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Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: Evidence from 260,061 Australians

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ABSTRACT

Objective. While many studies report that green spaces promote mental health, some suggest the psychological benefits of physical activity are amplified if participation occurs within greener environs. We investigated whether this relationship could be observed among adults in middle-to-older age.

Method. Multilevel logit regression was used to investigate association between green space and psychological distress (Kessler scores of 22+) among 260,061 Australians over 45 years old living in New South Wales (2006–2009). Physical activity was measured using the Active Australia survey. Percentage green space was estimated within a 1-kilometre of residence.

Results. In comparison to residents of the least green areas, those in the greenest neighbourhoods were at a lower risk of psychological distress (Odds Ratio 0.83, 95% CI: 0.76, 0.92) and were less sedentary (0.81: 0.77, 0.87). An interaction was observed between physical activity and green space ($p = 0.0028$). More green space did not appear to benefit mental health among the least active (0.99: 0.85, 1.15), but there was a protective association for the more physically active (0.82: 0.67, 0.99).

Conclusion. For adults in middle-to-older age, green spaces are not only important for promoting physical activity, but the mental health benefits of greener environs appear contingent upon those active lifestyles.

Background

The rising costs of obesity, type 2 diabetes mellitus and associated chronic diseases herald a daunting future for the sustainability of healthcare systems worldwide (Colagiuri et al., 2010; Lee et al., 2013). Encouraging physically active lifestyles is a crucial element of preventive health strategies and it has long been known that behavioural change must be reinforced by supportive contexts (Sallis et al., 2012). Evidence suggests that green spaces (e.g. parks) promote a range of health outcomes, including walking and more vigorous physical activities (Bowler et al., 2010; Lachowycz and Jones, 2011; Lee and Maheswaran, 2010). A small amount of green space may be beneficial, though access to a larger overall amount of greenery within the area where a person lives could have a more substantial impact on their chances of leading an active lifestyle (Astell-Burt et al., 2013b; Giles-Corti et al., 2005). The experience of nature is also said to trigger enhanced psychological restoration, just by virtue of immersion within a green space (Kaplan and Kaplan, 1989; Sternberg, 2009; Ulrich, 1984). As a result, policy makers increasingly regard green spaces as an important component of health-promoting environments (Nilsson et al., 2011).

Intriguingly, an emerging group of studies using small controlled samples has suggested that the well-known benefits of physical activity on mental health (Bauman, 2004) could be amplified among people who have access to green spaces (Bodin and Hartig, 2003; Hug et al., 2009; Pretty et al., 2005; Thompson Coon et al., 2011). In short, activity in greener areas may have greater health returns than the same activity in non-green areas. However, only a couple of studies have examined this hypothesis using population level data, reporting favourable results within Scotland (Mitchell, 2013) and Sweden (Annerstedt et al., 2012). It is not known whether these encouraging findings are generalizable among adults in middle-to-older age, but this is important to discover as one would hope that investments in green space planning policy will benefit those who shoulder the vast burden of chronic disease and are the biggest consumers of healthcare.

The health benefits of green space reported in general population studies and highly controlled samples may not directly translate to middle-to-older age adults due to systematic differences in the

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experience of nature. While adults over 45 years are more physically active than their peers if living in greener neighbourhoods (Astell-Burt et al., 2013a,b; Sugiyama and Ward Thompson, 2008), it is well known that participation in physical activity decreases markedly across the lifecourse (Koeneman et al., 2011; Owen and Bauman, 1992). Social interactions, which are entwined with physical activity (e.g. team sports) also decline as we age, yet this is another mechanism linking green spaces with better mental health (Francis et al., 2012a; Sugiyama et al., 2008). Meanwhile, the devastating consequences of falling among older adults (Gillespie et al., 2009; Kannus et al., 1999, 2005) may make venturing out in greener neighbourhoods, and utilizing green space for physical activity less attractive, thereby increasing the impact of social isolation on mental health (Cacioppo and Hawkley, 2003; Cacioppo et al., 2011). It is therefore plausible that green spaces may promote better mental health among adults in middle-to-older age, with greater returns among those who are more physically active, but this hypothesis remains untested.

The purpose of this paper was to examine the relationship between green space and mental health among of a large sample of Australians of 45 years and older. Our analysis had two aims: (1) to estimate cross-sectional association between an objective measure of green space and high risk of psychological distress; and (2) to examine the extent that exposure to green space amplified the benefits of physical activity on reducing the risk of psychological distress.

Methods

A sample of 260,061 participants with valid data was selected from 267,102 aged 45 to 106 years (mean age = 62.8, standard deviation = 11.2) in the 45 and Up Study (45 and Up Study Collaborators, 2008) Participants living in New South Wales (NSW) were randomly selected from records in the Medicare Australia database (the national provider of universal health insurance) and asked a range of questions on health and social issues between 2006 and 2009 (www.45andup.org.au). Although the response rate was 18%, findings from the 45 and Up Study have compared favourably with nationally representative surveys (Mealing et al., 2010). The University of New South Wales Human Research Ethics Committee approved The 45 and Up Study.

The dependent variable was a dichotomy of the Kessler Psychological Distress Scale (K10) (Kessler et al., 2002). The K10 measures symptoms of psychological distress experienced over the four weeks prior to completion of the questionnaire, including feeling tired for no reason, nervous, hopeless, restless, depressed, sad and worthless. Participants had five choices for each of the ten questions (none of the time = 1, a little of the time = 2, some of the time = 3, most of the time = 4, all of the time = 5) and these were summed to give the overall score. In line with previous work (Byles et al., 2012; Feng et al., 2013), we created a binary variable with scores of 22 and over identifying participants at high risk of psychological distress (Australian Bureau of Statistics, 2003).

Green space was derived using information extracted from 'meshblocks' (Australian Bureau of Statistics, 2005). Meshblocks are the smallest administrative units available in Australia, containing 100 residents on average and classified according to dominant land-use. The Australian Bureau of Statistics (ABS) attempted to ensure that meshblock boundaries do not cross cadastral boundaries or topographic features, such as water ways, transportation lines, mountain ranges, parks, reserves and other forms of open space. Each meshblock is classified according to its dominant land use, which in the case of 'parkland' can include different types of green spaces such as parks, woodland, bush and other vegetated areas. The ABS kept agricultural land and private gardens separate from the parkland category. We persisted with this distinction as our focus was on green space that would typically be open to the public for recreation and physical activity. The mean area of a meshblock in NSW classified as 'parkland' was 4.91 km^2, with a standard deviation of 126.85 km^2 accounting for the larger contiguous green spaces containing no usual residential population. A Geographic Information System (GIS) was used to assign a buffer of 1 km radius around the place of residence of every participant (proxied via population-weighted centroids of Census Collection Districts (CCDS), which contained 225 residents on average (Australian Bureau of Statistics, 2012)). The amount of parkland contained within each buffer was extracted and a percentage green space land use was calculated. The mean percentage green space within each buffer for the sample was 18.3% (standard deviation: 20.7%). This measure of green space has been used in previous analyses of the 45 and Up Study (Astell-Burt et al., 2013a,b, in press).

Physical activity was assessed using responses to question derived from the Active Australia Survey (Australian Institute of Health and Welfare, 2003): "How many times did you do each of these activities last week?" Participants could indicate moderate (e.g. gentle swimming) and vigorous (e.g. jogging) forms activity separately, as well as walking. The Active Australia Survey has been shown to have a satisfactory level of test–retest reliability (Brown et al., 2004). Quartiles of the overall level of physical activity were calculated by summing the number of minutes spent in each type of activity together.

Variables which could explain association between green space and mental health included social interactions, which were derived from four questions in the shortened version of the Duke Social Support Index (Koenig et al., 1993) ("How many times in the last week did you… i. spend time with friends or family who do not live with you"; ii. "talk to someone (friends, relatives or others) on the telephone"; iii. "you go to meetings of social clubs, religious groups or other groups you belong to?"; and iv. "How many people outside your home, but within one hour of travel, do you feel you can depend on or feel very close to?"). Responses to each of these questions were summed to give an overall measure of social interactions. Experience of falls within the last 12 months was derived from the question: "During the past 12 months, how many times have you fallen to the floor or ground?"

A range of other possible confounders previously shown to be correlated with mental health were controlled (Byles et al., 2012; Feng et al., 2013). These included age, gender, ancestry (Australian vs. non-Australian), country of birth (Australia vs. overseas), language spoken at home, annual household income, highest educational qualifications, economic status (e.g. employed), couple status, smoking status and number of alcoholic drinks consumed during an average week. Some previous work has demonstrated association between green space and weight status (Astell-Burt et al., 2013a), though findings across the literature are far from unequivocal (Lachowycz and Jones, 2011). Further, given the potential for reverse causality in the relationship between weight status and mental health, we considered Body Mass Index, derived from self-reported height and weight (Ng et al., 2011), as a confounder in these analyses. Local socio-economic circumstances were measured using the Socio-Economic Index for Areas (SEIFA) 'Index of Relative Socio-Economic Advantage/Disadvantage' (Trewin, 2001). The 'Accessibility/Remoteness Index of Australia' (ARIA) (Australian Population and Migration Research Centre, 2012) was used to differentiate between urban and remote areas.

GIS was used to map the geography of green space across NSW. Descriptive statistics were used to examine the patterning of psychological distress, physical activity, social interactions and experience of falls by proximity to green space. The data had a nested structure with participants clustered in 11,713 CCDs (22 participants per CCD on average). Multilevel logit regression models were developed to test association between green space and psychological distress, first adjusted for age and gender, then for physical activity, social interactions and experience of falls, followed by all other explanatory variables. The log-likelihood ratio test was used to identify statistically significant effects ($p < 0.05$). All analyses were conducted in 2013 using STATA V.12 (StataCorp LP, College Station, TX, USA).

Results

Fig. 1 illustrates the geography of green space in NSW, with substantive clustering across the state and within the city of Sydney (the most populous city in NSW). Table 1 shows the prevalence of psychological distress, physical activity, social interactions and experience of falls by contrasting levels of neighbourhood green space. Psychological distress (Odds Ratio (OR) 0.83, 95% Confidence Interval (95% CI) 0.76, 0.92) and physical inactivity (28.1%, OR 0.82, 95% CI 0.77, 0.87) were less common among residents of the greenest neighbourhoods. In contrast, no gradient was evident in the prevalence of social interactions or experience of falls by green space.

Table 2 reports the results of multilevel logit regression, examining association between green space and psychological distress, across four stages of adjustment. The first model illustrates this association adjusted for age and gender. More green space was associated with a lower risk of psychological distress.

With previous work suggesting that some of the key pathways linking green space and mental health being physical activity and social