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The role of physical activity in the relationship between urban green space and health

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ABSTRACT

Objectives

Local availability of green space has been associated with a wide range of health benefits. Possible causative mechanisms underpinning the green space and health relationship include the provision of physical activity opportunities, the stress-relieving effects of nature and the facilitation of social contacts. We sought to investigate whether urban green space was related to individual-level health outcomes, and whether physical activity levels were likely to be a mediating factor in any relationships found.

Study design

Cross-sectional analysis of anonymised individual health survey responses.

Methods

Neighbourhood-level green space availability was linked to 8157 respondents to the New Zealand Health Survey 2006/07, on the basis of their place of residence. Adjusted multi-level models were constructed for four health outcomes which are plausibly related to green space *via* physical activity: cardiovascular disease, overweight, poor general health and poor mental health ('SF-36'; 36-item short-form health survey).

Results

The greenest neighbourhoods had the lowest risks of poor mental health (odds ratio (OR) 0.81, 95% confidence interval (CI) 0.66 to 1.00). Cardiovascular disease risk was reduced in all neighbourhoods with >15% green space availability (e.g., OR 0.80, 95% CI 0.64 to 0.99, for those with 33-70% green space) but the relationship was not dose-response. Green space availability was not related to overweight or poor general health. Overall physical activity levels were higher in greener neighbourhoods, but adjustment for this only slightly attenuated the green space and health relationships.

Conclusions

Neighbourhood green space was related to better cardiovascular and mental health in a New Zealand health survey, independently of individual risk factors. Although physical activity was higher in greener neighbourhoods it did not fully explain the green space and health relationship.

Keywords: green space, New Zealand, physical activity, cardiovascular disease, mental health

INTRODUCTION

There is mounting evidence that the local availability of green space is related to improved health.[1-3] Greener living environments have been associated with reduced morbidity [4] and mortality [5] in a number of high income countries. The causative mechanisms that underlie green space and health relationships remain unclear, although three main contenders emerge from the literature: providing opportunities for physical activity, relief from stress and attention fatigue, and facilitation of social contact.[3,6] To date, population-level evidence for these mechanisms largely consists of findings that green environments are often related to health-benefiting levels of physical activity (PA), stress or social contacts, without directly exploring the role these factors play in the green space and health relationship.

Researchers have recently begun to explicitly test whether physical activity levels might explain the green space and health relationships found in various contexts.[7-9] In Adelaide, Australia, increased levels of walking (for recreation) explained the relationship between perceived greenness and physical health, and partly explained the mental health benefits of greener areas.[7] In contrast, cycling (for commuting purposes) did not mediate the relationship between green space and improved self-reported health in the Netherlands,[8] and leisure-time PA did not explain the relationship between neighbourhood environmental quality and self-reported health in Austria.[9] The role of physical activity in the relationship between green space and health is therefore likely to differ by PA type, and in various contexts. Nonetheless, from a health perspective the mode of PA is of little relevance: for improved physical and mental health the WHO recommends that adults aged 18-64 years do at least 150 minutes of *any* type of moderate-intensity PA each week, regardless of its purpose.[10] We therefore investigated the mediating role of *overall* physical activity levels (regardless of whether recreational or utilitarian) in the green space and health relationship.

The setting for this study was New Zealand, where it has been suggested that social inequalities in health may be partly attributable to the social patterning of salutogenic environments such as green space.[11] However, the scant green space and health research suggests the absence of a positive relationship, in contrast to most research from other countries. Witten et al. [12] found that area-level availability of parks was not associated with individual-level physical activity or being overweight in a nationally-representative sample. Richardson et al. [13] found that area-level availability of urban green space, whether usable (i.e., visitable) or non-usable (i.e., visible but not visitable), was not related to area-level rates of cardiovascular disease mortality. These findings, however, were based on either a restrictive definition of green space,[12] or on ecological associations.[13] The current research addresses some of the weaknesses in these studies. It examines whether overall neighbourhood green space levels are related to individual-level morbidity outcomes, and explores the mediating role of overall physical activity levels. By assessing the relationship between individual-level morbidity outcomes and neighbourhood levels of greenness (not just parks) our approach is likely to be more sensitive to any relationship between green space and health than the previous studies.

We selected four health outcomes that could be plausibly related to green space, because of the protective role of physical activity in their aetiology. Physical activity reduces the risk of overweight and obesity due to increased energy expenditure.[14] Cardiovascular disease (CVD) risk is also lowered, as physical activity reduces risk factors such as overweight, obesity and hypertension.[15] Mental health is improved in physically-active individuals, as a result of reduced anxiety and improved mood, selfesteem and cognitive function.[16] Due to these and other health benefits of physical activity, improved general health has also been found within physically active populations.[17]

METHODS

Study design

Neighbourhood-level green space availability was linked to individual respondents to the New Zealand Health Survey 2006/07 (cross-sectional data), on the basis of their place of residence. We used adjusted multi-level models to investigate the relationship between individual health outcomes and green space availability, and the role of individual physical activity in this relationship.

Green space measure

Development of our area-level green space measure is detailed elsewhere.[13] In brief, the definition of green space included natural areas (e.g., parks, beaches and fields) but excluded aquatic areas and private gardens. Three land use datasets were amalgamated to produce the classification: the Department of Conservation's Conservation Area Boundaries (2003), Land Information New Zealand's Core Record System (2004) and the Ministry for the Environment's Land Cover Database (2001). All green spaces of 0.02 ha (200 m^2) or larger were included. The proportion of green space within each Census Area Unit (CAU, the second smallest census geography in New Zealand, n = 1927, median population = 2000) was calculated. Green space quartiles were calculated for the 1009 urban CAUs in New Zealand in 2001 (mean area 5 km^2 and mean population 2630).

New Zealand Health Survey data

The 2006/07 New Zealand Health Survey (NZHS) is a national survey of the health status of 12,488 adults aged 15 years and over living in permanent private dwellings (target population 3.1 million).[18] The respondents were selected from a sampling frame of 1,385 meshblocks (New Zealand's smallest census geography).

Four binary health outcome measures were derived. A respondent was identified as overweight if their body mass index (BMI, based on objective measurements) exceeded the WHO overweight threshold for adults 18 years old and above (BMI $\geq$ 25) [19] or the Cole thresholds for under 18 year olds.[20] 'Poor general health' and 'poor mental health' were identified for respondents with derived general health and mental health scores in the lowest 25% of the sample. These scores were derived from responses to a 36-item short-form health survey (the 'SF-36') using standard methodology.[21] Cardiovascular disease (CVD) was identified if the respondent reported ever having been diagnosed with a heart attack, stroke, angina, heart failure or other heart diseases.

Physical activity levels were assessed in the survey by asking about the respondent's average weekly duration of brisk walking, moderate-intensity PA (i.e., activity that "makes you breathe a little harder than normal"), and vigorous-intensity PA (i.e., "makes you breathe a lot harder than normal"). Only moderate and vigorous-intensity PA was included, and each minute of vigorous activity counted for two minutes of moderate PA, in line with international guidelines.[10] 'Low PA' was defined as not meeting the guidelines (i.e., < 150 minutes per week), and 'medium PA' and 'high PA' were defined by dichotomising the remaining individuals into two equal-sized groups (150 to 600 minutes and > 600 minutes per week). Physical activity levels of more than 5040 minutes per week (equivalent to 12 hours moderate or 6 hours vigorous PA per day) were considered as reporting or data entry errors, hence these respondents (*n* = 79) were omitted. Although high, 5040 minutes per week appeared to be a natural cut-off given the distribution of activity levels within the sample.

CAU-level green space quartiles were appended to those survey respondents living in urban areas, based on the *meshblock* in which they lived at the time of the survey. Respondents living in rural areas (*n* = 3588) were therefore excluded from the analysis. Given that residents are likely to be exposed to green space both within and surrounding their meshblock of residence, as a result of their daily movements, we considered the *CAU*-level green space data to be appropriate for this green space and health research. There were an average of 21 meshblocks per CAU in NZ in 2006. For confidentiality reasons it was not possible to append the continuous green space data, nor to attach additional area-level covariates that may have been of interest (e.g., population density). After removing respondents with incomplete data (*n* = 743) the final dataset contained 8157 respondents (Table 1). Green space exposure levels did not differ significantly between urban respondents with complete and incomplete data.

[Table 1]

Statistical analyses

Two-level (meshblock and individual) logistic models with a random intercept were fitted using the software Stata/IC 11.1. Design variables were included to take into account the sample stratification and oversampling of some ethnic groups, to ensure the resulting estimates were representative of the target population.[22] The design variables were: stratum (ethnic composition, *n* = 21), quantiles of number of respondents in the meshblock (*n* = 8), number of adults in the household (1 to 5, where 5 represents households of five and over), and ethnicity (*n* = 4: Māori, Pacific peoples, Asian or European/Other).

Individual-level sociodemographic variables considered were sex, age group (15 to 24, 25 to 44, 45 to 64, and 65 plus), smoking behaviour (current/ex-/non-smoker) and an index of individual socioeconomic deprivation (NZiDep).[23] NZiDep was derived from the number of deprivation characteristics the respondent reported, of a total of eight. The raw numbers were recoded into five categories to ensure adequate populations (0 characteristics scored 1, 1 scored 2, 2 scored 3, 3 and 4 characteristics scored 4, and 5 or more characteristics scored 5). The validity of the index has been demonstrated, as has its applicability to all New Zealand adults regardless of their ethnicity or level of economic activity.[23] Model results were unaffected by the use of finer age groupings. As in other individual-level analyses of the green space and health relationship [1,3,4,7,8] we chose not to include area-level socioeconomic deprivation as a covariate. Our rationale was that neighbourhood green space availability may help explain the well-documented socioeconomic gradient in health.

The first stage of the analyses examined whether area-level green space was related to the four health outcomes, after adjustment for individual-level covariates. The second stage assessed whether green space was related to physical activity levels in the sample. The final stage involved assessing the contribution of physical activity levels to any green space and health relationships identified, by adding the PA variable to the initial models and examining any adjustments to these results.

RESULTS

After adjustment for individual-level covariates, neighbourhood greenness was associated with reduced risks of CVD and poor mental health (Table 2). Compared with the least green CAUs, risk of CVD was lower in greener neighbourhoods, although the association was only statistically significant for the residents of CAUs in quartile 3 (33.3 to 69.8% neighbourhood green space). There was no dose-response relationship between greenness and CVD across the green space quartiles. Individuals residing in the greenest quartile of CAUs were significantly less likely to have poor mental health (odds ratio (OR) 0.81, 95% confidence interval (CI) 0.66 to 1.00, p = 0.045), compared with individuals in the least green neighbourhoods. The relationship with mental health approximated a dose-response form, with lower risks seen for successively greener areas (p for trend = 0.02). Modelling mental health as a continuous variable (SF-36 Mental Health subscale score) produced a marginally non-significant relationship (p = 0.07 in greenest CAUs) in the same direction. Green space was unrelated to overweight or poor general health.

Individuals living in the greenest CAUs (quartile 4) were significantly more likely to conduct at least 150 minutes of PA per week than those in the least green quartile (Table 3; 44% more likely, $p < 0.001$), after adjusting for individual-level covariates. Propensity to meet the PA recommendation was also highest for Māori, males, under 65 year olds, and those with lower levels of individual socioeconomic deprivation.

In line with expectations, increased levels of physical activity were independently associated with lower risks of poor mental health (Table 4) and CVD (Table 5). Adjusting for respondents' levels of physical activity had a modest effect on the green space and health relationships – odds ratios and p-values increased marginally –

although the general patterns remained. The reduced risk of poor mental health previously found for the greenest CAUs was reduced to marginal non-significance (p = 0.08), but the results retained a dose-response gradient. The relationship between green space and CVD was also attenuated slightly after adjustment for individual physical activity levels, but remained significant (p = 0.047).

[Tables 2 to 5]

DISCUSSION

Residents of the greenest urban neighbourhoods had significantly lower risks of having poor mental health than those in the least green areas, and the results suggested a dose-response relationship. For CVD the results suggested that above a certain threshold the amount of green space was less important; individuals residing in neighbourhoods with more than 15% green space coverage had similarly reduced CVD risks. Alternatively, it is possible that the least green neighbourhoods have certain other characteristics (e.g., high population density, or urban centres) that relate to CVD risk. In contrast, risks of poor general health or overweight were not reduced in greener neighbourhoods. Important risk factors in the aetiology of these health outcomes (e.g., diet) may dwarf any benefits of green space.

Living in a greener neighbourhood was associated with increased likelihood of the respondent meeting recommended levels of physical activity, and physical activity levels reduced the risks of poor mental health and CVD. Physical activity levels had a small attenuating effect on the previously-noted relationships of green space with both health outcomes, but the relationships remained significant (or near significance at the 95% confidence level). While greener environments may therefore encourage greater levels of physical activity in New Zealand, this is likely to be only part of the reason why cardiovascular and mental health is better in greener neighbourhoods. Other causative mechanisms are likely to be pertinent. Future work should investigate the role of the restorative and stress-relieving effects of natural environments,[24,25] as the benefits of reduced stress and greater social support for mental health [26,27] are widely recognised. In addition, psychosocial factors such as anxiety, social isolation and chronic life stress are strongly related to the pathogenesis of CVD, via either behavioural or physiological mechanisms.[28] Given that key behavioural risk factors were adjusted for here (and that the CVD result remained significant after adjustment for overweight: results not shown) our results suggest the importance of the direct physiological pathway between green space and cardiovascular health. There is increasing evidence, both experimental and observational, that such attention restoration is the key mechanism in the green space and health relationship.[6]

Ours is the first study to find a positive relationship between green space and health in New Zealand. Previous studies found no such associations, and suggested that public green space could be a less important predictor of health in New Zealand than elsewhere because levels of access to green and other potentially healthy spaces are relatively ubiquitous in New Zealand cities, and private gardens are widespread and tend to be larger.[12,13] Similarly we found no relationship with overweight or poor general health. However, our finding of a beneficial relationship between green space and cardiovascular disease but not overweight was surprising, as the latter is a risk factor on the causative pathway to the former.[15]

We found that residents of greener urban neighbourhoods were more likely to meet the recommended levels of physical activity than those in the least green neighbourhoods.

Previous New Zealand work found that better access to parks was not related to PA.[12] This suggests that physical activity levels are more closely linked to the greenness of the wider neighbourhood environment than the accessibility of green destinations.

As the most relevant environmental attributes will vary from activity to activity (e.g., cycling vs. walking, recreational vs. utilitarian) the importance of focussing on specific types of activity has been noted.[29] We suggest that determining the environmental correlates of *overall* levels of PA, as here, also has salience for public health. Furthermore, this approach can inform the design of effective whole-population interventions, because prospective beneficiaries will not be restricted to those, for example, that engage in PA for recreation or for commuting purposes, or those that cycle or those that walk. We should caution that our finding may be context-specific. Although a study in Portland, Oregon, found similar results to ours,[30] research in the Netherlands noted an absence of a relationship between neighbourhood greenness and whether residents met the recommended amount of physical activity.[8]

The study has a number of important strengths. First, the comprehensive high-resolution green space dataset permitted the identification of all neighbourhood green spaces apart from private gardens. Our green space measure therefore captured the ‘greenness’ of the wider neighbourhood environment better than measures that focus on specific green destinations (e.g., parks). Second, the individual-level data were sourced from a representative national sample; hence the findings are nationally relevant. Finally, the use of multi-level modelling preserved important contextual and compositional details, and helped avoid the problems of ecological and atomistic fallacy.[31]

Certain limitations must be acknowledged. First, the physical activity duration data were self-reported and likely to contain inaccuracies, but by deriving a categorical variable we limited the effect of these concerns on the results. Second, we could not explore the role of other area-level covariates in the relationships because attaching these to the respondent data would have potentially identified particular places of residence. Third, our cross-sectional analysis was unable to account for selection bias, hence precludes causal inference between green space and health. Nonetheless, the independent associations found for green space with two health outcomes and one of their known causative mechanisms helped to strengthen the evidence. A longitudinal analysis could usefully address this limitation, although these data are currently available for New Zealand.

CONCLUSIONS

In New Zealand, increased neighbourhood greenness was related to lower risks of poor mental health and cardiovascular disease at the individual level, but was not related to overweight or poor general health. Overall levels of PA were also higher among residents of greener neighbourhoods, but only partly explained the green space and health relationships.

Although the environmental drivers of PA will vary by type, a better understanding of the determinants of *overall* levels of physical activity could help inform population-wide approaches for increasing physical activity levels. In New Zealand our findings suggest that greener neighbourhoods are likely to be advantageous for population-level physical activity and health.

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ETHICS

Not required.

COMPETING INTERESTS

None declared.

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Table 1. Summary information for urban-dwelling respondents to the 2006/07 New Zealand Health Survey[a] (n = 8,157).

Variable	Count	(%)
Sex		
Male	3,547	(43.5)
Female	4,610	(56.5)
Age group		
15 to 24	1,172	(14.4)
25 to 44	3,174	(38.9)
45 to 64	2,360	(28.9)
65+	1,451	(17.8)
Ethnicity		
European/Other	4,319	(53.0)
Asian	1,298	(15.9)
Māori	1,775	(21.8)
Pacific	765	(9.4)
NZiDep (NZ index of deprivation for individuals)		
1 (no deprivation characteristics)	5,029	(61.7)
2 (1 deprivation characteristic)	1,429	(17.5)
3 (2 deprivation characteristics)	684	(8.4)
4 (3 / 4 deprivation characteristics)	668	(8.2)
5 (5+ deprivation characteristics)	347	(4.3)
Smoking		
Current smoker	1,855	(22.7)
Ex-smoker	1,805	(22.1)
Non-smoker	4,497	(55.1)
CAU total green space level (% range)		
1 (< 15.69 = lowest)	2,324	(28.5)
2 (15.69 to 33.15)	2,502	(30.7)
3 (33.27 to 69.77)	2,191	(26.9)
4 (> 69.77 = highest)	1,140	(14.0)
Physical activity level		
Low (0 to 145 mins/week)	3, 238	(39.7)
Medium (155 to 600 mins/week)	2,506	(30.7)
High (610 to 5040 mins/week)	2,413	(29.6)
Ever been diagnosed with a CVD?		
No	7,181	(88.0)
Yes (= 'cardiovascular disease')	976	(12.0)
Overweight or obese?		
No	2,830	(34.7)
Yes	5,327	(65.3)
Lowest quartile of the SF-36 general health scale		
No	6,027	(73.9)
Yes (= 'poor general health')	2,130	(26.1)
Lowest quartile of the SF-36 mental health scale		
No	5,760	(70.6)
Yes (= 'poor mental health')	2,397	(29.4)

[a] Given the complex sampling frame of the survey and the deliberate oversampling of ethnic minorities these figures cannot be extrapolated to the urban population of New Zealand.

Table 2. The relationship between green space availability and four individual-level health outcomes. Results are given as odds ratios (+ 95% confidence intervals) relative to the reference category (odds ratio = 1.00). The results for each health outcome are adjusted for all covariates and survey design variables.

	Cardiovascular disease	Overweight/obese	Poor general health	Poor mental health
CAU green space level (% range)				
1 (< 15.69 = lowest)	1.00	1.00	1.00	1.00
2 (15.69 to 33.15)	0.82 (0.67 to 1.00)	1.05 (0.91 to 1.21)	1.03 (0.89 to 1.20)	1.02 (0.87 to 1.19)
3 (33.27 to 69.77)	0.80 (0.64 to 0.99)	1.01 (0.87 to 1.17)	1.02 (0.87 to 1.19)	0.87 (0.73 to 1.02)
4 (> 69.77 = highest)	0.84 (0.65 to 1.08)	0.93 (0.78 to 1.12)	1.02 (0.84 to 1.24)	0.81 (0.66 to 1.00)
Sex				
Male	1.00	1.00	1.00	1.00
Female	0.90 (0.77 to 1.05)	0.56 (0.50 to 0.62)	0.92 (0.82 to 1.02)	1.15 (1.03 to 1.28)
Age group				
65+	1.00	1.00	1.00	1.00
45 to 64	0.19 (0.16 to 0.23)	0.97 (0.83 to 1.14)	0.58 (0.49 to 0.67)	1.10 (0.93 to 1.31)
25 to 44	0.06 (0.05 to 0.08)	0.66 (0.57 to 0.78)	0.42 (0.36 to 0.50)	1.40 (1.18 to 1.67)
15 to 24	0.05 (0.03 to 0.07)	0.23 (0.18 to 0.28)	0.59 (0.48 to 0.73)	1.70 (1.38 to 2.11)
Ethnicity				
European/Other	1.00	1.00	1.00	1.00
Asian	0.59 (0.43 to 0.79)	0.51 (0.44 to 0.59)	1.14 (0.96 to 1.35)	1.45 (1.24 to 1.69)
Māori	1.12 (0.91 to 1.39)	2.68 (2.31 to 3.12)	1.25 (1.08 to 1.44)	0.97 (0.84 to 1.12)
Pacific	0.56 (0.40 to 0.80)	6.80 (5.23 to 8.85)	1.07 (0.87 to 1.31)	1.15 (0.95 to 1.40)
NZiDep				
1 (no deprivation characteristics)	1.00	1.00	1.00	1.00
2 (1 deprivation characteristic)	1.32 (1.06 to 1.65)	0.95 (0.83 to 1.09)	1.49 (1.29 to 1.72)	1.81 (1.58 to 2.08)
3 (2 deprivation characteristics)	1.48 (1.09 to 2.00)	1.08 (0.89 to 1.31)	2.00 (1.67 to 2.41)	2.57 (2.15 to 3.08)
4 (3 / 4 deprivation characteristics)	2.16 (1.62 to 2.89)	1.14 (0.92 to 1.39)	2.87 (2.38 to 3.46)	3.19 (2.65 to 3.84)
5 (5+ deprivation characteristics)	3.37 (2.37 to 4.80)	1.57 (1.17 to 2.10)	4.32 (3.39 to 5.51)	6.25 (4.85 to 8.05)
Smoking				
Current smoker	1.00	1.00	1.00	1.00
Ex-smoker	1.31 (1.04 to 1.64)	1.48 (1.25 to 1.74)	0.84 (0.72 to 0.98)	0.82 (0.70 to 0.96)
Non-smoker	0.95 (0.76 to 1.18)	1.21 (1.06 to 1.39)	0.63 (0.55 to 0.73)	0.78 (0.68 to 0.89)
Level 2 variance (S.E.)	0.00 (0.00)	0.04 (0.03)	0.07 (0.03)	0.14 (0.04)

Table 3. The relationship between area-level green space availability and the likelihood of a respondent meeting the national recommendation for physical activity (≥ 150 minutes a week). Results are given as odds ratios (+ 95% confidence intervals) relative to the reference category (odds ratio = 1.00). The results are adjusted for all covariates and survey design variables.

	Meets PA recommendation?
CAU green space level (% range)	
1 (< 15.69 = lowest)	1.00
2 (15.69 to 33.15)	1.10 (0.96 to 1.28)
3 (33.27 to 69.77)	1.10 (0.94 to 1.28)
4 (> 69.77 = highest)	1.44 (1.19 to 1.74)
Sex	
Male	1.00
Female	0.62 (0.56 to 0.68)
Age group	
65+	1.00
45 to 64	1.84 (1.59 to 2.13)
25 to 44	2.19 (1.88 to 2.54)
15 to 24	2.24 (1.85 to 2.71)
Ethnicity	
European/Other	1.00
Asian	0.55 (0.48 to 0.64)
Māori	1.16 (1.01 to 1.33)
Pacific	1.00 (0.83 to 1.20)
NZiDep	
1 (no deprivation characteristics)	1.00
2 (1 deprivation characteristic)	0.95 (0.83 to 1.08)
3 (2 deprivation characteristics)	0.89 (0.75 to 1.07)
4 (3 / 4 deprivation characteristics)	0.89 (0.74 to 1.08)
5 (5+ deprivation characteristics)	0.70 (0.55 to 0.90)
Smoking	
Current smoker	1.00
Ex-smoker	0.93 (0.80 to 1.08)
Non-smoker	0.96 (0.84 to 1.09)
Level 2 variance (S.E.)	0.14 (0.03)

Table 4. The relationship between total green space availability and risk of poor mental health, before and after adjustment for the potential mediating effect of physical activity. Results are given as odds ratios (+ 95% confidence intervals) relative to the reference category (odds ratio = 1.00). The results are adjusted for all covariates and survey design variables.

	Poor mental health	
	Baseline model	Baseline + physical activity level
CAU green space level (% range)		
1 (< 15.69 = lowest)	1.00	1.00
2 (15.69 to 33.15)	1.02 (0.87 to 1.19)	1.03 (0.88 to 1.20)
3 (33.27 to 69.77)	0.87 (0.73 to 1.02)	0.87 (0.74 to 1.03)
4 (> 69.77 = highest)	0.81 (0.66 to 1.00)	0.83 (0.68 to 1.02)
Amount of physical activity per week		
Low (0 to 145 mins/week)		1.00
Medium (155 to 600 mins/week)		0.81 (0.72 to 0.92)
High (610 to 5040 mins/week)		0.71 (0.62 to 0.80)
Level 2 variance (S.E.)	0.14 (0.04)	0.14 (0.04)

Table 5. The relationship between total green space availability and risk of cardiovascular disease, before and after adjustment for the potential mediating effect of physical activity. Results are given as odds ratios (+ 95% confidence intervals) relative to the reference category (odds ratio = 1.00). The results are adjusted for all covariates and survey design variables.

	Cardiovascular disease	
	Baseline model	Baseline + physical activity level
CAU green space level (% range)		
1 (< 15.69 = lowest)	1.00	1.00
2 (15.69 to 33.15)	0.82 (0.67 to 1.00)	0.82 (0.67 to 1.01)
3 (33.27 to 69.77)	0.80 (0.64 to 0.99)	0.80 (0.65 to 1.00)
4 (> 69.77 = highest)	0.84 (0.65 to 1.08)	0.87 (0.67 to 1.12)
Amount of physical activity per week		
Low (0 to 145 mins/week)		1.00
Medium (155 to 600 mins/week)		0.77 (0.65 to 0.92)
High (610 to 5040 mins/week)		0.67 (0.56 to 0.82)
Level 2 variance (S.E.)	0.00 (0.00)	0.00 (0.00)