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Recreational values of the natural environment in relation to neighbourhood satisfaction, physical activity, obesity and wellbeing

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ABSTRACT

Objectives: The aim of this population-based study was to investigate associations between recreational values of the close natural environment and neighbourhood satisfaction, physical activity, obesity and wellbeing.

Methods: Data from a large public health survey distributed as a mailed questionnaire in suburban and rural areas of southern Sweden were used (N = 24 819; 59% participation rate). Geocoded residential addresses and the geographical information system technique were used to assess objectively five recreational values of the close natural environment: serene, wild, lush, spacious and culture.

Results: On average, a citizen of the Scania region, inner city areas excluded, only had access to 0.67 recreational values within 300 metres distance from their residence. The number of recreational values near the residence was strongly associated with neighbourhood satisfaction and physical activity. The effect on satisfaction was especially marked among tenants and the presence of recreational values was associated with low or normal body mass index in this group. A less marked positive association with vitality among women was observed. No evident effect on self-rated health was detectable.

Conclusions: Immediate access to natural environments with high recreational values was rare in the study population and was distributed in an inequitable manner. Moreover, such access was associated with a positive assessment of neighbourhood satisfaction and time spent on physical activity, which can be expected to reduce obesity and increase vitality by having a buffering effect on stress.

There is a growing interest among landscape planners and public health officials in the effects of urbanisation on physical activity, obesity and wellbeing.[1–4] Most research has focussed on the effects of the built (man-made) environment, including economic influences (cost and access), neighbourhood safety and transportation opportunities.[5–11] Negative aspects of built environments have been linked to physical inactivity and obesity.[5 12] Less emphasis has been put on the role of close access to natural environments[13–18] and few large population-based studies have been based on objective assessments.[17 18]

Individuals interact with natural environments through active participation (eg, gardening or conservation), personal leisure-time activities (eg, walking, cycling or picnicking) or by simply viewing nature.[19] Active participation and activities in natural environments imply physical activity, which can be expected to have positive effects on obesity. Access to nearby natural environments is also likely to be beneficial for vitality and perceived general health.[13–15 17 20 21] Neighbourhood satisfaction, as part of the construct social coherence, has been linked to psychological wellbeing.[20] The sounds of nature may reduce stress and improve wellbeing.[14] Drops in blood pressure have been observed after walking in a natural environment.[15] Stronger effects of nearby natural surroundings on perceived general health have been observed in subgroups, eg, the elderly and ill, that spend more time at home.[17 22 23]

Since the 1960s, research concerning people's preferences for natural environments has resulted in evolutionary based hypotheses, claiming that people need natural environments with certain characteristics, eg, wildness, species richness and spaciousness, to enjoy and get on in their neighbourhood.[14 24–26] Interview studies conducted in 1995–2005 in landscape architecture/environmental psychology have revealed eight characteristics, recreational values, of urban open spaces (serene, wild, lush, spacious, culture, the common, the pleasure garden and festive/centre) that humans appreciate,[27 28] but no previous study has investigated the health effects related to such recreational values in large population settings.

In the present study, based on the geographical information system (GIS) and public health survey data from suburban and rural areas in southern Sweden, we aimed at investigating the role of the natural neighbourhood environment in promoting human health. Previous research has shown that the use of green areas already decreases markedly if they are 100–300 metres away from the residence.[13 21] We therefore hypothesised that the natural neighbourhood environment should be within easy walking distance from the residence in order to yield positive effects. We also hypothesised that not only the distance to but also the recreational values of the natural environment are important. We expected nearby natural surroundings to be more important for tenants, most often without access to their own garden that may compensate for the absence of other green areas.[17 29] Motivated by previous research,[17] we also investigated whether the positive effects were modified by gender and age.

MATERIALS AND METHODS

Public health survey

The study, which was conducted in accordance with the Swedish law of ethics, was based on data

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Table 1 Self-reported characteristics of 24 819 participants of the public health survey in suburban and rural areas of the Scania region in southern Sweden 2004 in relation to the number of recreational values of the natural environment present within 300 metres distance from their residence

		All	No of recreational values within 300 metres		
			0	1	2–5
Variable	N*	N = 24 819	N = 13 873	N = 6638	N = 4308
Age (years)†	24 819	50 (19–76)	49 (20–76)	50 (19–75)	51 (19–75)
Females	24 819	54.3	54.3	54.1	54.8
Born abroad	23 740	11.7	14.2	10.2	6.1
Educational level	23 283				
⩽9 Years at school		29.2	29.2	29.1	29.5
10–13 Years at school		34.2	34.4	34.5	33.0
University		31.9	31.7	31.9	32.5
Other education		4.7	4.8	4.6	5.0
Employment status	24 319				
Employed		58.7	57.8	59.8	59.6
Retired or on sick-leave		26.3	26.5	25.6	26.6
Student		6.8	7.5	6.4	5.4
Unemployed		4.4	4.8	4.1	3.9
Works at home or on leave		3.8	3.4	4.1	4.4
Type of residence	24 021				
Own house		60.4	54.2	62.8	76.9
Own flat		13.0	16.8	10.0	5.2
Rented flat or room		26.6	29.0	27.2	17.9
Problems with paying bills	24 264				
Never		74.5	74.6	73.8	75.5
Only very occasionally		17.5	17.3	18.1	17.1
At least every second month		8.0	8.1	8.1	7.5
Smoking status	24 655				
Never		55.1	55.1	53.7	57.2
Former		24.4	23.8	25.6	24.6
Current		20.5	21.1	20.6	18.2

*Number of answers.
†Median (2.5th–95th percentiles).
All characteristics are given in percentages if not otherwise stated.

from an extensive public health survey distributed as a mailed questionnaire in the Scania region in southern Sweden.[30] All individuals 18–80 years old, living in this region on 30 June 2004, constituted the study population (N = 855 599). The population was stratified by gender and geographical area, resulting in $2 \times 62 = 124$ different strata. Samples were randomly selected from the population registry such that an approximately equal number of individuals were contacted in each stratum. Answers were obtained during September 2004 to January 2005 from 27 963 individuals, a 59% participation rate. The participation

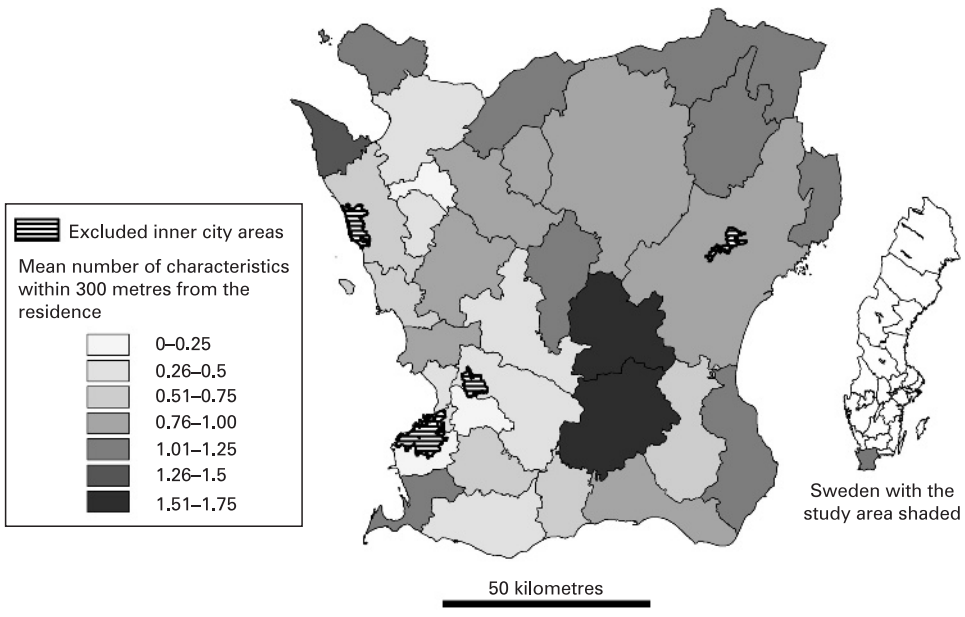


Figure 1 Mean number of recreational values of the natural environment within 300 metres distance from the residence in each of the 33 municipalities in the Scania region (range 0.08 for Staffanstorp municipality in the southwest to 1.68 recreational values on average for Hörby municipality in the middle of Scania).

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rate was higher among women, the elderly, individuals born in Sweden and among individuals with high education and income. Residential geocodes were obtained for 27 879 participants. Only survey participants of rural and suburban areas were included in the present study (N = 24 819; table 1). An assessment of the recreational values of the natural environments in inner city areas, mostly urban parks, was outside the scope of the present study and we therefore excluded survey participants from the inner city areas of Malmö, Lund, Helsingborg and Kristianstad (N = 3060).

We used a survey question regarding neighbourhood satisfaction as a first test of the importance of attractive natural surroundings very close (100–300 metres) to the residence and compared the effect among tenants and house-owners. We then investigated associations between nearby natural surroundings and survey questions regarding: (1) time spent on moderate physical activity per week; (2) body mass index (BMI); (3) self-rated physical and psychological health at present; (4) the 36-item short-form (SF-36) health survey item "vitality".

The phrasings of the two questions regarding neighbourhood satisfaction and physical activity were specific for the present and similar national and regional surveys (see Appendix 1). BMI was calculated as self-reported weight/length^2, rounded to the nearest integer and grouped as normal (<25 kg/m^2), overweight (25–29 kg/m^2) or obese (≥30 kg/m^2). The seven-graded scale for self-rated health had specified response options only at the ends of the scale (1, very poor (could not feel worse), 7, very good (could not feel better)). For SF-36 vitality, we used the median rating (1–6) of the four questions (full of life, a lot of energy, (not) worn out and (not) tired.[31–33]

Assessment of the natural neighbourhood environment

Interview studies conducted in 1995–2005 in landscape architecture/environmental psychology on preferences and habits regarding urban parks have revealed eight characteristics, recreational values, of natural surroundings that humans appreciate and that may have positive health effects.[27 28] With available data, we were able to establish objective definitions (see Appendix 2) that were possible to implement using the GIS technique for five of these recreational values, which were originally described as shown in the box.[27]

We assessed the presence/absence of each of the five recreational values within 100–300 metres from the centre of the property at each geocoded residential address. Data for this automatic assessment were obtained from Lantmäteriet (the National Land Survey of Sweden), which within the European Union program CORINE (Coordination of Information on the Environment)[34] mapped the land and vegetation cover of Sweden into approximately 58 classes, using 25 × 25 metre grids. Regional GIS databases from the County Administrative Board of Scania were also used. With the available data, we could not assess objectively the recreational values of urban parks in inner city areas (located in Malmö, Lund, Helsingborg and Kristianstad) and the assessments were therefore restricted to suburban and rural areas.

1. Serene—a place of peace, silence and care. Sounds of wind, water, birds and insects. No rubbish, no weeds, no disturbing people.
2. Wild—a place of fascination with wild nature. Plants seem self-sown. Lichen and moss-grown rocks, old paths.
3. Lush—a place rich in species. A place offering a variety of wild species of animals and plants.
4. Spacious—a place offering a restful feeling of "entering another world", a coherent whole, like a beech forest.
5. Culture—the essence of human culture. A historical place offering fascination with the course of time.

Statistical analysis

All analyses were conducted using SPSS 14.0 for Windows (SPSS Inc, Chicago, Illinois, USA). We considered p values below 0.05 and 95% confidence intervals (CI) for odds ratios (OR) that excluded unity as statistically significant. As a result of the stratified sampling scheme, weighted statistical analyses were used when population means and prevalences were estimated. We used Spearman's rank correlation coefficient to test associations between the number of recreational values (0–5) present near the residence and ordered response categories of the survey questions. Suggested associations were investigated further using ordinal regression under the cumulative odds model with location parameters only.[35 36] This model estimates the average OR of all possible dichotomisations of the ordinal response variable. All ordinal response variables were coded such that an OR greater than one implied a beneficial health effect. In the regression analyses, individuals with four and five recreational values near the residence were collapsed into one category because of too small numbers. Confounding adjustments were made for the broad list of individual determinants of health in table 1, using the categorisation presented. Four age categories were used: 18–29, 30–44, 45–64 and 65–80 years. For identified associations, we investigated effect modification by gender, age and type of residence (rented flat or room versus own house), respectively, using the likelihood ratio test for the cross-product term.[36] In a separate set of analyses, we also evaluated effects of the five individual recreational values by using two binary variables for each characteristic, indicating presence/absence within 100 and 300 metres, respectively. All recreational values with $p \leqslant 0.30$ in univariate analyses were included in a combined regression model, from which we excluded insignificant indicator variables one by one, starting with the variable with the highest p value. For each insignificant recreational value, the variable for 100 metres was always omitted before the 300 metres variable.

RESULTS

Recreational values of the natural neighbourhood environment in the survey sample

On average, a citizen of the Scania region, inner city areas excluded, had access to only 0.67 recreational values within a 300 metres distance from their residence (fig 1). We estimated that more than 70% of the study population had a natural neighbourhood environment either without any of the recreational values (58%) or with only the culture characteristic present (14%) within 300 metres distance. The most prevalent of the five recreational values within 300 metres distance from the residences were culture and lush (both estimated to be present near 24% of all residences in the study population), followed by spacious (10%), serene (6%) and wild (3%). Restricting the distance to 100 metres lowered the prevalences markedly (culture 15%, lush 7%, spacious 5%, serene 4% and wild 1%). The proportions of individuals born in Sweden and living in their own houses were noticeably higher in residential areas where more than one of the five recreational values were present (table 1).

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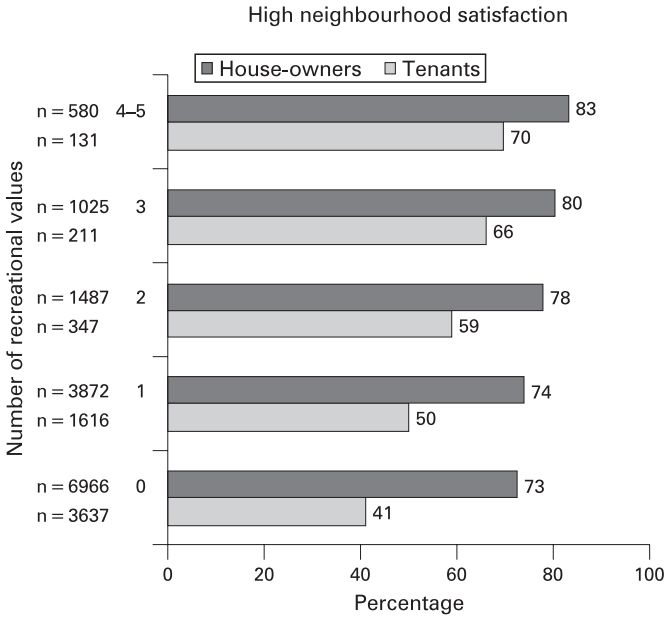


Figure 2 The relation between the number of recreational values (0–5) of the natural environment within 300 metres distance from the residence and the percentage that reports high neighbourhood satisfaction among house-owners (N = 13 930 answers) and tenants (N = 5942 answers).

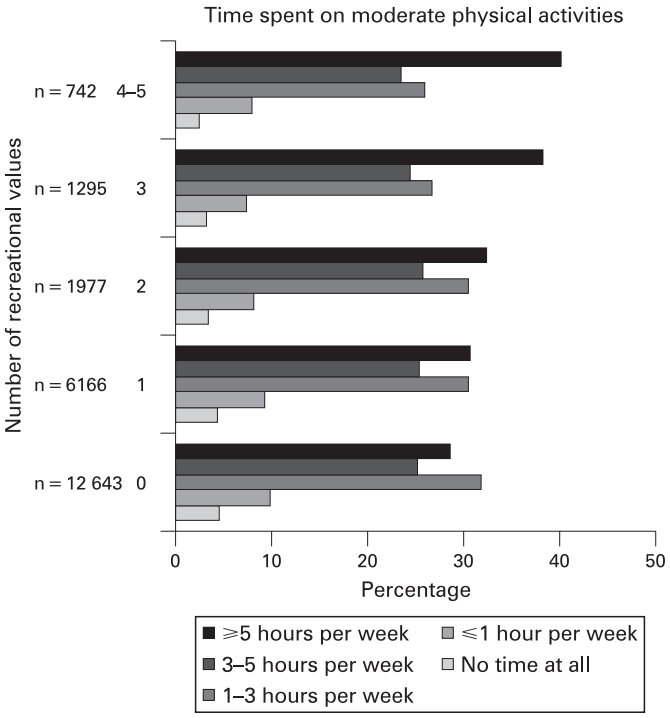


Figure 3 Time spent on moderate physical activities in relation to the number of recreational values (0–5) of the natural environment within 300 metres distance from the residence.

Associations with neighbourhood satisfaction

The number of recreational values near the residence was positively correlated with neighbourhood satisfaction ($p<0.001$ both for 100 and 300 metres). The overall neighbourhood satisfaction was highest among house-owners but the association with the number of recreational values was much more marked for tenants (fig 2). The effect on neighbourhood satisfaction was also evident among individuals living in their own flats (not in figures). For house-owners, serene (OR 1.4, 95% CI 1.1 to 1.6) and wild (OR 1.4; 95% CI 1.1 to 1.8) within 300 metres had the strongest impact on neighbourhood satisfaction in the multivariable regression analyses, whereas serene (OR 1.7; 95% CI 1.3 to 2.3) within 300 metres, lush within 300 metres (OR 1.4; 95% CI 1.2 to 1.7) and lush within 100 metres (OR 1.4; 95% CI 1.0 to 1.9) were the most important recreational values for tenants.

Associations with physical activity and BMI

There was a clear positive correlation between the number of recreational values present within 300 metres distance from the residence and time spent on moderate physical activities every week ($p<0.001$; fig 3). This association remained evident when adjusting for possible individual-level confounders in the multivariable analysis (table 2) and when the analysis was restricted to recreational values present within 100 metres (not in tables). No firm signs of effect modification by gender, age, or

Table 2 Ordinal regression analyses for the association between the number of recreational values of the natural environment within 300 metres from the residence and time spent on moderate physical activities and normal body mass index

	All (N = 24 819)	House-owners (N = 14 520)	Tenants (N = 6390)
	Time spent on moderate physical activities*‡	Normal BMI†§	Normal BMI†§
	OR (95% CI)	OR (95% CI)	OR (95% CI)
No of recreational values within 300 metres			
4–5	1.44 (1.24–1.66)	0.96 (0.81–1.14)	1.33 (0.94–1.89)
3	1.41 (1.26–1.57)	1.07 (0.93–1.22)	1.28 (0.96–1.71)
2	1.13 (1.04–1.24)	0.96 (0.86–1.08)	1.09 (0.87–1.36)
1	1.08 (1.02–1.15)	1.00 (0.92–1.08)	1.24 (1.10–1.40)
0	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)

BMI, Body mass index.
*Ordinal scale with five categories: never (reference category), ⩽1 h per week, 1–3 h per week, 3–5 h per week and ⩾5 h per week (see Appendix 1 available online only).
†Ordinal scale with three categories: obese (⩾30 kg/m^2; reference category), overweight (25–29 kg/m^2) and normal (<25 kg/m^2).
‡Adjusted for gender, age, born abroad, educational level, employment status, problems with paying bills, smoking status and type of residence.
§Adjusted for all individual factors in footnote ‡, except type of residence.

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Table 3 Ordinal regression analyses for the association between the number of recreational values of the natural environment within 300 metres from the residence and self-rated physical and psychological health and vitality

	All (N = 24 819)	Men (N = 11 332)	Women (N = 13 487)
	Self-rated physical and psychological health*†	Self-rated vitality‡	Self-rated vitality‡
	OR (95% CI)	OR (95% CI)	OR (95% CI)
No of recreational values within 300 metres			
4–5	0.95 (0.83 to 1.10)	0.91 (0.74 to 1.11)	1.07 (0.88 to 1.29)
3	1.08 (0.96 to 1.20)	1.06 (0.90 to 1.23)	1.22 (1.06 to 1.41)
2	1.05 (0.96 to 1.15)	1.04 (0.91 to 1.18)	1.06 (0.94 to 1.19)
1	1.00 (0.94 to 1.06)	0.92 (0.84 to 0.99)	1.08 (1.00 to 1.17)
0	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)

*Ordinal scale with seven categories ranging from "Very poor (could not feel worse)" to "Very good (could not feel better").
†Adjusted for gender, age, born abroad, educational level, employment status, problems with paying bills, smoking status and type of residence.
‡Adjusted for all individual factors in footnote †, except gender.

type of residence emerged ($p \geq 0.15$ in tests for interactions). Significant effects for recreational values within 300 metres on physical activity were observed for lush, spacious, serene and wild, all with similar OR in the range 1.1–1.2 in the regression analyses. No additional effects were seen for recreational values present within 100 metres.

There was a weak overall negative correlation between the number of recreational values within 300 metres distance from the residence and BMI ($p = 0.04$). After confounding adjustment, the beneficial effect on BMI was apparent among tenants but not among house-owners (table 2; p for interaction 0.02). The proportion of obese (BMI >30 kg/m^2) individuals among tenants was 17% in residences with zero recreational values within 300 metres (N = 3732) compared with 13% in residences with at least one recreational value present (N = 2385). The effect on BMI was not clearly differential with regard to gender ($p = 0.11$) or age ($p = 0.26$).

Associations with self-rated health and vitality

Some positive correlation between the number of recreational values and good self-rated health was seen for 300 metres ($p = 0.03$) but not for 100 metres distance from the residence ($p > 0.30$). The association was, however, weak and did not remain apparent after detailed confounding adjustment ($p > 0.30$; table 3). No signs of effect modification emerged ($p \geq 0.28$ in tests for interactions).

Vitality correlated positively with the number of recreational values both within 100 and 300 metres distance from the residence ($p = 0.02$ and $p < 0.001$). For 300 metres, a weak effect on vitality was still present after confounding adjustment among women but not among men (table 3; p for interaction 0.04). The proportion of women with high vitality (median score at least 5.0 out 6.0) was 37% in residences with zero recreational values within 300 metres (N = 7189) compared with 40% in residences with at least one recreational value present (N = 5684). The effect on vitality was not differential with regard to age ($p > 0.30$) or type of residence ($p = 0.23$). The presence of any of the five individual recreational values could not predict significantly self-rated health or vitality in the regression modelling (not in tables).

What is already known on this subject

Negative aspects of built (man-made) environments have been linked to physical inactivity and obesity

DISCUSSION

Principal finding

Recreational values of the nearby natural environment were positively associated with neighbourhood satisfaction, physical activity and, for tenants, with normal or low BMI. We also observed a positive association with vitality among women but less marked. No evident effect on self-rated health was detectable.

Strengths and weaknesses of the study

The major strengths of this study were the large number of participants and the extensiveness of the questionnaire, which made detailed confounding control possible. We used objective measures of the recreational values, which facilitated neighbourhood assessment for each residence using the GIS technique. Such assessment of natural surroundings should also be possible to conduct for other regions and countries if land types not present in southern Sweden are included in the definitions of the recreational values.

A major limitation was that, on the basis of the available data, we could not assess the recreational values of the natural surroundings in inner city areas and the generalisability of the results to such areas is therefore uncertain. We did not adjust the results for urbanity because we aimed at estimating total (direct plus indirect) effects associated with nearby natural surroundings. The absence of recreational values in nearby natural surroundings correlated strongly with urbanity and the health effects of built and natural environments are therefore hard to separate. Another limitation was the cross-sectional

What this paper adds

Positive natural neighbourhood environments, assessed with objective measures, were rare and distributed in a socially inequitable manner in suburban and rural areas of southern Sweden. Furthermore, they were associated with neighbourhood satisfaction and high physical activity and to some extent with high vitality and with normal/low BMI.

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Policy implications

Planning for and restoration of natural environments near residential areas should be seriously considered as an additional supportive tool to achieve sustainable and equitable health

setup that limits definite conclusions regarding cause–effects. The participation rate was low (59%), although not lower than in similar studies.[7] Participation was positively associated with determinants of socioeconomic status,[30] which implies that some association between the outdoor environment and participation was probably present. This may have yielded a tendency to overestimate the strength of the associations, provided that participation was also positively associated with wellbeing.

The validity of the questionnaire should also be considered. The questions about vitality were taken from a well-established instrument, the SF-36 health survey.[33] Reasonable overall validity of self-reported BMI was observed in a recent Swedish study[37] but the fraction of obesity was markedly underestimated compared with actual measurements. Such underestimations of BMI, would, if non-differential with respect to the neighbourhood environment, produce bias towards the null. The question about self-rated health has shown high concordance with similar single-question measures.[38] The questions about neighbourhood satisfaction and time spent on moderate physical activity were specific for the present and similar national and regional surveys.

The results in relation to previous studies

The effects of the recreational values of the natural environment on physical activity and on BMI among tenants were remarkably strong in relation to the individual determinants that we controlled for. The effects of objective measures of the quality of urban green space on physical activity were not evident in a study from the United Kingdom, whereas a large American study noted an average effect on body weight due to urban sprawl that was small but comparable in size with the effects of gender and smoking.[2 39] In a study from Greenwich, London,[40] dissatisfaction with green spaces close to the residence was positively associated with being in the lowest quartile for mental health, but was not associated with vitality, as measured by SF-36 subscales. Effects on mental health were not evaluated in the present study, whereas an association with vitality restricted to women was observed, using objective rather than perceived measures of the surroundings.

Contrary to most previous studies, our focus was on the effects of the natural neighbourhood environment and on areas characterised as suburban or rural. The effects of aesthetic qualities of the natural environment have been less clearly elucidated.[41 42] Two Dutch studies reported associations between the percentage of green space (agricultural and natural) within 1–3 kilometres distance from the residence and self-rated health.[17 18] Housewives, the elderly and individuals with lower education seemed to benefit more from access to green areas. No evident associations with self-rated health were found in the present study, which used measures of the surroundings much closer to the residence.

Possible mechanisms and implications

The current study highlights the importance of natural surroundings for neighbourhood satisfaction and for obesity avoidance among tenants in particular. Neighbour satisfaction is likely to increase general psychological wellbeing.[20] Access to recreational values of the natural environment was rare and was distributed in a socially inequitable manner. It is likely that the access to a private garden makes the house-owner less dependent on the common natural environment for well-being.[17 29]

Recent research from the United Kingdom has suggested that sociopolitical, physical and economic features of the neighbourhood environment could be more beneficial for women's than for men's health.[43] In our study, the natural neighbourhood environment had a beneficial effect on vitality among women only. As women on average had a lower self-rated vitality than men, it can be argued that women may both have more need for and more benefit from restorative surroundings. It is also possible that women's everyday lives are still more dependent on their close surroundings than men's. It may be argued, however, that this would also have applied to the elderly, which we did not find.

A crucial task of public health at present is to support individuals in making healthy choices.[44] Our findings imply that the natural environment is important for public health. Planning for and the restoration of natural environments near residential areas should thus be seriously considered as an additional supportive tool to achieve sustainable and equitable health. In this endeavour, the agendas for public health and natural environment indeed converge.[19] Most natural surroundings close to residential areas do not, however, qualify for natural preservation programmes but should nevertheless be regarded as key areas for human health promotion.

Issues for future research

The research strategy of linking geographically determined exposures to individual information on health status and health-related lifestyles, obtained from public health surveys, represents a fairly novel and very promising pathway. The strategy has the potential for supporting the idea that investments in one sector (the natural environment) could very well yield considerable gains in another sector (public health). It also clearly opens up for further development by means of methods developed in health economics (eg, computing disability-adjusted life years) for estimating the monetary value of health gains of the kind described. This would most certainly be helpful in guiding political priorities, especially if applied in the context of a sustainable development framework.

Competing interests: None declared.

REFERENCES

1. **Popkin BM,** Duffey K, Gordon-Larsen P. Environmental influences on food choice, physical activity and energy balance. *Physiol Behav* 2005;**86**:603–13.
2. **Ewing R.** Can the physical environment determine physical activity levels? *Exerc Sport Sci Rev* 2005;**33**:69–75.
3. **Edwards P,** Tsouros A. Promoting physical activity and active living in urban environments. The role of local governments. Copenhagen, Denmark: World Health Organization, Regional Office for Europe, 2006.
4. **Groenewegen PP,** van den Berg AE, de Vries S, *et al*. Vitamin G: effects of green space on health, well-being, and social safety. *BMC Public Health* 2006;**6**:149.
5. **Ewing R,** Schmid T, Killingsworth R, *et al*. Relationship between urban sprawl and physical activity, obesity, and morbidity. *Am J Health Promot* 2003;**18**:47–57.
6. **Humpel N,** Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity: a review. *Am J Prev Med* 2002;**22**:188–99.
7. **Harrison RA,** Gemmell I, Heller RF. The population effect of crime and neighbourhood on physical activity: an analysis of 15,461 adults. *J Epidemiol Community Health* 2007;**61**:34–9.
8. **Saelens BE,** Sallis JF, Frank LD. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Ann Behav Med* 2003;**25**:80–91.

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9. **Huston SL,** Evenson KR, Bors P, *et al*. Neighborhood environment, access to places for activity, and leisure-time physical activity in a diverse North Carolina population. *Am J Health Promot* 2003;**18**:58–69.
10. **Hartig T,** Böök A, Garvill J, *et al*. Environmental influences on psychological restoration. *Scand J Psychol* 1996;**37**:378–93.
11. **Lopez RP,** Hynes HP. Obesity, physical activity, and the urban environment: public health research needs. *Environ Health* 2006;**5**:25.
12. **Papas MA,** Alberg AJ, Ewing R, *et al*. The built environment and obesity. *Epidemiol Rev* 2007;**29**:129–43.
13. **Grahn P,** Stigsdotter U. Landscape planning and stress. *Urban Forestry Urban Greening* 2003;**2**:1–18.
14. **Kaplan R,** Kaplan S. *The experience of nature*. Cambridge: Cambridge University Press, 1989.
15. **Hartig T.** Testing restorative environments theory. Irvine: University of California, 1993.
16. **Ulrich RS,** Simons RF, Losito BD, *et al*. Stress recovery during exposure to natural and urban environments. *J Environ Psychol* 1991;**11**:201–30.
17. **de Vries S,** Verheij RA, Groenewegen PP. Natural environments – healthy environments? An exporatory analysis of the relationship between greenspace and health. *Environ Planning A* 2003;**35**:1717–31.
18. **Maas J,** Verheij RA, Groenewegen PP, *et al*. Green space, urbanity, and health: how strong is the relation? *J Epidemiol Community Health* 2006;**60**:587–92.
19. **Stone D.** Sustainable development: convergence of public health and natural environment agendas, nationally and locally. *Public Health* 2006;**120**:1110–13.
20. **Araya R,** Dunstan F, Playle R, *et al*. Perceptions of social capital and the built environment and mental health. *Soc Sci Med* 2006;**62**:3072–83.
21. **Nielsen TS,** Hansen KB. Nearby nature and green areas encourage outdoor activities and decrease mental stress. *CAB Reviews: Perspectives in Agriculture, Veterinary Sciences, Nutrition and Natural Resources* 2006;**1**:1–10.
22. **Ottosson J,** Grahn P. Measures of restoration in geriatric care residences. *J Housing Elderly* 2005;**19**:229–58.
23. **Ottosson J,** Grahn P. The role of natural settings in crisis rehabilitation. How does the level of crisis influence the response to experiences of nature with regard to measures of rehabilitation? *Landscape Res* 2008;**33**:51–70.
24. **Herzog TR.** A cognitive analysis of preference for natural environments. *Landscape J* 1987;**6**:140–52.
25. **Kellert SR,** Wilson EO. *The biophilia hypothesis*. Washington DC: Island Press, 1993.
26. **Coss RG,** Charles EP. The role of evolutionary hypotheses in psychological research. *Ecol Psychol* 2004;**16**:199–236.
27. **Grahn P,** Stigsdotter U, Berggren-Bärring A-M. A planning tool for designing sustainable and healthy cities. The importance of experienced characteristics in urban green open spaces for people's health and well-being. In: *Quality and significance of green urban areas*. Velp, The Netherlands: Van Hall Larenstein University of Professional Education, 2005.
28. **Grahn P,** Stigsdotter U, Berggren-Bärring A-M. Human issues: eight experienced qualities in urban open spaces. *Green structure and urban planning.* Final report of COST Action C11. Luxembourg: Office for Official Publications of the European Communities, 2005:240–8.
29. **Stigsdotter U,** Grahn P. A garden at your doorstep may reduce stress. Private gardens as restorative environments in the city. In: *Open Space: People Space International Conference on Inclusive Outdoor Environments*. Edinburgh, UK: Open Space Research Centre, Edinburgh College of Art, the International Play Association, Forestry Commission and Scottish National Heritage, 2004:1–6.
30. **Rosvall M,** Ali Khan F, Nilsson M, *et al*. Public health in the Scania region. Health survey 2004 [Hälsoförhållanden i Skåne. Folkhälsoenkät Skåne 2004]. Malmö, Sweden: Region Skåne, 2005.
31. **Brazier JE,** Harper R, Jones NM, *et al*. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. *BMJ* 1992;**305**:160–4.
32. **Lindeberg SI,** Ostergren PO, Lindbladh E. Exhaustion is differentiable from depression and anxiety: evidence provided by the SF-36 vitality scale. *Stress* 2006;**9**:117–23.
33. **Ware JE Jr,** Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992;**30**:473–83.
34. **Büttner G,** Feranec J, Jaffrain G. CORINE land cover update 2000. Copenhagen, Denmark: European Environmental Agency, 2002.
35. **McCullagh P.** Regression models for ordinal data. *J R Stat Soc B* 1980;**42**:109–42.
36. **Armstrong BG,** Sloan M. Ordinal regression models for epidemiologic data. *Am J Epidemiol* 1989;**129**:191–204.
37. **Nyholm M,** Gullberg B, Merlo J, *et al*. The validity of obesity based on self-reported weight and height: implications for population studies. *Obesity (Silver Spring)* 2007;**15**:197–208.
38. **Eriksson I,** Unden AL, Elofsson S. Self-rated health. Comparisons between three different measures. Results from a population study. *Int J Epidemiol* 2001;**30**:326–33.
39. **Hillsdon M,** Panter J, Foster C, *et al*. The relationship between access and quality of urban green space with population physical activity. *Public Health* 2006;**120**: 1127–32.
40. **Guite HF,** Clark C, Ackrill G. The impact of the physical and urban environment on mental well-being. *Public Health* 2006;**120**:1117–26.
41. **Hoehner CM,** Brennan Ramirez LK, Elliott MB, *et al*. Perceived and objective environmental measures and physical activity among urban adults. *Am J Prev Med* 2005;**28**:105–16.
42. **Humpel N,** Owen N, Leslie E, *et al*. Associations of location and perceived environmental attributes with walking in neighborhoods. *Am J Health Promot* 2004;**18**:239–42.
43. **Stafford M,** Cummins S, Macintyre S, *et al*. Gender differences in the associations between health and neighbourhood environment. *Soc Sci Med* 2005;**60**:1681–92.
44. **Hewitt P.** A vision for public health in the 21st century. *Public Health* 2006;**120**:1098–101.

Appendix 1 Survey questions about neighbourhood satisfaction and time spent on moderate physical activities per week

1. What is it like living in your neighbourhood?
- ► Very good
- ► Rather good
- ► Rather bad
- ► Very bad
- ► Do not know/not relevant

2. On an ordinary week, how much time do you spend on moderately demanding physical activities?
(eg walking quickly, gardening, heavier household work, cycling, swimming)
It may vary during the year but try to give an average estimate. Choose only one alternative!
- ► 5 hours per week or more
- ► More than 3 hours, but less than 5 hours per week
- ► Between 1 and 3 hours per week
- ► At most 1 hour per week
- ► No time at all
- ► Do not know/cannot judge

Appendix 2 Criteria for the assessment of the five recreational values of the natural environment

Serene	Wild*	Lush	Space	Culture
Included areas				
Broad-leaved forest	Forest	Mixed forest	Beaches, dunes, and sand plains	Non-urban parks
Mixed forest	Thickets	Marshes and mires	Bare rock	Farmland pointed out in an national plan
Pastures	Bare rock	Beaches, dunes, and sand plains	Sparsely vegetated areas	National interests of cultural preservation
Inland marshes	Inland marshes	Bare rock	Burnt areas	Nature reservation areas
Wet mires	Wet mires	All registered "key biotopes"	Natural grassland	
Other mires	Other mires	Pasture land of regional interest	Moors and heathland	
Water courses	Water courses	Biodiversity areas, Bird biotopes ref. Nature 2000	Forest >25 ha	
Lakes and ponds	Lakes and ponds	National park	Slopes >10 degrees	
	Slopes > 10 degrees		Farmland pointed out in an national plan	
			Coastal zones preservation	
Excluded areas				
Noise >30 dB(A)	Noise >40 dB(A)		Noise >40 dB(A)	
No artillery range	<800 m distance to wind power aggregates			

*All included areas for the Wild characteristics must either be located less than 1 km from a village or have a size above 15 ha.