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Do green fingers munch on more fruit and veggies? Health effects of home gardening

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Abstract

Inadequate consumption of fresh fruits and vegetables is a persistent problem in many highly urbanized Global North countries. The research suggests that the intake of fresh fruits and vegetables is influenced by households' food production in gardens. However, the connection between home gardening, consumption, and health is far from straightforward, and in the extant literature, the research evidence is limited. Therefore, this study presents the results of quantitative research exploring the relationship between the frequency of fresh fruit and vegetable consumption, gardening, and human health. Three objective aspects of health were included in the analysis: the cumulative occurrence of high blood pressure, diabetes, and high cholesterol levels. In addition, a subjective health evaluation and the body mass index (BMI) were considered. A large representative sample of 1699 respondents completed the questionnaire administered in Czechia in 2022. The results of bivariate tests revealed a significant relationship between gardening, consumption, and all health aspects. However, most of these relationships were mediated by other factors. When sociodemographic characteristics were controlled in the regression models, the results indicated that gardeners eat fresh fruits and vegetables more often and have lower BMIs than nongardeners. Better subjective health was linked to a more frequent fresh fruit and vegetable intake. By contrast, no relationship was observed between objective health and gardening or food consumption. The findings of this paper reveal the complex relationships of the three researched phenomena and highlight the importance of considering gardens' accessibility in scholarly debates and when formulating food and public health policies.

Plain Language Summary

Inadequate consumption of fresh fruits and vegetables is a persistent nutritional and health problem in many countries around the world. Our study focuses on

Abbreviations: BMI, body mass index; EU, European Union; WHO, World Health Organization.

the relationship between fruit and vegetable consumption, health, and productive gardening (home food growing). We conducted a large questionnaire-based survey of 1699 respondents in Czechia. The results show that gardeners eat fresh fruits and vegetables more often and have a lower body mass indices (weight to height ratio) than nongardeners. Besides that, more frequent fruit and vegetable consumption is linked to better assessment of one's health—people feel better. However, there is no relationship between the occurrence of selected diseases on the one hand and gardening or the frequency of fruit and vegetable consumption on the other hand. The study reveals the complex relationship between gardening, food consumption, and health. It also points to the relative importance of gardens for food and public health policies.

1 | INTRODUCTION

The consumption of fruits and vegetables has been an object of research and policymaking interest for decades, and attention to the topic has increased during the COVID-19 pandemic and due to recent food price inflation. The long-term trends concerning the consumption of fruits and vegetables are negative. For example, in the early 2010s, only six out of 28 member states in the European Union (EU) met the recommendation of World Health Organization (WHO) (Freshfel in Santeramo et al., 2018) for a daily intake of at least 400 g of fruits and vegetables per person (Aune et al., 2017; WHO, 2008, 2020). Despite recent marginal improvements—in 2021, the number of countries meeting this recommendation had increased to seven, and the average fruit and vegetable consumption in the EU grew slightly (Freshfel, 2023)—the European average of 364 g per capita per day remains below the lowest recommended intake. In Czechia, the focal country of this paper, a survey conducted in 2021 revealed that only 35% of respondents ate fresh fruits and vegetables daily (Smutná et al., 2024).

The health benefits of the increased consumption of fruits and vegetables are well established. A meta-analysis by Aune et al. (2017) demonstrated that a daily intake of 800 g of fruits and vegetables decreased the risks of cardiovascular disease and all-cause mortality by 28% and 31%, respectively. The study also indicated that a daily intake of 600 g of fruits and vegetables reduced total cancer risk by 14%. A cohort study in the United States, which examined the relationships between diet and weight changes over 20 years, observed an inverse relationship between fruit and vegetable intake and body weight (Mozaffarian et al., 2011).

In many cases, fruit and vegetable intake analyses have been limited to food purchased in shops (Bonanno et al., 2017; Dogbe & Revoredo-Giha, 2021; Irz et al., 2019; Silva et al., 2023) and have neglected to consider fruits and vegetables produced outside the market (i.e., those grown at home or in an allotment or community garden; the Freshfel's [2023] study also evidenced such neglect). "Gardening" or "food growing" herein refers to producing one's food in various locations, including gardens or on balconies. Other terms used in the literature include food self-provisioning, informal food production, subsistence farming, home food procurement, and domestic food production. Gardening is a widespread practice in both Global North countries with high urbanization levels, including Europe (Ančić et al., 2019; Vávra et al., 2018), the United States (Schupp & Sharp, 2012), Australia (Donati & Rose, 2020), and Japan (Kamiyama et al., 2016), and Global South countries such as China (Fan et al., 2019; Jehlička et al., 2024). The abovementioned studies have demonstrated that between one-third and two-thirds of the population of various countries informally grow food in gardens. The present study, therefore, represents an attempt to connect three important topics—gardening, fruit and vegetable consumption, and human health—in one analysis, aiming to provide insights into how these three components are related. These three topics have also been researched in the context of Global South countries and with miscellaneous results (e.g., Blakstad et al., 2022; Depenbusch et al., 2021). However, the type of gardening reflected in these case studies is different; therefore, our literature review and comparison with the results of previous research focus predominantly on the area of the Global North. Compared to the Global North, home food growing in Global South countries is often more economically relevant. Additionally, the case studies focus on various types of interventions, including additional support for food-growing households. This differs from most of the comparative or intervention studies conducted in a Global North, which are important for the context of our research (e.g., Litt et al., 2023; Nova et al., 2020).

As readers of this article will notice, some of the reviewed literature presents contradictory results. These were included to dutifully capture the state of the art of this research area, which supports the generally positive links between gardening, fruit and vegetable consumption, and health but also identifies case studies that do not confirm these positive effects.

Gardens are generally considered to have multiple benefits for human health (e.g., Twohig-Benett & Jones, 2018; Veen et al., 2020). A review by Soga, Gaston, et al. (2017) indicated that gardeners often have better mental health and subjective well-being than nongardeners (e.g., higher levels of life satisfaction and lower levels of stress, anxiety, and depression) and score better in several other health indicators (e.g., a lower body mass index [BMI] and more physical activity). The gardening effect is plausible even if sociodemographic characteristics are controlled for. However, some studies have failed to reveal any link between gardening and objective health indicators, such as BMI (e.g., Algert et al., 2016; Soga, Cox, et al., 2017). The recent COVID-19 pandemic reinforced the scholarly interest in research on gardening, and findings have confirmed gardening's importance for well-being and life satisfaction (e.g., Corley et al., 2021; Lehberger et al., 2021), social connections (Kingsley et al., 2022), and nutritional resilience (Smutná et al., 2024). Besides the abovementioned contexts, gardening research may focus on cultural, ecological, food security or resilience aspects, among many others (Taylor & Taylor Lovell, 2014).

The relevant comparative research exploring the relationship between gardening and fruit and vegetable consumption suggests that gardeners eat more fruits and vegetables than nongardeners. Some studies have found that food growing as a practice leads to higher fruit and vegetable intake among individuals who undertake this lifestyle change. These findings have been supported by case studies from the United States (e.g., Alaimo et al., 2008; Diekmann et al., 2018; Gray et al., 2014; Litt et al., 2011, 2015; Niles et al., 2021), Portugal (Nova et al., 2020), and Japan (Soga, Cox, et al., 2017). Studies on Czech gardeners have revealed that their fruit and vegetable consumption was higher than the country's average (Sovová, 2015, 2020). However, many studies have relied on low numbers of respondents or specific local samples of gardeners. In addition, a recent case study from the United States has not supported the positive effect of gardening on fruit and vegetable consumption (Litt et al., 2023).

Sociodemographic indicators, including age, education, and place of residence, may influence all three topics relevant to our research (engaging in gardening, consuming fruits and vegetables, and health). Some studies have argued that gardening is a widespread activity, with participation being more or less evenly distributed among different age, education, and income groups (e.g., Barnidge et al., 2013; Smith et al., 2015). However, others have identified family structure, income or employment status (e.g., Vávra et al., 2018), place of living (Smutná et al., 2024), and, more recently, the experience of financial loss during COVID-19 (Millard et al., 2022; Niles et al., 2021) as influencing the propensity to engage in this activity. The effect of sociodemographic factors on fruit and vegetable consumption has been shown by, for example, Alaimo et al. (2008) and Litt et al. (2011), who demonstrated higher consumption of fruits and vegetables by older people, women, and respondents with higher education. On the other hand, Barnidge et al. (2013) did not find that sociodemographic characteristics influenced the consumption of fruits and vegetables.

Core Idea

- Gardeners consume fresh fruits and vegetables more frequently than nongardeners.
- Sociodemographics (mainly age and education) mediate the relationship between gardening, consumption, and health.
- Neither fruit and vegetable consumption nor gardening affects objective health indicator (occurrence of diseases).
- Better subjective health (one's own assessment) is linked to more frequent fruit and vegetable consumption.
- Gardeners have lower body mass indices than nongardeners.

The brief literature review of the present study considered research covering three relationships, namely, those between health and fruit and vegetable intake, between health and gardening, and between gardening and fruit and vegetable intake. However, to our knowledge, only a limited number of studies looked at all three topics at once (Alaimo et al., 2008; Algert et al., 2016; Litt et al., 2011, 2015, 2023; Mead et al., 2021; Soga, Cox, et al., 2017). As mentioned above, the relationships are often tenuously demonstrated. Therefore, this study analyzed the relationship between gardening, fruit and vegetable consumption frequency, and health. Specifically, it addressed the following research questions:

- Do gardeners eat fresh fruits and vegetables more often than nongardeners do?
- Does fruit and vegetable consumption benefit human health, as measured both subjectively and objectively?
- Does gardening benefit human health, as measured both subjectively and objectively?
- How do these relationships change when sociodemographic indicators are controlled for?

This study was based on a large dataset of Czech respondents, which is representative of the general population. Furthermore, the study included food growing at home, a practice that, despite being widespread in many affluent societies, often escapes the attention of human health researchers and can be neglected or even contested by policies at local, national, or international levels (Pixová & Planck, 2024; Vávra et al., 2021). In addition, the analysis connected gardening, fruit and vegetable consumption, and the consideration of both subjective and objective health together in a single study.

In a broader sense, adopting the social science lens, it contributed to the health aspects of food research and added new knowledge to current debates on food policies (e.g., Halvey et al., 2021; Kingsley et al., 2023; Simón-Rojo, 2021; Soga, Cox, et al., 2017).

2 | MATERIALS AND METHODS

The data were collected through an online method. A survey was administered to 1699 respondents from the Czech National Panel—more specifically, the respondents were participants in a longitudinal survey titled "Living Through the Pandemic," which commenced in 2020 (the same respondents are asked to answer the same questionnaire repeatedly over time to track any changes). Data collection was performed by the company NMS Market Research in collaboration with the company PAQ Research and the Systemic Risk Institute consortium. Data collection during October and November 2022 included several topics, including household economics, health, food consumption, physical activity, and perceptions of political issues (for more information about the dataset, see Prokop and Röschová [2023]). Quota sampling was used to select the respondents of the longitudinal survey. This means that respondents were chosen according to sociodemographic characteristics to provide a sample reflecting an entire adult Czech population. The sample is representative in terms of sex, age, education, and region. However, respondents from cities with more than 50,000 inhabitants were overrepresented in the sample to allow better modeling to meet the original purpose of the longitudinal COVID-19 study. Therefore, the results presented in this paper were adjusted using poststratification weights to balance this overrepresentation. Weighted data are, thus, representative of the Czech population in all categories (sex, age, education, region, and municipality population). However, because the weighting procedure may influence the relationships between some specific subgroups of variables, we treated all sociodemographic characteristics as control variables.

The core research variables included growing one's food, the frequency of fresh fruit and vegetable consumption, self-reported health, BMI, and the occurrence of three health conditions: high blood pressure, diabetes, and high cholesterol. The question investigating the frequency of fresh fruit and vegetable consumption was part of a list of items focusing on the overall frequency of food consumption of different types of food. As the question did not specify any particular period, any potential bias due to the year's seasonality could be only implicit. Regarding growing food, respondents were asked whether they had grown any food during the year. This eliminates the potential bias in the answers caused by surveying the respondents after the end of the growing season.

Food growing included all types of gardens (home, allotment, weekend house, or community) and balconies. Food growing was coded as a dummy variable (currently growing fruits and vegetables or not) for further analysis. The original 5-point scale of self-reported health shown in Table 1 was later recoded using four points by merging the categories "very bad" and "bad" to account for the low occurrence of the latter category. BMI was calculated from the participant's self-reported height and weight (weight in kilograms divided by height in meters squared) and was subsequently split into five categories. BMI was then recoded into four categories for the linear regression because of the low occurrence of BMI < 18.5 kg/m^2. BMI was used despite our awareness of its limitations, including ethnic or gender sensitivity (Caleyachetty et al., 2021; Pray & Riskin, 2023). However, the Czech population is ethnically very homogeneous (predominantly white), and a separate regression analysis was carried out in the case of BMI (see Section 3). Concerning the three health conditions, respondents were asked whether they had received a medical diagnosis. Finally, a new variable summarizing objective health problems was created for the analysis (see Section 3).

Table 1 presents the main control variables used in this paper, as well as the frequencies of the answers. Sociodemographic variables comprised sex (assigned at birth), age group, municipality population, and household income. The category municipality population shows that the vast majority of the respondents live in municipalities, which are usually recognized as urban settlements in Czechia (2000 inhabitants or more). It also presents an overview of the number of household members, household composition, and the respondents' economic status to describe the sample (these variables were not used in any further analysis). Equivalized income was calculated as the total monthly household income divided by the consumption units, taking the OECD (n.d.) modified scale as an inspiration: first adult, 1; other adult or child 13+ years, 0.5; and younger child, 0.3. The result was split into four categories that were compared to the median income of Czech households according to the latest EU-SILC survey (CZSO, 2024). Data analysis was performed in IBM SPSS Statistics 28 by deploying descriptive methods, Pearson correlation analysis, and linear regressions. If not stated otherwise, statistical significance was set at $p < 0.05$ (i.e., there is a less than 5% probability that the observed outcome could have occurred by random chance). Microsoft Excel was used to create the figures.

3 | RESULTS

The results revealed that more than half of Czech households (55%) grew some food. The age and income of gardeners among our respondents did not differ significantly from those

TABLE 1 Overview of answers and sociodemographic characteristics.

Variable	Category	Percentage
Sex		
	Male	48.2
	Female	51.8
Age groups		
	20—34	20.4
	35—49	27.6
	50–64	24.8
	65+	27.2
Education		
	Primary	11.4
	Lower secondary	34
	Secondary with GCSE	34.6
	College/university	20
Municipality population		
	Up to 1999	22.3
	2000–19,999	30.1
	20,000–99,999	21.7
	100,000 or more	25.8
Household members		
	1	21.7
	2	39.3
	3	19.3
	4 or more	19.7
Household composition		
	Adults with child(ren)	30.3
	Adults without child(ren)	42.4
	Single parent with child(ren)	3.8
	Single adult	21.7
	Student/other	1.8
Economic status		
	Employee	47.7
	Self-employed	8.9
	Student	4.6
	Maternity/parental leave	4.3
	Retired	30.8
	Unemployed	2.2
	Other	1.5
Equivalized net monthly household income		
	Below the poverty level (60% of the median or less)	19
	Low income (below the median)	48.1
	Above-standard (up to 1.5× the median)	25.3
	High income (1.5× the median and more)	7.7
Growing own food (% yes)		
	Yes, we do	54.9
	No, but we are considering growing food in the future	6.7
	No, and we are not considering growing food	27
	No, but we used to	11.3
Frequency of fresh fruit and vegetable consumption		
	Rarely or never (max. once a month)	5
	2–3× a month	9.8
	Once a week	12.7
	2–3× a week	24.4
	4–6× a week	21
	Daily	27.1
How is your health in general		
	Very good	11.3
	Good	42
	Fair	35.2
	Bad	10.2
	Very bad	1.3
BMI (kg/m^2) categories		
	<18.5	1.6
	18.5–25	33
	25.1–30	34.5
	30.1–40	26.6
	>40	4.3
High blood pressure (% yes)		44.1
Diabetes (% yes)		13.5
High cholesterol (% yes)		34.7

Note: $N = 1699$, except for the equivalized net household income because of some missing values ($N = 1501$).
Abbreviation: BMI, body mass index.

of nongardeners. Significant differences, however, were found for sex ($r = 0.063$, $p = 0.010$), education ($r = 0.066$, $p = 0.006$), and municipality size ($r = -0.202$, $p < 0.001$). The letter r stands for the results of Pearson correlation; 0 shows no relationship between the two variables, while 1 or −1 shows total agreement. The value of p shows the probability of obtaining the observed outcome. For example, $p = 0.01$ means that there is a 1% chance that the observed outcome could have occurred by random chance.

For sex (among women, 58% were gardeners compared to 52% for men) and education (in the group with the lowest level of education, 46% were gardeners, while this number increased to 60% among those with the highest level of education), the differences were significant but still clustered around the mean. When municipality population was

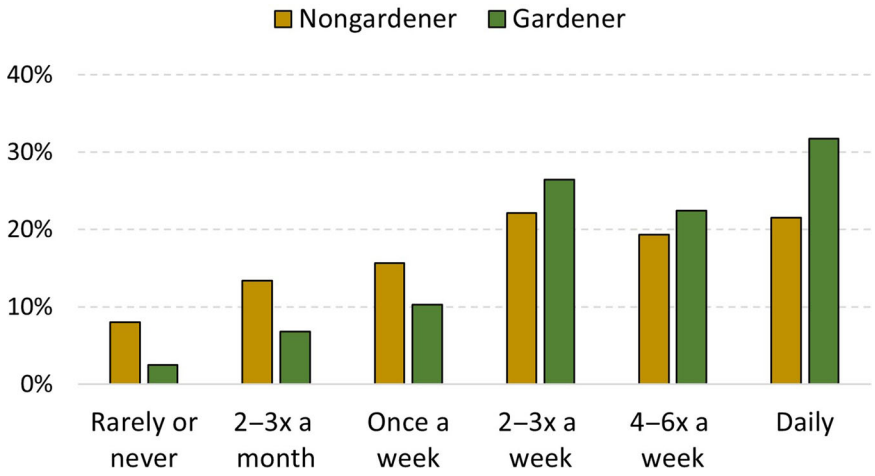

FIGURE 1 Frequency of fresh fruit and vegetable consumption among gardeners and nongardeners, $N = 1699$. Share of answers among each group. The sum of the categories makes 100% in each group.

considered, the share of gardeners ranged between 74% of respondents in the smallest municipalities (1999 inhabitants or less) and 45% of respondents in large cities (over 100,000 inhabitants). This finding supports the importance of home gardening in urban areas. Table 1 provides an overview of the sociodemographic characteristics of the respondents and the frequencies of answers to the questions (i.e., the variables used in the analysis).

The first research question focused on the relationship between food growing and the frequency of fruit and vegetable consumption. Pearson correlation testing revealed that gardeners ate fruits and vegetables more often than nongardeners ($r = 0.199$, $p < 0.001$). The largest differences were found in the most and least frequent categories: 31.7% of gardeners ate fresh fruits and vegetables daily, whereas 21.5% of nongardeners did so. The situation was reversed for the lowest frequency of fruit and vegetable intake. A mere 6.8% of gardeners ate fresh fruits and vegetables only twice or three times a month, whereas 13.4% of nongardeners did so. In addition, 8% of nongardeners reported rare or no consumption of fresh fruits and vegetables, but only 2.5% of gardeners did so (see Figure 1).

We controlled for the effect of sociodemographic characteristics in the linear regression (Table 2). Food growing per se retained a positive relationship with fruit and vegetable consumption. Almost all the control variables had some effect. Higher intake was associated with being a woman, being older, having a higher educational level, and having a higher income. Living in larger municipalities resulted in similar trends, but they were nonsignificant. Therefore, the answer to the first research question is yes—food growers consumed more fresh fruits and vegetables, even after controlling for sociodemographic factors. Figure 2 shows the importance of six particular factors from Table 2. All of them (except for the municipality population) are significant even if the effect of other factors is controlled for.

We used three indicators to analyze the relationship between food growing, fruit and vegetable consumption, and the state of health: (1) a single-item question measured subjective health; (2) BMI was calculated using the respondents' weight and height; and (3) a new composite variable representing objective health was constructed. This composite variable consisted of three binary items: high blood pressure, diabetes, and high cholesterol (calculated as the sum of them, see below). Table 1 presents the distribution of all indicators among the sample of respondents. Approximately half of them (53%) perceived their health as very good or good, and almost two-thirds (65%) had a BMI higher than 25 kg/m^2, which is the overweight threshold. Diagnosed high blood pressure and high cholesterol were common (44% and 35%, respectively), whereas the diabetes proportion was lower (14%). The three health conditions (high blood pressure, diabetes, and high cholesterol) were cumulatively aggregated. Table 3 presents the distribution of this composite indicator (i.e., the number of respondents with a combination of the objective health problems). Almost half of the respondents (42%) had none of the three surveyed conditions, while 7.5% suffered from all three.

The second research question concerned the relationship between fruit and vegetable consumption and health. Correlation analysis revealed that respondents who ate fruits and vegetables more often tended to suffer more from objective health problems ($r = 0.062$, $p = 0.010$). This counterintuitive result can be explained by the correlation between older age and higher frequency of fruit and vegetable consumption ($r = 0.164$, $p < 0.001$) and the simultaneous correlation between older age and higher number of health problems ($r = 0.495$, $p < 0.001$). The positive link between subjective health and the frequency of fruit and vegetable consumption was supported by the findings of the correlation analysis ($r = -0.083$, $p < 0.001$). Subjectively healthier people ate fruits and vegetables more often. Similar findings appeared when the BMI indicated overweight. Respondents who ate fruits and vegetables more often had a lower BMI ($r = -0.056$, $p = 0.022$) than those with less frequent consumption.

TABLE 2 Effect of gardening and sociodemographic characteristics on fruit and vegetable consumption.

	B	*β*	*p*
Growing any food (0 no, 1 yes)	0.589	0.201	**<0.001**
Sex (1 male, 2 female)	0.615	0.211	**<0.001**
Age groups (from 1 "20–34 years" to 4 "65+ years")	0.278	0.207	**<0.001**
Education (from 1 "primary" to 4 "university")	0.222	0.140	**<0.001**
Equivalized income (from 1 "poverty" to 4 "high income")	0.291	0.168	**<0.001**
Municipality (from 1 "up to 1999 inhabitants" to 4 "100,000 and more inhabitants")	0.060	0.045	0.068
Constant	0.915		**<0.001**
Adjusted $R^2 = 0.162$			

Note: $N = 1501$ because of some missing values. Linear regression-dependent variable: fresh fruit and vegetable consumption, with values from 1 (rarely or never [maximum once a month]) to 6 (daily). *B* stands for unstandardized regression coefficients and *β* stands for standardized coefficients (this allows comparison of the effect of all variables). $p < 0.05$ is considered significant and indicated in bold.

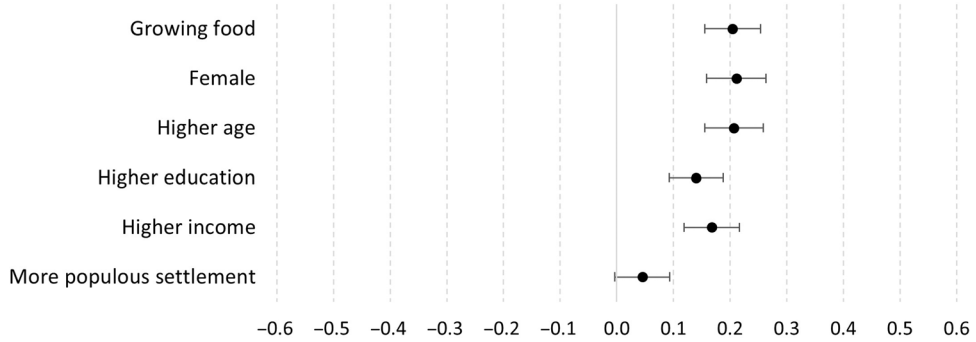

FIGURE 2 The measure of the effect of gardening and particular sociodemographic characteristics on fruit and vegetable consumption. The dots show standardized *β* coefficients as presented in Table 2. The whiskers show confidence intervals (particularly ±2 standard errors) of *β* coefficients (calculated by standardization of the *B* coefficients' errors). A higher number (absolute values) means a stronger effect. Whiskers overlapping the vertical 0 axis suggest lower or missing statistical significance (see *p* value in Table 2).

TABLE 3 Number of objective health problems.

Number of health problems	Percentage
None	42.2
1	30.7
2	19.6
3	7.5
Total	100

Note: $N = 1699$.

The third research question focused on the relationship between food growing and the three health-related topics: objective health, subjective health, and BMI. Compared to those who did not grow food, gardeners had fewer objective health problems ($r = -0.052$, $p = 0.031$), subjectively felt healthier ($r = -0.075$, $p = 0.002$), and had lower BMI ($r = -0.060$, $p = 0.014$). These results demonstrated evident links between food growing and health problems, but the significance thereof was weaker than for the relationship between health and fruit and vegetable consumption.

Three linear regression models were constructed to differentiate between the effects of the frequency of fruit and vegetable consumption, food growing, and control sociodemographic characteristics on health (Table 4). The relative importance of the particular factors is visually presented in Figure 3, which allows for an easy comparison of the effects. When controlling for other factors in Model 1, both the consumption of fruits and vegetables and gardening lost their significance. Younger age and a higher education level were linked to better objective health. In Model 2, better subjective health remained significantly associated with more frequent fruit and vegetable consumption, but the positive effect of gardening decreased (still evident but not significant). Younger age, higher income, and higher education (on the edge of significance) were control variables linked with better subjective health. Model 3 yielded the opposite results to Model 2. Gardening was significantly associated with a lower BMI, but a higher fruit and vegetable consumption frequency exhibited a nonsignificant positive trend. Almost all control variables affected the results—being a woman, being younger, being better educated, and living in larger

TABLE 4 Effect of fruit and vegetable intake, gardening, and sociodemographic characteristics on health.

	Model 1: Objective health			Model 2: Subjective health			Model 3: BMI categories		
	B	***β***	***p***	***B***	***β***	***p***	***B***	***β***	***p***
Fresh fruit and vegetable consumption (1 never, 6 daily)	−0.005	−0.008	0.740	−0.066	−0.115	**<0.001**	−0.024	−0.040	0.142
Growing any food (0 no, 1 yes)	−0.053	−0.028	0.242	−0.068	−0.040	0.099	−0.129	−0.073	**0.005**
Sex (1 male, 2 female)	−0.021	−0.011	0.641	0.072	0.043	.083	−0.234	−0.133	**<0.001**
Age groups (from 1 "20–34 years" to 4 "65+ years")	0.426	0.480	**<0.001**	0.283	0.364	**<0.001**	0.151	0.185	**<0.001**
Education (from 1 "primary" to 4 "university")	−0.093	−0.089	**<0.001**	−0.046	−0.050	0.050	−0.075	−0.078	**0.004**
Equivalized income (from 1 "poverty" to 4 "high income")	−0.017	−0.015	0.550	−0.146	−0.145	**<0.001**	−0.025	−0.023	0.400
Municipality (from 1 "up to 1999 inhabitants" to 4 "100,000 and more inhabitants")	0.006	0.006	0.783	−0.003	−0.004	0.874	−0.102	−0.126	**<0.001**
Constant	0.181		0.185	2.615		**<0.001**	2.666		**<0.001**
Adjusted R^2	0.248			0.191			0.075		

Note: The linear regression-dependent variables were as follows: Model 1, objective health with values from 0 "no problem" to 3 "all three problems" ($N = 1499$); Model 2, subjective health with values from 1 "very good" to 4 "very bad + bad" ($N = 1499$); Model 3, body mass index (BMI) recoded to four categories from 1 "<25.1" to 5 ">40" ($N = 1500$). *B* stands for unstandardized regression coefficients, and *β* denotes standardized regression coefficients (this allows comparison of the effect of all variables).

settlements were associated with a lower BMI. The models' overall explanatory power was adequate for objective and subjective health (25% and 19% variability, respectively) but low for BMI (only 8%). As sex is a significant independent variable in Model 3, separate regressions for men and women (not included in Table 4) show that food growing is related to lower BMI only among women. Similarly, the positive education effect is visible among the women's group. Additionally, the consumption of fresh fruit and vegetables also becomes significant among women. Men's BMI seems to be much less sensitive to the effect of surveyed factors.

Based on our findings, the answer to the second research question is not straightforward. When considering only the frequency of fruit and vegetable consumption, respondents who ate them more often were subjectively healthier and had lower BMI than others, but their objective health was worse. In the case of the third research question, gardeners reported less objective health problems, better subjective health, and lower BMI. Nevertheless, when control sociodemographic variables were included (the fourth research question), only two of the six associations remained significant: (1) subjectively healthier people ate fruits and vegetables more often and (2) gardeners had lower BMI.

4 | DISCUSSION

This section starts with a discussion of the results in comparison with the findings of previous studies. This is followed by considering the policy context focusing on public health and urban agriculture. A discussion of our case study's limitations concludes this part of the article. The results demonstrated the long-term popularity of gardening among Czech households (e.g., Smith et al., 2015), which has slightly increased since the onset of the COVID-19 pandemic (Smutná et al., 2024) and has remained high to date. Although sociodemographic characteristics affect the probability of individuals growing food to a certain extent, current findings are in accordance with previous research demonstrating that the phenomenon is widespread and socially inclusive (Smith et al., 2015). The difference in the incidence of food growing between smaller and larger municipalities remains stable (e.g., Jehlička et al., 2013; Smutná et al., 2024; Vávra et al., 2018). We speculate that the most likely reason for this is the more frequent distribution of private houses with gardens in villages and smaller towns. Yet the popularity of weekend houses (often with adjacent gardens) in the countryside, as well as the frequent presence of allotment gardens in cities and towns, may be one of the reasons for quite a high number of food-growing households living in large urban centers.

When discussing the frequency of fresh fruit and vegetable consumption, one must remember that the question categories used in our survey are slightly different from those used in previous research. The most frequent answer in our case was "daily," whereas some earlier studies employed scales that allowed the researchers to distinguish the number of portions per day (e.g., Algert et al., 2016; Litt et al., 2011). Therefore, eating fresh fruits and vegetables daily represents

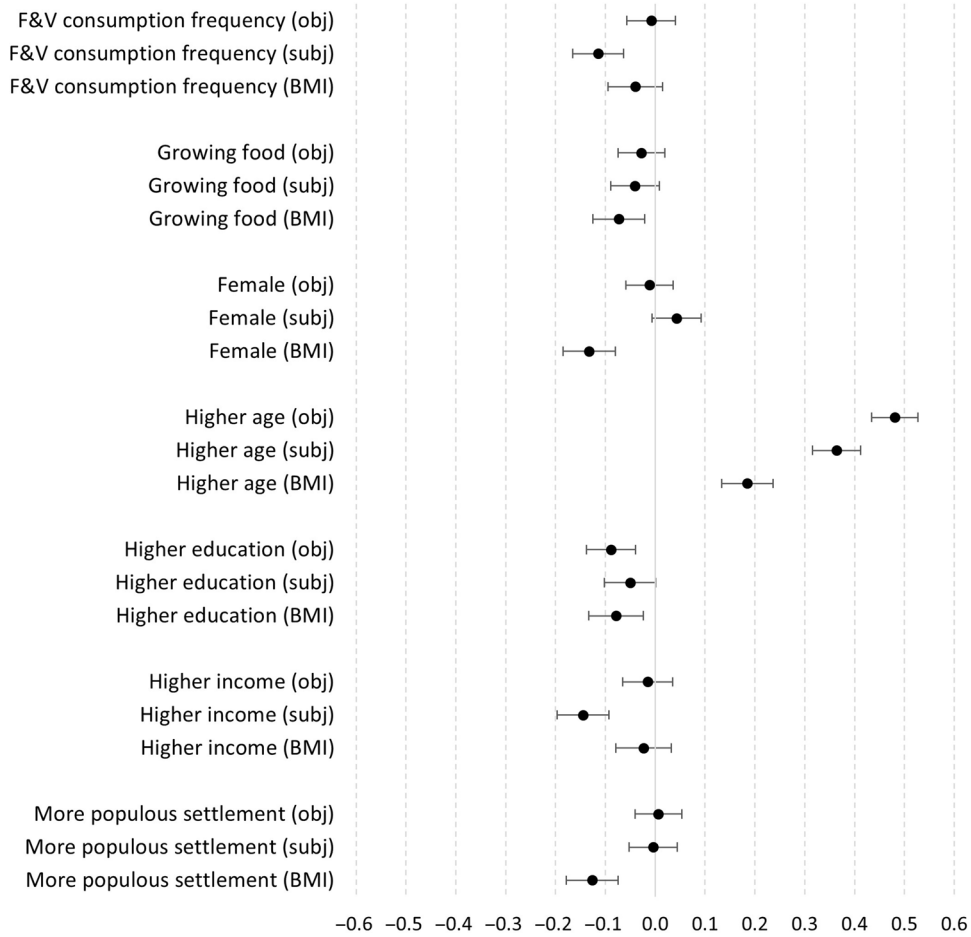

FIGURE 3 The measure of the effect of fruit and vegetable (F&V) consumption, gardening, and sociodemographic characteristics on health. The dots show standardized β coefficients as presented in Table 4. The whiskers show confidence intervals (particularly ±2 standard errors) of β coefficients (calculated by standardization of the B coefficients' errors). The factors are grouped to allow easy comparison among them in the three models. Abbreviations in brackets refer to the particular regression model: obj (Model 1): objective health, subj (Model 2): subjective health, BMI (Model 3): body mass index. A higher number (absolute values) means a stronger effect. Whiskers overlapping the vertical 0 axis suggest lower or missing statistical significance (see p value in Table 2).

the healthiest category in this study, although doing so does not necessarily mean meeting the WHO recommendations (WHO, 2008, 2020). The results demonstrated that only 27% of the respondents ate fresh fruits and vegetables daily, an even lower number than in a previous investigation conducted in Czechia in 2021 (35%, as reported in Smutná et al., 2024). The more frequent consumption of fruits and vegetables among Czech food growers corresponds with the findings of most studies that compared gardeners and nongardeners. This includes Japanese (Soga, Cox, et al., 2017) and US case studies (Alaimo et al., 2008; Barnidge et al., 2013; Litt et al., 2011, 2015; Niles et al., 2021).

Our research revealed that fresh fruit and vegetable consumption was substantially moderated by most sociodemographic control factors (sex, age, education, and income). However, gardening remained a significant predictor even when these factors were controlled in regression models. This means that simply living in a gardening household, regardless of other factors, makes one's diet healthier in terms of fresh fruit and vegetable consumption. This is an important finding, which differs from some of the previous studies. Barnidge et al. (2013) did not find any effect of sociodemographic characteristics on fruit and vegetable consumption. Alaimo et al. (2008) reported being female and having higher education being influential, and the case study by Litt et al. (2011) determined that only two factors—growing food in community gardens and higher educational attainment—positively influenced fruit and vegetable consumption. By contrast (and notably), the current study of a large representative survey sample of the Czech population found that both sociodemographic characteristics and food growing matter when it comes to healthy eating. This message carries vital importance for policymakers, especially in public health and food policy context (see below for details).

Our findings indicate a complex three-way relationship between objective health, fruit and vegetable consumption,

and gardening. The surprising link between a healthier diet (considering fruit and vegetable intake) and worse objective health disappeared in the regression model. When all sociodemographic indicators were controlled for, the results showed that younger and better-educated people were healthier. Consuming a diet rich in fruits and vegetables and growing one's food lost their importance, which was revealed by bivariate correlations. This may be explained by the uncertain causality, often overlooked in many studies on the public health aspects of gardening.

A review by Soga, Gaston, et al. (2017) and many case studies have highlighted the positive effects of gardening on the subjective health of gardeners compared to nongardeners (Corley et al., 2021; Litt et al., 2011; Soga, Gaston, et al., 2017), even though some authors did not identify this relationship (Alaimo et al., 2008) or discovered that this relationship was moderated by other factors (Litt et al., 2015). Our research confirmed a link between food growing and better subjective health, but the link lost its significance in the regression models (even though a nonsignificant trend remained). Being younger or having a higher income positively affected the relationship, as did higher fruit and vegetable consumption.

Concerning the BMI indicator, our research documented a high prevalence of overweight (35%) and obesity (31%) in Czechia, a serious public health problem. Our findings indicate a positive link between BMI and fruit and vegetable consumption, but this relationship disappeared when sociodemographic indicators were included in the analysis. By contrast, gardening remained important. Significant control variables, including being a woman, being younger, being better educated, and being a city dweller, were associated with a lower BMI, as was gardening. This contrasts with most previous studies, which did not prove a link between BMI and food growing (Alaimo et al., 2008; Soga, Cox, et al., 2017; Litt et al., 2023), except for Litt et al. (2011). The positive link between food growing and a lower BMI is another important policy message considering the high levels of overweight and obesity in Czechia and many other Global North countries (Eurostat, 2024) and the popularity of gardening in this part of the world.

Our findings confirm the importance of the social and health aspects of gardening and underscore the public health benefits of growing food at home. Building on our results, we argue that gardening should be considered in the formulation of public health policies (Kingsley et al., 2023; Smutná et al., 2024), urban food strategies (Simón-Rojo, 2021), and food-related conceptions in general. While food growing in community or backyard gardens is included in the urban agriculture strategies in some cities of the Global North (Halvey et al., 2021; Niedzwiecki et al., 2022), other research, particularly from Czechia, demonstrated the problematic aspects of urban food policies. Pixová and Planck (2024) found that while local governments in large cities perceive favorably and tend to support community gardening, their attitudes to the more widespread allotment gardening are more ambiguous and often hostile. Moreover, compared to the dominant environmental topic of biodiversity and climate change adaptation, health and food security aspects of food production are absent from policy debates. Similarly, there is little recognition of the benefits associated with home food growing in national food and regional development policies as well as in recent EU strategies, such as From Farm to Fork (Vávra et al., 2021). However, in keeping with relevant literature, our results point to the importance of home food production and distribution within Europe, the United States, and other Global North countries (e.g., Donati & Rose, 2020; Schupp & Sharp, 2012; Vávra et al., 2018). Gardening is a practice compatible with policy objectives in a range of contexts, including health (Kingsley, 2024; Soga, Gaston, et al., 2017), nutrition (Smutná et al., 2024), resilience (Jehlička et al., 2019) and sustainability (McGreevy et al., 2022). Therefore, policies that support access to gardens (especially in urban areas) and promote maintaining and sharing gardening knowledge and skills should be implemented.

As mentioned earlier, this study has some limitations. Our questionnaire did not ask for a frequency higher than "daily," and it did not reveal the number of servings or their weight. Moreover, any study such as this one must deal carefully with potential two-way causalities. These include gardening, leading to a better diet and higher physical activity, as well as better health leading to more intense gardening. Gardening can also influence health in many ways, not only through diet (as we suppose) but also through physical activity, social connections, spending time outdoors, and the like (Soga, Cox, et al., 2017). Furthermore, our research did not explore whether the higher frequency of fruit and vegetable consumption among gardeners was caused by the consumption of their produce or by shopping for healthier food. However, the studies listed in Section 1 suggest that it is due to the consumption of their produce (e.g., Nova et al., 2020; Soga, Cox, et al., 2017; Sovová, 2015, 2020). In addition, the effect of some sociodemographic indicators (e.g., sex) on food growing should be interpreted carefully because the question was phrased collectively (whether the household grows food). Moreover, gardening is usually practiced by several members of the same household rather than by only one. This question has already been discussed in the context of gardening research and partner homogamy (Vávra et al., 2018). Finally, a comparison of our weighted sample and results with previous research using non-weighted Czech datasets suggests the plausibility of our findings (Jehlička et al., 2013; Smith et al., 2015; Smutná et al., 2024; Vávra et al., 2018), yet we used the sociodemographic characteristics as a control tool but not for wider generalizations.

5 | CONCLUSION

This paper presented findings from the examination of a representative sample of the Czech adult population, aiming to investigate the relationship between objective and subjective health, fresh fruit and vegetable consumption, and growing food at home. The results revealed that gardening remains popular among all social groups of affluent societies, such as Czechia. Gardening is associated with a higher frequency of fruit and vegetable consumption, but the relationship between these two elements and the health aspect is complicated. When control sociodemographic factors were included, neither fruit and vegetable consumption nor food growing affected objective health, as measured by the occurrence of several diseases. The situation was reversed in the case of better subjective health, which was related to fruit and vegetable consumption, and, in the case of lower BMI, to gardening. Further research on the relationship between gardening, food consumption, and health can build upon our findings and attempt to connect the advantages of large representative surveys with the benefits of other methods, such as food diaries and objective health diagnoses. As things stand, however, from a more theoretical perspective, the inclusion of home food production in Global North countries into mainstream scholarship on food politics, economics, and other food studies remains an important challenge.

AUTHOR CONTRIBUTIONS

Jan Vávra: Conceptualization; data curation; formal analysis; investigation; methodology; writing—original draft; writing—review and editing. **Petr Jehlička**: Conceptualization; writing—original draft; writing—review and editing. **Maika Ohno**: Conceptualization; writing—review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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