

Environment and Human Health

Urban green space and stress

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This research is part of the Scottish Government's GreenHealth project. It asks if there is a link between green space and stress in deprived urban communities. Overall, it finds evidence that more urban green space is favourably associated with lower levels of self-reported stress and reduced physiological stress, as indicated by diurnal salivary cortisol patterns in a sample of middle-aged men and women not in work.

Main Findings

- More green space in deprived urban communities is associated with lower levels of self-reported stress (Figure 1) for a sample of middle-aged men and women not in work.
- More green space in the home neighbourhood is associated with lower stress as shown by salivary cortisol patterns for a sample of middle-aged men and women not in work.
- Higher levels of green space have a stronger relationship with diurnal cortisol concentrations in women than in men in such demographic groups in deprived communities.
- We have validated an objective method for measuring salutogenic (health improving) effects of environmental settings within people's everyday contexts.

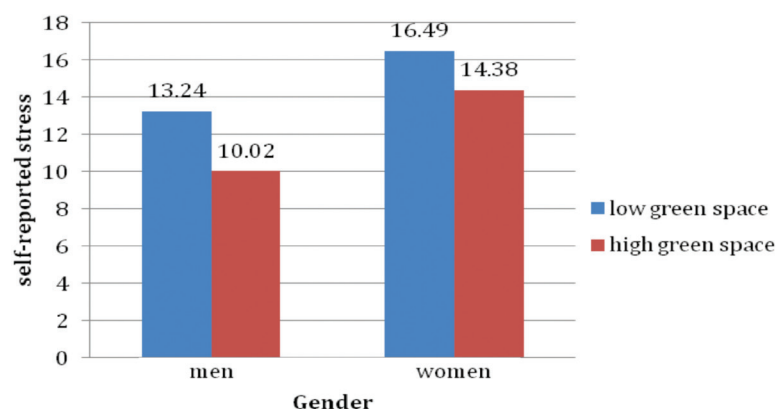


Figure 1: mean levels of self-reported stress in areas of low ($\leq 43\%$) and high ($>43\%$) urban green space

Background

Contact with green space has been associated with benefits to mental health, including stress recovery. This outcome is understood to arise from one or more of three possible pathways: the greater opportunities green space affords for physical activity which, in turn, improves mood; the increased opportunities that urban parks and green space offer for social contact – impromptu or planned; and opportunities for psychological restoration from stress and fatigue. It is believed that the ‘soft’ visual stimuli of natural settings support *involuntary attention* and recovery from the high cognitive demands of urban environments (e.g. from high levels of noise and traffic). However, objective physiological evidence of these benefits is currently limited to a small number of – mostly laboratory – studies showing positive effects of green space on blood pressure, heart rate, skin conductance and muscle tension.

In the last few years a number of studies have begun to explore cortisol as an indicator of stress response to environmental settings. Cortisol – a ‘stress hormone’ – is secreted in the adrenal glands. Most healthy adults have a high cortisol level first thing in the morning, dropping over the day to a low cortisol level at night. Disturbance in this pattern – higher or lower levels of normal secretion – can indicate prolonged or chronic stress. Experiments exploring the impact of green space on cortisol are largely limited to intervention studies measuring levels immediately before and after exposure to different green space settings. Whilst such studies have found that contact with natural environments reduced stress, none of these have measured diurnal cortisol patterns, which offer a more reliable biomarker of someone’s longer-term stress condition. In summary, very little research has examined stress patterns in relation to the long-term effects of familiar, everyday environments, set within the context of people’s normal patterns of activity and experience.

Research questions

Based on the existing evidence we asked the following two questions:

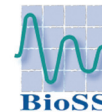
- 1 Among residents of deprived urban areas in Scotland, is the presence of different levels of green space in the home neighbourhood associated with stress as measured by diurnal patterns of cortisol secretion and self-reported stress?
- 2 Are there any sub-group patterns, for example in men compared with women?

Research undertaken

After exploratory analysis of several Scottish cities, Dundee was selected as the most appropriate case study area owing to its high levels of deprivation combined with neighbourhoods with varying levels of green space.

An exploratory study was first carried out to test the feasibility of using cortisol as a stress indicator in poor urban communities suffering from unemployment and income coping difficulties. We found this population were able to adhere to the precise sampling regime required to measure cortisol over two consecutive days. Results showed significant relationships between objective measures of neighbourhood green space, self-reported stress and the diurnal pattern of cortisol secretion. Higher levels of neighbourhood green space were linked with lower levels of self-reported stress and a steeper (i.e. healthier) diurnal decline in cortisol secretion.

A second study was carried out to expand these earlier findings within the same socially deprived urban population in a larger sample, paying particular attention to gender differences.



Study Design

The study was cross-sectional in design. Since cortisol concentration is highly sensitive to age, we restricted our sample to men and women aged 33–55 years. In previous research, green space and health links have been shown more strongly in poorer communities and in people whose time is more likely to be spent in and around the home. We therefore targeted recruitment of participants at people not in work for any reason (e.g. job-seeking unemployed, on invalidity benefit, carers) living in socio-economically deprived areas of Dundee as measured by the Carstairs indices of deprivation (Carstairs and Morris 1991), obtained via each participant's postcode.

Recruitment was carried out either via unemployment centres in Dundee (study 1) or door-to-door, with follow-up appointments carried out by the research team (study 2). Participants were briefed on the protocol for cortisol sampling and completed a short questionnaire on individual characteristics, including how well the household is coping on current income, self-reported stress, wellbeing and exercise levels.

Repeated salivary cortisol sampling took place over two consecutive weekdays (collected over 2 days/4 times per day) with text prompts sent to participants as reminders.

The percentage of green space in each participant's residential area was measured using the Census Area Statistics (CAS) for Wards. Dundee contains 31 CAS Wards with a mean percentage of green space of 33.89% (2001). The green space measure includes parks, woodlands, scrub and other natural environments, but not private gardens (although participants were asked whether they had access to a garden).

In statistical analyses, we explored green space percentage as a continuous variable (i.e. from 0 to 100%) and as a binary variable split at an optimal level of plus or minus 43% (determined using established statistical methods). The term 'low green space' henceforth refers to areas with less than or equal to 43% green space; the term 'high green space' to areas with over 43% green space. See Figures 2 and 3 for typical images of high and low green space areas. All analyses looked for effects above and

beyond age, gender and level of income deprivation in considering effects of percentage of green space in the residential environment. The analyses explored the diurnal pattern of cortisol (i.e. the slope from 3 hours to 9 hours after awakening) and the average daily concentration (i.e. the mean).



Fig 2: Dundee City
A Low Green Space Area



Fig 3: Dundee City
A High Green Space Area

Key findings

Our total sample of 106 comprised 50% women and 50% men, with a mean age of 45.

Self-reported stress: regression analyses showed that the level of green space (continuous variable) was a significant predictor of self-reported stress ($p < 0.05$); self-reported stress was lower in the high green space areas (see Figure 1, on the front page); higher stress levels were more likely in women and (for men only) associated with not having a garden.

Cortisol Slope: A greater diurnal cortisol decline was associated with the binary variable of high green space, compared to low green space.

This pattern is illustrated in Figure 4, showing that participants living in areas of higher green space had a steeper (healthier) cortisol diurnal decline (the solid black line) whilst participants living with lower neighbourhood green space had a flatter (less healthy) slope profile (the dotted line).

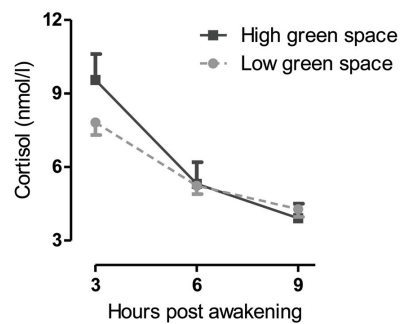


Figure 4: Difference in cortisol slope between participants living in high versus low green space areas

Cortisol Diurnal Mean Concentrations:

Significantly lower average cortisol concentrations were found in women, but there was also a significant interaction between percentage green space and gender. More neighbourhood green space was associated with higher – and

healthier – diurnal cortisol levels among women (i.e. a steeper slope – the solid black profile in Figure 5). In low green space, women showed a 'low and flat' slope indicative of 'burn out' and higher stress levels (the dotted line in Figure 5).

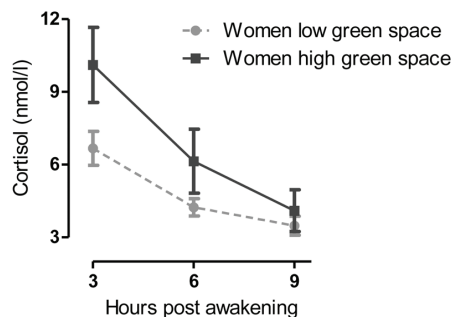


Figure 5: Differences in mean cortisol slope in women living in high vs low green space areas

Conclusions

- Levels of green space in the residential environment can significantly predict levels of self-reported stress and diurnal patterns of cortisol – a biomarker of stress – in deprived urban communities;
- The effect of green space on stress may be mediated by gender, with a stronger positive effect in our sample of increasing green space on cortisol concentrations in women (meaning green space is having a more positive effect on

stress regulation in women than in men). More research is needed to substantiate this for a wider sample and age range;

- Measuring diurnal patterns of salivary cortisol offers an ecologically valid method (i.e. observing people in their real-life contexts) to demonstrate evidence and further understanding of the salutogenic effects of green space.

Policy relevance

Whilst replication of this methodology is required to substantiate findings across urban Scotland, this study suggests:

- Increasing the amount of green space available in urban areas is likely to offer the potential for significant mental health benefits to some residents of deprived communities.
- The benefits may be particularly pertinent to women living in deprived urban communities, who appear to experience higher levels of stress.

For more information: Ward Thompson, C., Roe, J., Aspinall, P.A., Mitchell, R., Clow, A. & Miller, D. (2012) 'More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns' *Landscape and Urban Planning* vol 105, no. 3, pp. 221–229.

Roe, Jenny J., Ward Thompson, Catharine, Aspinall, Peter A., Brewer, Mark J., Duff, Elizabeth I., Miller, David, Mitchell, Richard and Clow, Angela (2013) Green Space and Stress: Evidence from Cortisol Measures in Deprived Urban Communities, *International Journal of Environmental Research and Public Health* 10(9), 4086-4103.

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References

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