Health and Place xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Health & Place

journal homepage: www.elsevier.com/locate/healthplace

# Individual and environmental factors associated with green exercise in urban and suburban areas

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ARTICLE INFO

*Keywords:*
Physical activity
Suburban
Adults
Health
Green area

ABSTRACT

In this study, we mainly aimed to explore the associations of personal and socio-demographic factors, and the supply of green areas and built sports facilities with green exercise (GE). We also compared the residents of the core urban area and suburban areas according to the level of leisure time physical activity (LTPA) they had.

A population-based sample of 3730 adults (aged 25–101 y) from Finland, filled out a questionnaire in 2015. Variables describing the supply of green areas and built sports facilities were objectively calculated. The green areas were classified into small (< 25 ha), middle-sized (25–150 ha) and large (> 150 ha) areas to reflect their qualities for GE. The data analysis methods included multinomial logistic regression, t-, and Chi Square tests.

Our results indicate that having a short distance to at least a middle-sized green area and high nature relatedness are important for participation in GE, both in core urban and suburban areas. More factors were found to be related to GE in the suburban areas compared to core urban areas and among the low LTPA compared to the high LTPA group.

## 1. Introduction

Physical activity (PA) reduces public health costs by preventing many physical and mental diseases, such as coronary heart disease, type 2 diabetes, depression, and breast and colon cancers (Lee et al., 2012; Teychenne et al., 2008). Population-level PA may be promoted via informational, behavioral, social, policy, and environmental approaches (Heath et al., 2012). One possible environmental approach to promote PA is to enhance green exercise (GE) in other words PA that takes place in natural environments, such as in forests, parks and along shores. It has been proposed that GE has additional health benefits compared to PA indoors (Thompson Coon et al., 2011), and that the benefits include stress reduction and cognitive restoration (James et al., 2015; Pietilä et al., 2015; Pasanen et al., 2014). In addition, exposure to green areas has been suggested to encourage PA (James et al., 2015; Dadvand et al., 2016).

Easy access to green infrastructure may promote PA (Pietilä et al., 2015; Neuvonen et al., 2007). Previously, the number of parks within a 0.5 km distance from home was found to positively associate with objectively measured PA in a large study from 14 cities in ten countries on five continents (Sallis et al., 2016). The presence and number of parks and green spaces have also been found to be positively associated with self-rated PA (Astell-Burt et al., 2014a, 2014b; McMorris et al., 2015; Liu et al., 2017). Despite some studies which did not find a direct link (Triguero-Mas et al., 2015; Calogiuri and Chroni, 2014; Ord et al., 2013), a positive association between exposure to green spaces and PA levels is generally identified in previous studies (Bowler et al., 2010).

From a residents' perspective, a relevant issue for GE is not only the accessibility of nature, but also the environmental quality and diversity of opportunities for activities and nature experiences offered by everyday living environments (Flowers et al., 2016; Tyrväinen et al., 2007). Perceived qualities of green spaces, such as the attractiveness of the landscape, peace and quiet, species richness and cultural features have been positively associated with PA (Tyrväinen et al., 2007; Bjork

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https://doi.org/10.1016/j.healthplace.2018.11.001
Received 18 April 2018; Received in revised form 18 October 2018; Accepted 6 November 2018

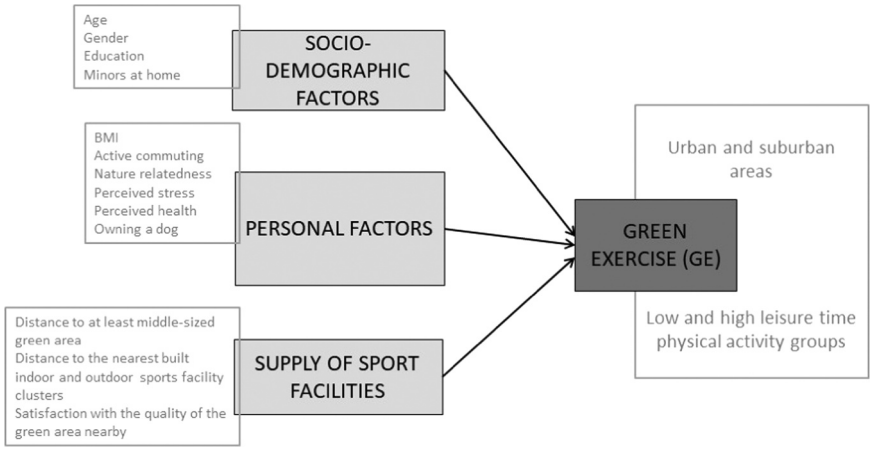


**Fig. 1.** Theoretical framework of the factors hypothesized to affect green exercise.

et al., 2008; de Jong et al., 2012). In addition, several quality factors positively affect the amount of PA that people engage in. These factors include, for example, the size and the connectivity of green areas, the attractiveness and diversity of the landscape, as well as versatile outdoor recreation possibilities and services (i.e. parking lots, lighting, and outdoor recreation trails) (Tyrväinen et al., 2007; Kaczynski et al., 2014). Moreover, over-crowding in a green area may prevent people from visiting the area (Arnberger and Mann, 2008). PA may also be higher among residents living closest to a well-maintained park with an organized layout and structured path network (Coombes et al., 2010) emphasizing the importance of park features. The presence of enjoyable places and being near to watercourses have also been found to be positively associated with PA (Karusisi et al., 2012).

In addition, socio-demographic factors may be associated both with PA behavior and the preferred environments for it, but the evidence on this association is mixed. The association between urban greenness and PA was the strongest in higher income groups and young adults in a Canadian study (McMorris et al., 2015). However, controversial non-significant associations are reported between income and GE (Ord et al., 2013) and between age, gender and urban greenspace visits (Dallimer et al., 2014). In Finland, young people, urban residents and highly educated people have been suggested to prefer indoor sports services and other built sport facilities in their activities (Husu et al., 2011). Although socio-demographic factors may not generally define visits to green areas, it has been suggested that older people especially prefer to exercise in nature (Husu et al., 2011; Calogiuri et al., 2016).

An individual's relationship with nature has also recently been found to enhance physical activity in green areas. Nature relatedness may be of great significance to GE and could help in meeting PA recommendations (Flowers et al., 2016). Another study has suggested that people who met PA targets and had a higher degree of nature relatedness than average, engaged more in outdoor PA (Lawton et al., 2017). In addition, other personal factors, such as convenience, stress relief and reducing feelings of anxiety may motivate people to visit local green spaces (James et al., 2015; Calogiuri and Elliott, 2017). Moreover, good perceived health can facilitate GE while poor perceived may health restrict it (James et al., 2015).

In Finland, the green infrastructure provides an important resource for those who wish to be physically active, and it has been studied that 36% of the physical leisure time activity of adults occurs in natural environments (Husu et al., 2011). Importantly, Finns live, on average, approximately 600 m from the forest closest to their homes, and 96% of Finnish adults participate in outdoor recreation in many different forms (Sievänen and Neuvonen, 2011). In Finland, cities and towns are still relatively green compared to many other European countries (Tyrväinen et al., 2005). However, in international studies close proximity and a high proportion of green space has not always been found to associate with PA (Mäki-Opas et al., 2016). Therefore, more accurate measurements including the size and the type of green space and the user's perspectives have been suggested to be used studies in relatively green cities. According to Tyrväinen et al. (2007), urban nature and daily outdoor recreation are important to people living in the suburbs of cities in Finland, where they seem to especially appreciate tranquility, the feeling of being in the forest and naturalness. However, the relevance of nature to people can vary by the residential area. Easy accessibility to the city center or urban services are appreciated more by people living in compact urban areas, while easy access to nature is often more appreciated by people living in suburban areas (Faehnle et al., 2011). However, green areas are only one place which provides opportunities for PA to occur. According to a Finnish study of 6874 adults, 14% of the self-reported leisure time PA takes place in indoor sports facilities (Husu et al., 2011).

There is only a little research that takes into account all the socio-demographic, personal and environmental factors associated with green exercise of the participants. We had two aims in this population-based study: 1) We aimed to comprehensively explore how personal and socio-demographic factors and supply of green areas and built sports facilities are associated with the amount of GE. 2) We also compared the core urban and suburban residents and the high/low leisure time PA groups according to the differences in supply of green areas and other factors related to green exercise. The theoretical framework of the study is presented in Fig. 1.

## 2. Material and methods

### 2.1. Study design

We used the responses from the Helsinki Capital Region Environmental Health Survey data measuring the health, health behavior and environmental factors in Helsinki, which is a city of 620,000 inhabitants and the capital of Finland. Approximately 40% of Helsinki consists of green and recreational areas, while the forest accounts for about one fifth of the area (Jaakkola et al., 2013). Most of the green areas are located in the suburbs, while the majority of indoor sports facilities are located in core urban areas (Fig. 2).

The Helsinki Capital Region Environmental Health Survey data was collected in 2015 using both mailed and electronic questionnaires. A random sample of 8000 Helsinki residents aged 25 years or more was drawn from the Population Register. Of these, 3730 (47%) people participated in this survey. The respondents were slightly over presented by the female gender 59% (53% among Helsinki residents aged 25–100) and by age groups of 55–64 years 18% (15%) and at least 65

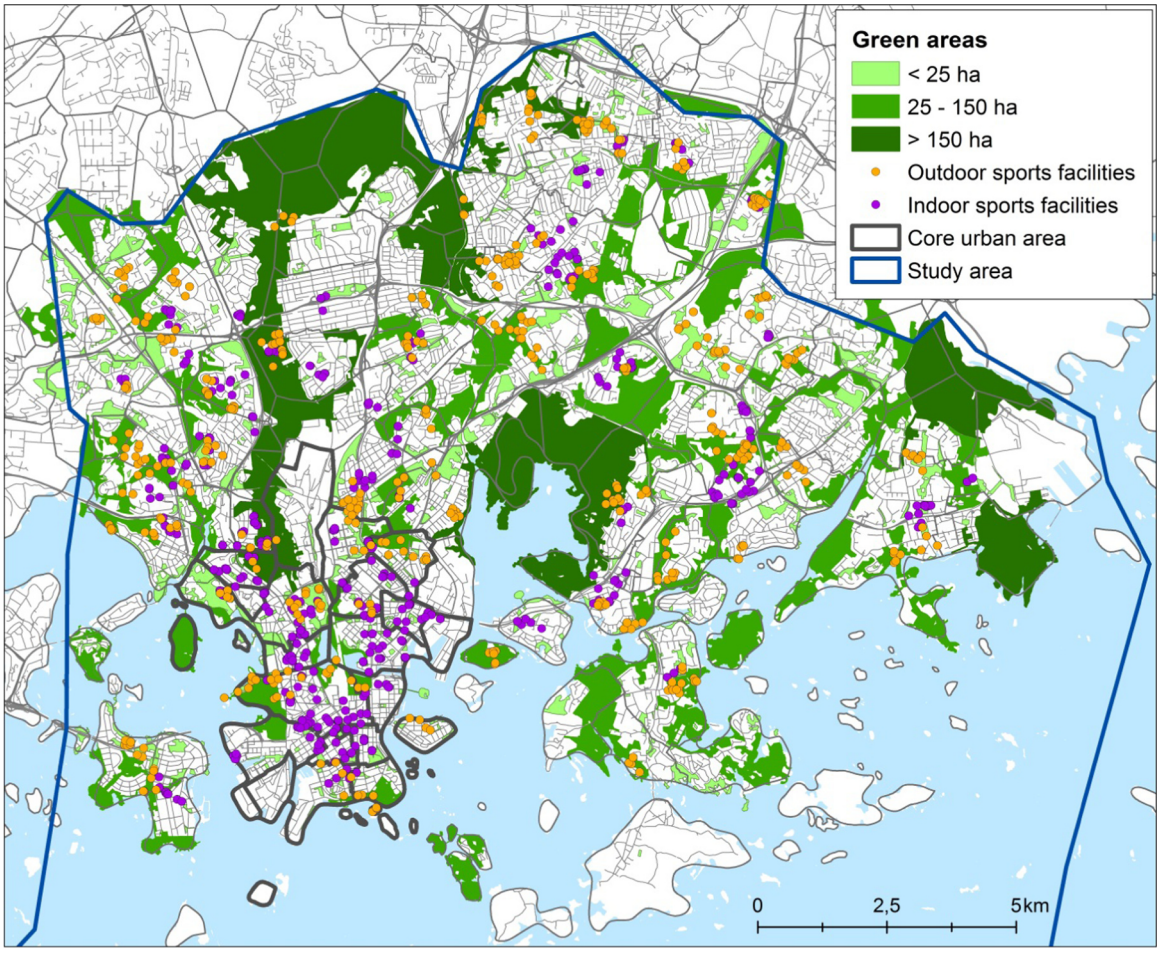


**Fig. 2.** Location of the indoor and the outdoor sport facilities, small (< 25 ha), middle-sized (25–150 ha) and large (> 150 ha) green areas and the core urban area in Helsinki.

years 34% (22%) (Table 1). The proportion of respondents with a basic or middle school level of education was lower, and was 16% compared to the Helsinki population (24%). (Statistics Finland.) The residential areas of the participants were divided into core urban and suburban areas according to the postal code areas (Tyrväinen et al., 2016; Lönnqwist, 2015).

### 2.2. Measures of physical activity

The amount of green exercise and leisure time physical activity were self-reported. Participants reported how often they exercised outdoors (e.g. in parks, forests, or fields) during the warm season (May to September) and in the cold season (October to April) with alternatives: 1) Never (0 points), 2) Less often than once a week (1 point), 3) 1–2 times a week (2 points), 4) 3–4 times a week (3 points), and 5) 5 times weekly or more (4 points). The sum of the points (0–8 points) was used as the GE score and classified into four levels in a multinomial regression analysis: 1) ever or rarely (0–2 points), 2) relatively often (3–4 points), 3) often (5–6 points) and 4) very often (7–8).

The amount of LTPA that the participants engaged in was obtained via the question: How often are you physically active during your leisure time for a minimum of 20 min at a time so that you get at least slightly winded and that you sweat (excluding active commuting to work or school)? From the answer options 1) Never, 2) Less often than once a week, 3) 1–2 times a week, 4) 3–4 times a week, and 5) 5 times weekly or more, options 1–3 were categorized as low LTPA and options 4–5 as high LTPA. The instrument originates from the National FINRISK Study (Borodulin et al., 2017). Due to its old history, validation studies were not routinely included in the 1970's, yet fairly similar physical activity instruments have later been validated, showing modest validity against objectively measured physical activity (Helmerhorst et al., 2012).

The participants also reported whether they walked or cycled to work or school in warm (1 point) and cold seasons (1 point) and if they walked or cycled for example to grocery store in warm season (1 point). The active commuting score was a sum of these points.

### 2.3. Socio-demographic and personal-level variables

In addition to their age and gender, participants reported their highest level of education from the alternatives: basic school education, middle school, vocational upper secondary school, general upper secondary school, former post-secondary level, polytechnic degree or university graduate. They were also asked if they have minors at home.

The participants rated their current health status as very good, quite good, moderate, quite poor or poor (Rasanen et al., 2015) and a 2-level variable was used (very good/pretty good vs. moderate/pretty poor/poor) in the analysis. In addition, participants reported (in a single question) whether they had suffered from stress during the last month and the measure used was a dichotomous variable (quite often/continually vs. never/seldom/occasionally). They also reported if they own a dog and their body mass index (BMI) was calculated from self-reported height and weight (BMI = $kg/m^2$).

To measure the connection the respondents to our survey had to nature, we used the brief measure of nature relatedness (NR6) (Nisbet et al., 2009; Nisbet and Zelenski, 2013), which is a scale designed to

**Table 1**
Characteristics of the study participants according to the leisure time physical activity status (LTPA) and the comparison between the survey respondents and the Helsinki population. The values are means (standard deviation, SD) or proportions (%).

| Variable | All (N = 3730) | Low LTPA, n = 1947 | High LTPA, n = 1692 | p[a] | Aged 25+ population in Helsinki[b], % |
|---|---|---|---|---|---|
| Mean age, years | 54.9 (17.1) | 54.6 (17.0) | 54.2 (16.8) | 0.441 | |
| Age, years | | | | 0.147 | |
| 25–34, N (%) | 646 (17.3) | 325(16.7) | 316 (18.7) | | 26 |
| 35–44, N (%) | 521 (14.0) | 284 (14.6) | 233 (13.8) | | 19 |
| 45–54, N (%) | 602 (16.1) | 331 (17.0) | 270 (16.0) | | 18 |
| 55–64, N (%) | 683 (18.3) | 380 (19.5) | 298 (17.6) | | 15 |
| 65–100, N (%) | 1278 (34.3) | 627 (32.2) | 575 (34.0) | | 22 |
| Gender, N (%) | | | | 0.149 | |
| Female | 2210 (59.2) | 1169 (60.0) | 976 (57.7) | | 53 |
| Male | 1520 (40.8) | 778 (40.0) | 716 (42.3) | | 47 |
| Education, N (%) | | | | **0.001** | [c] |
| Basic school education, middle school | 574 (15.7) | 305 (15.8) | 232 (13.9) | | 24 |
| Vocational or general upper secondary school, post-secondary level (old) | 1456 (39.6) | 808 (42.1) | 617 (36.9) | | 30 |
| Polytechnic degree or university graduate | 1647 (44.7) | 808 (42.1) | 502 (49.2) | | 46 |
| Minors at home (vs. no), N (%) | 619 (16.8) | 380 (19.8) | 304 (18.2) | 0.224 | |
| Median household income | 30,001–50,000€ | 30,001–50,000€ | 30,001–50,000€ | | 35 160 €[d] |
| Mean nature relatedness score | 3.5 (0.8) | 3.4 (0.8) | 3.5 (0.8) | **0.002** | |
| BMI, kg/m2 | 25.7 (4.7) | 26.2 (5.1) | 25.0 (4.0) | < **0.001** | |
| Living in core urban area (vs. suburban area), N (%) | 1027 (27.5) | 551 (28.3) | 450 (26.6) | 0.251 | |
| LTPA, 20 min at a time, N (%) | | | | | |
| Less than once a week | 742 (20.4) | | | | |
| 1–2 times a week | 1205 (33.1) | | | | |
| At least 3 times a week | 1692 (46.5) | | | | |
| Active commuting, N (%) | | | | < **0.001** | |
| None | 795 (27.4) | 467 (30.1) | 327 (24.3) | | |
| Regularly walking to work OR walking to do errands | 901 (31.0) | 489 (31.5) | 410 (30.5) | | |
| Regularly walking to work in the warm season AND walking to do errands | 440 (15.2) | 231 (14.9) | 208 (15.5) | | |
| Regular active work commuting throughout the year and walking to do errands | 767 (26.4) | 364 (23.5) | 398 (29.6) | | |
| Green exercise score (points 0–8) | 4.6 (2.0) | 4.0 (1.9) | 5.4 (1.9) | < **0.001** | |
| Suffers from stress often or continually (vs. never/occasionally), N (%) | 623 (17.2) | 362 (19.0) | 256 (15.6) | 0.008 | |
| At least quite good perceived health (vs. poor or moderate), N (%) | 2463 (67.0) | 1145 (59.7) | 1286 (76.7) | < **0.001** | |
| Owns a dog (vs. no), N (%) | 516 (14.0) | 263 (13.6) | 244 (14.6) | 0.400 | |
| Distance to at least a middle-sized green area (m) | 420 (360) | 420 (360) | 410 (350) | 0.240 | |
| Distance to the nearest group of built outdoor sports facilities (m) | 680 (430) | 680 (430) | 680 (430) | 0.937 | |
| Distance to the nearest group of built indoor sports facilities (m) | 790 (650) | 780 (650) | 800 (650) | 0.400 | |
| At least quite satisfied with the quality of the green area nearby (vs. not satisfied), N (%) | 3023 (82.6) | 1556 (81.2) | 1408 (84.3) | **0.015** | |

[a] p = chi-square test or the independent samples *t*-test for the difference between the low and high LTPA groups.
[b] = Data source: Statistics Finland.
[c] = aged 15+ yrs.
[d] = Data source: Statistics Finland, Open data by postal code area.

briefly assess people's level of relatedness to nature. The scale has six items and the participants answered questions such as “I take notice of wildlife wherever I am,” and, “My relationship to nature is an important part of who I am.” The participants responded with a five-point Likert scale ranging from strongly disagree to strongly agree.

The participants also evaluated their satisfaction with the quality of the green areas in their residential environment on a Likert scale, and this was used as a dichotomous variable (very satisfied or quite satisfied vs. not satisfied/dissatisfied or quite/very dissatisfied) in the analysis. It was evaluated with a single question: “How satisfied are you with the quality of the green areas in your living environment”.

### 2.4. Supply of green areas and built sports facilities

To calculate the supply of green areas in Helsinki, as a starting point, we used spatial data of green areas in Helsinki from the year 2003 used in a previous study on nature areas and health in urban and suburban areas in Helsinki (Tyrväinen et al., 2016). The data was constructed using the green area database of the City of Helsinki Public Works Department, aerial photographs of the city and annually published SeutuCD 2003, describing features such as road network and land-use within the Helsinki Metropolitan Area. The data was updated for this study taking into account recent land-use changes such as new residential and industrial areas based on data from The National Land Survey from 2014 and 2016. Green areas in Helsinki included: forests, wetlands, parks, agricultural lands, community gardens, and all other vegetated areas excluding built-up sport areas with facilities and golf-courses. The green areas were classified into small (< 25 ha), middle-sized (25–150 ha) and large (> 150 ha) green areas to reflect their qualities and the opportunities they provide for various types of uses. At least in the Helsinki area the size of the area correlates with the facilities and services provided for green exercise. For example the largest areas have the cross-country skiing opportunities provided during the winter time. The other quality aspects include the landscape, feeling of being in the forest, silence – many of these issues are appreciated by Finns. The area size correlates often positively with these items. In the classification, those areas that were connected via cycle or walking paths were considered continuous green areas. The distances to the closest small, middle-sized and large green areas from the participant's home address were calculated with the Network analyst extension in the ESRI ArcGIS software package (version 10.3.1). Distance was calculated using primarily walkways and cycle paths, and using bigger

roads only if the before mentioned were absent. Based on our preliminary analysis, the shortest distance to *at least* a middle-sized green area was used in the further analysis. In other words, with this variable, the distance was normally measured to the nearest middle-sized green area, but if a large green area was nearer participant's home address than the middle-sized area, we used the distance to the larger area in the analysis. We also calculated the distance to the nearest body of water, but this was not associated with green exercise and therefore not included in the main analyses.

In addition, we measured distances to the nearest cluster of built outdoor and indoor sports facilities. The outdoor and indoor facilities for the 20 most popular Finnish types of sports (The Finnish Olympic Committee, 2010) were selected from the spatial data for national sports facilities (University of Jyväskylä, LIPAS database, 26th of May 2017). The indoor sports facilities included gyms, sports halls, fitness centers, dance rooms, swimming pools, skiing tunnels, indoor ice rinks, riding stables, and others. The built outdoor sports facilities included courts for different ball games, stadiums, skating parks, golf courses, beaches and outdoor pools. Clusters were formed by creating a 150-m buffer zone around each sports facility and combining the overlapping buffers into connected areas. The areas which included at least four indoor/outdoor sports facilities were used as a cluster of indoor/outdoor sports facilities in the analysis.

The supply of sports facilities and green areas of different sizes, and the core urban area are presented in Fig. 2.

### 2.5. Statistical analysis

The self-rated green exercise score was used as a dependent variable in the analyses and the statistical significance was set at $p < 0.05$. As a preliminary analysis, we studied the association between GE and different sizes of green areas with a Pearson correlation. Differences in participant characteristics between the low and high LTPA groups were analyzed using a chi-square test for the categorical variables and an independent samples *t*-test for the continuous variables.

To evaluate the factors associated with GE among all participants as well as among the low and the high LTPA groups according to the residential area (core urban/suburban areas), separate multinomial logistic regression (MLR) analyses using the forward entry method were carried out using the IBM SPSS Statistics for Windows, Version 22.0 computer software. The variables were entered in the model all at once and MLR analysis was done separately for all six groups: 1) core urban residents, 2) suburban residents, 3) low LTPA core urban residents, 4) low LTPA suburban residents, 5) high LTPA core urban residents, and 6) high LTPA suburban residents. Variables associated with GE according to the theoretical framework (age, gender, BMI, education, nature relatedness, active commuting, distance to green area/indoor sports facility/outdoor sports facility, perceived stress and health, minors at home, owning a dog and satisfaction with the quality of the green area) were entered in the regression analysis. The results are presented as odds ratios (OR) with 95% confidence intervals (CI).

## 3. Results

In the preliminary analyses on the correlation between the green exercise and the supply of green area among all the study participants ($N = 3609$), the strongest correlation was detected between the amount of green exercise and the distance to *at least* a middle-sized (25–150 ha) green area (Pearson correlation = −0.151; p-value < 0.001). *At least* means that the distance was normally measured to the nearest middle-sized green area, but if a large green area was nearer than the middle-sized area, we used the distance to the larger area. The associations with the largest (> 150 ha) and the smallest areas (< 25 ha) were non-significant (−0.022, $p = 0.184$; −0.022, $p = 0.190$, respectively). The correlation between the GE and middle-sized green areas was −0.040 ($p = 0.016$) and with the nearest green area regardless of the size was −0.105 ($p < 0.001$).

The characteristics of the study participants are presented in Table 1. More than half of the participants were categorized as having a low level of LTPA with 20 min of exercise no more than twice a week, and 46.5% fell into the high LTPA group with 20 min of exercise at least three times a week. Participants in the low LTPA group had higher BMI values ($p < 0.001$) and a lower level of education ($p < 0.001$) than the participants in the high LTPA group. Participants with high LTPA had higher level of active commuting ($p < 0.001$), more green exercise ($p < 0.001$), they suffered less often from stress ($p = 0.008$) and perceived health better ($p < 0.001$) compared to people with lower LTPA. Participant with low LTPA also had lower nature relatedness score ($p = 0.002$) and were less satisfied with the quality of the green areas in their neighborhoods ($p = 0.015$) compared to the high LTPA group, but there were no statistical differences in the objectively measured characteristics of their living environments. Altogether 27.5% lived in the core urban area of Helsinki and the rest in the suburbs.

Results of the multinomial logistic regression analysis showed more statistically significant associations for GE in the suburban area compared to core urban area and in the low LTPA compared to high LTPA group (Table 2). When higher GE levels 3 (often) and 4 (very often) were compared to level 1 (never or rarely), nature relatedness was positively associated with GE despite the level of LTPA and living environment. In general, there were more statistically significant associations when level 1 (never or rarely) was compared to higher GE levels 3 (often) and 4 (very often) than to level 2 (relatively often), and thus the results of the comparison to higher levels (3 and 4) are reported more precisely below. Moreover, in Level 2 the amount of GE is quite low.

When *all study participants* where considered, all socio-demographic and personal factors were significantly associated to GE among suburban residents (Table 2). Older age, female gender, higher education, having minors at home, nature relatedness, active commuting, good perceived health and having a dog at home were all positively associated with GE. On the other hand, BMI and perceived stress were negatively related to GE among suburban adults. Considering factors indicating supply of sport facilities, being satisfied with the quality of the green area nearby were associated with GE in both living environments when comparing level 1 to level 3, but only in suburban area when level 1 compared to level 4 (Table 2). A short distance to at least a middle-sized green area was associated with green exercise, both in the core urban area and the suburban area when highest level of GE was compared to lowest level of GE (4 vs 1), and in suburban area when level 3 compared 1. In core urban area also the distance to the nearest outdoor sports facility was associated with GE (Table 2).

Considering *low leisure time physical activity group,* among suburban adults the results showed generally similar trends on the association of socio-demographic and personal factors on GE as when suburban adults of all participants were considered. None of the factors indicating the supply of sport facility in either of the residential areas were related to GE when level 2 or 3 was compared to level 1, but while comparing 4–1, short distance to green area and quality of green areas were associated with GE in the suburbs and short distance to build outdoor facility in core urban area.

In the *high leisure time physical activity group*, only few socio-demographic and personal factors were associated with GE in both residential areas. Nature relatedness was positively associated in both living environments, and active commuting in suburban area. Having a dog at home were also associated to GE, but only when level one was compare to highest GE level (1 vs 4). Of the factors indicating the supply of sport facility, the distance to a green area was negatively related to GE when the highest level was compared to level 1 (1 vs 4) in the suburban group (Table 2). The quality of green areas were positively associated with GE in both residential areas when level 1 was compared to level 3, but only in suburban when compared to highest level (1 vs 4).

**Table 2**
Multinomial logistic regression of factors related to the 4-level green exercise score according to the level of leisure time physical activity and the residential area.

| Green exercise score, 4-level | | ALL | | LOW LTPA | | HIGH LTPA | |
|---|---|---|---|---|---|---|---|
| | | Core urban, n = 785, r2 = 0.315 OR (95% CI) | Suburban, n = 1893, r2 = 0.335 OR (95% CI) | Core urban, n = 432, r2 = 0.312 OR (95% CI) | Suburban, n = 999, r2 = 0.376 OR (95% CI) | Core urban, n = 353, r2 = 0.380 OR (95% CI) | Suburban, n = 892, r2 = 0.333 OR (95% CI) |
| 2 vs 1[a] | Age, years | **0.97 (0.96–0.99)** | 1.00 (0.99–1.01) | **0.98 (0.96–0.99)** | 1.00 (0.99–1.01) | **0.97 (0.94–1.00)** | 0.99 (0.97–1.02) |
| | Gender, female (vs. male) | 0.84 (0.55–1.29) | 1.04 (0.77–1.41) | 0.88 (0.53–1.46) | 1.11 (0.78–1.59) | 1.11 (0.48–2.59) | 0.90 (0.49–1.67) |
| | Higher education (vs. not) | 1.22 (0.78–1.90) | **1.48 (1.06–2.05)** | 1.23 (0.74–2.06) | 1.37 (0.93–2.02) | 1.39 (0.55–3.53) | 1.62 (0.84–3.10) |
| | Minors at home (vs. no) | 1.33 (0.68–2.58) | **1.90 (1.28–2.82)** | 1.36 (0.62–2.96) | **2.15 (1.34–3.44)** | 1.36 (0.33–5.52) | 1.55 (0.73–3.32) |
| | Nature relatedness score | **1.61 (1.21–2.13)** | **1.39 (1.15–1.68)** | **1.53 (1.09–2.16)** | **1.47 (1.17–1.84)** | **2.06 (1.20–3.54)** | 1.21 (0.83–1.78) |
| | BMI, kg/m2 | 0.97 (0.92–1.02) | 0.98 (0.95–1.01) | **0.94 (0.89–1.00)** | 0.98 (0.94–1.01) | 1.09 (0.97–1.21) | 1.00 (0.93–1.08) |
| | Active commuting score | 1.02 (0.85–1.24) | **1.29 (1.12–1.49)** | 1.01 (0.80–1.28) | **1.20 (1.02–1.42)** | 0.94 (0.65–1.37) | **1.46 (1.06–2.00)** |
| | Suffers from stress often or continually (vs. never/occasionally) | 0.86 (0.53–1.39) | 0.76 (0.53–1.10) | 0.99 (0.56–1.75) | **0.62 (0.40–0.95)** | 0.57 (0.22–1.46) | 1.36 (0.61–3.03) |
| | At least quite good perceived health (vs. poor or moderate) | 1.06 (0.66–1.72) | **2.15 (1.54–3.00)** | 0.95 (0.55–1.65) | **2.07 (1.42–3.02)** | 1.26 (0.41–3.89) | 2.00 (0.91–4.39) |
| | Owns a dog (vs. no) | 1.23 (0.50–3.04) | 0.94 (0.53–1.66) | 1.92 (0.67–5.54) | 0.99 (0.52–1.91) | 0.30 (0.05–1.99) | 0.88 (0.25–3.05) |
| | Distance to at least middle-sized green area, km | 0.89 (0.55–1.43) | 0.78 (0.47–1.30) | 0.96 (0.54–1.70) | 0.75 (0.41–1.39) | 0.63 (0.23–1.71) | 0.82 (0.31–2.22) |
| | Distance to the nearest group of built outdoor sports facilities, km | 0.64 (0.38–1.06) | 0.89 (0.59–1.34) | 0.55 (0.30–1.01) | 0.78 (0.48–1.26) | 1.12 (0.37–3.35) | 1.04 (0.47–2.29) |
| | Distance to the nearest group of built indoor sports facilities, km | 1.03 ( 0.62–1.73) | 1.12 (0.86–1.47) | 0.93 (0.51–1.71) | 1.26 (0.91–1.74) | 2.40 (0.68–8.42) | 0.93 (0.55–1.57) |
| | At least quite satisfied with the quality of the green area nearby (vs. not satisfied) | 1.45 (0.92–2.29) | 1.25 (0.86–1.82) | 1.20 (0.69–2.10) | 1.12 (0.71–1.76) | 1.81 (0.75–4.38) | 1.66 (0.82–3.36) |
| 3 vs 1 | Age, years | 0.99 (0.97–1.00) | **1.01 (1.00–1.03)** | 0.99 (0.96–1.01) | 1.01 (0.99–1.03) | 0.99 (0.97–1.02) | 1.02 (1.00–1.04) |
| | Gender, female (vs. male) | 1.45 (0.9–2.33) | **1.41 (1.03–1.94)** | **2.11 (1.06–4.24)** | **2.14 (1.41–3.26)** | 1.73 (0.75–3.97) | 1.02 (0.56–1.85) |
| | Higher education (vs. not) | 1.05 (0.65–1.71) | **1.58 (1.12–2.22)** | 1.05 (0.54–2.06) | **1.66 (1.06–2.60)** | 1.22 (0.50–2.98) | 1.24 (0.66–2.33) |
| | Minors at home (vs. no) | 1.82 (0.89–3.72) | **2.01 (1.33–3.03)** | 2.11 (0.82–5.40) | **2.60 (1.53–4.41)** | 2.05 (0.52–8.16) | 1.78 (0.84–3.76) |
| | Nature relatedness score | **2.28 (1.66–3.12)** | **1.70 (1.39–2.07)** | **2.24 (1.41–3.55)** | **1.59 (1.22–2.07)** | **2.88 (1.69–4.90)** | **1.96 (1.34–2.85)** |
| | BMI, kg/m2 | 0.95 (0.89–1.00) | **0.92 (0.89–0.95)** | **0.91 (0.84–0.99)** | **0.92 (0.88–0.96)** | 1.06 (0.95–1.18) | 0.95 (0.88–1.02) |
| | Active commuting score | **1.24 (1.01–1.53)** | **1.46 (1.26–1.70)** | **1.43 (1.04–1.96)** | **1.35 (1.11–1.63)** | 1.07 (0.74–1.54) | **1.54 (1.14–2.09)** |
| | Suffers from stress often or continually (vs. never/occasionally) | **0.41 (0.23–0.72)** | **0.50 (0.34–0.75)** | **0.41 (0.18–0.92)** | **0.48 (0.29–0.81)** | 0.39 (0.15–1.02) | 0.70 (0.32–1.57) |
| | At least quite good perceived health (vs. poor or moderate) | 1.60 (0.92–2.79) | **2.31 (1.63–3.28)** | 1.15 (0.55–2.43) | **1.96 (1.25–3.07)** | 1.22 (0.41–3.59) | 1.39 (0.67–2.90) |
| | Owns a dog (vs. no) | 1.59 (0.61–4.15) | **2.14 (1.23–3.74)** | **3.50 (1.03–11.96)** | **2.16 (1.07–4.36)** | 0.62 (0.11–3.39) | 2.51 (0.81–7.79) |
| | Distance to at least middle-sized green area, km | 0.70 (0.41–1.21) | **0.57 (0.33–0.97)** | 0.66 (0.30–1.44) | 0.49 (0.23–1.03) | 0.55 (0.20–1.49) | 0.50 (0.19–1.33) |
| | Distance to the nearest group of built outdoor sports facilities, km | **0.52 (0.29–0.93)** | 1.09 (0.72 (1.65) | 0.44 (0.19–1.04) | 1.11 (0.63–1.93) | 0.82 (0.27–2.45) | 0.95 (0.44–2.04) |
| | Distance to the nearest group of built indoor sports facilities, km | 0.84 (0.46–1.56) | 1.14 (0.87–1.51) | 1.09 (0.46–2.56) | 1.15 (0.79–1.66) | 1.41 (0.39–5.10) | 1.15 (0.69–1.90) |
| | At least quite satisfied with the quality of the green area nearby (vs. not satisfied) | **2.29 (1.34–3.92)** | **2.04 (1.35–3.10)** | 2.24 (0.98–5.13) | 1.71 (0.95–3.08) | **2.64 (1.10–6.36)** | **3.26 (1.63–6.53)** |
| 4 vs 1 | Age, years | 1.00 (0.98–1.02) | **1.01 (1.00–1.03)** | 0.99 (0.96–1.02) | 0.99 (0.97–1.01) | 1.02 (0.98–1.06) | **1.03 (1.01–1.06)** |
| | Gender, female (vs. male) | 1.38 (0.75–2.55) | **1.53 (1.06–2.22)** | 1.91 (0.78–4.66) | **2.74 (1.56–4.83)** | 1.59 (0.59–4.31) | 1.03 (0.54–1.96) |
| | Higher education (vs. not) | 0.98 (0.53–1.82) | **1.55 (1.05–2.30)** | 1.70 (0.68–4.25) | 1.52 (0.85–2.71) | 0.71 (0.25–2.01) | 1.28 (0.65–2.52) |
| | Minors at home (vs. no) | 1.89 (0.77–4.63) | **2.04 (1.29–3.23)** | 2.51 (0.78–8.13) | **2.05 (1.08–3.92)** | 2.31 (0.46–11.72) | 2.14 (0.96–4.76) |
| | Nature relatedness score | **2.43 (1.62–3.64)** | **2.18 (1.72–2.76)** | **2.42 (1.35–4.34)** | **1.70 (1.19–2.41)** | **2.98 (1.57–5.65)** | **2.79 (1.85–4.20)** |
| | BMI, kg/m2 | **0.93 (0.86–1.00)** | **0.92 (0.88–0.95)** | 0.93 (0.84–1.04) | **0.93 (0.88–0.99)** | 1.02 (0.89–1.16) | 0.93 (0.86–1.01) |
| | Active commuting score | **1.44 (1.09–1.91)** | **1.72 (1.45–2.05)** | 1.39 (0.92–2.10) | **1.35 (1.05–1.75)** | 1.34 (0.85–2.11) | **1.93 (1.39–2.67)** |
| | Suffers from stress often or continually (vs. never/occasionally) | 0.51 (0.24–1.06) | **0.46 (0.29–0.75)** | 0.51 (0.19–1.40) | **0.46 (0.24–0.90)** | 0.50 (0.15–1.71) | 0.64 (0.26–1.53) |
| | At least quite good perceived health (vs. poor or moderate) | 1.74 (0.83–3.62) | **2.99 (1.95–4.59)** | 1.41 (0.51–3.88) | **2.52 (1.36–4.65)** | 1.54 (0.41–5.81) | 1.77 (0.79–3.98) |
| | Owns a dog (vs. no) | **22.03 (8.80–55.19)** | **23.24 (13.36–40.43)** | **33.63 (10.02–112.87)** | **34.67 (17.29–69.53)** | **15.30 (2.97–78.72)** | **23.40 (7.49–73.11)** |
| | Distance to at least middle-sized green area, km | **0.48 (0.23–0.99)** | **0.30 (0.15–0.57)** | 0.50 (0.17–1.50) | **0.31 (0.12–0.82)** | 0.31 (0.09–1.04) | **0.22 (0.08–0.67)** |
| | Distance to the nearest group of built outdoor sports facilities, km | **0.33 (0.14–0.74)** | 1.03 (0.63–1.67) | **0.30 (0.09–0.99)** | 1.14 (0.55–2.36) | 0.49 (0.13–1.89) | 0.85 (0.37–1.95) |
| | Distance to the nearest group of built indoor sports facilities, km | 1.25 (0.55–2.85) | 0.97 (0.70–1.34) | 0.98 (0.31–3.07) | 0.85 (0.52–1.40) | 3.45 (0.76–15.64) | 1.05 (0.61–1.82) |
| | At least quite satisfied with the quality of the green area nearby (vs. not satisfied) | 1.43 (0.72–2.84) | **2.25 (1.35–3.74)** | 0.70 (0.27–1.82) | **2.59 (1.11–6.02)** | 2.14 (0.68–6.70) | **3.29 (1.50–7.20)** |

Adjusted for all the variables presented in this table.
Statistically significant associations are in bold text. Missing data was excluded listwise.
OR = Odds ratio, CI = Confidence interval, $r^2$ = Nagelkerke regression coefficient for the model.
Coloring: Light grey = socio-demographic factors, moderate grey = personal factors, dark grey = the supply of sports facilities (Fig. 1).
[a] GE levels = 1 “never or rarely”, 2 “relatively often”, 3 “often”, and 4 “very often”.

## 4. Discussion

In this adult-population-based study, a short distance to at least a middle-sized green area was associated with green exercise, both in the core urban area and suburban area among all study participants. This association, however, was found only in the suburban area after the participants were divided into low and high LTPA groups. More factors were found to be related to GE in the suburban area compared to the core urban area as well as for the low LTPA compared to the high LTPA group. A short distance to build outdoor sports facilities was related to higher levels of GE only among core urban residents. Nature relatedness was positively associated with GE despite the LTPA level or the living environment. In addition, a good level of perceived health, female gender, age, BMI, perceived stress and quality of the green area as well as a high degree of active commuting were associated with GE.

According to previous studies, there is strong evidence of a positive association between the availability and proximity of green areas and GE (Calogiuri and Chroni, 2014) which is consistent with our study. Fewer studies have taken into account the size and the connectivity of the green areas as we have done in this study. Earlier studies have mainly used green areas with a minimum size of 1.5 or 2 ha (Mäki-Opas et al., 2016; Foster et al., 2009) and have not studied how the size of the area affects its use for PA. The quality of nature areas including the size, the habitat diversity and the type of the green area (e.g. park, forest, water element included) seem to be good indicators for predicting the usability of green areas for PA (Tyrväinen et al., 2016; Korpela et al., 2010; Keskinen et al., 2018). In a recent Finnish study, however, the association between the supply of green areas and physical commuting activity was not detected (Mäki-Opas et al., 2016), but larger green areas were not included as they were in our study.

More green areas exist outside the core urban area and the opportunities for GE are better in suburban Helsinki, and thus more correlates of GE were probably found in the suburbs for this reason. A previous Finnish study also suggested that restorative experiences are stronger in people's favorite places in urban woodlands and outdoor activity areas in nature compared to built facilities in urban settings (Korpela et al., 2010). Furthermore, shorter distance to built outdoor sports facilities were related to higher levels of GE in the core urban area. This may be partly because built outdoor sports facilities are often located in proximity of green areas or because the participants may have reported their physical activity in built outdoor sports facilities as GE.

The activation of physically inactive people is a global concern. Fewer factors were associated with GE for the high LTPA compared to the low LTPA group. These results suggest, that physically active people are motivated to take exercise in all environments and green areas do not need to be located near their homes. According to our study, people with higher levels of nature relatedness, who engage in active commuting, have a lower BMI, and have lower levels of perceived stress engaged in higher levels of GE, although they did not specifically report high LTPA. Thus our findings suggest that green areas may provide an opportunity to engage in PA for those with lower level of leisure time physical activity. Customizing GE services to different groups may be necessary.

Consistent with our study, nature relatedness has been found to be associated with GE in previous studies in the UK and Australia (Flowers et al., 2016; Lin et al., 2014). In addition, these studies (Flowers et al., 2016; Lin et al., 2014) suggest that nature relatedness is even a stronger predictor of park use than the objectively measured availability of green areas. In the UK study, the quantity of local green space was assessed by cross-referencing respondents' home postcodes with general land use databases, and in the Australian study buffers were used in the calculation of green areas. This differs from the GIS methods used in our study because we also took into account the user's perspective (connectivity of the areas via cycle or walking paths) and the size of the green area in the calculation. The perceived quality of green areas has been also found to predict GE in previous studies (Flowers et al., 2016). The found association between taking green exercise and perceived health in this study corresponds with previous studies in that health status is a strong correlate of general physical activity (Bauman et al., 2012).

The strength of our study is its population-based study sample and the use of GIS methods in the determination of the availability of green areas and built sports facilities. In addition, the qualities, such as the size and the connectivity of the green areas were comprehensively taken into account. The variables describing the supply of green areas were measured in an attempt to follow the actual ways that people seek access to green areas (by walking and using cycle paths).

Our study is limited because the questions on GE and LTPA may partly be overlapping and may suffer from overreporting due to self-reporting methods. We expect that recalling the frequencies of visiting nature areas may cause bias to data, especially to green exercise score. To reduce the bias respondents were asked the frequency of visits on summer and winter time in separate questions. The data were collected at one point in time, and thus the results cannot be interpreted in terms of causalities. Although the survey participation was based on the random sample of Helsinki residents (aged 25 + ), the response rate was less than 50%. However, the general theme of the survey was not only focussed on the green exercise, and it implies that data covers also the infrequent visitors to nature. Our study, with a large sample size, has sufficient statistical power to identify the factors influencing the outcome variable; however, in the stratified modelling (e.g. core urban residents with low leisure time physical groups or suburban residents with high leisure time physical activity) the increased number of respondents in these groups might have enhanced the statistical significance of the variables. Without GPS we would not know where the respondents are usually physically active and this may bias our results.

The odds ratios of owning a dog were quite high in the regression analysis (Hosmer and Lemeshow, 2000) and because of this, the ORs and their 95% CIs of this variable are interpreted to be only allusive. High ORs may be due to small numbers of dog owners in the level 4 GE group. We also conducted the multinomial regression analysis without the variable “owning a dog” and the results remained roughly the same. Because of the previous research on the positive association between dog ownership and PA (Christian et al., 2013), we still wanted to include the variable in the analysis.

In this study, personal and socio-demographic factors associated with GE e.g. health status, stress levels, nature relatedness and LTPA were mainly self-reported, and were not objective measures. This may suggest that an individual's own experiences are relevant to GE. Therefore it will also be important to include subjective factors besides objective ones in the future studies.

Globally and in Helsinki, the significant potential for increasing PA might be in the creation of supportive policies in sectors outside health such as transportation, communication, urban planning and having a good supply of green spaces (Pratt et al., 2012). Considering the hectic everyday life and the increasing amount of health problems linked to modern lifestyles, natural areas seem to be a valuable resource for public health promotion, and the role and importance of natural areas at the population level needs to be better understood.

## 5. Conclusion

Based on our study, a short distance to at least a middle-sized green area and a high degree nature relatedness are of great importance for green exercise despite the living environment. In addition, active commuting and being satisfied with the quality of green areas nearby

increases the odds of people exercising in green areas. The green environment may provide an opportunity to engage in physical activity especially for suburban residents and those with lower level of leisure time physical activity.

## Acknowledgements

We would like to thank Vesa Nivala and Tuija Sievänen from Natural Resources Institute Finland and Pekka Tiittanen from National Institute for Health and Welfare for their co-operation in this study.

## Declarations of interest

None.

## Funding

This study was funded by the Ministry of Education and Culture (OKM/84/626/2015, OKM/24/626/2016, OKM/75/626/2017) and Natural Resources Institute Finland (Project no. 41007-00073400). The funding sources had no role in the study implementation.

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