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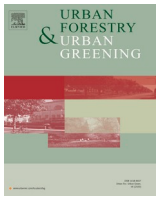

Understanding how we can encourage front gardening: Analysing capability and opportunity factors from a nationally representative survey

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ABSTRACT

Front gardens provide environmental and public health benefits to urban spaces, but are increasingly being covered with impermeable surfacing rather than plants and greenery. To complement and extend the exploration of motivations in the literature on front gardening, we used data collected in a national survey of 1000 adults aged 20–64 in England to explore what capability and opportunity factors affect whether people gardened in their front gardens and the time they spent on this. We found that feeling experienced affected whether someone gardened, but not time spent gardening, whilst greater general and specific knowledge and self-efficacy was associated with all gardening behaviour. In terms of opportunity factors, only time, convenience and rental status were significant factors. Future interventions should build knowledge, experience and self-efficacy, whilst ensuring they are not too time-intensive or inconvenient.

1. Introduction

Greenery in urban areas can help to mitigate the effects of climate change and biodiversity loss. While carbon capture through photosynthesis in plants is well-known, there is also evidence that up to 75% of terrestrial carbon is sequestered in soil (Edmondson et al., 2014). Vegetation retains rainwater on leaves and bark, and rainwater runoff takes time to filter through soil. These processes slow the rate at which rainfall hits drainage systems and reduce the volume, enabling drainage to cope with increasingly intense rain, reducing the risk of flash flooding (Kelly, 2018). Planting helps to cool the local environment through shading, evapo-transpiration and reduced reflection (albedo effect; (Cameron and Blanuša, 2016)). Vegetation and soil provide habitats for diverse fauna, from microscopic organisms and fungi, to invertebrates, birds and mammals.

In addition, green spaces, particularly in urban environments, provide vital support for physical and mental health. Physical health is improved through increased opportunities for outdoor physical activity and socialising within a healthier environment (Gascon et al., 2015), better sleep quality (Shin et al., 2020) and lower body mass index and inflammation levels (Chaparro et al., 2018). Improvements in air quality also confer protective health benefits (Zupancic et al., 2015). In addition to physical effects, green spaces are theorised to trigger restorative undirected attention (Young et al., 2020), as opposed to task-focussed directed attention in work-related activities, providing a sense of mental relief. It is therefore unsurprising that green spaces have been clearly linked to long term mental health benefits (Gascon et al., 2015; Wendelboe-Nelson et al., 2019).

Whilst previous work has focussed mainly on green spaces such as community gardens in studying their role upon health (Alaimo et al., 2016; Al-Delaimy and Webb, 2017; Gregis et al., 2021), within an urban UK setting garden spaces are equally likely to be as important. Eighty-eight per cent of British homes have access to private garden space (Office for National Statistics, 2020). Private gardens offer opportunity for active engagement with nature and the environment, and the activity of gardening is associated with better health outcomes (Soga et al., 2017), reduced risk of vitamin D deficiency (De Rui et al., 2014), increased fruit and vegetable intake and lower BMI (Kegler et al., 2020), suggesting it promotes a healthy lifestyle. Larger gardens have also been associated with better self-reported health (Brindley et al., 2018). Furthermore, private gardens are spaces which do not require council funding or maintenance.

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In particular, front gardens are an under-utilised and under-studied space despite compelling evidence for their benefits to mental health (Chalmin-Pui, Roe, et al., 2021). Of the limited research specifically on front gardens, much focuses on design (Daniels and Kirkpatrick, 2006; Scheerlinck and Schoonjans, 2016) and ecology (Daniels and Kirkpatrick, 2012), including the relationship between front gardens and urban flooding (Warhurst et al., 2014). Front gardens are likely to provide shared and community effects – Chalmin-Pui and colleagues proposed a sense of community as an important factor for participation in a national competition for front gardens (Chalmin-Pui et al., 2023). Despite being a private space they are usually seen by and may impact upon passers-by as well as those dwelling in the home. Gu et al. (Gu et al., 2024) recently explored the visual impact of the front garden of a multi-storey residential block, comparing the impact on owners in the block and passers-by and found some differences in preferences regarding garden characteristics. Slater and Peillon (2009) discussed how front gardens represent interactions between society and nature, and are shaped by both social and natural processes.

Despite the benefits, front garden greenery has reduced in recent decades. More hard standing and car parking space has been introduced, with a 40% loss of lawns in London over a period of nine years and two-thirds of front garden space being impermeable surfaces (Smith et al., 2011) and there is continuing evidence for loss of vegetation and tree cover in front gardens (Sainsbury and Slater, 2023). Front garden greenery relies substantially on individual citizens' behaviours, motivations and preferences; and preferences for types of garden landscape can vary considerably (Kurz and Baudains, 2012; Van Den Berg and Van Winsum-Westra, 2010). However, there is a clear lack of literature focussing on individual behaviour change with regards to front gardens.

We frame this study within the context of the established behaviour change model COM-B (Capability-Opportunity-Motivation-Behaviour, Michie et al., 2011). This states that for a behaviour to occur, a person must have motivation, social and physical opportunity and physical and psychological capability (Michie et al., 2011). This framework is widely used in analysing and designing behaviour change interventions (Allison et al., 2022; Brierley et al., 2021), and allows the exploration of a wide range of both systemic and individual barriers and facilitators to behaviour, as well as further mapping onto possible interventions. The model's particular value lies in its recognition of a suite of quite different influencing factors without assuming that a particular factor is more important.

In a previous study, we explored the varying motivations for planting in front gardens in England, and based on factor analysis found that motivations could be grouped into three sets – intrinsic motivations relating to enjoyment and personal benefit, aesthetic motivations relating to creating an attractive space, and utilitarian motivations relating to maintaining a functional benefit from a front garden (Murtagh & Frost, 2023). Whilst there has been substantial exploration of motivations for gardening from the UK and other countries (Al-Mayahi et al., 2019; Chalmin-Pui et al., 2021; Clayton, 2007), these often neglect the more practical and social barriers and facilitators that can occur. Furthermore, much of the previous work has focussed on older people and their experiences of and benefits from gardening (Wang and MacMillan, 2013). However, older people are likely to experience different facilitators and barriers, such as greater time if they are retired, health problems which may limit gardening ability and different caring responsibilities. Previous qualitative work indicated that these and other practical barriers are likely to be important (Frost & Murtagh, 2023). In this paper we therefore focus on the other aspects of COM-B that are likely to be salient, namely, capability and opportunity, within the wider age-range of working-age adults.

In the current paper we extend our previous study to understand the importance and prevalence of capability and opportunity barriers and facilitators associated with gardening behaviour. As planting and maintaining greenery are difficult behaviours to capture, in this paper we use the activity of gardening in the front garden as a target behaviour, as well as time spent front gardening on the assumption that greater time gardening will in turn lead to greater levels of greenery in front gardens and the consequent environmental and health benefits.

As much previous work has focussed on those who already garden, our paper aims to fill a gap by exploring factors relevant to the behaviour change necessary to shift from non-gardening to gardening in front gardens as well as increasing behavioural engagement in front gardening. Our work therefore aims to answer the following research questions:

1. Do capability and opportunity factors predict front gardening behaviour?
2. What are the most important capability and opportunity factors for front gardening behaviour?

2. Materials and methods

We conducted a national survey on front gardens and gardening and carried out two analyses of the data for this paper. The survey was carried out in May 2021 with 1000 participants aged 20–65 years with a front garden space at least the size of three large bins. The survey focussed on working age adults. We defined working age as 20–65 years.

Participants were recruited through a market research company through their large-scale participant panel, with demographic quotas to ensure representativeness of the UK general adult public on gender, ethnicity and on home ownership. The survey included questions on demographics, front garden characteristics, capabilities, opportunities and motivations to garden in the front garden and time spent gardening in an average week in summer. Respondents were asked: "In an average week in summer, approximately how much time do you spend gardening in the *front* garden? " with a choice to answer in hours and/or minutes. Sociodemographic questions included age, gender, ethnicity, home ownership, type of home, size of household, employment status and net household monthly income. Items to provide basic characterisation of the front garden were estimated width and length, and percentage vegetation. Based on findings from our earlier qualitative study (Frost & Murtagh, 2023) and informed by the literature, we generated 23 factors likely to influence front gardening. These were categorised according to the COM-B model into capability, opportunity and motivational factors. Motivational factors were analysed elsewhere (Murtagh & Frost, 2023)– below we analyse the responses to six Capability items and ten Opportunity factors. A single item was used for each factor, with data collected through 7-point Likert scales (from strongly disagree to strongly agree, see Tables 3 and 4 for the full list). We used a mix of positive and negative phrasing in order to reduce response bias.

The survey received ethical approval from University College London Bartlett School of Construction and Project Management Ethics Committee (ref 2020-StF-NM-002). Participants provided informed consent through reading the information sheet and confirming they were happy to proceed with the survey. Data were analysed as outlined below using SPSS v27.

2.1. Analysis 1: Do capability and opportunity factors predict front gardening behaviour?

The six capability and 11 opportunity factors were aggregated into capability and opportunity scales by taking the mean of the 1–7 scoring, which allowed inclusion of those with missing or not applicable data for one or more scale items. Negative items were reverse scored, so higher scale score items indicates fewer barriers and more facilitators. Those rated as non-applicable were recoded to missing. Three cases had missing data for the total capability and opportunity scales, leaving n=997 for analysis.

To assess how the scales influenced gardening status, we dichotomised time spent gardening in an average week in summer into non-gardeners (0 mins) or gardeners (>0 mins) which we refer to as

gardening status below. Because of this, we did not exclude participants with extreme high values from this analysis (n=3 above >2400 mins per week). We carried out independent t-tests to see whether capability and opportunity scales scores differed between the groups, with $p<0.05$ considered significant. On the capability test, variances were not equal, therefore the comparison with equal variances not assumed was used. Variances were equal for the opportunity test.

To explore associations with time spent gardening, we excluded those with 0 values and missing capability or opportunity scale items (total n=809). The variable time spent gardening was positively skewed, so log transformation was used. We carried out linear regression to explore the impact of capability and opportunity scale scores on time spent gardening, including sociodemographic characteristics (age, gender, income and education). Finally, we ran a model including both capability and opportunity factors. In this model, we also included the aggregated motivation scale (seven questions based on interest, flood risk, amount of work to do, aesthetics and pride) to understand how the different elements of the COM-B behaviour change model affected time spent gardening.

2.2. Analysis 2: What are the most important capability and opportunity factors for front gardening behaviour?

To identify the importance of different capability, and opportunity factors, the Likert responses for these variables were classified into four categorical variables: disagree (1−3), neutral (4), agree (5−7) and n/a (n/a). We descriptively summarised barriers and facilitators across our whole sample and by gardeners/non-gardeners. We carried out Chi-squared analyses to determine which barriers and facilitators were significantly associated with front gardening. For this analysis we excluded those who selected neutral or 'not applicable'. Total N for each analysis therefore varied according to item.

We also explored the effects on time spent gardening, including on those who reported spending any time gardening in an average week in summer ("gardeners", n=811/1000). As the data were positively skewed, we used the log transformation and carried out independent samples t-tests on log-transformed time spent gardening between those who agreed and disagreed with each factor.

3. Results

3.1. Survey respondents

Survey respondents had a mean age of 45.47 (SD 11.8) years and 57.8% were female (see Table 1 for demographics). Ethnicities included 85.8% White British, 7% Asian/Asian British, 3.2% Black/Black British, 1.7% Chinese and 2.3% mixed/other, which is in line with the 2021 UK census (Office for National Statistics, 2022). Most were employed full time working mainly outside the home (43.4%), 13.2% were mainly working from home, 15% were employed part time, 11.7% were a full time homemaker or carer, 8.9% were retired, 1.1% were students, 3.3% were seeking employment and 0.2% were furloughed (a UK Covid-19 mitigation measure which meant the incomes of those who were unable to work due to pandemic-related closures or restrictions were financially supported). There was a spread of responses according to educational level, region and household net income, and 12.4% reported a disability that limited their gardening ability. Most (67.1%) were homeowners and 32.4% tenants (0.5% other), which is in line with national rates (Office for National Statistics, 2018). Demographics in gardeners and non-gardeners were similar, with slight tendencies towards more gardeners being in full time employment, owning rather than renting, having a slightly larger garden and a further degree (Table 1). The majority lived in semi-detached houses (39.8%), closely followed by detached houses (28.3%) and terraced houses (28.2%) and a small amount in a ground floor flat (2.9%). Average front garden size was 56 m^2 (range 6.25–375 m^2).

Table 1
Sample demographics by gardening status.

	Non-gardeners	Gardeners	Total
Mean (SD) age (years)	47.2 (10.5)	45.07 (12.1)	45.5 (11.8)
Gender (%female)	114 (60.3%)	464 (57.2%)	578 (57.8%)
Ethnicity (N, %)			
White British	160 (84.7%)	698 (86.1%)	858 (85.8%)
Asian/Asian British	14 (7.4%)	56 (6.9%)	70 (7.0%)
Black/Black British	5 (2.6%)	27 (3.3%)	32 (3.2%)
Chinese	4 (2.1%)	13 (1.6%)	17 (1.7%)
Mixed/other	6 (3.3%)	17 (2.1%)	23 (2.3%)
Employment status (N, %)			
Full time outside the home	71 (37.6%)	363 (44.8%)	434 (43.4%)
Full time, mainly working from home	26 (13.8%)	106 (13.1%)	132 (13.2%)
Part-time	27 (14.3%)	123 (15.2%)	150 (15.0%)
Full time homemaker or carer	34 (18.0%)	83 (10.2%)	117 (11.7%)
Retired	9 (4.8%)	80 (9.9%)	89 (8.9%)
Student	0 (0%)	11 (1.4%)	11 (1.1%)
Seeking employment	12 (6.3%)	21 (2.6%)	33 (3.3%)
Furloughed	0 (0%)	2 (0.2%)	2 (0.2%)
Educational level (N, %)			
Primary school	1 (0.5%)	10 (1.2%)	11 (1.1%)
GCSE/O level or equivalent	55 (29.1%)	183 (22.6%)	238 (23.8%)
A level or equivalent	43 (22.8%)	176 (21.7%)	219 (21.9%)
Higher national diploma/BTEC equivalent	21 (11.1%)	89 (11.0%)	110 (11.0%)
Primary degree	47 (24.9%)	204 (25.2%)	251 (25.1%)
Further degree	22 (11.6%)	147 (18.1%)	169 (16.9%)
Household net income after tax (N, %)			
<£1000/month	22 (11.6%)	61 (7.5%)	83 (8.3%)
£1001-£2000/month	53 (28.0%)	187 (23.1%)	240 (24.0%)
£2001–3000/month	43 (22.8%)	229 (28.2%)	272 (27.2%)
£3001–4000/month	27 (14.3%)	140 (17.3%)	167 (16.7%)
£4001–5000/month	12 (6.3%)	77 (9.5%)	89 (8.9%)
>£5001/month	18 (9.5%)	75 (9.2%)	93 (9.3%)
Prefer not to say	14 (7.4%)	42 (5.2%)	56 (5.6%)
Disability limiting gardening (N, % yes)	21 (11.1%)	103 (12.7%)	124 (12.4%)
Home ownership (N, %)			
Owned	113 (59.8%)	558 (68.8%)	671 (67.1%)
Rented	75 (39.7%)	249 (30.7%)	324 (32.4%)
Other	1 (0.5%)	4 (0.5%)	5 (0.5%)
Average front garden size (m^2)	43 m^2	59 m^2	56 m^2

In total, there were 811 gardeners (reported spending >0 min gardening in an average week in summer) and 189 non-gardeners. In an average week in summer, respondents reported spending a median of 60 min (Interquartile range (IQR) 110 min) gardening in their front garden per week.

3.2. Analysis 1: Do capability and opportunity factors predict gardening behaviour?

Gardeners had mean capability scale scores of 4.89/7.00, significantly higher than non-gardeners (4.41, $p<0.001$, see Table 2). Likewise, gardeners had higher opportunity scores (5.09 vs 4.85, $p=0.012$). Cronbach's alpha for scales was 0.747 for capability and 0.774 for

Table 2
Total capability and opportunity scale scores by gardening status.

	N	Capability score	Significance	Opportunity score	Significance
Gardeners	809	4.89 (1.15)	$p<0.001$	5.09 (1.17)	$p=0.012$
Non-gardeners	188	4.41 (1.53)		4.85 (1.21)	

opportunity, indicating good internal consistency.

Table 3 shows regression models of capability and opportunity on time spent gardening. Capability significantly predicted log transformed time spent gardening (beta=0.147, $p<0.001$), explaining 2% of the variance ($R^2=0.022$). When age, gender, income and education were included, only age was also significant besides capability in the model, and the model explained 4.9% of the variance.

Opportunity also significantly predicted time spent gardening (beta=0.093, p=0.008), and predicted 0.9% variance ($R^2=0.009$). When age, gender, income and education were included, only age was a significant predictor besides opportunity, and this model explained 3.9% variance.

Motivation significantly predicted time spent gardening (beta=0.071, p=0.003), explaining 1% of the variance. When including age, gender, income and education in the model, motivation was still a significant predictor, alongside age. This model explained 2.5% variance. Capability therefore explained the most variance out of the three factors.

When capability, opportunity and motivation were included in the same model alongside demographics, only capability was a significant predictor (beta 0.070, $p=0.003$), opportunity (beta= −0.016, $p=0.0724$) and motivation (beta=0.030, p=0.299) became non-significant. Analysis 1 therefore answers question 1,and demonstrates that both capability and opportunity factors predict front gardening behaviours, and that capability is the strongest factor out of capability, opportunity and motivation.

3.3. Analysis 2: What factors have the strongest impact on gardening behaviour?

Table 4 shows the list of factors and the number who agreed or disagreed with each factor in total and by gardening status (i.e. categorised as gardener or non-gardener as described above).

Four out of six capability barriers were associated with gardening status. Gardeners were significantly more likely to agree they had the knowledge to garden (both in general and specifically to their garden conditions) and self-efficacy (all $p<0.001$). Non-gardeners were more likely to endorse the statement that they did not have enough experience to grow plants in their front garden ($p=0.029$), although overall there were relatively low levels of endorsement for this barrier. Interestingly, substantial numbers of non-gardeners (42–77%) positively endorsed capability facilitators, whilst 9–37% gardeners endorsed capability barriers. Endorsing the statement that another person in the household was better at gardening or being unable to look after plants in the front garden was not associated with gardening status. This suggests knowledge and self-efficacy could be more important than perceived ability.

Table 3
Regression models of the influence of capability and opportunity factors on log-transformed time spent gardening.

Model		B	Beta			Significance
1. Capability only	**Capability**	0.073				P<0.001
			0.147			
	Adjusted $R^2 = 0.020$					
2. Capability and demographics	**Capability**	0.095				P<0.001
			0.192			
	Age	-0.008	-0.175			P<0.001
	Gender	0.043	0.041			P=0.238
	Income	0.007	0.019			P=0.598
	Education	-0.002	0.041			P=0.881
	Adjusted $R^2 = 0.043$					
3. Opportunity alone	**Opportunity**	0.046				P=0.008
			0.093			
	Adjusted $R^2 = 0.007$					
4. Opportunity and demographics	**Opportunity**	0.084				P<0.001
			0.171			
	Age	-0.009	-0.194			P<0.001
	Gender	0.049	0.046			P=0.189
	Income	0.005	0.012			P=0.731
	Education	-0.003	-0.008			P=0.831
	Adjusted $R^2 = 0.033$					
5. Motivation	**Motivation**	0.071			0.104	P=0.003
	Adjusted $R^2 = 0.010$					
6. Motivation and demographics	**Motivation**	0.090	0.131			P<0.001
	Age	-0.007	-0.146			P<0.001
	Gender	0.053	0.050			P=0.159
	Income	0.003	0.008			P=0.838
	Education	-0.003	-0.007			P=0.842
	Adjusted R^2=0.025					
7. Capability, opportunity, motivation and demographics	**Capability**	0.070		0.141		P=0.003
	Opportunity	0.024		0.049		P=0.314
	Motivation	0.030		0.044		P=0.299
	Age	-0.009		-0.191		P<0.001
	Gender	0.045		0.043		P=0.217
	Income	0.005		0.014		P=0.702
	Education	-0.004		-0.010		P=0.786
	Adjusted R^2=0.044					

Note: significant factors in **bold**

Table 4
Factors influencing front gardening and differences for gardeners versus non-gardeners.

	Factor	Garden?	Disagree	Agree	Neutral	X^{2b}
Capability	**When it comes to planting in my front garden, I know what to do[a] (Knowledge: general)**	Gardeners	148 (22%)	528 (88%)	-	P<0.001
		Non-gardeners	58 (42%)	80 (58%)	-	
		Total	206 (22%)	608 (63%)	144 (15%)	
	I do not have enough experience to grow plants in the front garden (Experience)	Gardeners	440 (65%)	232 (35%)	-	P=0.029
		Non-gardeners	81 (56%)	64 (44%)	-	
		Total	521 (53%)	296 (30%)	167 (17%)	
	I know how to grow the right plants for the environment in my front garden (soil type, sunshine) (Knowledge: specific)	Gardeners	234 (37%)	406 (63%)	-	P<0.001
		Non-gardeners	83 (55%)	69 (45%)	-	
		Total	317 (32%)	475 (48%)	192 (19%)	
	I am capable of growing plants in my front garden (Self-efficacy)	Gardeners	61 (9%)	643 (91%)	-	P<0.001
		Non-gardeners	35 (23%)	115 (77%)	-	
		Total	96 (10%)	758 (77%)	132 (13%)	
	Someone else in my household is better at gardening than me, so I let them do it (Comparative ability)	Gardeners	345 (57%)	264 (43%)	-	P=0.212
		Non-gardeners	88 (62%)	53 (38%)	-	
		Total	433 (47%)	317 (34%)	179 (19%)	
	I am not able to look after plants in the front garden (Ability)	Gardeners	543 (77%)	165 (23%)	-	P=0.315
		Non-gardeners	110 (73%)	41 (27%)	-	
		Total	653 (67%)	206 (21%)	120 (12%)	
Opportunity	It is too costly to have plants in front of my house (Cost)	Gardeners	510 (75%)	173 (25%)	-	P=0.756
		Non-gardeners	105 (73%)	38 (27%)	-	
		Total	615 (63%)	211 (22%)	147 (15%)	
	I think front gardens should be for parking the car (Need for parking space)	Gardeners	457 (70%)	197 (30%)	-	P=0.545
		Non-gardeners	105 (73%)	40 (28%)	-	
		Total	562 (58%)	237 (24%)	176 (18%)	
	Because of its position, my front garden is not suitable for growing anything (Environmental suitability)	Gardeners	521 (74%)	180 (26%)	-	P=0.962
		Non-gardeners	114 (72%)	39 (28%)	-	
		Total	635 (65%)	219 (22%)	127 (13%)	
	I find it convenient to keep things growing in the front garden (Convenience)	Gardeners	172 (28%)	448 (72%)	-	P<0.001
		Non-gardeners	62 (47%)	71 (53%)	-	
		Total	234 (24%)	519 (53%)	218 (22%)	
	I don't want to invest much time or money in the front garden because I'm renting (Renting: time/money)[c]	Gardeners	85 (44%)	107 (56%)	-	P=0.015
		Non-gardeners	16 (27%)	44 (73%)	-	
		Total	101 (32%)	151 (48%)	63 (20%)	
	Planning or other regulations prevent me from having more greenery at the front (Policy and regulations)	Gardeners	515 (78%)	146 (22%)	-	P=0.628
		Non-gardeners	118 (80%)	30 (20%)	-	
		Total	633 (68%)	176 (19%)	116 (13%)	
	I don't have plants in the front in case they get stolen or vandalised (Security)	Gardeners	520 (74%)	185 (26%)	-	P=0.393

(*continued on next page*)

Table 4 (*continued*)

Factor	Garden?	Disagree	Agree	Neutral	X^{2b}
	Non-gardeners	124 (77%)	37 (23%)	-	
	Total	644 (66%)	222 (23%)	112 (11%)	
I don't have enough space to have greenery in front of my house (Space)	Gardeners	559 (78%)	160 (22%)	-	P=0.859
	Non-gardeners	128 (77%)	38 (23%)	-	
	Total	687 (70%)	198 (20%)	101 (10%)	
My tenancy agreement allows me to grow what I like in the front garden (Renting: flexibility)[c]	Gardeners	28 (14%)	170 (86%)	-	P=0.080
	Non-gardeners	14 (24%)	45 (76%)	-	
	Total	42 (14%)	215 (69%)	53 (17%)	
I have time to look after plants in my front garden (Time)	Gardeners	114 (16%)	584 (84%)	-	P<0.001
	Non-gardeners	49 (33%)	100 (67%)	-	
	Total	163 (17%)	684 (69%)	140 (14%)	

Notes: Responses of 'not applicable' are excluded. [a] Items reaching significance are in bold; [b] neutral category is not included in Chi-squared calculation. [c]Analyses of rental factors were only carried out in those that self-reported renting at the start of the survey (n=249, responses could also be neutral or n/a)

Surprisingly, there were few significant opportunity barriers. The only significant factors were time to look after plants in the front garden ($p<0.001$), convenience ($p<0.001$) and not wanting to invest time or money due to renting ($p=0.015$). Cost, need for parking, garden position and orientation, space for a front garden, threat of vandalism/theft, tenancy agreements and planning regulations were not associated with front gardening (all $p>0.05$) and relatively few agreed with these statements across both gardeners and non-gardeners.

With regards to the influence of individual factors on time spent gardening in those who already garden (Table 5), similar factors were significantly associated with this. Knowing what to do and knowing how to grow the right plants (both $p<0.001$) and self-efficacy (p=0.047) were significantly associated with spending more time gardening. Experience ($p=0.247$), ability to garden ($p=0.981$) and comparative ability (someone else in the household being better at gardening) ($p=0.632$) were not associated with the amount of time spent gardening.

For opportunity factors, having time to look after plants and finding it convenient to keep things growing were associated with significantly greater time spent gardening (both $p<0.0001$). In those who were renting, not wanting to spend time and money due to renting was associated with less time gardening ($p=0.034$), although having a flexible tenancy agreement was not ($p=0.431$). Factors such as cost, parking, security, space and garden position were not significantly associated with time spent gardening. Somewhat counter intuitively, agreeing that policy and regulations prevented them having more greenery at the front was associated with spending more time gardening ($p=0.009$).

Table 5
Capability and opportunity factors associated with time spent gardening.

	Factor	Time spent gardening (min) Mean (SD)		
		Disagree	Agree	Comparison (coeff.[&] and p value)
Capability	**Knowledge (general)**	183 (510)	259 (472)	0.309 P<0.001
	Experience	249 (429)	253 (555)	-0.053 P=0.247
	Knowledge (specific)	62 (48)	284 (507)	0.232 P<0.001
	Self-efficacy	61 (80)	258 (482)	0.146 P=0.047
	Comparative ability	259 (460)	241 (496)	-0.023 P=0.632
	Ability	238 (417)	278 (591)	-0.001 P=0.981
Opportunity	Cost	202 (271)	344 (717)	-0.061 P=0.217
	Need for parking space	197 (267)	354 (717)	-0.057 P=0.240
	Environmental suitability	244 (431)	262 (549)	-0.013 P=0.797
	Convenience	288 (743)	244 (417)	0.299 P<0.001
	Renting (time/money)*	217 (317)	143 (278)	-0.174 P=0.034
	Policy and regulations	236 (427)	279 (560)	0.141 P=0.009
	Security	204 (270)	341 (718)	-0.011 P=0.816
	Space	197 (270)	357 (723)	-0.035 P=0.999
	Renting (flexibility)*	190 (385)	176 (283)	0.096 P=0.431
	Time	55 (47)	264 (488)	0.299 P<0.001

[&]log transformed
*Sample limited to those who stated they lived in rented accommodation and were gardeners (n=249, responses could also be neutral or n/a)

4. Discussion

This is the first study to our knowledge to compare factors affecting gardening in front gardens across both gardeners and non-gardeners, exploring a range of factors beyond motivations. Overall, capability and opportunity scales were associated with gardening status and time spent front gardening, over and above the inclusion of sociodemographic factors, although opportunity was not a significant predictor when capability was also included in the model, suggesting capability factors are likely to be more important than opportunity or motivation. This finding is a particularly positive contribution to knowledge on behavioural interventions as it emphasises factors that are more amenable to address in practical terms. A number of capability factors showed a significant distinction between front gardeners and non-gardeners while relatively few barriers to opportunity were significant. Similar but fewer items on each scale were associated with time spent front gardening.

Table 6 compares the significant factors between gardeners and non-gardeners, and increased time spent front gardening in those who garden. Tentatively, we suggest that the former point to approaches which may be more effective in changing behaviour from non-engagement to engagement and the latter indicate approaches for increasing engagement in front gardening. Our results suggest that increasing general and specific knowledge about gardening and increasing self-efficacy is likely

Table 6
Differences in capability and opportunity factors between different gardening behaviours.

Non-gardeners vs Gardeners	Time spent front gardening by those who garden
Capability: • Knowledge (general) • Knowledge (specific) • Experience • Self-efficacy	Capability: • Knowledge (general) • Knowledge (specific) • Self-efficacy
Opportunity: • Convenience • Renting (time/money) • Time	Opportunity: • Convenience • Renting (time/money) • Time • Policy and regulations

to encourage all gardening behaviour, whereas schemes to provide experience (e.g. participation in gardening schemes) are likely to be best targeted at those who do not already garden to build capability.

In the UK, The Royal Horticultural Society's (RHS) campaigns for front gardens (Royal Horticultural Society, 2023) is likely to provide some increase in knowledge; however this is typically targeted at gardeners and further local council or public health schemes are needed to raise knowledge in those unfamiliar with the RHS. Previous studies have looked at ways to influence knowledge and skills for gardening, and found the most effective interventions to date appear to be those which have an interactive component and are personalised to the specific garden. Interactive interventions where residents surveyed their gardens for various plant and animal species, with subsequent personalised written feedback on biodiversity, reported positive shifts in knowledge of local species, attitudes towards biodiverse gardens and some participants changed to more eco-friendly gardening behaviour (Van Heezik et al., 2012). One Swedish campaign encouraged garden meadows, flower planting and bee hotels, and enabled citizens to record changes over time in pollinator levels, finding good engagement and positive associations with pollinator levels suggesting increases in gardening behaviour (Persson et al., 2023). A comparison of Australian community wildlife gardening schemes found that newsletters, provision of native plants or vouchers and a site assessment were associated with positive changes in biodiversity knowledge after participation (Shaw and Miller, 2016). Our findings provide theoretical support to these studies, suggesting that they were effective through addressing general and specific knowledge.

The opportunity factors of time, convenience and not wanting to spend time and money due to renting were significant in both analyses. Other opportunity factors such as cost and threat of vandalism were less influential than expected from our previous qualitative work (Frost & Murtagh, 2023). Indeed, it may be that when asked to explain their non-engagement with front gardening, people tend to rely on 'rational' and 'expected' arguments relating to cost or parking space whereas a complex, interacting set of factors involving capability and motivation are at play, alongside opportunity, as our findings here would suggest. One unexpected finding was that those endorsing that planning regulations prevented them having more greenery at the front were more likely to spend time gardening. We hypothesise that this may be due to reverse causality – that those who spend a lot of time gardening may be more aware of planning restrictions.

Interventions therefore need to account for factors such as rental status, convenience and time when trying to overcome capability barriers. While interventions could be designed specifically for tenants, convenience can be more easily addressed, and indeed was addressed in the interventions cited above e.g. provision of native plants or vouchers (Shaw and Miller, 2016). Another previous study which directly provided suitable plants to householders showed positive effects on some salivary cortisol parameters, reduced stress, increased pride in the local street and had cascade effects, with other people in the street requesting similar plants (Chalmin-Pui et al., 2021). Although community-based interventions are often considered, recent work suggests that it is possible to provide these types of interventions remotely too. A US virtual gardening programme based on Social Cognitive Theory which included live online sessions and providing equipment to grow plants discussed in the sessions resulted in positive feedback from participants (Spaccarotella et al., 2023). Based on our findings, we can suggest that the equipment enhanced opportunities, specifically convenience, and that the online sessions enhanced capabilities, in particular general and specific knowledge.

However, in the extensive literature on time, it is recognised that there are multiple and heterogeneous understandings and experiences of time (Jaszczolt, 2023) and time allocated to leisure versus domestic work can be highly flexible (Vega-Rapun et al., 2020) - front gardening could be seen as either. This implies that time may depend highly upon perception and can be influenced by motivation to perform certain behaviours above others. In this case increasing motivation may be helpful. Not wanting to spend time and money due to renting also reduced the likelihood of front gardening and the time spent front gardening. This has also been shown in a survey and interview study regarding growing food in gardens (Goodfellow and Prahalad, 2022). This suggests that further work is needed to tailor interventions to those who are renting, including seeking the views of landlords and tenants as to how this can be encouraged.

This study is one of the first to demonstrate that capability and opportunity factors are important alongside motivation, and to identify specific factors associated with front gardening versus not gardening and time front spent gardening. This extends the literature beyond motivations to garden in existing gardeners. We have particularly focussed on front gardens as a neglected topic with particular relevance to public health and climate change. Our survey used a nationally representative sample and built upon previous qualitative work.

Our main study limitation is the use of self-reported data for gardening time, which is likely to be subject to recall bias and digit preference (responses tended to cluster around the values of 30 and 60 min). However, this is a difficult behaviour to capture objectively – future studies may benefit from using diaries to more accurately self-report this data. Likewise, self-selection of respondents may have resulted in a higher proportion of gardeners than non-gardeners. National data indicate the number of working age people reporting gardening in 2019/20 was 47% (Department for Digital, Culture, Media and Sport, 2020). Although there is evidence of a potential shift in meanings (Kingsley et al., 2023) and increased interest in gardening (Bieri et al., 2024) since the Covid pandemic, gardeners are still likely to be over-represented in our survey. The numbers however are adequate for our analysis. At present, established validated scales for capability and opportunity do not exist. Although these were developed from initial qualitative work, it is possible that other factors may be missing within this. We did not ask about the number of species or specific species of plants in gardens, or how these were arranged, all of which may make a difference to time spent gardening or the environmental effects.

5. Conclusions

Enhancing capability as well as addressing opportunity barriers is essential when developing future interventions to encourage gardening in front gardens. Future interventions to engage non-gardeners in front gardening should focus on building general and garden-specific knowledge, as well as building experience and self-efficacy. General and specific knowledge is also likely to be helpful in increasing time spent gardening in those who already garden. Interventions should ensure they are convenient, do not take too much time, and account for rental status.

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Author statement

NM and RF conceptualised the idea and methodology, acquired funding, organised data collection and managed and coordinated the project. RF led this analysis, including data presentation and writing an initial draft. NM provided review and feedback at all stages.

CRediT authorship contribution statement

Rachael Frost: Writing – review & editing, Writing – original draft, Resources, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Niamh Murtagh:** Data curation, Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare no conflict of interest.

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