilitating chronic diseases, the active inclusion of organic gardens into urban planning could become part of the solution. The implications for public health are promising and profound. Urban organic gardens could provide availability and influence the consumption of healthy food, more green space in cities and be part of the answer to counter negative trends imposed by urbanization.

During our face to face interviews one dimension that emerged clearly was the constant exchange of knowledge among participants, who discussed among themselves the most diverse aspects of the trade –from the preparation of the soil to the productivity of each species and variety. The lack of prior gardening knowledge of the participants ended up promoting their socialization, in addition to the horizontal transfer of know-how and experience. Hence a new community is created that likely elevates the group's environmental awareness level through contamination. Further research should explore the actual dynamics.

Environmental awareness has proven to be one of the hallmarks of the horticultural experience. Recycling practices clearly showed improvement. Also, a drastic improvement in composting practices could be measured –a trend most likely prompted by the fact that a composter was made available for each plot free of charge. Solid waste management it's a big public health concern, in fact the by-products of an urban lifestyle are increasing even faster than urbanization.<sup>28</sup> The last report from the World Bank Group says that world cities generate about 1.3 billion tons of solid waste/year and by the year 2025 this volume is expected to increase to 2.2 billion tonnes.<sup>28</sup> The same happens with organic waste with an estimated volume of 38 billion metric tons produced worldwide.<sup>29</sup> Since waste growth is an inevitable consequence of human urbanization there's a need to find solutions to counter such environmental and public health concerns. As we show in this investigation urban organic gardening could really be a big part of the answer by influencing recycling practices and given the opportunity to compost leftovers.

The influence of vegetable gardening on political optics and action could not be established as there were no elections in the year preceding the first evaluation. This parameter is not always easy to evaluate due to the time in between elections (usually 4 years). However social intervention (as in volunteering) was

clearly improved. It is possible the horizontal transfer of knowledge among the garden colleagues encouraged such changes.

Some methodological aspects in this study contribute to data reliability. Both assessments were carried out during gardening appropriate months: the first during summer/early fall and the second at springtime. Also, there were very few losses: almost all gardeners initially registered were available at follow-up as well. And because the questionnaire was prepared specifically for this study (and there was a single researcher collecting data) the before and after comparison was made that much easier.

Nevertheless, the possibility that some of these results may be slanted due to information bias cannot be ruled out, since the participants, knowing the objectives of the study, may have tried to fit in with the researcher's expectations. In addition, the evaluation period was short. It could happen that the gardening commitment decreases in the long term, at least with some people. It should also be noted that the sample studied, because of its profile, is not necessarily representative of other community gardens. These characteristics will certainly influence levels of motivation, expectations and the ability to improve self-behaviors.

## Conclusion

Study results reinforce the hypothesis that an organic community vegetable garden can induce significant positive behavioral changes among its users. In particular this research suggests horticulture is associated with positive improvements in personal environmental behaviors, awareness of the environment's high social priority and increased organic food, fruit and vegetables consumption.

## Editor in charge

Carlos Álvarez-Dardet.

## Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

### What is known about the topic?

The negative ecological and public health implications of a growing urbanization in society lead to the search for policies aimed at improving quality of life, environmental sustainability and citizen health. Urban vegetable gardening is one of the tools available to local and state governments where little funding can go a long way.

### What does this study add to the literature?

This work opens important paths for public health. Urban gardening exposure has an immense untapped potential to bring improved environmental behavior to city dwellers. Our results bring detail into the advantages of introducing this type of infrastructure into urban planning. We found positive outcomes in environmental practices such as recycling, talking friends and family into recycling, composting leftovers or choosing to walk/bike to save gas.

## Authorship contributions

P. Nova: collection, analysis and interpretation of data; design and study conception; writing of the manuscript. E. Pinto: design and study conception; critical revision of the study and approval of the final version of the article; study coordination; writing of the manuscript. M. Silva: design and study conception; critical revision of the study and approval of the final version of the article; study coordination; writing of the manuscript. B. Chaves: critical revision of the study and approval of the final version of the article.

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## Conflicts of interest

None.

## References

1. Su M, Fathb B, Yanga Z. Urban ecosystem health assessment: a review. *Sci Total Environ.* 2010;408:2425–34.
2. United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2015 Revision, Key Findings and Advance Tables. 2015. 241.
3. Commission of the European Communities (CEC). Green paper on the urban environment. Brussels; 1990.
4. European Commission. The Aalborg commitments. Denmark; 2004.
5. European Commission. Leipzig charter on sustainable European cities. Brussels; 2007.
6. European Environment Agency. The European environment — state and outlook 2015 — synthesis report. Luxembourg; 2015.
7. Boukharaeva L. Family urban agriculture as a component of human sustainable development. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources.* 2006; 1.(025).
8. Nowak DJ, Crane DE, Stevens JC. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry & Urban Greening.* 2006;4:115–23.
9. Mougeot L. Growing better cities: urban agriculture for sustainable development. Ottawa: International and Development Research Centre; 2006.
10. Zeeuw H, Gundel S, Waibel H. The integration of agriculture in urban policies. In N. Bakker, M. Dubelling, S. Gundel, V. Sabel-Koschella, A. Zeeuw (eds.), *Growing Cities, Growing Food: Urban Agriculture on the Policy Agenda.* Feldafing, Germany: Food and Agriculture Development Centre (ZEL). 2000; 1: 161–180.
11. Kabisch N, Qureshi S, Haase D. Human-environment interactions in urban green spaces — a systematic review of contemporary issues and prospects for future research. *Environ Impact Assess.* 2015;5:25–34.
12. Mattijssen TJM, Olafsson AS, Moller MS, et al. Urban green infrastructure: connecting people and nature for sustainable cities. A summary for policy makers. Green Surge D8.5. Copenhagen; 2017.
13. European Commission. Green Surge: green infrastructure and urban biodiversity for sustainable urban development and the green economy. 2017. Available at: [https://cordis.europa.eu/project/rcn/110888\\_en.html](https://cordis.europa.eu/project/rcn/110888_en.html)
14. Duncan MJ, Eyre E, Bryant E, et al. The impact of a school-based gardening intervention on intentions and behaviour related to fruit and vegetable consumption in children. *Journal of Health Psychology.* 2015;20.
15. Chen H, Tu H. Exploring dimensions of attitudes toward horticultural activities. *Hortscience.* 2010;45:1120–5.
16. Clatworthy J, Hinds J, Camic PM. Gardening as a mental health intervention: a review. *Mental Health Review Journal.* 2014;18:214–25.
17. Wang D, MacMillan T. The benefits of gardening for older adults: a systematic review of the literature. *Activities, Adaptation & Aging.* 2013;37:153–81.
18. Verra M, Angst FBT, Lehmann S, et al. Horticultural therapy for patients with chronic musculoskeletal pain: results of a pilot study. *Alternative Therapies in Health and Medicine.* 2012;18.
19. Camargo R, Coelho E, Gundim D, et al. Uso da hortoterapia no tratamento de pacientes portadores de sofrimento mental grave. *Enciclopédia Biosfera.* 2015:3634–43.
20. Hawkins J, Mercer J, Clayton D. Growing a healthy older population in Wales: project summary and key findings. Wales: National Institute for Social Care and Health Research. 2013.
21. Instituto Nacional de Estatística. Classificação Portuguesa das Profissões 2010. Lisboa, Portugal: INE; 2010.
22. Hine R, Peacock J, Pretty J. Evaluating the impact of environmental volunteering on behaviours and attitudes to the environment. Report for BTCV Cymru, University of Essex; 2007.
23. Berezowitz C, Bontrager YA, Schoeller D. School gardens enhance academic performance and dietary outcomes in children. *J Sch Health.* 2015;85.
24. Dymont JE, Bell AC. Our garden is colour blind, inclusive and warm: reflections on green school grounds and social inclusion. *International Journal of Inclusive Education.* 2006;12:169–83.
25. Robinson CW, Zajicek JM. Growing minds: the effect of a one-year school garden program on six constructs of life skills of elementary school children. *Hort Technology.* 2005;15:453–7.
26. Dirks AE, Orvis K. An evaluation of the junior master gardener program in third grade classrooms. *Hort Technology.* 2005;15:443–7.
27. Nova P, Pinto E, Chaves B, et al. Growing health and quality of life: benefits of urban organic community gardens. *J Nutrition Health Food Sci.* 2018;6:1–7.
28. The World Bank. What a waste: a global review of solid waste management. Urban Development Series Knowledge Papers. 2012:15.
29. Kiyasudeen K, Ibrahim MH, Quaik S, et al. Prospects of organic waste management and the significance of earthworms: introduction to organic wastes and its management. Rotterdam: Springer International Publishing; 2016.