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Cross-sectional associations of different types of nature exposure with psychotropic, antihypertensive and asthma medication

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ABSTRACT

Background Exposure to natural environments is thought to be beneficial for human health, but the evidence is inconsistent.

Objective To examine whether exposure to green and blue spaces in urban environments is associated with mental and physical health in Finland.

Methods The Helsinki Capital Region Environmental Health Survey was conducted in 2015–2016 in Helsinki, Espoo and Vantaa in Finland (n=7321). Cross-sectional associations of the amounts of residential green and blue spaces within 1 km radius around the respondent's home (based on the Urban Atlas 2012), green and blue views from home and green space visits with self-reported use of psychotropic (anxiolytics, hypnotics and antidepressants), antihypertensive and asthma medication were examined using logistic regression models. Indicators of health behaviour, traffic-related outdoor air pollution and noise and socioeconomic status (SES) were used as covariates, the last of these also as a potential effect modifier.

Results Amounts of residential green and blue spaces or green and blue views from home were not associated with medications. However, the frequency of green space visits was associated with lower odds of using psychotropic medication (OR=0.67, 95% CI 0.55 to 0.82 for 3–4 times/week; 0.78, 0.63 to 0.96 for ≥5 times/week) and antihypertensive (0.64, 0.52 to 0.78; 0.59, 0.48 to 0.74, respectively) and asthma (0.74, 0.58 to 0.94; 0.76, 0.59 to 0.99, respectively) medication use. The observed associations were attenuated by body mass index, but no consistent interactions with SES indicators were observed.

Conclusions Frequent green space visits, but not the amounts of residential green or blue spaces, or green and blue views from home, were associated with less frequent use of psychotropic, antihypertensive and asthma medication in urban environments.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Exposure to natural environments is thought to be beneficial for human health, but the evidence is inconsistent.

WHAT THIS STUDY ADDS

⇒ In this cross-sectional study, higher frequency of green space visits was associated with lower frequency of psychotropic, antihypertensive and asthma medication use, and the association was not dependent on socioeconomic status. Amounts of residential green and blue spaces or green and blue views from home were not associated with psychotropic, antihypertensive and asthma medication use.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Mounting scientific evidence supporting the health benefits of nature exposure is likely to increase the supply of high-quality green spaces in urban environments and promote their active use. This might be one way to improve health and welfare in cities.

INTRODUCTION

Nature exposure (ie, exposure to green and blue spaces) is thought to be beneficial, especially for mental, cardiovascular and respiratory health.[1–4] For example, many reviews have reported an association between green space exposure and mental[1 5] and cardiovascular[1 6–8] health, mainly based on cross-sectional studies. However, reviews of longitudinal and experimental studies have evaluated the evidence as inconsistent or suggestive.[9–12] In particular, findings for asthma have been inconsistent.[11] In addition to some protective associations, exposure to different types of green spaces has been linked to adverse asthma outcomes in some,[13] but not all,[14] studies. Regarding blue space exposure, a review of mainly cross-sectional studies suggests an association between exposure to blue space and mental well-being, while evidence regarding cardiovascular health is more limited.[2]

Inconsistent evidence may stem from differences, for example, in study designs; characteristics of green space exposure, such as definitions, quality and accessibility[15]; cultural and individual characteristics, such as environmental preferences[4 16] and intrinsic motivation to nature visits.[17] Therefore, it is possible that such associations do not exist in some populations. A majority of evidence on the association between green space and health is derived from objectively measured residential green space, and information on the actual active or passive use of green space is often lacking.[5 18] However, tentative evidence suggests that visiting green spaces or even having views over green spaces may be more strongly associated with health and well-being than the mere amount of green space in the residential area.[19]

Despite inconsistent evidence, there are plausible pathways that can explain potential beneficial effects of nature exposure on physical and mental health and well-being, such as increased physical activity, reduced stress, social cohesion and beneficial immunological reactions,[4 11 18 20–22] but these mechanisms and the interlinkages between them are not yet fully understood.

Medication use indicates an illness that is serious enough to require the use of a prescribed drug. However, medications have rarely been used as indicators of health status in studies on the health effects of nature exposure. This study aimed to investigate whether the amounts of residential green and blue space, frequency of green space visits and green or blue views from home are separately associated with self-reported use of psychotropic (anxiolytics, hypnotics and antidepressants), antihypertensive and asthma medication in Finland. These medicine groups were chosen because mental health problems, insomnia, hypertension and asthma are major disease groups from a public health perspective, and information on the relationship between nature exposure and asthma is lacking. Another aim was to assess potential effect modification by socioeconomic status (SES) because there is some evidence that the health benefits of nature exposure might be most evident among lowest socioeconomic groups—for example, due to the lack of access to other health-promoting resources.[23 24]

MATERIALS AND METHODS

The Finnish Institute for Health and Welfare conducted the Helsinki Capital Region Environmental Health Survey in Helsinki, Espoo and Vantaa between 2015 and 2016 using a mailed self-administered questionnaire.[25] These three cities comprise the capital region and largest urban area in Finland. The survey gathered information on how the urban population experiences exposure to various environmental factors in their living environment, related health risks and personal health status. The former Population Register Centre (currently Digital and Population Data Services Agency) provided three random samples from native Finnish-speaking residents aged 25 years or older in Helsinki (n=8000, data collected between May and August in 2015), Espoo (n=4000, June−August 2016) and Vantaa (n=4000, June−August 2016). The total eligible sample size was 16 000, and a response rate of 46% resulted in 7321 participants. To maximise the number of observations, each exposure–endpoint combination was allowed to have its own total number of observations (n=5881–6031).

In comparison with the general population of Helsinki in 2015 and Espoo and Vantaa in 2016, based on Statistics Finland's free-of-charge statistical databases, the proportion of women was higher among the questionnaire respondents (57% among the respondents vs 52% among the general population). Most respondents belonged to the age groups 45–54, 55–64 and 65–74 years. The proportion of respondents in the age group 45–54 years was similar to (19%), and slightly higher in age groups 55–64 years (20% vs 16%) and 65–74 years (20% vs 13%) than, that in the general population of Helsinki, Espoo and Vantaa. Additionally, the prevalence of medication use among the respondents was approximately similar to the prevalence of the corresponding diseases in Finland, based on the Duodecim online Health Library.

Exposure variables

The amounts of residential green and blue spaces were calculated as proportions of green space (%) and blue space (%) in a buffer around the centre point coordinates of the respondent's residential building, based on high-resolution land use and land cover data from the Urban Atlas 2012[26] (online supplemental figure S1). The amount of green space within a 1 km radius around the respondent's home (%) was chosen as the main green space exposure variable because 1 km is a widely used approximation of a 10 min walking distance.[27] Green space consisted of the following Urban Atlas land use classes (class code): green urban areas, meaning public green areas for predominantly recreational use, such as gardens, zoos, parks, castle parks and cemeteries (14 100); forests (31 000); herbaceous vegetation associations, including natural grassland and moors (32 000); and wetlands (40 000). Arable land—for example, fields (21 000) and pastures (23 000), was excluded because it was not thought to be accessible. To help the interpretation of results of the logistic regression analyses, results on the amount of residential green space (used as continuous variable) were scaled to represent 10% increase in exposure. In the sensitivity analyses, the amount of green space within a 300 m radius around the respondent's home was used as an alternative exposure variable instead of 1 km because 300 m is a commonly used threshold for accessibility.[27]

In the Urban Atlas 2012, class 50 000 (water) includes the total area of lakes and rivers (minimum mapping unit of 1 ha). For sea areas, only coastal areas are included in class 50 000, whereas open sea areas are unclassified. Thus, open sea areas were taken from the National Land Survey of Finland Topographic Database 12/2015. If water data from the National Land Survey of Finland Topographic Database had been used instead of the Urban Atlas, 95 respondents out of 5987 would have been classified as blue space '>10%' instead of '>0–10%'. This difference is negligible (1.6% of the respondents) (online supplemental figure 2). More than half (54%) of the respondents had no blue space around their homes; thus, the amount of blue space within 1 km radius around the respondents' home (%) was categorised (0%, >0%–10%, >10%). Cut-off points for the categories were selected to ensure a sufficient number of observations in each category.

To assess the frequency of green space visits, respondents were asked how often they spent time or exercised outdoors in green spaces (parks, forests, meadows, etc) during the warm season (May–September). The response options were: (1) never; (2) <1 time per week; (3) 1–2 times per week; (4) 3–4 times per week and (5) ≥5 times per week. The first two options were combined for the analyses.

Information about green and blue views from home was obtained by asking the respondents whether they had a view of green or blue space from any of the windows of their dwelling. In the questionnaire, green areas were defined as forests, parks, fields, meadows, boglands and rocks (and any playgrounds and play fields in them), and blue areas as sea, lakes and rivers. The response options were: (1) no; (2) yes, I look at it seldom; (3) yes, I look at it occasionally and (4) yes, I look at it often. Options 2 and 3 were combined for the analyses.

Outcome variables

Self-reported use of psychotropic medication (anxiolytics, hypnotics and antidepressants), antihypertensives and asthma medications was used as outcomes. Other medicine groups enquired in the questionnaire were analgesics for different purposes, hypnotics, hay fever medication, acetosalicylic acid for the prevention of myocardial infarction, anticoagulants and antibiotics. The respondents were asked about the last time they had used different medicine groups, and the response options were: (1) within the last week; (2) 1–4 weeks ago; (3) 1–12 months ago; (4) more than a year ago and (5) never. For the analyses, medication use was dichotomised by combining the first three options (yes) and the last two options (no). Self-reports on doctor-diagnosed depression, hypertension and asthma were used as alternative outcomes in sensitivity analyses. A vast majority (95%) of the respondents had congruent responses between antihypertensive medication use and doctor-diagnosed hypertension and asthma medication use and doctor-diagnosed asthma. There were no comparable disease questions in the questionnaire about the use of psychotropic medication.

Covariates

Variables likely to be associated with exposure and outcome were selected a priori based on published literature[5 6 9] or rational judgement and included as covariates (online supplemental figure 3). Details of age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work and use of recreational property (ie, spending time at holiday houses, secondary residences and summer cottages) during the warm season (weeks per year) were obtained from the questionnaire. The zip area-level annual mean income (€) and unemployment rate (%, used in sensitivity analyses) were acquired from Statistics Finland. Variables that might be mediators of the examined associations (body mass index (BMI) and leisure-time physical activity,[28] and pet ownership) or have less often been examined as potential confounders (living in a detached/single family house and living longer than 1 year in the current apartment) were introduced into model 3 in the sensitivity analyses.

Residential exposure to traffic noise (L_{den} dB) was estimated based on façade noise maps from the Sito Consulting Company. Calculations for 2017 were carried out in accordance with the Environmental Noise Directive 2002/49/EC using the Common Noise Assessment Methods in Europe (CNOSSOS-EU) and data from 2016.

Residential outdoor levels of NO_2 from road traffic ($\mu g/m^3$) were based on emission and dispersion modelling.[29] The dispersion model used was the 'Contaminants in the Air from a Road-Finnish Meteorological Institute' (CAR-FMI),[30] which considers the chemical reactions causing nitrogen oxides to become oxidised. The highest modelled annual average concentration in 2010–2014 at the nearest outdoor receptor point was used as a proxy for the home outdoor concentration. This was the only indicator available, but it was not expected to have a significant effect on the spatial variability of the estimated exposures. The grid size for NO_2 varied from 25 m, close to the major roads, to 500 m in rural areas.

Statistical analyses

All statistical analyses were performed using SAS Enterprise Guide 7.15 HF8. Means, frequencies and Pearson's correlation coefficients were calculated using univariate and bivariate analyses.

Multivariate associations between green and blue space indicators and medication use were modelled using a logistic generalised additive model (GAMPL procedure in SAS). Thin-plate regression splines were used to explore whether the exposure–response relationships were linear. Based on the non-linear curves in these analyses, age and BMI (in the sensitivity analyses) were added to the models as splines.

In the logistic regression analyses, the crude model was adjusted for age and sex (model 1), and the second model (model 2) was additionally adjusted for socioeconomic indicators (marital status, employment status, education, annual household income and area-level annual mean income), health behaviour (alcohol use, smoking and physical activity at work) and recreational property during the warm season. Finally, other environmental exposures (traffic noise and NO_2 from road traffic) were added (model 3). The results are presented as OR estimates and their 95% confidence intervals (95% CIs).

Respondents with missing values for any of the variables used in model 3 were excluded from all the analyses to produce comparable results from models 1–3. To test the potential effect of exclusions, model 1 was run without excluding all exposure–outcome pairs. The ORs and their CIs remained essentially similar to the results from model 1 with exclusions.

To explore the potential effect modification by SES, the interaction term between each of the exposure variables and SES indicators was included in model 3 for all the four exposures and three outcomes. For the interaction analyses, education and annual household income were compressed into three categories instead of the original four, and continuous area-level annual mean income and area-level unemployment rate were categorised into tertiles. If the p value for the interaction term was <0.10, a stratified analysis was performed. To produce an overall p value for the interaction term, a logistic regression model (the LOGISTIC procedure in SAS) was used instead of a logistic generalised additive model; thus, age was categorised (25–34, 35–44, 45–54, 55–64, 65–74 and ≥75 years) instead of treating it as a spline.

To assess the consistency and robustness of the findings, various alternative and additional variables were introduced individually into the model 3 for the sensitivity analyses. First, we tested alternative exposure variables: the amounts of green and blue space within a 300 m buffer (instead of a 1 km buffer), all green spaces (including fields and pastures that were not included in the original variable) within 1 km of the respondent's home and all natural spaces (the sum of all green and blue spaces) within 1 km of the respondent's home. Second, self-reported doctor-diagnosed depression, hypertension and asthma were used as the alternative outcomes. Third, the following alternative covariates were used: area-level unemployment rate (%, instead of area-level annual mean income), categorised area-level annual mean income (instead of continuous) and categorised NO_2 from road traffic (instead of continuous). Fourth, additional covariates were included in model 3 individually: BMI (as a spline), leisure-time physical activity, pet ownership, living in a detached/single family house and city. Finally, model 3 analyses were restricted to those who had lived longer than 1 year in their current apartment (93% of the respondents).

RESULTS

Univariate and bivariate analyses

The characteristics of the study population are presented in tables 1 and 2, respectively. The Pearson correlation coefficients between continuous environmental exposures and SES indicators, means of continuous exposures and SES indicators by categorical exposures and SES indicators, and frequencies of categorical exposures by SES indicators are presented in online supplemental tables S1−S7. For example, those who reported visiting green spaces often had a slightly higher amount of residential green spaces around their home (online supplemental table 2), but the differences between the categories were negligible.

Table 1 Characteristics of the study population (n=5987): categorical variables

Characteristics	No	%
Sex (n=5987)		
Female	3418	57
Male	2569	43
Marital status (n=5987)		
Single	1025	17
Married, cohabiting or in a registered partnership	3947	66
Divorced, separated or widowed	1015	17
Education (n=5987)		
Comprehensive school	803	13
Vocational or high school	1378	23
College or university of applied sciences	1926	32
University	1880	32
Employment status (n=5987)		
Working full time	3176	53
Working part time	352	6
Retired	1960	33
Unemployed	291	5
Other (incl. student, at home mother/father)	208	3
Annual household income (before taxes) (n=5987)		
≤€30 000	1462	24
>€30 000–50,000	1527	26
>€50 000–90,000	1899	32
>€90 000	1099	18
Smoking (n=5987)		
No	4785	80
Yes, <1 unit per day	280	5
Yes, 1–9 units per day	387	6
Yes, ≥10 units per day	535	9
Alcohol use (during the last week) (n=5987)		
Not at all	1889	32
1–6 portions	2995	50
≥7 portions	1103	18
Physical activity at work (n=5987)		
High, my work is physically strenuous	698	12
Moderate	1196	20
Low, my work is mainly sedentary OR not working	4093	68
Using recreational property during warm season (n=5987)		
Not at all/<2 weeks per year	3944	66
2–8 weeks per year	1517	25
> 8 weeks per year	526	9
Psychotropic medication use (n=5987)		
Yes	1195	20
No	4792	80
Antihypertensive medication use (n=6031)		
Yes	1625	27
No	4406	73
Asthma medication use (n=5983)		
Yes	699	12
No	5284	88
Frequency of green space visits (n=5886)		
Never/<1 time per week	1014	17
1–2 times/week	1917	33
3–4 times/week	1712	29
≥5 times/week	1243	21
Green view from home (n=5939)		
No	1397	24
Yes, I look at it seldom/occasionally	1800	30
Yes, I look at it often	2742	46
Blue view from home (n=5949)		
No	5234	88
Yes, I look at it seldom/occasionally	248	4
Yes, I look at it often	467	8
Amount of residential blue space (n=5987)		
0%	3245	54
>0%–10%	1781	30
>10%	961	16

Multivariate analyses

Amounts of residential green and blue spaces were not associated with self-reported use of psychotropic (table 3), antihypertensive (table 4), or asthma (table 5) medications, although OR estimates for the amount of residential green space and asthma medication use (OR=1.06, 95% CI 0.99 to 1.14) and amount of residential blue space >0–10% and psychotropic medication (1.10, 0.95 to 1.28) were >1. Similarly, green or blue views from home were not associated with medication use (tables 3–5), but the OR estimates were >1 for looking at the green view seldom or occasionally and both antihypertensive (1.07, 0.88 to 1.30) and asthma (1.11, 0.88 to 1.39) medications.

The frequency of green space visits was associated with decreased odds of medication use. In the main model, when the reference was <1 green space visit per week, the odds for psychotropic medication use were 0.67 (95% CI 0.55 to 0.82) for those visiting green spaces 3–4 times per week and 0.78 (0.63 to 0.96) for those visiting green spaces at least five times per week (table 3). The respective odds for antihypertensive medication use were 0.64 (0.52 to 0.78) and 0.59 (0.48 to 0.74) (table 4), and for asthma medication use, 0.74 (0.58 to 0.94) and 0.76 (0.59 to 0.99) (table 5). Overall, the effect estimates remained essentially similar for the different models with different sets of confounders.

The only indication of effect modification based on the p value and consistency of effect estimates across categories was observed between the frequency of green space visits and annual household income in the model for psychotropic medication use. The effects of visiting green spaces were stronger among those reporting lowest annual household income (<€30 000), whereas these associations were non-existent among those reporting highest annual household income (>€90 000) (online supplemental table 8).

Sensitivity analyses

The results remained essentially similar when using alternative exposure, outcome, SES and air pollution variables, as well as additional covariates. Adding BMI to the main model attenuated the associations regarding antihypertensive and asthma medication use (online supplemental table 9).

DISCUSSION

In this cross-sectional study in the Helsinki capital region of Finland, a higher frequency of green space visits was associated with a lower frequency of psychotropic, antihypertensive and asthma medication use, and the association was not dependent on SES. The amounts of residential green and blue spaces or green

Table 2 Characteristics of the study population (n=5987): continuous variables

Characteristics	Mean	SD	Median	Minimum	Maximum
Age, years	54	16	54	25	100
Area-level annual mean income, €1000	27	6	26	12	69
Arealevel unemployment rate, %	6.0	1.6	6.0	1.6	14
Amount of residential green space, %	25	5	24	2	82
Road traffic noise, dB*	58	14	50	30	75
NO_2 from road traffic, μg/m^3	7.3	4.3	6.3	0	31

*Average sound pressure in decibels.

and blue views from home were not associated with medication use, although there were some increased estimates, and due to limited sample size, associations cannot be ruled out.

Previous evidence on the effects of nature exposure on mental, cardiovascular and respiratory health is somewhat mixed.[1 2 5–12] In line with our results for the association between nature exposure and mental health, in a survey across 18 countries (n=16 703), no clear associations were observed between green or blue space exposure indicators and antidepressive or anxiety medication use,[31] and in a cross-sectional study of ageing cohorts in four European studies (n=16 189), no association between distance to the nearest green space and self-reported depressed affect was observed.[32] In contrast to our results, a recent longitudinal study from Finland (n=19 851) observed an association between high residential greenness and low risk of doctor-diagnosed depression[33]; however, no information on visits to green space were used. Contrary to our results, a Spanish cross-sectional study (n=958) found that surrounding greenness was associated with decreased odds of self-reported benzodiazepine use.[34]

For hypertension, a cross-sectional study using data from Barcelona and Brussels (n=5735) reported an association between distance to the nearest green space and self-reported hypertension in Barcelona but not in Brussels.[35] Another cross-sectional study from Brazil (n=3418) found a beneficial association between increased number of street trees and decreased distance from urban parks and decreased prevalence of hypertension diagnosis.[36]

The associations between nature exposure and respiratory diseases, such as asthma, are thought to be bidirectional. Vegetation can improve air quality and is a source of beneficial microbial agents; however, it is also a source of allergens, which may exacerbate allergic responses and interact with air pollution.[37] Additionally, beneficial effects have been observed mainly in children and adolescents.[38] When studying asthma, the results can be affected by geographical study area, types of vegetation and other environmental exposures, as well as seasonality.[11] A review of mainly cross-sectional studies reported a suggestive association between increased green space exposure and decreased incidence

Table 3 Odds ratios (OR) and 95% confidence intervals (CIs) for the association between nature exposure and psychotropic medication use

	Psychotropic medication use*					
	Model 1†		Model 2‡		Model 3§	
	OR	95% CI	OR	95% CI	OR	95% CI
Amount of residential green space¶ (n=5987)	0.94	0.89 to 1.00	0.96	0.90 to 1.01	0.96	0.90 to 1.02
Frequency of green space visits (n=5886)						
Never/<1 time per week	ref	ref	ref	ref	ref	ref
1–2 times/week	0.76	0.63 to 0.91	0.80	0.66 to 0.97	0.80	0.66 to 0.97
3–4 times/week	0.64	0.53 to 0.78	0.67	0.55 to 0.82	0.67	0.55 to 0.82
≥5 times/week	0.74	0.60 to 0.91	0.77	0.63 to 0.95	0.78	0.63 to 0.96
Green view from home (n=5939)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	0.94	0.79 to 1.13	0.96	0.80 to 1.16	0.97	0.81 to 1.17
Yes, I look at it often	0.93	0.79 to 1.10	0.97	0.82 to 1.15	0.98	0.83 to 1.16
Amount of residential blue space (n=5987)						
0%	ref	ref	ref	ref	ref	ref
>0%–10%	1.10	0.95 to 1.27	1.11	0.95 to 1.28	1.10	0.95 to 1.28
>10%	1.04	0.87 to 1.25	1.04	0.86 to 1.27	1.03	0.85 to 1.26
Blue view from home (n=5949)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	1.02	0.74 to 1.42	1.03	0.74 to 1.44	1.03	0.74 to 1.43
Yes, I look at it often	1.00	0.79 to 1.26	1.03	0.81 to 1.32	1.03	0.80 to 1.31

*Anxiolytics, hypnotics and antidepressants, based on the question 'When was the last time you used the following medication?' Within the last week/1–4 weeks ago/1–12 months ago=YES; never/more than a year ago=NO.
†Model 1 (crude) adjusted for age and sex.
‡Model 2 adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season and area-level annual mean income.
§Model 3 (main) adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season, area-level annual mean income, road traffic noise and NO_2 from road traffic.
¶Within a 1 km radius around the respondent's home, calculated for 10% increase.

Table 4 Odds ratios (OR) and 95% confidence intervals (CIs) for the association between nature exposure and antihypertensive medication use

	Antihypertensive medication use*					
	Model 1†		**Model 2‡**		**Model 3§**	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Amount of residential green space¶ (n=6031)	1.01	0.95 to 1.07	0.99	0.94 to 1.06	0.99	0.93 to 1.05
Frequency of green space visits (n=5928)						
Never/<1 time per week	ref	ref	ref	ref	ref	ref
1–2 times/week	0.83	0.69 to 1.00	0.84	0.70 to 1.02	0.84	0.69 to 1.02
3–4 times/week	0.63	0.52 to 0.76	0.64	0.53 to 0.78	0.64	0.52 to 0.78
≥5 times/week	0.60	0.49 to 0.74	0.60	0.48 to 0.74	0.59	0.48 to 0.74
Green view from home (n=5982)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	1.07	0.89 to 1.30	1.08	0.89 to 1.31	1.07	0.88 to 1.30
Yes, I look at it often	0.94	0.79 to 1.12	0.95	0.80 to 1.14	0.94	0.79 to 1.13
Amount of residential blue space (n=6031)						
0%	ref	ref	ref	ref	ref	ref
>0%–10%	1.02	0.88 to 1.19	1.03	0.89 to 1.19	1.03	0.88 to 1.19
>10%	0.93	0.78 to 1.12	1.00	0.82 to 1.21	0.97	0.80 to 1.19
Blue view from home (n=5993)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	0.83	0.59 to 1.17	0.86	0.61 to 1.21	0.85	0.60 to 1.21
Yes, I look at it often	0.83	0.66 to 1.05	0.88	0.69 to 1.12	0.86	0.68 to 1.10

*Based on the question 'When was the last time you used the following medication?' Within the last week/1–4 weeks ago/1–12 months ago=YES; never/more than a year ago=NO.
†Model 1 (crude) adjusted for age and sex.
‡Model 2 adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season and area-level annual mean income.
§Model 3 (main) adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season, area-level annual mean income, road traffic noise and NO_2 from road traffic.
¶Within a 1 km radius around the respondent's home, calculated for 10% increase.

of asthma.[8] In the present study, more frequent green space visits were associated with less frequent asthma medication use, but this association was attenuated after adjusting for BMI. This might be explained by the fact that obesity is a known risk factor for asthma.[39] In contrast, in the present study the OR estimate for asthma medication use increased with increasing amounts of residential green space. Similar increased estimates have been previously observed—for example, in a Spanish cross-sectional study among children (n=3178), regarding proximity to green space and self-reported current asthma.[14]

In the present study, the frequency of green space visits was the only type of nature exposure that showed an inverse association with medication use. This finding is in line with tentative evidence emphasising the importance of actual use of green space in relation to mental health,[19 31] and it suggests that the same holds true for other health conditions, such as asthma and hypertension. The absence of an association between objectively evaluated nature exposure and health in this and some earlier studies can be explained, for instance, by the lack of information on the quality of green areas,[40] or the fact that a mere amount of accessible green space does not necessarily indicate an actual interaction between the individual and surrounding environment.[10 41] It is also possible that in certain populations, an association between nature exposure and health cannot be observed. It should also be noted that Finland has a high forest coverage, high frequency of nature visits and the majority of outdoor recreation occurs in municipality-owned areas.[42 43] In addition, Finnish cities are relatively green[44 45]; thus, it is possible that the amount of green space is not a limiting factor in this study, but that those willing to use green space can access it with minimal effort.

For blue space exposure, there is suggestive evidence of an association with better mental well-being.[2] For example, a recent cross-sectional study conducted in the UK (n=21 097) observed an inverse association between residential freshwater coverage and mental health,[28] whereas a Spanish cross-sectional study did not.[34]

Evidence regarding green or blue views from homes is scarce. Contrary to our results, a small Spanish cross-sectional study (n=465) suggests that enjoying a view of green space from home could decrease the risk of self-reported depression.[21]

In the present study, many of the observed associations between residential green spaces and medications were attenuated when BMI was included in the models, indicating that the potential association is likely mediated, at least partially, by BMI. This was also reflected in the observation that those who reported visiting green spaces often had a slightly lower BMI than those who visited green spaces less often.

No consistent effect modification by SES was observed in this study, and there was practically no variation in the frequency of green space visits or the amount of residential green space according to SES. However, in line with previous findings, it was observed that the inverse association between the frequency of green space visits and psychotropic medication use was most evident among those reporting the lowest annual household income. In addition to differences in, for example, study populations and designs, the lack of a consistent effect modification could be explained by the fact that in Europe, public green spaces, such as parks, have better quality in lower-SES neighbourhoods compared with, for example, those in North America.[24] Similar inconsistent effect modification by SES was observed in a recent

Table 5 Odds ratios (OR) and 95% confidence intervals (CIs) for the association between nature exposure and asthma medication use

	Asthma medication use*					
	Model 1†		Model 2‡		Model 3§	
	OR	95% CI	OR	95% CI	OR	95% CI
Amount of residential green space¶ (n=5983)	1.07	1.01 to 1.16	1.07	0.99 to 1.14	1.06	0.99 to 1.14
Frequency of green space visits (n=5881)						
Never/<1 time per week	ref	ref	ref	ref	ref	ref
1–2 times/week	0.81	0.65 to 1.02	0.85	0.68 to 1.07	0.85	0.68 to 1.07
3–4 times/week	0.69	0.54 to 0.87	0.74	0.58 to 0.95	0.74	0.58 to 0.94
≥5 times/week	0.72	0.56 to 0.93	0.76	0.59 to 0.99	0.76	0.59 to 0.99
Green view from home (n=5937)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	1.13	0.90 to 1.41	1.11	0.89 to 1.39	1.11	0.88 to 1.39
Yes, I look at it often	1.08	0.87 to 1.33	1.10	0.90 to 1.36	1.10	0.89 to 1.36
Amount of residential blue space (n=5983)						
0%	ref	ref	ref	ref	ref	ref
>0%–10%	1.03	0.86 to 1.23	1.03	0.86 to 1.23	1.03	0.86 to 1.23
>10%	0.93	0.74 to 1.17	1.00	0.79 to 1.28	0.99	0.77 to 1.26
Blue view from home (n=5946)						
No	ref	ref	ref	ref	ref	ref
Yes, I look at it seldom/occasionally	0.80	0.51 to 1.24	0.81	0.52 to 1.26	0.80	0.52 to 1.26
Yes, I look at it often	1.00	0.75 to 1.34	1.07	0.80 to 1.44	1.06	0.79 to 1.43

*Based on the question 'When was the last time you used the following medication?' Within the last week/1–4 weeks ago/1–12 months ago=YES; never/more than a year ago=NO.
†Model 1 (crude) adjusted for age and sex.
‡Model 2 adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season and area-level annual mean income.
§Model 3 (main) adjusted for age, sex, marital status, education, employment status, annual household income, smoking, alcohol use, physical activity at work, using recreational property during warm season, area-level annual mean income, road traffic noise and NO_2 from road traffic.
¶Within a 1 km radius around the respondent's home, calculated for 10% increase.

Finnish longitudinal study on residential greenness and doctor-diagnosed depression.[33]

Strengths and limitations

One of the strengths of the present study is the combination of objective and self-reported information on nature exposure that reflects different aspects of exposure (ie, amount/availability vs use of green space, active vs passive use of green space, and accessible vs non-accessible green space). In addition, the questionnaire data enabled extensive confounder control in the statistical analyses. Another strength is the availability of individual-level data on exposure to traffic noise and traffic-related air pollution.

One of the limitations is that healthy individuals are typically more likely to answer self-administered questionnaires than those with health problems or problems with other aspects of life,[46] which might bias the results. Nevertheless, the response rate of the questionnaire was 46%, which is relatively high nowadays.[47 48] Furthermore, detailed data on the quality of green space (for example, size and type) and data covering private green areas are lacking. In Helsinki, having a short distance to at least a middle-sized green area and high nature-relatedness are important for participation in green exercise.[40] For blue space exposure, we had no self-reported information on visits to blue spaces, and the amount of residential blue space did not cover blue spaces that were <1 hectare in size. The latter limitation had only a minor effect on the results.

A major limitation that complicates the drawing of conclusions in this study is the cross-sectional design. Especially, when exposure variables describe the active use of green spaces, such as visiting green spaces, and the temporal order is not evident, it is possible that the findings reflect the fact that better health enables a person to spend more time outdoors. Finally, it should also be noted that medication use indicates a serious, diagnosed illness that requires a prescribed drug, but it is not a perfect indicator of current health status, especially when the symptoms are less severe.

CONCLUSION

More frequent visits to green spaces were associated with less frequent use of psychotropic, antihypertensive and asthma medications in the Helsinki capital region. However, amounts of residential green and blue spaces and having a green or blue views from home were not associated with these health indicators. The observed associations were partially explained by BMI. No consistent effect modification by SES indicators was observed.

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