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ASSOCIATIONS OF URBAN GREEN SPACE USE WITH ANXIETY, STRESS AND INSOMNIA SYMPTOMS AMONG FINNISH SUBURBAN RESIDENTS

ABSTRACT

***Objectives**: There is compelling evidence of the positive effects of nature exposure on mental health. However, a growing proportion of the population lives in cities, where the incidence of mental health problems is higher than in rural environments. To examine whether nature in suburban areas associates with mental health indicators, we examined the association of visiting and viewing of green spaces with anxiety, stress and insomnia symptoms among suburban residents. **Materials and methods:** The data consisted of a postal and online survey collected in ten suburban areas of Finland in 2021 (n=1667). We analysed the association of visiting and viewing of green spaces with anxiety, stress and insomnia symptoms using multinomial regression analysis, in the whole dataset and stratified by gender and age tertiles. **Results:** Visits to green spaces during the warm season 1–2 times a week (vs. no visits) were associated with higher likelihood of the absence of anxiety symptoms in men, women and those over 56 years old. Visits to green spaces during the warm season were also associated with no stress in women and those over 56 years old, and no insomnia symptoms in men. Viewing green spaces was associated with no stress and low level of insomnia symptoms only in those over 56 years old. **Conclusions:** Viewing and visiting green spaces are associated with lower levels of anxiety, stress and insomnia symptoms. The associations were stronger among women and those aged over 56 years. Further research is needed on the association of urban green space use on young people's mental health.*

KEYWORDS: URBAN NATURE, NATURAL ENVIRONMENTS, MENTAL HEALTH, PUBLIC HEALTH, ENVIRONMENTAL PSYCHOLOGY

INTRODUCTION

In 2023, over 100,000 Finns were paid a sickness allowance due to mental health disorders, accounting for 30% of all sickness allowances [1]. Among 16–34-year-olds, mental health disorders accounted for up to 46% of all reimbursed sickness absence periods (i.e. those lasting over 9 weekdays) [1]. According to the OECD, the direct and indirect costs of mental health disorders in Finland are the second highest in Europe relative to GDP, after Denmark. These costs mainly consist of social and unemployment benefits. However, only 5.6% of all healthcare spending is allocated to mental health, which is significantly less than in other Nordic countries [2].

Anxiety disorders contribute significantly to the global burden of disease. Due to their high prevalence, chronicity and comorbidity, they are ranked as the sixth leading cause of years lived with disability (YLD) [3]. Between 2010 and 2021, anxiety disorders showed the largest increase in disability-adjusted life years (DALY) among 25 diseases [3]. They are associated with poorer perceived quality of life [4] and greater loss of quality-adjusted life years (QALY) [5]. According to the Healthy Finland study, 6% of Finnish women and 4% of men reported experiencing generalized anxiety [6].

Anxiety disorders are preceded by symptoms. Anxiety symptoms have been associated with more harmful health behaviours [7], while anxiety disorders have further been associated with the incidence of somatic diseases and risk factors for chronic diseases, such as hypertension, in the general population [8].

Stress can be defined as a response to environmental demands that exceed an individual's adaptive resources and threaten their wellbeing [9]. Stress is associated with anxiety

disorders, major depression, insomnia, migraines, irritable bowel syndrome and substance abuse [10]. Stress and anxiety increase psychological distress. Additionally, loneliness, job dissatisfaction and work-family conflicts are associated with psychological symptoms [11]. According to the Healthy Finland study, one in five working-age individuals experiences significant psychological distress [12]. When considering not only clinically diagnosed mental disorders but also the milder feelings of anxiety and stress experienced by people, not captured in official statistics, the impact of psychological symptoms on individuals and society is significant.

Insomnia is a contributing factor in many mental and somatic chronic diseases [13,14] and it increases the risk of overall mortality [14,15]. Sleep deprivation impairs performance in tasks requiring attention [16] and the ability to make decisions [17]. According to the 2024 Healthy Finland study, 24.1% of Finns aged 20–64 reported sleeping too little [18]. Insomnia is estimated to have economic impacts not only through direct healthcare costs but also through indirect costs due to reduced productivity, accidents and decreased wellbeing [19].

With urbanization, an increasing proportion of the world's population lives in urban environments. Living in urban areas is associated with a higher prevalence of mental health disorders compared to rural environments [20–22]. In Finland, as the population grew rapidly after World War II, new residential areas representing a new type of construction were built outside city centres, in the middle of fields and forests – the suburbs were born [23]. Initially, moving to a suburb meant moving to the tranquillity of nature, away from the dirty and crowded city centre [24]. The emphasis on proximity to nature was used to describe the relative superiority of suburbs compared to urban centres [25]. In his book "Asemakaavaoppi" published in 1947, architect Otto-Iivari Meurman, who introduced the concept of Finnish residential suburbs, emphasized the consideration of health aspects in the city planning [26]. One of the leading principles of planning, according to him, was to preserve nature throughout the residential area, to provide sufficient recreational space, sports and hiking areas for residents, and to place these areas so that they are easily accessible to citizens. According to Meurman, city residents should have the opportunity to swim in the waters during the summer and have recreational areas for skiing in the winter [26].

Nature in urban environment is often referred to as green spaces, while the definition of green space varies in the literature. In studies examining the interactions between green spaces and human health, green spaces are most often defined as areas covered with vegetation, which can be public or private. A green space can be built, such as gardens or parks, or more natural, such as forests [27].

The psychological effects of nature experiences have been the subject of research for several decades. According to Rachel and Stephen Kaplan's Attention Restoration Theory (1989), a fatigued person recovers and their attention is restored through nature experiences [28]. In nature, attention is drawn to the environment spontaneously, without conscious direction of attention, which helps in recovery. According to the Kaplans, the restorative effects of natural environments can be divided into four components: Nature allows for detachment from the demands of everyday life (being away), immersion and connection with nature (extent), fascination with interesting natural elements (fascination), and nature resonates with the individual's inherent needs, to be and relax (compatibility). At the core of the Kaplans' theory is the restorative effect of nature and the restoration of attention. They defined fatigue as psychological stress resulting from tasks requiring attention and focus, distinguishing it from stress [28].

Ulrich et al. (1991), on the other hand, observed the restorative effect of nature even after a stressful situation in an experiment where participants' physiological responses were monitored while they watched videos of natural and urban landscapes [29]. Participants exposed to natural landscapes recovered from stress more quickly. In Ulrich et al.'s experimental study design, the stressful situation did not require specific attention, as in the Kaplans' theory. The restorative effect of nature was attributed to a change in emotional state to a more positive one [29].

Since then, a significant amount of research evidence on the wellbeing effects of nature experiences has been accumulated, in relation to both mental health symptoms and diagnosed disorders [30]. In their pilot study, Ward Thompson et al. (2012) found that the greenness of the neighbourhood was associated with lower salivary cortisol levels and lower perceived stress, particularly among low-income residents [31]. Exposure to green spaces has also been found to be associated with lower heart rate, diastolic blood pressure, HDL cholesterol and reduced risk of cardiovascular mortality [32,33]. In a recent cohort study of 46-year-olds, greater greenness of the residential environment was associated with a lower risk of experiencing severe depressive symptoms [34]. In experimental research, viewing a natural landscape (vs. viewing a built environment) before an acute stressful event was associated with positive physiological responses, such as increased heart rate variability during stress recovery [35]. In addition, even a short walk in urban green spaces increased participants' perceived psychological recovery compared to walking in the

city centre [36]. Viewing a natural landscape through a window after tasks requiring cognitive processing has also been found to lower participants' heart rate [37].

Living in a greener residential area has been found to reduce the risk of sleeping less than six hours a night [38]. Additionally, the use of green spaces has been associated with better sleep quality [39]. Afternoon forest walks have been found to increase the duration of sleep the following night, calm night-time movements, and improve perceived sleep quality and depth [40]. The health benefits of green spaces are thought to be mediated through psychological and physiological recovery, increased physical activity and reduced exposure to urban stressors such as noise and traffic [41]. There is also evidence that the health effects of nature differ between genders and age groups. For men, living near a green space was associated with better mental health in early and middle adulthood, while for women, a similar association was observed in older age [42]. Furthermore, several sociodemographic factors such as education, employment status, income and household status are known to associate with both mental health and nature visitation patterns [43,44] due to, e.g. selection of living area and the amount of leisure time. Therefore, adjusting for these potential confounders has been a recommended practice [41].

Van den Berg et al. studied the association of visiting green spaces with mental health and vitality in four European cities [45]. A positive association between time spent in green spaces and perceived mental health was found in all cities, regardless of cultural and climatic conditions [45]. In a Swedish study involving nine cities, a protective association was found between visiting urban green spaces and the prevalence of self-reported stress-related illnesses [46].

There is evidence on the short-term effects of visiting and viewing urban green spaces on psychological recovery conducted by experimental study designs. However, there is relatively little research on the association between visiting and viewing green spaces and less severe mental health and insomnia symptoms in everyday life. Therefore, in our study, we investigate whether visiting green spaces and viewing green spaces from home are associated with anxiety, stress or insomnia symptoms experienced by suburban residents. Our research questions are: 'Are visiting or viewing green spaces associated with anxiety, stress and insomnia symptoms among suburban residents?' and 'Do age or gender affect these associations?' The purpose of this study is to provide information on the association between use of green spaces by suburban residents and less severe mental health symptoms. The information can be used in urban planning efforts to promote mental wellbeing, and in the self-care of those suffering from anxiety, stress or insomnia.

MATERIALS AND METHODS

PARTICIPANTS AND DATA COLLECTION

The data for this study were collected as part of the Wellbeing Factors in the Residential Environment survey conducted by the Finnish Institute for Health and Welfare (THL) and the Finnish Environment Institute (SYKE). The survey was part of the Spatial information and residents' experiences for development of comfortable living environments (HYVIÖ) research project, funded by the Ministry of the Environment. The questionnaire, entitled "Determinants of wellbeing in living environment survey", included nearly 70 items concerning characteristics of residential areas, housing conditions, as well as wellbeing, health status and lifestyle. Recipients were given information about the aims of the project and the main themes in the survey, including the availability of services and perception of environmental characteristics in the respondents' residential areas, as well as their health, wellbeing and health behaviour.

The survey was sent to 5,000 randomly selected suburban residents aged 18 or older from two postal code areas in five Finnish cities (Helsinki, Kuopio, Oulu, Vantaa, Vaasa) 500 residents from each postal code area. The sample was provided by Finnish Digital and Population Data Services Agency, the official Finnish population registry, using simple randomization. The selected suburbs were predominantly apartment building areas located a few kilometres from the city centres, except for Helsinki, where the suburbs were located approximately ten kilometres from the city centre. In addition, the survey was sent to 1,000 residents in the central areas of Helsinki and Kuopio. Data collection was conducted via email and postal survey between October and December 2021. A total of 2,072 urban residents aged 18–97 responded to the survey. Compared with the target population in the study areas, women and older respondents were over-represented: 55% of respondents specified their gender as female (vs 52% in the target population), and 40% were aged 65 or older (vs 23% in the target population). To enhance representativeness, the data were weighted to match the age and gender distribution of the target suburban populations.

Fifteen respondents were excluded from the dataset for completing the survey twice (n=6), not residing in the target postal code area (n=6), or not completing the survey themselves (n=3). For this study, respondents living in central city areas (n=370) were also excluded. A total of 18 respondents (1.1%) reported their gender as "other" or chose not to specify their gender. There were also 2 missing responses (0.1%) for gender.

These cases were excluded from the dataset. The final suburban sample consisted of 1,667 respondents.

VARIABLES

Exposure to green spaces was assessed through questions about viewing green spaces from the apartment window and spending time or engaging in outdoor activities in green spaces. The latter was asked separately for the warm and cold seasons.

Viewing Green Spaces

Viewing green spaces was based on the question: "Can you see green spaces from any of your apartment windows?" The response options were: "yes, I often view the scenery," "yes, I occasionally view the scenery," "yes, but I rarely view the scenery" and "no." These four response options were recoded into a three-category variable by combining the last two options. The resulting categories were: "does not view green spaces," "occasionally views green spaces" and "often views green spaces."

Visiting Green Spaces

Time spent in green spaces was assessed with two questions: "How often do you engage in outdoor activities or spend time in green spaces during the warm season (May–September)?" and "How often do you engage in outdoor activities or spend time in green spaces during the cold season (October–April)?" The instructions included a description of green spaces: "In the following questions, green spaces refer to forests, parks, fields, meadows, bogs and rocky areas." The response options were: "never," "less than once a week," "1–2 times a week," "3–4 times a week" and "5 times a week or more." For both warm and cold seasons, responses were regrouped into three categories: less than once a week ("never" or "less than once a week"), 1–2 times a week and at least 3 times a week ("3–4 times a week" or "5 times a week or more").

Health Variables

Anxiety and stress were assessed with the question: "Think about the past month (30 days). Indicate how often the following issue has been on your mind or the symptom has bothered you." The symptoms were "felt anxious" and "suffered from stress." The response options were: "never," "rarely," "occasionally," "often" and "constantly." These were categorized into three groups: no ("never" or "rarely"), occasionally ("occasionally") and often ("often" or "constantly").

Symptoms of insomnia were assessed using the Jenkins Sleep Scale (JSS) [47]. The scale includes four items on insomnia symptoms: "Think about the past month (30 days). Indicate how often you have experienced the following symptoms: trouble falling asleep, waking up several times per night, trouble staying asleep (including waking too early), and feeling tired and worn out after a usual amount of sleep." Respondents rated each symptom on a scale: "not at all," "1–3 nights/month," "about one night/week," "2–4 nights/week," "5–6 nights/week" or "almost every night." Each symptom was classified into two categories: the symptom occurred at most one night per week, or the symptom occurred at least two nights per week. A binary variable was then created: no insomnia symptoms (none of the symptoms occurred more than once per week) and insomnia symptoms (at least one symptom occurred at least two nights per week) (similar to Halonen et al. [48]).

Background Variables

The gender options in the survey were "female," "male" and "other or prefer not to say." Age was derived from the respondent's reported year of birth. In adjusted models, age was included as a continuous variable. For analyses examining associations between green space exposure and health variables across age groups, age was categorized into tertiles to ensure adequate sample sizes: 18–33 years, 34–56 years and over 56 years.

Other potential confounding variables were selected based on previous literature [43,44]. These included educational attainment (basic education/secondary education/higher education), employment status (employed/retired/other), total gross annual household income (less than 15,000 € / 15,001–30,000 € / 30,001–50,000 € / over 50,000 €), cohabitation with a partner (yes/no or no partner) and presence of children under 18 in the household (yes/no).

STATISTICAL METHODS

First, distributions were described for health, green space and background variables by gender and age. The statistical significance of bivariate associations was assessed using the chi-square test. Also, the bivariate associations between green space variables (viewing and visiting) and health outcomes (anxiety, stress and insomnia) were analysed by cross-tabulating each health variable with each green space variable, stratified by gender and age tertiles, and tested using the chi-square test.

To control for background variables, the associations of viewing and visiting green spaces with health variables were further analysed using multinomial regression analysis. The

associations were first assessed in unadjusted models and then by adjusting for potential confounders one at a time. Finally, for each green space variable and health outcome, a fully adjusted model was constructed including all covariates: age, gender, educational level, employment status, total gross annual household income, cohabitation with a partner and presence of children in the household. In the adjusted models stratified by age, we excluded employment status and presence of children in the household (only in the model for over 56-year-olds) due to small prevalence in some categories (e.g. being retired in the youngest age group), which caused issues with convergence. In the analyses, the reference group consisted of those who used green spaces less than once a week.

Multinomial models (both unadjusted and adjusted) were run for the full sample, separately for men and women, and separately for each age tertile. The results are presented as Odds ratios (OR) for absence of symptoms, with 95% confidence intervals and p-values. Results showing the estimates for occasional symptoms of stress and anxiety are provided as Supplements (*Tables S2b, S3b, S4b, S5b*). A p-value of <0.05 was considered statistically significant. The data were analysed using IBM SPSS Statistics version 29.0.2.

RESULTS

DESCRIPTIVE RESULTS

The average age of the respondents was 46.4 years (standard deviation 19.5 years). The average age was 45.8 years for men and 46.9 years for women. The distributions of exposure, outcome and background variables by gender are presented in *Table 1*. Among women, 56% reported viewing green spaces from their window often, compared to 39% of men. The frequency of visiting green spaces during warm season also differed by gender: 59% of women reported spending time in green spaces at least three times per week, compared to 48% of men.

During cold season, visiting green spaces was less frequent for both genders. Among women, 36% reported visiting green spaces at least three times a week, compared to 28% of men. Gender differences in visiting and viewing green spaces were statistically significant across all variables (*Table 1*). Men and women also differed in terms of health variables: women were significantly more likely to report anxiety, stress and insomnia symptoms. Insomnia symptoms were relatively common, with 61% of women and 50% of men reporting symptoms.

The prevalence of anxiety and stress, as well as green space viewing and visiting, varied by age group (*Table S1*). Respondents aged 18–33 reported higher levels of anxiety and stress than older age groups. Insomnia was similarly prevalent across all age groups. Older age was associated with more frequent viewing of green spaces (among over 56 years old 63% reported viewing often, among 18–33 years old 35%).

Most respondents lived with a partner and had no children under the age of 18 (*Table 1*). Nearly 90% had at least secondary level of education. There were no statistically significant gender differences in educational level or employment status. However, income levels differed: 33% of men reported a total annual household income over 50,000 €, compared to 25% of women.

Table 1. Distributions for exposure, outcome and background variables by gender.

	Total (n=1602–1665)		Men (n=779–810)		Women (n=816–855)		p-value[1]
	n	% or mean (sd)	n	% or mean (sd)	n	% or mean (sd)	
Age	**1665**	**46.4 (19.5)**	**810**	**45.8 (18.7)**	**855**	**46.9 (20.2)**	
Viewing green spaces							**<0.001**
Does not view green spaces	355	21.4	204	25.2	151	17.8	
Occasionally views green spaces	512	30.9	286	35.4	226	26.6	
Often views green spaces	792	47.7	319	39.4	473	55.6	
Visiting green spaces during warm season							**<0.001**
Less than once a week	296	18.0	168	21.2	127	15.0	
1–2 times a week	465	28.4	247	31.1	218	25.8	
At least 3 times a week	877	53.6	378	47.7	499	59.1	
Visiting green spaces during cold season							**<0.001**
Less than once a week	600	36.0	321	40.3	278	32.8	
1–2 times a week	515	30.9	252	31.6	264	31.2	
At least 3 times a week	529	32.2	224	28.1	305	36.0	
Felt anxious							**<0.001**
No	968	59.7	537	67.9	431	51.9	
Occasionally	365	22.5	143	18.1	222	26.7	
Often	289	17.8	111	14.0	178	21.4	
Suffered from stress							**<0.001**
No	708	43.8	407	51.5	301	36.4	
Occasionally	503	31.1	238	30.1	265	32.0	
Often	406	25.1	145	18.4	261	31.6	
Insomnia symptoms							**<0.001**
No	716	44.5	392	50.3	324	38.9	
Yes	895	55.5	387	49.7	508	61.1	

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	Total (n=1602–1665)		Men (n=779–810)		Women (n=816–855)		p-value[1]
	n	% or mean (sd)	n	% or mean (sd)	n	% or mean (sd)	
Educational attainment							**0.241**
Basic education	187	11.2	100	12.4	87	10.2	
Secondary education	805	48.5	377	46.8	428	50.1	
Higher education	668	40.3	328	40.7	340	39.8	
Total gross annual household income							**0.003**
Less than 15,000 €	354	22.1	178	22.6	176	21.6	
15,001 € – 30,000 €	409	25.5	180	22.9	229	28.1	
30,001 € – 50,000 €	377	23.6	172	21.9	206	25.2	
Over 50,000 €	463	28.9	257	32.7	205	25.1	
Employment status							**0.087**
Employed	809	48.6	416	51.4	393	46.0	
Retired	425	25.5	197	24.3	228	26.7	
Other	432	25.9	197	24.3	234	27.4	
Presence of children in the household							**0.385**
No	1332	80.2	641	79.3	692	81.0	
Yes	329	19.8	167	20.7	162	19.0	
Cohabitation with a partner							**0.156**
Yes	861	52.0	435	53.8	426	50.4	
No or no partner	793	48.0	373	46.2	420	49.6	

[1] Pearson's chi-square -test

CROSS-TABULATIONS AND MULTINOMIAL REGRESSION MODELS

Anxiety

Based on cross-tabulations, women who frequently viewed green spaces from the window had lower levels of anxiety (χ^2=14.15; df=4; p=0.007). In adjusted multinomial regression models, the association remained in the same direction but was no longer statistically significant (*Table 2*). When examined by age group, no association was observed between viewing green spaces and anxiety symptoms (*Table S3a*).

Among both women and men, visiting green spaces during the warm season was associated with less anxiety symptoms. Those who visited green spaces 1–2 times per week were more likely to report no anxiety symptoms compared to those who visited green spaces less than once a week (men: OR for no anxiety = 2.24; 95% CI 1.17–4.26; women: OR = 1.99; 95% CI 1.04–3.84) (*Table 2*). Among women, but not men, a similar association was also observed for those who visited green spaces

at least three times per week. When analysed by age group, more frequent visits to green spaces were associated with no anxiety symptoms only among those over 56 years old (1–2 times/week: OR = 3.44; 95% CI 1.05–11.23; ≥3 times/week: OR = 2.88; 95% CI 1.21–6.84).

During the cold season, visiting green spaces at least three times per week was associated with no anxiety symptoms among women (OR for no anxiety = 1.72; 95% CI 1.06–2.81; *Table 2*). Among men, no such association was observed. In age-stratified analyses, the association was observed only among those over 56 years old (1–2 times/week: OR = 3.42; 95% CI 1.16–10.11; ≥3 times/week: OR = 2.95; 95% CI 1.22–7.13). No associations between green space use and anxiety symptoms were observed in the younger age groups (18–56 years). The unadjusted odds rations for the absence of anxiety by gender and age tertile are presented in *Tables S2a* and *S3a*.

Table 2. Adjusted Odds Ratios (OR) for the association between green space exposure and absence of / no anxiety.

	No Anxiety								
	Total (n=1542–1553)			Men (n=779–810)			Women (n=816–855)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Viewing green spaces									
Does not view green spaces	1.00			1.00			1.00		
Occasionally views green spaces	0.98	(0.66–1.44)	0.905	0.68	(0.39–1.18)	0.173	1.42	(0.81–2.48)	0.223
Often views green spaces	0.87	(0.60–1.27)	0.480	0.62	(0.35–1.11)	0.106	1.19	(0.71–1.98)	0.519
Visiting green spaces during warm season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	1.86	(1.20–2.89)	**0.006**	2.24	(1.17–4.26)	**0.014**	1.99	(1.04–3.84)	**0.039**
At least 3 times a week	1.42	(0.97–2.09)	0.075	1.12	(0.66–1.91)	0.672	1.93	(1.08–3.45)	**0.026**
Visiting green spaces during cold season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	1.05	(0.74–1.49)	0.790	0.82	(0.48–1.38)	0.447	1.37	(0.85–2.21)	0.198
At least 3 times a week	1.22	(0.85–1.75)	0.294	0.81	(0.46–1.43)	0.469	1.72	(1.06–2.81)	**0.030**

Note: Adjusted for age, educational attainment, employment status, annual gross household income, cohabitation with a partner and presence of children under 18 in the household

Stress

Based on cross-tabulation, those frequently viewing green spaces more often reported no stress symptoms compared to those who did not view green spaces (men: χ^2=12.56; df=4; p=0.014; women: χ^2=19.17; df=4; p<0.001). In unadjusted multinomial regression models, the association was statistically significant only among women, but after adjusting by background variables, the association was no longer statistically significant (*Tables 3, S4a*). When analysed by age group, frequent viewing of green spaces from the window (vs. not viewing) was associated with no stress among those over 56 years old (OR for no stress = 2.69; 95% CI 1.04–6.94).

Visiting green spaces during the warm season, both 1–2 times per week and at least three times per week, was associated with no stress symptoms among women (*Table 3*) and among those over 56 years old, compared to those who visited green spaces less than once a week (≥3 times/week, over 56 years: OR for no stress = 2.48; 95% CI 1.13–5.47). Among men and those aged 18–56, visiting green spaces during the warm season was not associated with stress.

Among those over 56 years old, frequent visits to green spaces during the cold season were associated with no stress (≥3 times/week: OR for no stress = 2.70; 95% CI 1.20–6.05). No associations between visits to green spaces during the cold season and stress were observed when analysed by gender or among those aged 18–56. The unadjusted odds rations for the absence of stress by gender and age tertile are presented in *Tables S4a* and *S5a*.

Table 3. Adjusted Odds Ratios (OR) for the association between green space exposure and absence of / no stress.

	No Stress								
	Total (n=1540–1550)			**Men (n=758–765)**			**Women (n=782–786)**		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Viewing green spaces									
Does not view green spaces	1.00			1.00			1.00		
Occasionally views green spaces	1.03	(0.70–1.52)	0.866	0.74	(0.43–1.26)	0.270	1.57	(0.87–2.83)	0.137
Often views green spaces	1.04	(0.72–1.51)	0.822	0.73	(0.43–1.25)	0.253	1.46	(0.84–2.52)	0.180
Visiting green spaces during warm season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	1.57	(1.02–2.41)	**0.039**	1.44	(0.79–2.65)	0.238	2.29	(1.18–4.45)	**0.015**
At least 3 times a week	1.11	(0.76–1.64)	0.588	0.67	(0.29–1.15)	0.146	2.10	(1.16–3.80)	**0.014**

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	No Stress								
	Total (n=1540–1550)			Men (n=758–765)			Women (n=782–786)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Visiting green spaces during cold season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	1.08	(0.77–1.52)	0.651	1.13	(0.68–1.90)	0.635	1.04	(0.64–1.69)	0.878
At least 3 times a week	0.99	(0.70–1.41)	0.960	0.56	(0.33–0.94)	**0.027**	1.50	(0.92–2.44)	0.101

Note: Adjusted for age, educational attainment, employment status, annual gross household income, cohabitation with a partner and presence of children under 18 in the household

Insomnia Symptoms

Viewing green spaces was not associated with the prevalence of insomnia symptoms in the total sample or when analysed by gender. However, in age-stratified multinomial regression models, frequent viewing of green spaces was associated with the absence of insomnia among individuals over 56 years old (OR for no insomnia symptoms = 1.95; 95% CI 1.06–3.59).

Visiting green spaces during the warm season 1–2 times per week was associated with better sleep among men (OR for no insomnia symptoms = 1.77; 95% CI 1.16–2.70; *Table 4*) and among those aged 34–56 (OR = 1.99; 95% CI 1.13–3.50). No association was observed between visiting during the warm season and insomnia among women or in other age groups.

During the cold season, visiting green spaces was not associated with insomnia symptoms (*Table 4*). The unadjusted odds rations for no insomnia symptoms by gender and age tertile are presented in *Tables S6a* and *S6b*.

Table 4. Adjusted Odds Ratios (OR) for the association between green space exposure and absence of / no insomnia symptoms.

	No Insomnia Symptoms								
	Total (n=1538–1548)			Men (n=749–755)			Women (n=789–792)		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Viewing green spaces									
Does not view green spaces	1.00			1.00			1.00		
Occasionally views green spaces	1.07	(0.80–1.42)	0.643	0.96	(0.66–1.40)	0.826	1.27	(0.81–1.99)	0.299
Often views green spaces	1.16	(0.86–1.52)	0.309	1.07	(0.73–1.57)	0.729	1.27	(0.84–1.93)	0.256
Visiting green spaces during warm season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	1.59	(1.16–2.16)	**0.004**	1.77	(1.16–2.70)	**0.008**	1.39	(0.85–2.29)	0.194
At least 3 times a week	1.08	(0.81–1.45)	0.594	1.04	(0.70–1.53)	0.854	1.07	(0.68–1.68)	0.760
Visiting green spaces during cold season									
Less than once a week	1.00			1.00			1.00		
1–2 times a week	0.96	(0.74–1.23)	0.725	0.99	(0.70–1.33)	0.963	0.91	(0.63–1.32)	0.627
At least 3 times a week	1.04	(0.81–1.34)	0.743	0.92	(0.64–1.33)	0.666	1.10	(0.77–1.57)	0.614

Note: Adjusted for age, educational attainment, employment status, annual gross household income, cohabitation with a partner and presence of children under 18 in the household

Background Variables

Adjustment for the background variables had some effects on the main results, mainly in terms of significance, so that p-values below 0.05 were more typical in the unadjusted models. In the few cases where the estimates were significant in the adjusted but not unadjusted models (e.g. anxiety and stress symptoms in women), the estimates were mostly to the same direction.

The associations between the background variables and the outcomes (*Tables S7*, *S8*, *S9*) were largely as expected. For example, being employed was associated with higher likelihood of stress and insomnia symptoms, and low income was associated with higher likelihood of anxiety symptoms. Contrary to expected, residing with children or a partner showed no associations with the outcomes.

DISCUSSION AND CONCLUSIONS

In this study, we analysed the associations of viewing and visiting green spaces during both warm and cold seasons with symptoms of anxiety, stress and insomnia among Finnish suburban residents. We also analysed these associations by age and gender. Our findings indicate that more frequent visits to green spaces, particularly during the warm season, is associated with absence of anxiety, stress and insomnia symptoms. Most associations were stronger among women compared to men, and among individuals aged over 56 years compared to younger age groups.

Viewing green spaces was associated with lower stress and insomnia symptoms only among those over 56 years old. These findings are consistent with previous research. A recent study by Zhang et al. found that greener window views were associated with better sleep quality among individuals over 70 years old [49]. The authors suggested that the improvement in sleep quality may be mediated by the stress-reducing effects of exposure to green spaces through the window [49]. Similarly, having a bedroom window view of a yard, water or green space has been associated with a lower risk of reporting poor sleep quality [50]. Hazer et al. also found that more frequent viewing of green spaces was associated with reduced stress in urban populations [51]. One possible explanation for the age-specific association found in this study is that older individuals may have mobility limitations, making window views a more important source of nature exposure. Similar findings have been reported during COVID-19 lockdowns [52]. While the immediate mood-enhancing effects of viewing natural landscapes have been widely studied in experimental psychology [53], these effects may not always translate into improved mental health at the population level.

In addition to viewing green spaces, visiting green spaces—especially during summer—appears beneficial. Visits to green spaces 1–2 times per week during the warm season were associated with higher likelihood of absence of anxiety symptoms among men, women and individuals over 56 years old. Among women and those aged over 56, more frequent visits (at least three times per week) indicated similar association. Among men, increasing the frequency of weekly visits to green spaces did not yield additional health benefits for the outcomes studied. A similar pattern was observed in a study from UK, where self-reported health and wellbeing peaked among those who spent 2–3 hours per week in green spaces [54]. On the other hand, Hazer et al. found that the more time participants spent in green spaces per week, the lower their stress levels were [51]. The threshold for health benefits appears to vary depending on the type of exposure and the outcome.

In our study, visiting green spaces 1–2 times and at least three times per week during the warm season was also associated with lower stress among women and individuals aged over 56. Among men, visiting green spaces 1–2 times per week during the warm season was associated with a lower likelihood of reporting insomnia symptoms. Similarly, in the study by Grigsby-Toussaint et al., greater access to green spaces was associated with a lower likelihood of reporting insufficient sleep among men [55].

The associations between visits to green spaces and health outcomes were weaker during the cold than warm season. Visiting at least three times per week during the cold season was associated with lower anxiety symptoms among women and individuals over 56. In the oldest age group, cold season visitation was also associated with lower stress. However, no associations were observed for insomnia. In large-scale population studies using satellite imagery and geospatial data, as well as experimental studies on short-term effects of green space exposure, data collection often occurs during the summer when vegetation is at its greenest [41]. Summer soundscapes, that are missing during Finnish winters, such as birdsong, leaf sound and flowing water, have been shown to reduce stress [56]. In Finland, the amount of daylight also varies with the seasons, being very low in winter, which can affect mood and sleep [57]. Although season inevitably affects the landscape and soundscape, and potentially visitation patterns to green spaces, previous studies suggest that nature visits can still promote health during the cold season. For example, a large 18-country study, including Finland, found that the association between nature visits and wellbeing and reduced psychological distress persisted regardless of season [58]. Brooks et al. also found that nature contact had a positive effect on mood and reduced mental health symptoms in a wintertime experimental study [59].

The response rate in our study was relatively low (34%), although typical for population surveys. The generalizability of the findings is supported by the geographic and sociodemographic diversity of the selected suburbs. The responses were also weighted to match the age and gender distribution of the target suburbs to maximize representativeness of the analytic sample. However, it is likely that those with keener interest in their residential area, as well as health and wellbeing, were more likely to respond to a survey on these themes. It is also possible that individuals experiencing severe anxiety, stress or insomnia symptoms were less likely to complete the survey. These may have further affected the representativeness of the sample. The reliability of the results is strengthened by the inclusion of several potential confounding variables, whose addition affected in

some cases the significance level but mostly not the direction of the estimates. Anxiety and stress symptoms were based on self-reported experiences and possibly reflect mild mental health issues. However, if mild symptoms can be prevented through nature visits, this may help prevent more serious health problems. This should be confirmed in longitudinal studies. The anxiety and stress symptoms experienced during the month prior to the survey were assessed using a single-item measure, rather than a validated scale, which may have compromised the reliability of the measurement. Insomnia symptoms were assessed using the Jenkins Sleep Scale, which has been shown to be a consistent and useful tool for studying sleep difficulties [60].

We had no information on the purpose or duration of visits to green spaces, which may have influenced the results. However, even brief contact with nature has been shown to improve immediate mood [61]. If the purpose of outdoor activity was exercise, such as jogging, the positive effects may be mediated through physical activity, whose positive connection with mental health has been well established [62]. The cross-sectional design of the study further limits causal inference. It is possible that mental health symptoms reduce the tendency to engage in outdoor activities, which may affect the interpretation of association. However, there is also some evidence that those experiencing anxiety are more likely to visit nature weekly compared to those without such symptoms [63]. Stronger evidence on the association of green space use with stress, anxiety and insomnia symptoms would require longitudinal studies with more detailed data on the purpose and duration of green space use. This would also allow for more precise dose–response analyses.

The youngest age group (18–33-year-olds) reported the highest levels of anxiety and stress but showed no association with green space exposure. They also viewed and visited green spaces less frequently than older age groups. In line with our study, in the study by Pyky et al., older age and female gender were associated with more frequent nature activity among suburban residents, regardless of overall physical activity levels [43]. Among older adults, this may be explained by a stronger orientation towards nature [64], as nature connectedness also increases time spent in nature [43]. The role of age in the association between green space use and health outcomes among suburban residents should be further examined with larger samples, as the age-stratified analyses in our study had somewhat limited statistical power.

In conclusion, visiting green spaces even 1–2 times per week (vs. less than once a week) was associated with higher likelihood of absence of anxiety, stress and insomnia symptoms among residents of Finnish suburbs. These associations were particularly evident among women and individuals over 56. The findings suggest that green space use could be recommended as a preventive measure for mental health problems.

Supplementary Material

Supplementary tables are available at Psychiatria Fennica online.

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