Impact of community gardening on lifestyles' sustainability: quantitative & qualitative evaluation of a natural experiment

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Keywords: quasi-experiment, health promotion, food supply, nutrition, physical activity, accelerometer, well-being, connection to nature, urban garden, mental health

Posted Date: July 2nd, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-39237/v1>

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Abstract

Background: Despite the increasing number of studies on gardening and health, evidence of health benefits of community gardening is limited by cross-sectional design. The “JARDiNS” quasi-experimental study aimed to assess the impact of community garden participation on the adoption of more sustainable lifestyles in French adults.

Methods: Individuals starting gardening in community gardens in Montpellier (France) in 2018 (N=66) were compared to pairwise matched individuals with no experience in community gardening (N=66). Monthly household food supplies, physical activity measured by accelerometers and questionnaires on physical, mental and social well-being, sensitivity to food waste, and connection with nature were used to explore sustainability of lifestyles in social/health, environmental and economic dimensions. Data were collected at baseline (t0) and 12 months later (t1). Linear mixed models were used to determine the independent effect of community gardening on investigated lifestyles components. In-depth interviews were conducted at t1 with 15 gardeners to better understand changes that may have occurred in gardeners’ lives during the first year of gardening.

Results: At t0, gardeners had lower education level, lower BMI and reported lower percentage of meals consumed outside of the home in total household meals compared to non-gardeners ($p<0.05$). At t1, the mean weight of fruit and vegetables harvested from the garden was 19.5g/d/p. Participating in the community garden had no significant impact on any of the social/health, environmental and economic lifestyle components investigated. Qualitative interviews suggested the existence of pre-established health and environmental consciousness in some gardeners and revealed several barriers to the participation such as lack of time, lack of gardening knowledge, difficulty of gardening, health problems and conflicts with other gardeners.

Conclusions: Using a longitudinal design allowing causality assessment, no impact was observed of the first year of community gardening on lifestyle sustainability. The pre-established sensitivity to sustainability and the various barriers encountered by new gardeners might explain the absence of community gardening impact. Further rigorous longitudinal studies are needed to determine whether or not community gardening is a relevant public health tool.

Trial registration: The study was registered at clinicaltrials.gov as NCT03694782. Date of registration: 3rd October 2018, retrospectively registered.

Background

In recent years an increasing body of literature has provided evidence that exposure to green spaces could address a wide range of public health domains such as mental health, wellbeing or cardiovascular diseases through its positive effects on stress, depression, physical activity or social cohesion [1–5]. Gardening is a popular way to engage with green spaces as it provides urban dwellers an avenue to access nature and safe and healthy food. Community gardens usually refer to plots of land collectively gardened by a group of people living in an urban area in diverse settings such as schools, neighborhoods, nursing homes or hospitals [6, 7]. Beyond evidence drawn from community gardening within institutions such as schools or health care settings [8–11], several studies have investigated the potential health effects of community gardening on urban residents. Increased intake of fruits and vegetables, increased physical activity and better social and mental health

findings have been reported in several qualitative studies [12, 13]. Among quantitative studies on the relationship between community gardens participation and health, cross-sectional studies still dominate the literature. The majority of these studies focused on nutrition-related outcomes, finding a positive association between community gardening and fruit and vegetable consumption [14–18]. Some studies also found that community gardeners report better social involvement and cohesion with neighbors [15, 17–20], better mental health [15], higher level and frequency of physical activity [18] and lower BMI [21, 22] than non-gardeners, while others found no association for at least one of these health outcomes [15, 17, 18], resulting in overall inconclusive results.

The lack of conclusive evidence regarding difference in health related behaviors and health status between gardeners and non-gardeners is partly due to methodological limitations of existing studies including the use of convenience samples, small sample sizes, and self-reported measurements [23, 24]. Alaimo *et al.* encouraged the next generation of gardens' research to take advantage of natural experiments, in which the experimental conditions are self-determined without being manipulated by researchers, to evaluate the health impacts of community gardens [24]. Thus, while several randomized controlled trials on gardening are under way in the United States [25–27], natural experiments offer another opportunity of longitudinally assessing the changes induced by community gardening.

The term “lifestyles” is commonly used in public health to define a cluster of habits that include an individual's behaviors, inclinations, preferences and values that affect health status [28]. Beyond health-related outcomes, shaping behavioral patterns from a sustainability perspective could lead to more sustainable lifestyles [29]. Community gardening could raise gardeners' environmental awareness and encourage the adoption of more sustainable dietary practices by fostering collective thinking about biodiversity and eco-friendly practices [30, 31]. Besides, by providing access to fresh food harvested from the garden, community gardens could favor food affordability by reducing food expenses [32] or changing purchasing behaviors [33]. Community-based interventions targeting gardening could effectively promote more sustainable lifestyles by positively influencing the three fundamental pillars of sustainability, namely health (including social outcomes), environmental and economic [34]. The present study is aimed at assessing the impact of community garden participation on the adoption of more sustainable lifestyles in a European urban context. We used both qualitative and quantitative approaches to better explore changes that may have occurred in gardeners' lives during the first year of gardening, and the potential benefits to their physical, social and mental health.

Methods

Study setting, population and design

JARdInS is a quasi-experimental study conducted between 2018 and 2019. The design and protocol of the study have already been described in a previous paper [35]. Briefly, a convenient sample of new gardeners (herein referred to as “gardeners”) was constituted in 2018 (experiment group). All known community gardens (N = 34) in Montpellier (France) were contacted and informed about the study. Then, throughout the gardening season (from March to November), each new individual entering one of the contacted gardens was invited to participate in the JARdInS study. Inclusion criteria were as follows: 1) starting gardening in a community garden, 2) being willing to be involved in the study for one year, 3) be at least 18 years old, 4) being able to read French, and 5) residing in the city of Montpellier. Exclusion criteria were: 1) past experience of at least one household member in community gardening, 2) self-reported strong experience in gardening, and 3) never shopping for household

food supply. In parallel, a matched-control group of non-gardeners was formed by selecting volunteers participating in a population-based survey on food supply behaviours in Montpellier (“Mont’Panier” survey). To be selected, participants from the control group must neither garden, nor have had prior experience in a community garden or have planned to join one. Matching criteria were: age (< 30; 30–50; >50 years old), gender, household income (< 1110; 1110–2000; 2000–2700; >2700 € per month and per consumption unit) and household composition (single adult with no child; single adult with at least 1 child; >1 adult with no child; >1 adult with at least 1 child). Data were collected at baseline (t0) and 12 months later (t1). Household fruit and vegetables supply was the main outcome of the study. A total sample size of 160 participants (80 gardeners and 80 non gardeners) was previously evaluated to detect an increase of one portion of fruit and vegetables per day and per person in the gardeners group, with a planned attrition rate of 30% [35].

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the French Institute for Health and Medical Research and the Commission Nationale Informatique et Libertés (IRB00003888); verbal informed consent was obtained following recommendation of the Research Ethics Committee. The JArDinS study was registered at clinicaltrials.gov as NCT03694782. Participants received a 15 € voucher at t0 and at t1 for returning all data collection materials duly completed.

Quantitative evaluation

Data collection and lifestyles sustainability assessment

Details about collection and assessment of all outcome variables of the JArDinS study have been summarized in a previous methodological paper [35]. To investigate the social/health, environmental and economic dimensions of sustainability, participants were instructed 1) to complete a 1-month food supply diary and collect food receipts, 2) to wear a hip-worn triaxial accelerometer (wGT3X-BT or wActiSleep-BT, Actigraph, Pensacola, FL, USA) for 9 consecutive days and 3) to fill in an online questionnaire including declared body height and weight, and validated questionnaires on mental well-being, social health, sensitivity to food waste, and connection with nature.

The social/health dimension was approached by measuring : 1) the healthiness of household’s food supply based on i) fruits and vegetables household supply (in gram as consumed per day and per person, including fruit and vegetables from the garden), ii) two indicators of good and bad nutritional quality : the mean adequacy ratio (MAR) [36] and the mean excess ratio (MER), respectively [37], iii) the Healthy Purchase Index (HPI) estimating the healthiness of household food purchases, based on food expenditure only [38]; 2) participant’s physical activity energy expenditure (PAEE) and time spent during daytime in inactivity (< 1.5 METs), light intensity activities (between 1.5 and 3 METs) and moderate-to-very vigorous intensity activities (> 3 METs) using a previously validated model that combines an automatic activity-recognition algorithm with an activity-specific count-based model [39]; 3) self-reported BMI; 4) mental well-being (WEMWBS) [40]; and 5) level of social isolation (UCLA Loneliness Scale, V3) [41]. Specific details regarding the data analyses of food supply diary and accelerometer are described in an Additional file 1.

The environmental lifestyles dimension was assessed through key indicators of food practice sustainability, namely 1) the greenhouse gas emissions (GHGE, in g CO₂eq), atmospheric acidification (in g SO₂eq), marine eutrophication (in g Neq) and animal to plant protein ratio of household food supply; 2) participants’ sensitivity to food waste (Sensitivity to food waste scale) [42]; 3) and their connection with nature (Nature Relatedness

Scale) [43]. Because of the skewed distribution of the sensitivity to food waste score participants were classified in two categories: “high sensitivity to food waste” (score > median at t0) or “low sensitivity food waste” (score < median at t0).

The economic dimension was approached by household food expenditure and expenditure share by food groups. For food coming from the garden, or from gifts or food aid, a theoretical expenditure was attributed based on the mean observed food price for that product in the rest of the sample.

Additional information

The online questionnaire further provided information on socioeconomic characteristic of participants, percentage of meals consumed outside of the home in total household meals, participant’s exclusion of selected foods and perceived competence in gardening (“beginner”, “intermediate”, “advanced”), as well as a social desirability scale (the Balanced Inventory of Desirable Responding Short Form) [44]. The questionnaire for gardeners also contained a specific section on the community garden to collect information on the characteristics of the garden, garden-to-home distance and transportation used to go to the garden at t0; and periods of inactivity in the garden during the past year (ranging from none to > 9 months), as well as frequency of gardening during activity periods (“>1 time/week”, “1–3 times/month”, “<1 time/month”) at t1.

To compare our results to gardeners’ perception of changes that took place in their lives, we sent them an online post-survey questionnaire, in which gardeners were asked if they had perceived a change in their fruit and vegetable consumption, physical activity, life satisfaction and social relation during the past year (five response categories : “strong increase”, “slight increase”, “no change”, “slight decrease” or “strong decrease”) and if that change was due to community garden.

Statistical analyses

Sociodemographic characteristics and key outcome variables of participants at baseline were compared between the two groups (gardeners vs. non-gardeners) using paired t-test for continuous variables and McNemar test for categorical variables. We investigated changes in the lifestyles sustainability components between the two groups across time (pre- to post-test) using linear mixed-effect models (SAS PROC MIXED) for continuous variables and logistic mixed-effect models (SAS PROC GLIMMIX) for dichotomous variables. Group, time and the time*group interaction were treated as a fixed effect. Within-person variation was modelled by using a compound symmetry covariance matrix. Significant time*group interaction indicated a difference in outcome over time between the two groups. Different adjustments were used depending on the outcome variable. Models on physical activity were adjusted for baseline education level and BMI (Model A). Models on food supply and models on self-report data were further adjusted for percentage of meals consumed outside of the home (Model B), and social desirability scale (Model C), respectively. Model on BMI was adjusted for baseline education level, percentage of meals consumed outside of the home and social desirability scale (Model D). Indicators with skewed distribution were log-transformed to improve heteroscedasticity and improve normality of the residuals.

All analyses were performed with the SAS statistical software package Ver. 9.4 for Windows (SAS Institute, Cary, NC, USA), with statistical significance at $p < 0.05$.

Qualitative evaluation

The qualitative evaluation was based on interviews with 15 new community gardeners in the study conducted over 7 weeks in May and June 2019. We selected a sample size of 15 as it allowed us to select individuals from geographically and socioeconomically varied community gardens. The interview sample included 11 women and 4 men. All interviews were conducted and recorded in French and later professionally transcribed into English for analysis using an online translation and transcription service. We held interviews in the participants' homes or community gardens, whichever was more convenient. Interviews ranged from 11 to 50 minutes. Using a semi-structured interview guide, we led interviews with 5 to 7 open-ended questions directed at the new gardener experience to better understand changes that may have occurred in gardeners' lives during the first year of community garden participation. We checked each transcript carefully for accuracy against the recordings after receiving it from the transcription service. Assisted by Atlas Ti qualitative software, we followed grounded theory methodology by analysing the data inductively without a predetermined codebook. We selected key concepts by extracting repetitive topics in the data for closer analysis, sorting codes into larger code groups, and visually networking these groups to distil salient themes [45].

Results

Participant Eligibility and Sample Size

In total 296 potential participants were approached (152 gardeners starting gardening in a community garden and 144 matched non-gardeners) and 141 were not included resulting in a final sample of 155 participants at baseline (response rate: 49.3% for gardeners and 55.6% for controls) (Fig. 1). We recruited gardeners from 19 different community gardens during the two gardening seasons: March-June (57.6%) and September-November (42.3%). The plots obtained were maintained either collectively (68.2%) or individually (31.8%). Gardens were rarely located next to gardeners' homes. Gardeners either walked/biked to the garden (72.7%, mean travel time: 8.6 min) or used car/public transportation (27.3%, mean travel time: 21.2 min). Only 14 participants were lost to follow-up between t0 and t1, and 66 matched pairs were included in the analysis.

Participant characteristics

Sociodemographic characteristics of the participants at baseline are shown in Table 1. The mean age of gardeners was 44.0 years. Most of them were women, subjects who held a university degree, and reported having no experience in gardening. There were some differences between the gardeners and the controls at baseline: gardeners had lower education level, lower BMI and gardeners' households reported lower percentage of meals consumed outside of the home.

Table 1
Baseline sociodemographic characteristics of gardeners and non-gardeners of the JArDinS study

	Gardeners (N = 66)	Non-gardeners (N = 66)	<i>P</i> - value ^a
- Matching criteria -			
Individual level			
Age (year), mean (SD) :	44.0 (14.0)	44.9 (13.7)	0.706
Women, N (%)	50 (75.8)	50 (75.8)	0.808
Household level			
Household structure, N (%) :			0.999
Single adult with no child	25 (37.9)	25 (37.9)	
Single adult with at least 1 child	6 (9.1)	7 (10.6)	
> 1 adult with no child	20 (30.3)	20 (30.3)	
> 1 adult with at least 1 child	15 (22.7)	14 (21.2)	
Household income (€/month/CU), N (%)			0.605
< 1110	14 (21.2)	11 (16.7)	
1110–2000	29 (43.9)	26 (39.4)	
2000–2700	11 (16.7)	17 (25.8)	
>2700	10 (15.2)	9 (13.6)	
NA	2 (3.0)	3 (4.5)	
- Other sociodemographic characteristics -			
Individual level			
Education level, N (%)			
Elementary school	1 (1.5)	1 (1.5)	0.049^b
Secondary school	15 (22.7)	6 (9.1)	
University or equivalent	50 (75.8)	59 (89.4)	
BMI (kg/m ²)	22.6 (3.0)	23.8 (4.0)	0.046
No meat or fish eater, N (%)	13 (19.7)	8 (12.1)	0.157
Experience in gardening, N (%) :			1.000 ^c
Beginner	47 (71.2)	47 (71.2)	
Intermediate	19 (28.8)	17 (25.8)	

	Gardeners (N = 66)	Non-gardeners (N = 66)	<i>P-value</i> ^a
Advanced	0	2 (3.0)	
Household level			
Percentage of meals consumed outside of the home in total household meals (%), mean (SD)	16.4 (11.7)	20.6 (15.3)	0.033
CU: consumption unit			
^a P-value for the difference between the two groups using paired t-test for age and BMI, and McNemar test for other variables.			
^b The first two categories were grouped together for statistical analysis			
^c The last two categories were grouped together for statistical analysis			

Change in sustainability of lifestyles

Results of the mixed-effect models are shown in Table 2. At baseline, there were no pre-existing differences between the two groups on any of the components of lifestyles, except for the contribution of added fats & seasonings to total household food expenditure. For both groups, physical activity significantly decreased between t0 and t1, while inactivity increased. Other changes due to time were, in both groups, an increase of BMI, an increase of sensitivity to food waste and a decrease in beverages expenditure share.

Table 2
Group differences and time effects of components of lifestyles sustainability among gardeners and non-gardeners

Sustainability components, means (SD) ^a	Model ^b	Gardeners (N = 66)		Non-gardeners (N = 66)		Group P-Value	Time P-Value	Group* Time P-Value
		t0	t1	t0	t1			
- Health dimension -								
<i>Healthiness of household's food supply^{c,d}</i>								
Fruit & Vegetables ^e (g/d/p)	B	402.4 (238.2)	400.0 (231.2)	433.6 (285.4)	445.6 (304.5)	0.241	0.637	0.999
MAR (% adequacy/2000 kcal)	B	76.5 (7.3)	75.8 (8.1)	76.3 (7.1)	76.9 (6.5)	0.679	0.936	0.356
MER (% excess/2000 kcal)	B	96.6 (19.5)	96.1 (23.4)	100.2 (25.3)	98.8 (29.7)	0.617	0.705	0.844
HPI [range: 0–15]	B	8.7 (2.1)	9.0 (2.1)	9.0 (2.3)	9.1 (1.9)	0.218	0.282	0.604
<i>Physical activity</i>								
PAEE (kJ/kg/d)	A	43.2 (13.8)	40.3 (12.3)	41.9 (12.4)	39.9 (13.5)	0.489	0.027	0.664
Inactivity (h/d)	A	9.4 (1.4)	9.9 (1.5)	9.4 (1.5)	9.8 (1.4)	0.333	< .0001	0.995
Low-intensity activity (h/d)	A	2.8 (0.8)	2.7 (0.9)	2.8 (1.0)	2.6 (0.8)	0.792	0.003	0.544
Moderate-to-vigorous intensity activity (h/d)	A	1.9 (0.9)	1.6 (0.7)	1.8 (0.7)	1.7 (0.8)	0.555	< 0.001	0.362
BMI (kg/m ²)	D	22.6 (3.1)	22.8 (3.1)	23.8 (4.0)	23.9 (4.1)	0.111	0.038	0.679
WEMWBS [range: 14–70]	C	51.1 (6.7)	51.5 (6.9)	51.8 (6.7)	51.5 (5.7)	0.406	0.899	0.546
UCLA Loneliness Scale [range: 20–80]	C	42.1 (10.4)	40.1 (10.9)	40.1 (9.8)	40.5 (9.5)	0.727	0.570	0.227
- Environmental dimension -								
High sensitivity to food waste, N (%)	C	30 (45.5)	40 (60.6)	27 (40.9)	30 (45.5)	0.274	0.018	0.214
Nature Relatedness Scale [range: 1–5]	C	4.1 (0.5)	4.1 (0.5)	3.9 (0.5)	4.0 (0.5)	0.060	0.198	0.395

Sustainability components, means (SD) ^a	Model ^b	Gardeners (N = 66)		Non-gardeners (N = 66)		Group P-Value	Time P-Value	Group* Time P-Value
<i>Environmental impact of household's food supply^{c,d}</i>								
GHGE (in g CO ₂ eq/2000 kcal) ^e	B	3099 (997)	3151 (1131)	3294(886)	3240 (889)	0.382	0.836	0.678
Atmospheric acidification (in g SO ₂ eq/2000 kcal) ^e	B	33.1 (12.2)	33.3 (12.0)	37.6 (15.0)	35.4 (12.1)	0.256	0.398	0.373
Marine eutrophication (in g Neq/2000 kcal) ^e	B	11.9 (3)	12.5 (3.9)	13.3 (3.5)	13 (3.9)	0.124	0.972	0.271
Animal to plant protein ratio of household food supply ^e	B	56.9 (16.1)	56.4 (17.4)	61.8 (15.4)	59.1 (15.6)	0.368	0.091	0.245
- Economic dimension -								
Household food expenditure (€/d/p) c,d	B	7.0 (3.1)	6.7 (3.2)	6.8 (3.3)	6.8 (3.2)	0.841	0.682	0.630
<i>Share of food groups (%€)^{c,d} :</i>								
Fruits & Vegetables	B	26.5 (11.1)	27 (10.4)	26.6 (12.3)	29.4 (15.6)	0.258	0.100	0.237
Starches	B	10.1 (5.2)	10.6 (5.1)	9.2 (4.7)	8.8 (4.5)	0.177	0.836	0.228
Meat, fish & Eggs	B	18.8 (9.5)	18.7 (10.2)	20.2 (9.2)	20.2 (10.9)	0.507	0.908	0.901
Dairy products	B	11.8 (5.1)	11.5 (4.8)	11.3 (4.4)	11.2 (5.2)	0.495	0.669	0.825
Mixed dishes ^e	B	8.9 (6.2)	8.4 (6.1)	8.3 (6.1)	8.9 (8.2)	0.098	0.496	0.998
Sweet products	B	10.4 (5.5)	11.7 (8.2)	11.1 (5.6)	10.1 (6.0)	0.853	0.855	0.078
Added fats & seasonings ^e	B	4.4 (3.0)	4.9 (2.8)	3.5 (2.6)	3.6 (2.6)	0.003	0.507	0.216
Beverages ^e	B	9.5 (6.2)	8.4 (5.8)	10.1 (7.4)	8.1 (6.1)	0.745	0.021	0.240

Sustainability components, means (SD) ^a	Model ^b	Gardeners (N = 66)	Non-gardeners (N = 66)	Group P-Value	Time P-Value	Group*Time P-Value
<p>Abbreviations: MAR: Mean Adequacy ratio; MER: Mean Excess Ratio; HPI: Healthy Purchase Index; WEMBWS: The Warwick-Edinburgh Mental Wellbeing Scale; MAR: Mean Adequacy Ratio; MER: Mean Excess Ratio; HPI: Healthy Purchase Index; PAEE: Physical activity energy expenditure; GHGE: GreenHouse Gas Emissions.</p> <p>^a Unless specified.</p> <p>^b Model A was adjusted on BMI and education level. Model B = Model A + percentage of meals consumed outside of the home. Model C = Model A + social desirability scale. Model D was adjusted on education level, percentage of meals consumed outside of the home and social desirability scale.</p> <p>^c Variable measured at the household level and not at the individual one.</p> <p>^d Including produce from the garden and foods from gifts or food aid, gifts or food aid. For food expenditure variables, a mean price was attributed to these foods (see method section).</p> <p>^e Variable was log-transformed to improve normality</p>						

At t1, the quantity of fruit and vegetables harvested from the garden was 19.8 (SD 36.2) g/d per person (data not shown). No significant impact of participating in a community garden was observed neither on the main outcome variable (household fruit and vegetables supply) nor on any of the other outcomes, as shown by the lack of significance for the interaction terms (group*time) (Table 2). Even when removing the theoretical expenditure attributed to produce from the garden, there was no measurable impact of garden participation on total food expenditure and on food-group expenditure shares (data not shown).

At t1, 24% of the gardeners surveyed had dropped out the garden during the year. There was inter-individual variability in the frequency of garden attendance during the year, the majority of gardeners visiting the garden at least once a month throughout the year (56.1%) or over a period from 6 to 9 months (18.2%), while others visited the garden for shorter periods, from 3 to 6 months (16.6%) or only few times a year (9.1%). Sensitivity analyses performed on sub-samples including only active gardeners (who visited the garden at least once a month throughout the year, N = 37) or only those who did not drop out the garden during the year (N = 50) also showed a non-significant effect of participating in a community garden on outcome variables (Additional files 2 & 3). In the post-survey questionnaire, the majority of gardeners stated they did not perceive any change in their fruit and vegetables consumption, physical activity, life satisfaction and social relation due to gardening (Additional files 4).

Qualitative evaluation

The qualitative evaluation provided elements of answers that could explain the lack of change in gardeners' lifestyles observed in the quantitative study. Of the 15 gardeners interviewed, the majority were active gardeners (N = 9), 4 visited the gardens over a period from 6 to 9 months and 2 less than 3 months.

Nine respondents perceived no change in their lifestyles after one year of gardening. This lack of benefit cannot only be explained by having a negative gardening experience, as one gardener described: "My life is the same as

before [the garden], but it's true that it's a plus to have this garden anyway. It's among the positive things in my life, but after that it's not really changing my life actually" (Woman 1, age 54). A couple of respondents pointed out that participation in the garden was just part of their health and environmental consciousness: "I was already a nature enthusiast before. What I mean is that I have always been environmentally conscious, and caring about nature" (Man 1, age 34).

It is also possible that a follow-up period of one year is not sufficient to perceive changes. For example, one woman shared: "I hope I'll improve over time" (Woman 7, age 63).

The interview also highlighted several barriers to community garden participation the most mentioned being the lack of time to garden. Nine gardeners, mostly women, confessed facing greater challenges balancing the demands of gardening with their personal and professional lives, which could lead to feelings of guilt. One gardener mentioned:

At first, I didn't know if I would have enough time to invest myself in the garden [...]. Indeed, it actually requires a lot of time. [...] You see what time I get home from work and everything. I don't have time for this. I see them working. At first, I felt guilty, I thought, "Oh, now I see them and so on, and then I don't go there" I had no experience of gardening and how long it took. [...] It's true that it's great, it's almost in a meditative state, it brings me a lot of well-being, but it takes a lot of time (Woman 2, age 42).

The demands of daily life are an important factor associated with participation, regardless of gardeners' motivation:

My problem is to go there regularly. I said yes, I signed, and I thought I'm going to participate a lot. In the end, not that much, because I had a lot of events. My place of work changed. My husband was very ill. My father was very ill, while he's in Toulouse, et cetera. My car is broken, there are things like that.... [...] If it was in the same neighbourhood it would be easier. (Woman 3, age 61).

The distance between the garden and the house can be an additional source of discouragement outweighing benefits from the garden:

What's difficult is not the time, it is the trip. It's to organize the movement because you don't come for 10 minutes, you come to stay longer than that. Therefore, the moving time, and the round trips make you sometimes not to always find the time to do it. If it was just next door, it would have been easier. (Woman 4, age 41).

These quotations underline how difficult it was for participants to make time in their busy lives to access the garden away from their homes. Other barriers mentioned by the gardeners were difficulties of gardening and the lack of experience (N = 3). One gardener explained that:

What I first noticed was that this work is not actually simple as people think. It's not just planting and harvesting. You have to know what you're planting. You have to know many plants. I know some of them. No, it's not an easy job. You need to also know how to manage water because you can garden by putting a lot of water especially here in the South. It's a bit risky. It's depends. Since we don't want to use pesticides, we want it to be as natural as possible. It's not always an easy job. (Woman 5, age 65).

Lack of gardening knowledge, especially for beginning gardeners, can lead to a negative gardening experience if they are not helped or supervised by other more expert gardeners, as explained by this woman:

I had to make mistakes, I don't know which ones because we don't have— It's a garden where there aren't many people, so it's hard to get advice, it's hard to look at on the internet. That's not what I expect from a garden, that's the discussion, that's what I want to get tips, because there are people who have been doing this for a longer time. It didn't work for me. (Woman 6, age 60).

The difficulty of gardening, especially soil preparation and bending down can be a hindrance for people with fragile health such as the elderly: “After all, I’m 63 years old, and I don't have the corpulence, the physical resistance to mix the soil. Moreover, I sleep very badly because I feel pain everywhere. (Woman 7, age 63).

Although many gardeners mention the friendly moments in the garden, tension related to the management of garden can arise and lead to conflicts between gardeners. This was notably the case for one of the interviewed gardeners:

I refuse all fixed patterns of thinking. These people, unfortunately, behind their participatory democracy side, are oligarchs, sorry. I can't stand the oligarchy. Oligarchy is the power of a few behind a pseudo-democratic form. I don't want to be given orders, at least not in the garden, so I refuse to see them and leave. (Woman 8, age 48).

Discussion

JArDinS is the first longitudinal study to examine the causal effect on gardeners’ lifestyles of participating in a community garden, one year after entry. We found no impact of one-year garden participation on healthiness of household’s food supply, physical activity, BMI, mental well-being and social health, connection to nature, sensibility to food waste, as well as, environmental impact and expenditure of food supply. In light of our results, it seems that participating in community gardens for one year is not sufficient to promote more sustainable lifestyles. The present study is not consistent with previous ones [14–16, 18–22, 33], but the existing literature in this field is full of shortcomings. Firstly, previous studies were all based on cross-sectional design, which are at high risk of selection bias. Our longitudinal study suggest that it is likely that most previous cross-sectional studies have been actually conducted on only a small percentage of all gardeners once involved in the studied gardens; and this small percentage was made of highly motivated and experienced gardeners who did not abandon the activity because they already had positive health consciousness and/or environmental attitudes. Secondly, previous studies were conducted predominantly amongst vulnerable populations in low-income areas or industrial cities in the USA [12], and therefore outcomes cannot easily be generalized to other settings and other populations. Thirdly, health outcomes were mostly collected by declarative questionnaires, which are subject to desirability and memory bias [46]. For example, frequency of fruit and vegetable intake was mainly estimated based on short food frequency questionnaire [14–18], whose can yield to a biased and imprecise assessment of fruit and vegetable consumption [47] and their validity remains moderate [48]. The measure of household food and beverage purchasing behaviour through the collection of food receipt and records offer a more objective approach to estimate dietary behaviours at the household level [49]. We did not record dining out food purchase data, however, in France, food consumption is mainly driven by household food purchases [50]. Similarly, self-reported measure of physical activity is less accurate than objective methods for estimating PAEE and PA intensity [51–53]. Among the objective measurement tools, accelerometers allow to capture easily large

amounts of data over several days and have gained popularity to quantify more precisely PAEE and PA intensity [51–53]. A currently ongoing trial in USA uses accelerometers to assess whether community gardening could increase physical activity among mixed-income population [26]. This trial will similarly evaluate if community gardening improves fruit and vegetable consumption, social support, mental health, and reduces age-associated weight gain and sedentary time, but the results are still unknown.

Our results suggest that practicing gardening for one year in a community garden may not be sufficient to modify health and sustainability behaviors. Even without considering less active gardeners, or those who dropped out of their garden during the year, we did not find any evidence of a positive impact of gardening on gardeners' lifestyles (Additional files 1 & 2), but findings from the sensitivity analyses are to be taken with caution because the reduction of the sample also reduced statistical power. The literature is unclear whether the benefits of community gardening depend on the frequency of garden attendance, as some studies observed increased healthier behaviours among the most regular gardeners [54, 55], while others found no significant association [15, 56, 57]. More broadly, many questions regarding the health benefits of exposure to green spaces remain unanswered and further studies are needed to understand which forms of nature contact are the most beneficial, the duration of exposure needed, variation of effects across population and settings as well as the psychological pathway involved [58]. We also found that the active gardeners had a slightly but significantly higher connection to nature at baseline (Additional file 1), reinforcing the idea that the most involved gardeners might have been more predisposed to stay in the garden because of positive attitudes enabling them to better cope with the difficulties of gardening. This hypothesis of a pre-established health and sustainability consciousness of gardeners before entering the garden was supported by the qualitative evaluation. Surprisingly, we found an increase of inactivity and BMI after one year. It is likely that the habituation of participants in both groups to the data collection tools might have resulted in a decreased of the desire to emphasize their "healthy behavior".

We found that gardeners differed from non-gardeners at baseline for some characteristics. They had slightly lower BMI, level of education and their households consumed less meals outside of the home, which is consistent with their higher expenditure for added fats & seasonings (i.e., cooking ingredients). One major threat of non-random design is the risk of non-comparability of experiment and control groups (i.e. differences in outcomes might be explained by baseline differences between the groups rather than by the effect of the intervention) [59]. But random sampling was not achievable in our setting, where new membership and plot renewal in community gardens were decided by local authorities or private managers. Nevertheless, longitudinal pre-post quasi-experimental designs offer robust alternative to randomized control trials to determine a causal relationship [60]. We used a pairwise matching process controlling for individual-level and contextual-level variables to reduce selection bias and strengthen internal validity of the study [60]. Furthermore natural experiments improve external validity by giving a more realistic representation of the effectiveness of an intervention in a real world setting [60]. We acknowledge that our study is not without limitations. First, despite investigating several components of lifestyles across the three dimensions of sustainability, it is always possible that other unmeasured variables might have changed following gardening participation. Second, the majority of participants held a university degree and displayed healthier food purchases pattern at baseline than the French general population [61], with higher budget share of fruit and vegetables (27% vs 12% in the general population) (data not shown). It is well-known that volunteers tend to be more motivated and concerned about their health than the general population, leading to an underestimation of the effect of the intervention [62]. Third, it can also

be argued that insufficient statistical power and inability of data collection tools to detect change could explain the lack of results, nevertheless, the sample was large enough to observe significant differences between the groups initially and findings from the post-questionnaire survey did not support this interpretation (Additional file 3). Fourth, knowing that changes in diet take time, it is likely that a follow up of one year might not have been long enough to detect a change in food practices.

The interviews suggested that the lack of effect of community gardening on gardeners' lifestyles could also be explained by the difficulties that the gardeners encountered throughout the year, such as lack of time, health problems or conflicts with other gardeners. While motivations for participating in community gardens are well documented in the literature, there are few studies that focus on the barriers encountered by gardeners. The available research agree that lack of time, knowledge, practical skills, physical capacity or conflicting personal and social expectations are major hindrances to gardener involvement[63–65]. These obstacles can be expected to be particularly difficult for beginner gardeners; thus preventing them from changing their behaviour.

Conclusion

JArDinS is the first study examining the causal effect on gardeners' lifestyles of participating in a community garden, one year after entry. We found no significant improvement of healthiness, environmental impact and expenditure of food supply, nor on physical activity, BMI, mental well-being, social isolation, sensibility to food waste and connection to nature after one year of participation. Based on previous cross-sectional studies, community gardening is believed to confer health, social, environmental and economic benefits to gardeners but the prior findings might have been confounded by selection and declaration bias. Our study highlights the need of further rigorous longitudinal studies with larger sample sizes, longer follow-up and dose-response effect analyses of community garden participation to lend support to a causal link between community garden and health. It is critically important to understand the difficulties encountered by new gardeners and to identify solutions to these barriers. Multicomponent interventions including health, social, governance, economic, environmental and agronomic considerations could be tested to encourage long-term participation in community gardens, to determine whether or not community gardening can serve as a public health tool to promote more sustainable lifestyles for urbanites worldwide.

Abbreviations

BMI: Body Mass Index; WEMBWS: The Warwick-Edinburgh Mental Wellbeing Scale; MAR: Mean Adequacy Ratio; MER: Mean Excess Ratio; HPI: Healthy Purchase Index; PAEE: Physical activity energy expenditure; MET: Metabolic Equivalent of Task; GHGE: GreenHouse Gas Emissions; CU: consumption unit

Declarations

Ethics approval and consent to participate:

All subjects received an information letter describing the purpose and the procedures of this study, as well as participant's right and data confidentiality before they participated in the study. A verbal consent was given by each participant, following recommendation of the Research Ethics Committee. The study was conducted in

accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the French Institute for Health and Medical Research and the Commission Nationale Informatique et Libertés (IRB00003888). The JArDinS study was registered at clinicaltrials.gov as NCT03694782.

Consent for publication:

Not applicable

Availability of data and materials:

The data that support the findings of this study are available from MT but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of data controller (CM) and interested parties.

Competing interests:

Not applicable

Funding:

This research was part of the Surfood-Foodscape project. This work was publicly funded through ANR (the French National Research Agency) under the “Investissements d’avenir” programme, reference ANR-10-LABX-001-01 Labex Agro, and coordinated by the Agropolis Foundation. It was also supported by the Olga Triballat Institute. The funders had no role in the design of the study or the collection, analysis and interpretation of data, or in writing the manuscript.

Authors' contributions:

ND supervised the study. ND, CM, MP and MT designed the JArDinS study. MT and MP were in charge of the investigation and collected data. Under the supervision of JL, AS collected and analysed data from the in-depth interviews. MT wrote the first draft of the manuscript. All authors proposed critical comments and approved the manuscript for publication.

Acknowledgements:

We would like to thank the local organizations in charge of organizing and managing community gardens in Montpellier who facilitated the recruitment process, as well as the study participants for their time and involvement in the study. We thank the team of the Surfood-Foodscape project, especially Pascale Scheromm, Christophe Soulard, Nicolas Bricas, Simon Vonthron for their comments and suggestions. We also would like to thank Maël Garnotel for assisting in the use of the accelerometers.

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Figures

Figure 1

Flow diagram of the JArDinS study

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