Examining Group Walks in Nature and Multiple Aspects of Well-Being: A Large-Scale Study

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Abstract

Purpose: Outdoor walking groups can facilitate interaction with nature, social interaction, and physical activity, yet little is known about their efficacy in promoting mental, emotional, and social well-being. National group walk programs are especially underevaluated for these outcomes. The present study sought to identify the mental, emotional, and social well-being benefits from participating in group walks in nature.

*Design: Drawing on an evaluation of the Walking for Health program in England, a longitudinal study investigated the mental, emotional, and social well-being of individuals who did (Nature Group Walkers) and did not (Non-Group Walkers) attend group walks in nature. Both groups were statistically matched using propensity score matching (*n = *1,516). Between-group* t *tests and multiple regressions were performed to analyze the influence of nature-based group walks on depression, perceived stress, negative affect, positive affect, mental well-being, and social support.*

Findings: Group walks in nature were associated with significantly lower depression, perceived stress, and negative affect, as well as enhanced positive affect and mental well-being, both before and after controlling for covariates. There were no group differences on social support. In addition, nature-based group walks appear to mitigate the effects of stressful life events on perceived stress and negative affect while synergizing with physical activity to improve positive affect and mental well-being.

Originality/Value: The present study identifies the mental and emotional well-being benefits from participation in group walks in nature and offers useful information about the potential health contribution of national outdoor group walk programs. Key Words: Group walks—Nature and health—Depression—Mental well-being—Emotional well-being—Social well-being—Walking.

Introduction

The projected global increase of depression, obesity, cardiovascular disease (CVD), and dementia (Department of Health, 2011; Health and Social Care Information Centre, Lifestyle Statistics, 2013; World Federation for Mental Health, 2012; World Health Organization, 2008, 2013) presents alarming public health problems. Stress can exacerbate mental and physical ill health, as it is a risk factor of both depression and CVD (Cohen & Janicki-Deverts, 2012; Kessler, 1997; Shevlin et al., 2007). Prevention and low-cost amelioration of these health issues is necessary in order to reduce health-care demands and treatment costs (Council of Economic Advisers, 2009; Department of Health, 2012). Undertaking physical activity in nature is a novel approach for the prevention of these critical health issues (Bird, 2007; Frumkin & Fox, 2011; Maller et al., 2005). The UK Department of Health lists use of nature as a determinant of public health (Department of Health, 2013) with potential savings for the UK's National Health Service of £2.1 billion per year (DEFRA, 2011, p. 46). Walking—an accessible, low-risk, and inexpensive form of physical exercise (Department of Health, 2011)—has been shown to reduce depression (Robertson et al., 2012; World Federation for Mental Health, 2012) and physiological

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stress (Hartig et al., 2003), prevent obesity (Morabia & Costanza, 2004; Pucher et al., 2010) and CVD (Boone-Heinonen et al., 2009), and stabilize cognitive functioning for those at risk of dementia (Smith et al., 2013). A small body of research suggests that walking in a natural environment may provide additional benefits to well-being when compared to walking indoors (Bowler et al., 2010; Thompson Coon et al., 2011) or in an urban environment (Bowler et al., 2010; Marselle et al., 2013). Indeed, research has shown that a single, short-term walk in a natural environment provides greater reductions in negative emotions (Berman et al., 2008; Hartig et al., 2003; Park et al., 2011) and physiological stress (Hartig et al., 2003) and greater improvements in positive emotions (Berman et al., 2008; Hartig et al., 2003) compared to an urban environment walk. Although walking is the most common form of physical activity in the US and the UK (CDC, 2012a; Hillsdon & Thorogood, 1996; National Institute for Health and Clinical Excellence, 2012), less than half of adults in both countries meet the recommended levels of physical activity (CDC, 2012b; Department of Health, 2011). Finding ways to increase the uptake of moderately intense walking could contribute to meeting physical activity guidelines.

Group walking

The Centers for Disease Control and Prevention, and others, recommend walking in a group in order to increase physical activity in the general population (CDC, 2012a; Kahn et al., 2002; Kassavou et al., 2013). People are more likely to walk in the company of another person (Ball et al., 2001) and prefer (Johansson et al., 2011) and enjoy (Plante et al., 2007) walking with others outdoors more than walking outdoors alone. Several researchers have found that the social connections of a walking group are a part of what attracts people to initiate and maintain participation (South et al., 2013; Wensley & Slade, 2012). Group walk programs increase walking behavior (Kassavou et al., 2013) and have high retention rates (Gusi et al., 2008). Proponents argue that walking group interventions are also cost effective in that every £1 spent on a group walk program could save the National Health Service £7 (Walking for Health, 2013a). National group walking programs have been established throughout Great Britain (e.g., Ramblers Association) and in England (e.g., Walking for Health), Scotland (e.g., Paths for All), and Wales (e.g., Let's Walk Cymru). In the US, walking group programs are more grassroots and city-based (Institute at the Golden Gate, 2010), although there is at least one national program, the American Volkssport Association, with more than 300 walking clubs (American Volkssport Association, 2013). Walking for Health (WfH) is one of the largest public health interventions for physical activity in the UK (Fitches, 2011), with 70,000 people attending 3,400 group walks each week (Walking for Health, 2013c).

National group walk programs have the potential to address population public health through improved physical, mental, emotional, and social well-being. Most quantitative investigations of the effects of such programs have concentrated on physical well-being (CLES Consulting, 2010; Dawson et al., 2006; Jackson, 2011; Paths for All, 2013; Phillips et al., 2011, 2012; Walking for Health, 2013c). Few studies have quantitatively evaluated the effect of national group walk programs on depression, perceived stress, or mental or social well-being. Doust and Tod (2007) found that individuals maintained high levels of mental health through continued participation in Let's Walk Cymru. Pretty et al. (2007) found an improvement in emotional well-being and self-esteem immediately following participation in two outdoor walking groups. Qualitative research suggests that WfH group walks have a positive effect on social well-being (Dawson et al., 2006; Hynds & Allibone, 2009; South et al., 2013; Villalba van Dijk et al., 2012).

Much of the evidence about the well-being benefits of group walks in nature comes from small-sample research studies. Compared to a group walk indoors or in an urban environment, group walks in natural environments significantly reduce depression (Roe & Aspinall, 2011), perceived stress (Roe & Aspinall, 2011), and negative affect (Peacock et al., 2007; Roe & Aspinall, 2011) and significantly increase positive affect (Mayer et al., 2009; Nisbet & Zelenski, 2011). A specific measure of positive mental well-being has not been used in a group walk context.

Rationale for the present study

Most evaluations of national group walk programs are in the "gray literature" not published in peer-reviewed journals (e.g., CLES Consulting, 2010; Coleman et al., 2011; Dawson et al., 2006; Doust & Tod, 2007; Fitches, 2011; Hynds & Allibone, 2009; Jackson, 2011; Paths for All, 2013; Phillips et al., 2011, 2012; Villalba van Dijk et al., 2012; Walking for Health, 2013c). These studies frequently lack a comparison group (e.g., Doust & Tod, 2007; Pretty et al., 2007); thus any identified positive effects could be due to other factors, such as physical activity, the natural environment, or being in a research study (Bird, 2007; Newton, 2007). Brown et al. (2011) highlight the need for such control or comparison groups. Additionally, insight is needed into whether well-being benefits of nature-based group walks occur independently of physical activity.

The lack of quantitative research on mental and social well-being outcomes is noticeable, highlighting a need to broaden investigations into well-being. Similarly, understanding the longer-term well-being

effects from nature-interaction is under-researched, as the majority of studies measure well-being immediately before and after engagement in the activity (Thompson Coon et al., 2011).

It is essential for public health research to know whether the findings from the small sample group walk studies can be found in a large, general population sample. Research of national group walk programs has the potential to satisfy the call for larger-scale studies in nature and health research (Bowler et al., 2010; Thompson Coon et al., 2011), as these studies would facilitate large sample sizes (> 1,000) (e.g., CLES Consulting, 2010; Phillips et al., 2012).

Study aim and hypotheses

The present study aims to investigate the influence of nature-based group walks on multiple aspects of well-being. The study tests three hypotheses:

(i) individuals who take part in nature-based group walks would experience significantly less (a) depression, (b) perceived stress, and (c) negative affect compared to individuals who do not take part in such walks;
(ii) individuals who take part in nature-based group walks would experience significantly greater (a) positive affect, (b) mental well-being, and (c) social well-being compared to individuals who do not take part in such walks;
(iii) the positive well-being from such walks would be independent of other covariates of well-being, such as physical activity and stressful life events.

Method

Study design and participants

The study reported here draws from a larger observational, longitudinal study about the mental, emotional, and social well-being from participation in WfH. Ethical approval was obtained from De Montfort University's Human Research Ethics committee. All participants were recruited from a sampling frame, provided by WfH, of all individuals who had attended at least one WfH group walk, provided an e-mail address, and gave consent to be contacted for evaluation purposes. Online questionnaires were used to collect data at Time 1 (T1) and 13 weeks later at Time 2 (T2). Participants were invited to take part in the study via an invitation e-mail with a Web link to the T1 questionnaire. Participants gave informed consent prior to starting the T1 questionnaire. Non-Group Walkers were defined as individuals who had not taken part in any group walk in the 6 months prior to T1 (Phillips et al., 2011) and confirmed at T2 their nonparticipation in a group walk during the 13-week interim. Group Walkers were defined as individuals who had attended at least one WfH walk in the 6 months prior to T1 (Phillips et al., 2011) and continued to attend at least one WfH walk between T1 and T2. All study participants were over 18 years of age and resident in England. For the study reported here, additional eligibility criterion for Group Walkers was that the main type of environment for one's WfH walks during the 13-week interim was nature (i.e., natural and seminatural places, green corridor, farmland, urban green space, coastal area, or a mixture of any of the above) (see Marselle et al., 2013). These participants are labeled Nature Group Walkers. Individuals who stated they had walked in urban public spaces or an unclassified environment were excluded from this analysis.

Measures

Measures included demographic and health data, covariates, and outcome variables. See Fig. 1 for details of the time course for data collection.

Demographic and health data. Participant characteristics assessed at T1 included age, gender, marital status, highest level of education, and social deprivation (Department for Communities and Local Government, 2011). Additional information obtained from the WfH

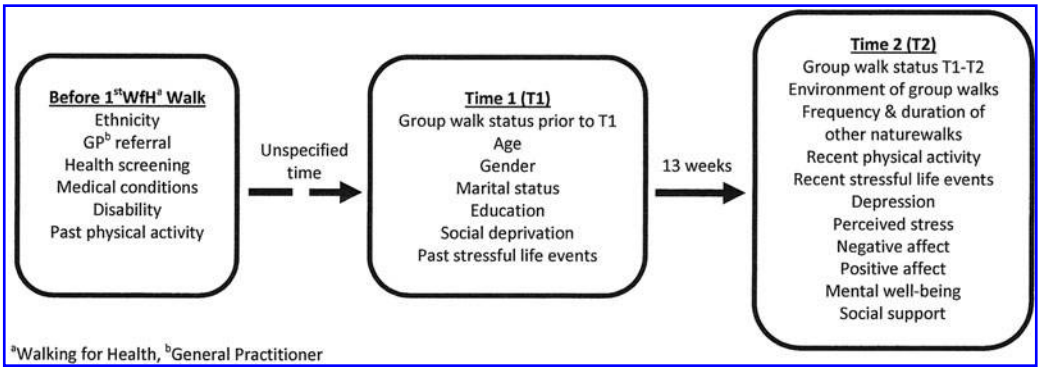

Fig. 1. Time course of data collection indicating information collected at each time point. Items collected "Before 1st WfH Walk" came from the WfH database (Walking for Health, 2013b); items from Time 1 and Time 2 were collected via online questionnaires.

database (Walking for Health, 2013b) included ethnicity, whether the participant was referred to WfH by their general practitioner (GP), health screening conditions that may affect walking group participation (e.g., pain in chest when exercising, joint pain), diagnosed medical condition (e.g., diabetes, heart disease), disability (e.g., physical, sensory), and number of days of 30 min of physical activity in the week prior to starting WfH ("past physical activity").

Covariates.

Stressful life events. The List of Threatening Experiences (Brugha et al., 1985; Brugha & Cragg, 1990) collected information on the number of stressful life events (0–11) experienced in the year prior to T1 ("past stressful life events") and in the 13 weeks preceding T2 ("recent stressful life events"). Stressful events included serious illness or injury to self or a close relative; death of a family member or close friend; marital separation or relationship breakup; interpersonal problems; unemployment; financial crisis; legal problems or property loss (Office for National Statistics, 2002). The scale has been used in previous nature and health research (van den Berg et al., 2010).

Frequency and duration of other nature walks. A single item at T2 assessed the frequency of other nature walks (i.e., nature walks outside of a walking group) a participant had done in the 13-week interim, which might be alone or with others. Participants were asked, "On average, how frequently do you walk or hike in green space (such as a local park, natural area, national park, countryside)?" Nature Group Walkers were instructed to exclude WfH walks. Responses were recorded on a 7-point scale (1 = *never;* 7 = *daily*). Average duration of these walks was assessed with a single-item measure; responses were on an ordinal scale with 15 min increments (range 0–195 min).

Physical activity. Frequency of engaging in 30 min of physical activity in the week preceding T2 was assessed with a single item ("recent physical activity"). Participants were asked, "In the last seven days on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate?" (Milton et al., 2011). All participants were asked to include any "sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that is part of your job." Nature Group Walkers could include their WfH group walks. Responses were recorded on an 8-point scale (0 = *0 days;* 7 = *7 days*).

Outcome measures. All six outcome measures were assessed at T2.

Depression. The 10-item Major Depressive Inventory (Olsen et al., 2004) assessed how frequently participants felt symptoms of depression (e.g., "Have you lost interest in daily activities? Have you had trouble sleeping at night?") in the past 2 weeks on a 6-point scale (0 = *at no time;* 5 = *all the time*). Total scores range from 0 (no depression) to 50 (extreme depression) (Olsen et al., 2004). The measure has been used in the UK in a previous nature and health study (Marselle et al., 2013). Internal consistency (Cronbach's α) of the scale has been reported as 0.90 (Forsell, 2005).

Perceived stress. The 10-item Perceived Stress Scale (Cohen et al., 1983) assessed how frequently participants experienced certain thoughts and feelings (e.g., "Felt nervous or stressed? Felt you were not on top of things?") in the past month on a 5-point scale (0 = *never;* 4 = *very often*). Total scores range from 0 to 40; higher scores indicate greater psychological stress. This measure has been used in previous nature and health studies in the UK (Marselle et al., 2013; Ward Thompson et al., 2012). Internal consistencies of the scale range from .78 to .91 (Cohen & Janicki-Deverts, 2012).

Negative and positive affect. The Positive and Negative Affect Schedule (Watson et al., 1988) assessed both negative and positive affect. Participants rated the frequency of experiencing 10 negative (e.g., upset, guilty) and 10 positive (e.g., interested, excited) emotions in the past 2 weeks on a 5-point scale (1 = *very slightly or not at all;* 5 = *extremely*). For each subscale, total scores range from 10 to 50; higher scores demonstrate greater negative or positive affect. The Positive and Negative Affect Schedule has been used in previous nature and health studies (Berman et al., 2008, 2012; Marselle et al., 2013; van den Berg & Custers, 2011). Crawford and Henry (2004) report internal consistencies for the negative affect ($\alpha = 0.85$) and positive affect ($\alpha = 0.89$) subscales.

Mental well-being. Participants rated statements on the 14-item Warwick Edinburgh Mental Well-being Scale (Tennant et al., 2007) in relation to their experience (e.g., "I've been feeling optimistic about the future; I've been feeling useful") during the past 2 weeks on a 5-point scale (1 = *none of the time;* 5 = *all of the time*). Resulting scores range from 14 to 70; higher scores indicate higher levels of mental well-being. This measure has been used in previous nature and health studies in the UK (Marselle et al., 2013; Mitchell, 2013; Ward Thompson et al., 2012). The scale has high internal consistency ($\alpha = 0.91$) (Tennant et al., 2007).

Social well-being. Social well-being was assessed using the 10-item Appraisal subscale of the Interpersonal Support Evaluation List (ISEL) (Cohen et al., 1985)[1], which measures perceived availability of emotional social support (e.g., "There are several people that I trust to help

[1]Items on the ISEL have been updated since 1985. For the updated version, see http://www.psy.cmu.edu/~scohen.

solve my problems; There is no one I feel comfortable talking to about intimate personal problems"). Two items were modified to better fit the sample[2]. Participants rated how true each statement was on a 4-point scale (0 = *definitely false;* 3 = *definitely true*), with a possible total score range of 0–30. Higher scores indicate greater emotional social support. No time frame was used. The ISEL has been used in the UK general population (Rees et al., 1999; Steptoe, 2000; Wood et al., 2008); this was the first time it was used in nature and health research. The scale has high internal consistency ($\alpha = 0.95$) (León et al., 2010).

Statistical analyses

Propensity score analysis. At the start of the study, group differences on demographic, health status, and past stressful life events were assessed with chi-square and independent samples *t* tests. Significant differences ($p < .05$) between Nature Group Walkers and Non-Group Walkers existed on age, gender, ethnicity, education, disability, past physical activity, and past stressful life events. These group differences could confound analyses of the influence of nature-based group walks on well-being. To adjust for confounders and make the groups comparable, propensity score matching (PSM) (Rosenbaum & Rubin, 1983) was used. PSM has been used in public health research investigations of outdoor physical exercise (Boer et al., 2007; Cohen et al., 2013; Hendriksen et al., 2010). A propensity score is the conditional probability that a study participant belongs to the treatment group (i.e., Nature Group Walkers) given all the observed covariates.

Propensity scores were estimated using logistic regression with group walk participation as the outcome variable and selected covariates (i.e., age, gender, ethnicity, education, disability, past physical activity, past stressful life events) as predictors. Participants were matched using 1:1 nearest neighbor matching with replacement, the recommended approach when there are fewer "control" than "treated" participants (Dehejia & Wahba, 1999). Each "control" participant (Non-Group Walker) was thus matched to one or more "treated" participants (Nature Group Walkers) with the most similar propensity score. "Control" participants "receive a frequency weight that reflects the number of times they were selected as a match" (Stuart, 2010, p. 13). To ensure "good" matches, a caliper of .25 standard deviations of the logit of the propensity score was applied (Ho et al., 2007); "control" participants not identified as a "good" match for a "treated" participant were "pruned" from the sample (Stuart, 2010). The end result is a reduced sample of participants that have similar propensity scores. The PSM procedure was performed using the SPSS PSM plug-in "psmatching" (Thoemmes, 2012).

The propensity-matched sample was assessed statistically, numerically, and graphically to ensure that the two groups were similar on the selected covariates after matching. The PSM output indicated that matching improved covariate balance and reduced standardized mean differences between the two groups (output available upon request).

Study analyses. All analyses were performed using SPSS 20.0 and were weighted by the propensity score weight. The choice of statistical analyses was influenced by available analyses in SPSS that can accommodate fractional weights (Maletta, 2007; F. Thoemmes, personal communication, 12 February 2013; UCLA: Statistical Consulting Group, 2013). Chi-square and independent samples *t* tests evaluated group differences on demographics, preexisting health, and covariate variables on the matched sample. Effect size was calculated using Pearson's correlation coefficient *r* (Field, 2009).

Group differences on all six outcome measures were assessed with independent samples *t* tests; negative affect and depression were log-transformed prior to analysis due to substantial positive skewness. Listwise deletion was applied in all independent *t* tests with Bonferroni corrected significance levels of $p < .008$ ($\alpha = .05/6$).

Standard multiple regression assessed the effect of nature-based group walks on multiple aspects of well-being, after controlling for covariates. Separate regression models were conducted for each outcome variable using the same procedure. Health screening conditions (0 = no health conditions; 1 = 1 or more health conditions), recent stressful life events, frequency of other nature walks, duration of other nature walks, recent physical activity, and group walk participation (0 = Non-Group Walkers; 1 = Nature Group Walkers) were entered as predictors. Following examination of residual plots, depression and negative affect were both log-10 transformed, and social support was reflected and square-root transformed (Tabachnick & Fidell, 2013). The reflected and transformed social support variable has the opposite interpretation of the original variable. No multicollinearity was found in the predictor variables. Listwise deletion was applied, and significance levels were set at $p < .05$.

Results

Characteristics of the study population

Figure 2 shows the participant flow through the study. Valid responses on both questionnaires were obtained from 1,991 participants.

[2]The item "There is someone I could turn to for advice about making career plans or changing my job" was inappropriate for a sample that could contain retired individuals. It was modified to "There is someone I could turn to for advice about changing my job or volunteer focus" (T. C. León, personal communication, 23 July 2011). The item "There really is no one who can give me an objective view of how I'm handling my problems" was modified by changing the word "objective" to "honest" (León et al., 2010).

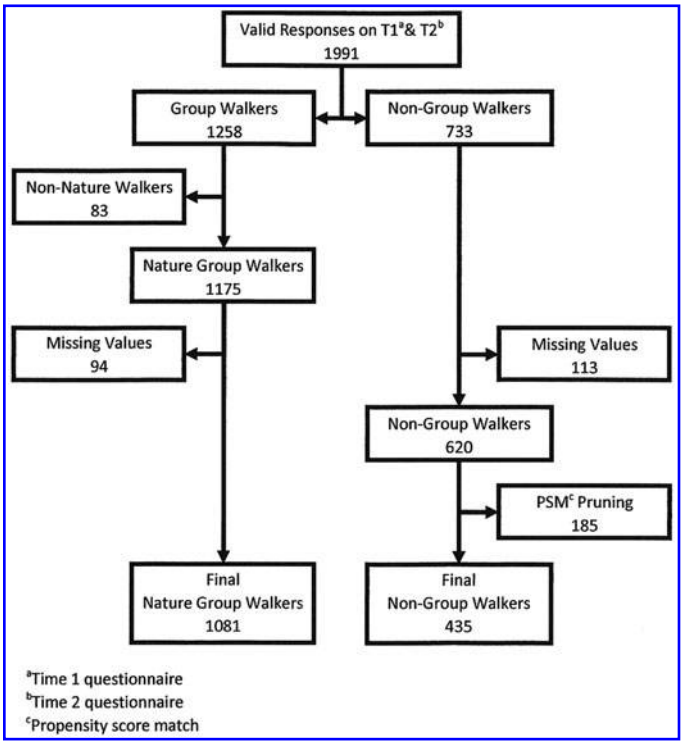

Fig. 2. Composition of study groups: Group Walkers were removed if they had not walked in nature; participants from either group were removed if they had missing values on covariate measures; and propensity score matching procedures "pruned" Non-Group Walkers that did not match Nature Group Walkers within .25 standard deviation of the logit of the propensity score.

Following removal based on eligibility criteria, missing data, or PSM pruning, the final propensity-matched sample consisted of 1,516 participants ($n = 1{,}081$ Nature Group Walkers, $n = 435$ Non-Group Walkers).

Table 1 details the demographic, health status, and covariates of the propensity-matched sample. The propensity-matched sample was mostly aged 55 and over (88.3%), female (66.2%), of partnered marital status (71.1%), of White ethnicity (96.8%), highly educated (53%), and lived in the least socially deprived areas of England (51%). After matching, the two groups remained significantly different on health screening conditions only (Table 1); this was subsequently included as a covariate in the regression analyses. Regarding planned covariates collected at T2, Nature Group Walkers spent significantly more time on other nature walks and engaged in more recent physical activity than Non-Group Walkers (Table 1).

Results on multiple aspects of well-being

Table 2 details the mean scores for all six well-being outcome variables for both groups. On average, Nature Group Walkers experienced significantly less depression, perceived stress, and negative affect and significantly greater mental well-being and positive affect compared to Non-Group Walkers; effect sizes were small to medium (.19 to .24 range) (see Table 2). There were no significant group differences in social support.

Results of the standard multiple regression analyses are shown in Table 3. The variance explained by all six regression models significantly differed from zero. The variance explained by all predictors combined was 10.4% in depression, 9.5% in perceived stress, 7.3% in negative affect, 10.2% in positive affect, 6.6% in mental well-being, and 1.8% in social support.

Depression

Controlling for other significant predictors, group walks in nature were significantly associated with lower depression. Recent stressful life events were significantly associated with an increase in depression. Increased frequency of other nature walks and recent physical activity were both significantly associated with less depression. Duration of other nature walks was a marginally significant predictor of lower depression. The standardized regression coefficients are directly comparable and provide insight into the relative rank of a predictor in the model (Field, 2009). Group walk participation was the strongest predictor of less depression ($\beta = -.19$), followed by the positive predictor, recent stressful life events ($\beta = .17$) (Table 3).

Perceived stress and negative affect

Group walks in nature were significantly associated with less perceived stress and less negative affect, controlling for other predictors. Recent stressful life events were significantly associated with greater perceived stress and negative affect. Increased frequency of other nature walks and recent physical activity were both significantly associated with reduced perceived stress and negative affect. Recent stressful life events was the strongest predictor of more perceived stress ($\beta = .21$) and more negative affect ($\beta = .19$). Group walk participation was the second strongest predictor of perceived stress ($\beta = -.15$) and negative affect ($\beta = -.16$), in the opposite direction.

Positive affect and mental well-being

Controlling for other predictors, Nature Group Walkers were significantly associated with greater mental well-being and positive affect compared to Non-Group Walkers. Greater frequency of other nature walks and recent physical activity were both significantly

Table 1. Characteristics of the Matched Sample[a] on Demographics, Health Status, Past Stressful Life Events, Past Physical Activity, Along With Planned Covariates Used in the Analyses: Recent Stressful Life Events, Frequency and Duration of Other Nature Walks, and Recent Physical Activity

DEMOGRAPHICS HEALTH STATUS PLANNED COVARIATES	NATURE GROUP WALKERS $n=1081$	NON-GROUP WALKERS $n=435$	TOTAL $n=1516$	STATISTIC	p VALUES
Age (55+) (%)	88.3	88.4	88.3	$\chi^2(1)=.000$	.995
Gender (female) (%)	65.5	68.1	66.2	$\chi^2(1)=.952$	.329
Marital status (partnered) (%)	71.3	70.4	71.1	$\chi^2(1)=.122$	.727
Ethnicity (White) (%)	96.7	97.2	96.8	$\chi^2(1)=.314$	.575
Education (tertiary/higher education) (%)	52.2	54.9	53.0	$\chi^2(2)=3.560$	.169
Social deprivation (least deprived) (%)	50.9	51.5	51.0	$\chi^2(2)=.224$	.894
GP referral to WfH (yes) (%)	6.2	7.9	6.7	$\chi^2(1)=1.369$	.242
Health screening condition (%)	16.2	20.5	17.4	$\chi^2(1)=4.039$	.044
Diagnosed medical condition (%)	34.8	38.5	35.9	$\chi^2(1)=1.904$	.168
Disability (%)	8.9	6.7	8.2	$\chi^2(1)=2.033$	.154
Past stressful life events[b] (none) (%)	32.9	32.5	32.9	$\chi^2(2)=.061$	.970
Past physical activity[c,d] [mean (*SD*)]	3.50 (1.94)	3.32 (2.13)	3.45 (2.00)	$t(740.02)=1.502$	.134
Recent stressful life events[e] [mean (*SD*)]	.62 (.89)	.59 (.82)	.61 (.87)	$t(1514)=.702$	.480
Frequency of other nature walks[d,e] [mean (*SD*)]	3.82 (1.47)	3.75 (1.71)	3.80 (1.54)	$t(706.50)=.810$	.420
Duration of other nature walks[d,e] (walked for 1 hr) (%)[f]	19.2	16.3	18.4	$t(946.98)=11.587$	.001
Recent physical activity[d,g] [mean (*SD*)]	3.46 (1.79)	2.94 (2.11)	3.31 (1.90)	$t(689.96)=4.504$	.001

[a]Propensity score matched sample; analysis weighted by propensity score weight. [b]One year prior to Time 1 questionnaire. [c]One week prior to first WfH walk. [d]Equal variances not assumed. [e]Within 13 weeks between Time 1 and Time 2 questionnaires. [f]Statistic calculated on mean duration; percent walking for 1 hr, the mode, presented in table. [g]One week prior to Time 2 questionnaire. GP, general practitioner; WfH, Walking for Health.

associated with greater positive affect and mental well-being. Recent stressful life events were significantly associated with less mental well-being and positive affect. Duration of other nature walks was significantly associated with greater positive affect only. Recent physical activity was the strongest predictor for both mental well-being ($\beta=.13$) and positive affect ($\beta=.20$), followed by group walk participation ($\beta=.12$, $\beta=.14$, respectively).

Social support

Due to transformation of the data, negative regression coefficients indicate greater social support in Table 3. Group walk participation was not a significant predictor of social support. The size and direction of the regression coefficients suggest that having a health condition prior to starting WfH or experiencing a recent stressful life event were associated with significantly less social support. Frequency of other nature walks was significantly associated with greater social support; this variable was the strongest predictor of social support ($\beta=-.10$).

Discussion

This study investigated the influence of nature-based group walks on mental, emotional, and social well-being. A national group walk program in England, Walking for Health (WfH), was evaluated. To our

Table 2. Comparison of Mean Scores of Time 2 Depression, Perceived Stress, Negative Affect, Positive Affect, Mental Well-Being, and Social Support for Matched[a] Nature Group Walkers and Non-Group Walkers

OUTCOMES[b]	NATURE GROUP WALKERS $n = 1081$ [MEAN (*SD*)]	NON-GROUP WALKERS $n = 435$ [MEAN (*SD*)]	*t* TEST[c]	EFFECT SIZE *r*[d]
Depression[e]	6.53 (5.70)	9.78 (7.96)	$t(1514) = 8.47^{***}$	.21
Perceived stress[f]	11.27 (6.15)	13.54 (7.02)	$t(715.75) = 5.89^{***}$	.22
Negative affect[e,f]	14.38 (4.76)	16.26 (6.08)	$t(710.41) = 6.05^{***}$	.22
Positive affect[f]	34.80 (6.90)	31.87 (8.33)	$t(685.52) = 6.50^{***}$	.24
Mental well-being[f]	53.04 (7.27)	50.55 (8.87)	$t(680.92) = 5.18^{***}$	.19
Social support	22.94 (6.44)	22.82 (6.47)	$t(1514) = .328$	.01

[a]Propensity score matched sample; analysis weighted by propensity score weight. [b]Higher scores indicate greater: depression (range 0–50), perceived stress (range 0–40), negative affect (range 10–50), positive affect (range 10–50), mental well-being (range 14–70), and social support (range 0–30). [c]Independent samples *t* test. [d]Effect size calculated as Pearson's *r*. [e]Log-transformed variable, untransformed means reported. [f]Equal variances not assumed. $^{***}p < .001$.

knowledge, this is the first study to explore the multiple aspects of well-being from participating in group walks in nature on a national scale.

Consistent with our hypotheses, individuals who attended group walks in nature reported significantly less depression, perceived stress, and negative affect and significantly greater mental well-being and positive affect than individuals who did not take part in group walks. No group difference was present on social support. Controlling for the effects of health condition, recent stressful life events, frequency and duration of other nature walks, and recent physical activity did not alter the results. Our findings add to the limited base of evidence for the positive well-being benefits of outdoor group walks for depression (Armstrong & Edwards, 2003, 2004; Gusi et al., 2008; Robertson et al., 2012; Roe & Aspinall, 2011), perceived stress (Roe & Aspinall, 2011), and positive and negative affect (Hine et al., 2011; Mayer et al., 2009; Nisbet & Zelenski, 2011; Peacock et al., 2007). The research on group walking, to date, has not examined positive mental well-being as a specific outcome variable; thus the results presented here add new insight.

Our results show that the strongest predictor of levels of depression was group walking in nature, controlling for the effect of recent stressful life events or recent physical activity. With depression projected to be the number one cause of global burden of disease by 2030 (World Federation for Mental Health, 2012), the results suggest that nature-based group walks could be used to help manage depressive feelings in individuals and in the general population.

Recently experienced stressful life events were the strongest predictor of perceived stress and negative affect, contributing to an increase in both. Group walks in nature—as the second strongest predictor—were associated with significantly less perceived stress and negative affect. The results suggest that nature-based group walks may mitigate or "undo" the increase in perceived stress and negative affect associated with stressful life events, although additional research is required to discern this. Previous research has found working or living near a natural environment can buffer the relationship between stressful life events and well-being (Corraliza & Collado, 2011; Leather et al., 1998; Ottosson & Grahn, 2008; van den Berg et al., 2010; Wells & Evans, 2003). Qualitative studies suggest that gardening can help individuals cope with stress (Hawkins et al., 2013; Stuart, 2005). Future research could determine whether nature-based group walks moderate the negative effects of stressful life events on perceived stress and negative affect.

Physical activity was the strongest predictor of mental well-being and positive affect. This is unsurprising considering the wealth of data on the benefits of physical activity for psychological well-being (Biddle & Mutrie, 2008). However, nature-based group walks were the second strongest predictor of both variables, positively influencing mental well-being and positive affect, controlling for physical activity. These results suggest that both physical activity and group walks in nature benefit these aspects of well-being. Further research could usefully investigate if there is an additive benefit from the interaction of nature-based group walks and physical activity on mental well-being and positive affect.

Our nonsignificant finding for group walks in nature on social support is consistent with some previous literature (Armstrong & Edwards, 2003, 2004; Hawkins et al., 2011; Irvine et al., 2013). Nevertheless, it is unexpected, as qualitative research has identified social benefits to participation in WfH (Dawson et al., 2006; Hynds & Allibone, 2009; South et al., 2013; Villalba van Dijk et al., 2012). The nonsignificant result from this study may be due to measurement choice; the Appraisal subscale of the ISEL has been criticized for measuring both tangible practical support and emotional support (Parkinson, 2008) and may also tap intimate areas of support that

Table 3. Standard Regression Analyses of Matched[a] Sample of Nature Group Walkers and Non-Group Walkers for Time 2 Depression, Perceived Stress, Negative Affect, Positive Affect, Mental Well-Being, and Social Support Adjusted for Health Screening Conditions, Recent Stressful Life Events, Frequency and Duration of Other Nature Walks, and Recent Physical Activity ($n = 1490$[b])

PREDICTORS		DEPRESSION[c,d]	PERCEIVED STRESS[d]	NEGATIVE AFFECT[c,d]	POSITIVE AFFECT[d]	MENTAL WELL-BEING[d]	SOCIAL SUPPORT[e]
Constant	$B =$	1.03	15.39	1.209	28.24	46.74	2.77
	$SE\ B =$	.03	0.56	.011	0.63	0.68	.103
	$p =$	*< .001*	*< .001*	*< .001*	*< .001*	*< .001*	*< .001*
Health screening conditions[f]	$\beta =$	0.03	0.02	0.02	−0.04	−0.02	.08
	$p =$	*0.21*	*0.53*	*0.51*	*0.12*	*0.53*	*.002*
Recent stressful life events[g]	$\beta =$	0.17	0.21	0.19	−0.07	−0.05	.06
	$p =$	*< .001*	*< .001*	*< .001*	*0.01*	*0.04*	*.02*
Frequency other nature walks[g]	$\beta =$	−0.10	−0.11	−0.08	0.06	0.11	−.10
	$p =$	*< .001*	*< .001*	*.003*	*0.02*	*< .001*	*.001*
Duration other nature walks[g]	$\beta =$	−0.05	−0.05	−0.01	0.07	0.04	.03
	$p =$	*.06*	*.09*	*.74*	*0.01*	*0.10*	*.35*
Recent physical activity[h]	$\beta =$	−0.10	−0.07	−0.06	0.20	0.13	−.01
	$p =$	*0.001*	*0.02*	*0.03*	*< .001*	*< .001*	*.74*
Group walk participation[i]	$\beta =$	−0.19	−0.15	−0.16	0.14	0.12	−.01
	$p =$	*< .001*	*< .001*	*< .001*	*< .001*	*< .001*	*.62*
Adjusted R^2		.104***	.095***	.073***	.102***	.066***	.018***

[a]Propensity score matched sample; analysis weighted by propensity score weight. [b]Number reduced due to listwise deletion of participants with missing values on any variable. [c]Log-transformed. [d]Higher scores indicate greater depression, perceived stress, negative affect, positive affect, or mental well-being. [e]Reflected and square root transformed; negative regression coefficients indicate greater social support. [f]Health screening condition prior to first WfH walk: 0 = no health conditions, 1 = 1 or more health conditions. [g]Within 13 weeks between Time 1 and Time 2 questionnaires. [h]Within 1 week prior to Time 2 questionnaire. [i]Group walk participation: 0 = Non-Group Walkers, 1 = Nature Group Walkers. ***$p < .001$. *B*, unstandardized regression coefficient; *SE*, standard error; β, standardized regression coefficient; WfH, Walking for Health.

might not easily come up in a group setting. Other researchers have investigated social well-being from nature-interaction with measures of loneliness and lack of social contacts (Maas et al., 2009). Future quantitative investigations of group walks may want to use a measure of loneliness, as recent research suggests that loneliness is a risk factor of early death in older people (Sample, 2014). Alternatively, future studies investigating social support in nature and health studies may need to use new measures of social well-being grounded in the understandings revealed in qualitative research (South et al., 2013; Wensley & Slade, 2012).

Interestingly, other nature walks did significantly affect social support. There are several possible reasons for this apparently anomalous result. First, these other nature walks may not be alone; one could be accompanied by friends or family not involved in WfH group walks. Second, these walks may bring the individual in social contact with other people, which may foster friendship or a sense of community in the neighborhood (Toohey et al., 2013) and thus social support. Third, other nature walks may be done with an intimate other (e.g., partner, best friend) with whom the participant may have the sort of intimate discussions that address items on the ISEL scale.

Indeed, one might anticipate that such discussions may be more likely with one other person rather than in a walking group.

The frequency of other nature walks was significantly associated with less depression, perceived stress, and negative affect and greater positive affect and mental well-being. Duration of other nature walks was significantly associated with greater positive affect only. The findings suggest that frequency of walking in nature may be more predictive of well-being than the amount of time spent in it. National guidelines recommend 30 min of physical activity—which can include walking—5 days a week to improve health (Department of Health, 2011). Our results suggest that recommending short but frequent nature walks may also improve multiple aspects of well-being.

Limitations and strengths

This study has a number of limitations. First, while the PSM method ensured there were no significant group differences on measured covariates, it remains possible that differences existed on unmeasured confounding variables (Harder et al., 2010). Second, although we controlled for the effect of other predictors of well-being in the regression model, other explanatory variables could account for group differences. Third, due to eligibility criteria, it is possible that Nature Group Walkers may not have attended a WfH walk during the assessment of their well-being. However, the majority (83.3%) of Nature Group Walkers did indicate attending a WfH walk in the previous fortnight. Fourth, the measure of physical activity by self-report can be imprecise (Tucker et al., 2011), although participants specifically were asked about number of days of the week when they engaged in physical activity lasting 30 min or more that is enough to raise the breathing rate, giving an approximation of intensity. Fifth, the low overall predictive power of the final models is likely due to unmeasured variables influencing these complex outcomes, such as genetics, temperament, or social interactions (Kendler et al., 1993), but could be influenced by any remaining mismatch in sample selection or the methods chosen for variable measurement. Sixth, reverse causality cannot be resolved in this research design. Finally, participants were mostly female, older, White, and affluent; while likely to be unrepresentative of the adult general population living in England, participants were representative of the population involved in WfH (Fitches, 2011).

This study makes an important contribution to the literature on the effects of nature-based group walks on mental, emotional, and social well-being. The large sample of adults from the general population of England, engaged in a national walking program, enabled statistical control of other significant predictors of well-being and sufficient power to detect a small yet significant effect. Use of PSM technique improved the ability to investigate the effect of participation in a national outdoor group walk program on mental and emotional well-being.

Future research

Future exploration of the effects of nature-based group walks on mental and emotional well-being could utilize quasi-experimental pre-post or randomized research designs that would have better inferential potential and reduce limitations of sampling and reverse causality. Further research is needed to discern whether nature group walks moderate, or buffer, the relationship between stressful life events and multiple aspects of well-being. Future studies could also usefully investigate if there is an optimum frequency and duration of contact with green space—whether alone or in groups—for mental and emotional well-being. The mechanisms through which nature-based group walks affect these aspects of well-being could also be explored. Three proposed mechanisms of the nature-health relationship include physical activity, social interaction, and restorative benefits of nature (Hartig et al., 2014). Future research could usefully investigate whether these mechanisms explain the positive relationships reported in this study. Future studies may also want to assess whether the type and quality of the natural environment for a group walk have any impact on well-being. Qualitative studies may explore the individual differences in well-being benefits from nature group walks, based on familiarity, attachment, and childhood experience with both the natural environment and walking.

Implications

The research presented here provides support for national outdoor group walk programs as a public health intervention. Such programs have previously been shown to increase levels of physical activity (Kassavou et al., 2013), and our study suggests that the benefits go beyond those from physical activity only. Group walks in nature were associated with less depression, negative affect, and perceived stress, as well as greater positive affect and mental well-being. These positive psychological results may be useful for motivating participation in an outdoor walking program (Williams et al., 2008). Public health walking programs could utilize these findings to communicate the positive well-being outcomes from participation in nature-based group walks. Such positive framed messages may foster greater behavior change (Kobau et al., 2011).

Likewise, health care professionals, who are in position to identify individuals at risk for depression, life stress, or negative emotions, may welcome this additional nonpharmacological approach as part of a comprehensive package of care. In fact, WfH was originally initiated by a GP, Dr. William Bird, who realized the potential for

group walks in improving the health of individuals as well as the public (Walking for Health, 2010). We note that only 6.2% of Nature Group Walkers were referred to WfH by their GP; thus there may be scope for outreach to GPs and other health professionals about the benefits of group walks in nature.

Conclusion

The present study found that group walks in nature were associated with significantly less depression, perceived stress, and negative affect and greater positive affect and mental well-being. Given the increase in mental ill health and physical inactivity in the population in the developed world, group walk programs in local natural environments may make a potentially important contribution to both public health and individual well-being with benefits in mental health, coping with stress, and improved emotions.

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REFERENCES

American Volkssport Association. (2013). *American Volkssport Association: America's premier noncompetitive sports organization.* Universal City, TX: American Volkssport Association. Retrieved March 7, 2014, from http://www2.ava.org/What_We_Are_About/AVA_Fact_Sheet.pdf

Armstrong, K., & Edwards, H. (2003). The effects of exercise and social support on mothers reporting depressive symptoms: A pilot randomized controlled trial. *International Journal of Mental Health Nursing, 12,* 130–138.

Armstrong, K., & Edwards, H. (2004). The effectiveness of a pram-walking exercise programme in reducing depressive symptomatology for postnatal women. *International Journal of Nursing Practice, 10,* 177–194.

Ball, K., Bauman, A., Leslie, E., & Owen, N. (2001). Perceived environmental aesthetics and convenience and company are associated with walking for exercise among Australian adults. *Preventive Medicine, 33,* 434–440.

Berman, M., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological Science, 19,* 1207–1212.

Berman, M., Kross, E., Krpan, K., Askren, M., Burson, A., Deldin, P., … Jonides, J. (2012). Interacting with nature improves cognition and affect for individuals with depression. *Journal of Affective Disorders, 140,* 300–305.

Biddle, S. J. H., & Mutrie, N. (2008). *Psychology of physical activity: Determinants, well-being and interventions* (2nd ed.). London: Routledge.

Bird, W. (2007). *Natural thinking: Investigating the links between the natural environment, biodiversity and mental health.* London: Royal Society for the Protection of Birds.

Boer, R., Zheng, Y., Overton, A., Ridgeway, G. K., & Cohen, D. A. (2007). Neighborhood design and walking trips in ten U.S. metropolitan areas. *American Journal of Preventive Medicine, 32,* 298–304.

Boone-Heinonen, J., Evenson, K. R., Taber, D. R., & Gordon-Larsen, P. (2009). Walking for prevention of cardiovascular disease in men and women: A systematic review of observational studies. *Obesity Reviews, 10,* 204–217.

Bowler, D. E., Buyung-Ali, L., Knight, T., & Pullin, A. S. (2010). A systematic review of evidence for the added benefits to health of exposure to natural environments. *BMC Public Health, 10,* doi:10.1186/1471-2458-10-456.

Brown, A. M., Johnston, L., Currie, M., & Muñoz, S. (2011). *A contribution to the evidence base for evaluating health interventions in natural environment settings: A review of methods and evaluation approaches.* Review commissioned by the Forestry Commission and conducted by the Centre for Rural Health, University of Highlands and Islands, Inverness, UK. Retrieved July 9, 2013, from http://www.forestry.gov.uk/pdf/OtHER_Final_report_300411.pdf/$file/OtHER_Final_report_300411.pdf

Brugha, T., Bebbington, P., Tennant, C., & Hurry, J. (1985). The list of threatening experiences: A subset of 12 life event categories with considerable long-term contextual threat. *Psychological Medicine, 15,* 189–194.

Brugha, T., & Cragg, D. (1990). The list of threatening experiences: The reliability and validity of a brief life events questionnaire. *Acta Psychiatrica Scandinavica, 82,* 77–81.

CDC. (2012a). *6 in 10 adults now get physical activity by walking.* Atlanta, GA: Centers for Disease Control and Prevention. Retrieved March 20, 2013, from http://www.cdc.gov/features/vitalsigns/walking

CDC. (2012b). Facts about physical activity. Atlanta, GA: Centers for Disease Control and Prevention. Retrieved March 20, 2013, from http://www.cdc.gov/physicalactivity/data/facts.html

CLES Consulting. (2010). *Evaluation of Get Walking Keep Walking: Third year report.* Manchester, UK: CLES Consulting.

Cohen, D. A., Lapham, S., Evenson, K. R., Williamson, S., Golinelli, D., Ward, P., … McKenzie, T. L. (2013). Use of neighbourhood parks: Does socio-economic status matter? A four-city study. *Public Health, 127,* 325–332.

Cohen, S., & Janicki-Deverts, D. (2012). Who's stressed? Distributions of psychological stress in the United States in probability samples from 1983, 2006, and 2009. *Journal of Applied Social Psychology, 42,* 1320–1334.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behaviour, 24,* 386–396.

Cohen, S., Mermelstein, R., Kamarck, T., & Hoberman, H. (1985). Measuring the functional components of social support. In I. G. Sarason & B. R. Sarason (Eds.), *Social support: Theory, research and application* (pp. 73–94). The Hague, the Netherlands: Martinus Nijhoff.

Coleman, R. J., Kokolakakis, T., & Ramchandani, G. (2011). *Walking for health attendance study* (National England Commissioned Report No. 098). Peterborough, UK: Natural England.

Corraliza, J. A., & Collado, S. (2011). La naturaleza cercana como moderadora del estrés infantil [Nearby nature as a moderator of stress during childhood]. *Psicothema, 23,* 221–226.

Council of Economic Advisers. (2009). *The economic case for health care reform.* Washington, DC: Executive Office of the President. Retrieved July 13, 2013, from http://www.whitehouse.gov/assets/documents/CEA_Health_Care_Report.pdf

Crawford, J. R., & Henry, J. D. (2004). The Positive and Negative Affect Schedule (PANAS): Construct validity, measurement properties and normative data in a large non-clinical sample. *British Journal of Clinical Psychology, 43,* 245–265.

Dawson, J., Boller, I., Foster, C., & Hillsdon, M. (2006). *Evaluation of changes to physical activity amongst people who attend the Walking the Way to Health Initiative (WHI)—prospective study.* Cheltenham, UK: The Countryside Agency. Retrieved August 13, 2013, from http://funding4sport.co.uk/downloads/walk-evaluation-of-those-that-attended.pdf

DEFRA. (2011). *The natural choice: Securing the value of nature.* Presented to Parliament by the Secretary of State for Environment, Food and Rural Affairs, by Command of Her Majesty. Retrieved August 14, 2013, from http://www.official-documents.gov.uk/document/cm80/8082/8082.pdf

Dehejia, R. H., & Wahba, S. (1999). Causal effects in nonexperimental studies: Reevaluating the evaluation of training programs. *Journal of the American Statistical Association, 94,* 1053–1062.

Department for Communities and Local Government. (2011). *The English Indices of Deprivation 2010.* London: Department for Communities and Local Government. Retrieved August 15, 2013, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6871/1871208.pdf

Department of Health. (2011). *Start active, stay active: A report on physical activity for health from the four home countries' chief medical officers.* London: UK Government. Retrieved August 14, 2013, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/216370/dh_128210.pdf

Department of Health. (2012). *The case for change—The Health and Social Care Act 2012.* London: UK Government. Retrieved July 13, 2013, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/138275/A2.-Factsheet-Case-for-change-240412.pdf

Department of Health. (2013). *Public health outcomes framework. Improving outcomes and supporting transparency. Part 2: Summary technical specifications of public health indicators.* London: UK Government. Retrieved March 11, 2014, from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263662/2901502_PHOF_Improving_Outcomes_PT2_v1_1.pdf

Doust, J., & Tod, D. (2007). *Walking the Way to Health Wales: Evaluation phase 2—implementation.* Aberystwyth, UK: Department of Sport & Exercise Science, University of Wales Aberystwyth.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London: Sage.

Fitches, T. (2011). *Who took part in Walking for Health?* (Natural England Research Report No. NERR041). Peterborough, UK: Natural England.

Forsell, Y. (2005). The Major Depression Inventory versus Schedules for Clinical Assessment in Neuropsychiatry in a population sample. *Social Psychiatry and Psychiatric Epidemiology, 40,* 209–213.

Frumkin, H., & Fox, J. (2011). Contact with nature. In A. L. Dannenberg, H. Frumkin & R. J. Jackson (Eds.), *Making healthy places: Designing and building for health, well-being and sustainability* (pp. 229–243). Washington, DC: Island Press.

Gusi, N., Reyes, M. C., Gonzalez-Guerrero, J. L., Herrera, E., & Garcia, J. M. (2008). Cost-utility of a walking programme for moderately depressed, obese, or overweight elderly women in primary care: A randomised controlled trial. *BMC Public Health, 8,* doi:10.1186/1471-2458-8-231.

Harder, V. S., Stuart, E. A., & Anthony, J. C. (2010). Propensity score techniques and the assessment of measured covariate balance to test causal associations in psychological research. *Psychological Methods, 15,* 234–249.

Hartig, T., Evans, G. W., Jamner, L. D., Davis, D. S., & Garling, T. (2003). Tracking restoration in natural and urban field settings. *Journal of Environmental Psychology, 23,* 109–123.

Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health, 35,* 207–228.

Hawkins, J. L., Mercer, J., Thirlaway, K. J., & Clayton, D. A. (2013). "Doing" gardening and "being" at the allotment site: Exploring the benefits of allotment gardening for stress reduction and healthy aging. *Ecopsychology, 5,* 110–125.

Hawkins, J. L., Thirlaway, K. J., Backx, K., & Clayton, D. A. (2011). Allotment gardening and other leisure activities for stress reduction and healthy aging. *HortTechnology, 21,* 577–585.

Health and Social Care Information Centre, Lifestyle Statistics. (2013). *Statistics on obesity, physical activity and diet: England, 2013.* Retrieved July 11, 2013, from https://catalogue.ic.nhs.uk/publications/public-health/obesity/obes-phys-acti-diet-eng-2013/obes-phys-acti-diet-eng-2013-rep.pdf

Hendriksen, I. J. M., Simons, M., Garre, F. G., & Hildebrandt, V. H. (2010). The association between commuter cycling and sickness absence. *Preventive Medicine, 51,* 132–135.

Hillsdon, M., & Thorogood, M. (1996). A systematic review of physical activity promotion strategies. *British Journal of Sports Medicine, 30,* 84–89.

Hine, R., Wood, C., Barton, J., & Pretty, J. (2011). *The mental health and wellbeing effects of a walking and outdoor activity based therapy project. A report for Discovery Quest and Julian Housing.* Colchester, UK: University of Essex.

Ho, D. E., Imai, K., King, G., & Stuart, E. A. (2007). Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis, 15,* 199–236.

Hynds, H., & Allibone, C. (2009). *What motivates people to participate in organised walking activity?* (Natural England Research Report No. NERR028). Peterborough, UK: Natural England.

Institute at the Golden Gate. (2010). *Park prescriptions: Profiles and resources for good health from the great outdoors.* Sausalito, CA: Institute at the Golden Gate. Retrieved October 22, 2013, from http://www.parksconservancy.org/assets/programs/igg/pdfs/park-prescriptions-2010.pdf

Irvine, K. N., Warber, S. L., Devine-Wright, P., & Gaston, K. J. (2013). Understanding urban green space as a health resource: A qualitative comparison of visit motivation and derived effects among park users in Sheffield, UK. *International Journal of Environmental Research and Public Health, 10,* 417–442.

Jackson, J. (2011). *Evaluation of choosing health physical activity projects 2009–2011. Final report.* Lincoln, UK: University of Lincoln. Retrieved August 14, 2013, from http://eprints.lincoln.ac.uk/5109/1/final_reportpr.pdf

Johansson, M., Hartig, T., & Staats, H. (2011). Psychological benefits of walking: Moderation by company and outdoor environment. *Applied Psychology: Health and Well-being, 3,* 261–280.

Kahn, E. B., Ramsey, L. T., Brownson, R. C., Heath, G. W., Howze, E. H., Powell, K. E., … Corso, P. (2002). The effectiveness of interventions to increase physical activity: A systematic review. *American Journal of Preventive Medicine, 22,* 73–107.

Kassavou, A., Turner, A., & French, D. P. (2013). Do interventions to promote walking in groups increase physical activity? A meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 10,* doi:10.1186/1479-5868-10-18.

Kendler, K. S., Kessler, R. C., Neale, M. C., Heath, A. C., & Eave, L. J. (1993). The prediction of major depression in women: Toward an integrated etiologic model. *American Journal of Psychiatry, 150,* 1139–1148.

Kessler, R. (1997). The effects of stressful life events on depression. *Annual Review of Psychology, 48,* 191–214.

Kobau, R., Seligman, M. E. P., Peterson, C., Diener, E., Zack, M. M., Chapman, D., & Thompson, W. (2011). Mental health promotion in public health: Perspectives and strategies from positive psychology. *American Journal of Public Health, 101,* e1–e9.

Leather, P., Pyrgas, M., Beale, D., & Lawrence, C. (1998). Windows in the workplace: Sunlight, view, and occupational stress. *Environment and Behavior, 30,* 739–762.

León, T. C., Nouwen, A., Sheffield, D., Jaumdally, R., & Lip, G. Y. H. (2010). Anger rumination, social support, and cardiac symptoms in patients undergoing angiography. *British Journal of Health Psychology, 15,* 841–857.

Maas, J., van Dillen, S. M. E., Verheij, R. A., & Groenewegen, P. P. (2009). Social contacts as a possible mechanism behind the relation between green space and health. *Health & Place, 15,* 586–595.

Maletta, H. (2007). *Weighting.* Retrieved August 14, 2013, from http://www.spsstools.net/Tutorials/WEIGHTING.pdf

Maller, C., Townsend, M., Pryor, A., Brown, P., & St Leger, L. (2005). Healthy nature healthy people: 'Contact with nature' as an upstream health promotion intervention for populations. *Health Promotion International, 21,* 45–54.

Marselle, M. R., Irvine, K. N., & Warber, S. L. (2013). Walking for well-being: Are group walks in certain types of natural environments better for well-being than group walks in urban environments*? International Journal of Environmental Research and Public Health, 10,* doi:10.3390/ijerph10115603.

Mayer, F. S., Frantz, C. M., Bruehlman-Senecal, E., & Dolliver, K. (2009). Why is nature beneficial? The role of connectedness to nature. *Environment and Behavior, 41,* doi:10.1177/0013916508319745.

Milton, K., Bull, F., & Bauman, A. (2011). Reliability and validity testing of a single-item physical activity measure. *British Journal of Sports Medicine, 45,* 203–208.

Mitchell, R. (2013). Is physical activity in natural environments better for mental health than physical activity in other environments? *Social Science & Medicine, 91,* 130–134.

Morabia, A., & Costanza, M. C. (2004). Does walking 15 minutes a day keep the obesity epidemic away? Simulation of the efficacy of a population wide campaign. *American Journal of Public Health, 94,* 434–440.

National Institute for Health and Clinical Excellence. (2012). *Walking and cycling: Local measures to promote walking and cycling as forms of travel or recreation.* Manchester, UK: NICE.

Newton, J. (2007). *Wellbeing and the natural environment: A brief overview of the evidence.* Swindon, UK: Economic and Social Research Council. Retrieved July 6, 2013, from http://www.esrc.ac.uk/my-esrc/grants/RES-173-27-0007/outputs/read/9ac46fe9-7b56-4f9d-b5c7-9300d29addc6

Nisbet, E. K., & Zelenski, J. M. (2011). Underestimating nearby nature: Affective forecasting errors obscure the happy path to sustainability. *Psychological Science, 22,* 1101–1106.

Office for National Statistics. (2002). Appendix B: The questionnaire. In N. Singleton, A. Lee & H. Meltzer (Eds.), *Psychiatric morbidity among adults living in private households, 2000: Technical report* (p. 38). London: Office of National Statistics.

Olsen, L., Mortensen, E., & Bech, P. (2004). Prevalence of major depression and stress indicators in the Danish general population. *Acta Psychiatrica Scandinavica, 109,* 96–103.

Ottosson, J., & Grahn, P. (2008). 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 Research, 33,* 51–70.

Park, B., Furuya, K., Kasetani, T., Takayama, N., Kagawa, T., & Miyazaki, Y. (2011). Relationship between psychological responses and physical environments in forest settings. *Landscape and Urban Planning, 102,* 24–32.

Parkinson, J. (2008). *Review of scales of positive mental health validated for use with adults in the UK: Technical report.* Edinburgh: Health Scotland.

Paths for All. (2013). *Research summaries.* Edinburgh: Paths for All. Retrieved March 7, 2014, from http://www.pathsforall.org.uk/pfa/support/monitoring-a-evaluation.html

Peacock, J., Hine, R., & Pretty, J. (2007). *Got the blues, then find some greenspace: The mental health benefits of green exercise activities and green care.* Colchester, UK: Centre for Environment and Society, Department of Biological Sciences, University of Essex.

Phillips, R., Knox, A., & Langley, E. (2011). *Walking for Health: 'Inactive' walkers—barriers to participation, and activity substitution* (Natural England Commissioned Report No. 068). Sheffield, UK: Natural England.

Phillips, R., Knox, A., & Langley, E. (2012). *What impact did Walking for Health have on the physical activity levels of participants?* (Natural England Commissioned Report No. 075). Peterborough, UK: Natural England.

Plante, T. G., Gores, C., Brecht, C., Carrow, J., Imbs, A., & Willemsen, E. (2007). Does exercise environment enhance the psychological benefits of exercise for women*? International Journal of Stress Management, 14,* 88–98.

Pretty, J., Peacock, J., Hine, R., Sellens, M., South, N., & Griffin, M. (2007). Green exercise in the UK countryside: Effects on health, and psychological well-being, and implications for policy and planning. *Journal of Environmental Planning and Management, 50,* 211–231.

Pucher, J., Buehler, R., Bassett, D., & Dannenberg, A. (2010). Walking and cycling to health: A comparative analysis of city, state, and international data. *American Journal of Public Health, 100,* 1986–1992.

Rees, T., Ingledew, D. K., & Hardy, L. (1999). Social support dimensions and components of performance in tennis. *Journal of Sports Sciences, 17,* 421–429.

Robertson, R., Robertson, A., Jepson, R., & Maxwell, M. (2012). Walking for depression or depressive symptoms: A systematic review and meta-analysis. *Mental Health and Physical Activity, 5,* 66–75.

Roe, J., & Aspinall, P. (2011). The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health & Place, 17,* 103–113.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70,* 41–55.

Sample, I. (2014). Loneliness twice as unhealthy as obesity for older people, study finds. Retrieved March 7, 2014, from http://www.theguardian.com/science/2014/feb/16/loneliness-twice-as-unhealthy-as-obesity-older-people

Shevlin, M., Houston, J., Dorahy, M., & Adamson, G. (2007). Cumulative traumas and psychosis: An analysis of the national comorbidity survey and the sample British psychiatric morbidity survey. *Schizophrenia Bulletin, 34,* 193–199.

Smith, J. C., Nielson, K. A., Woodard, J. L., Seidenberg, M., & Rao, S. M. (2013). Physical activity and brain function in older adults at increased risk for Alzheimer's disease. *Brain Sciences, 3,* 54–83.

South, J., Giuntoli, G., & Kinsella, K. (2013). *An evaluation of the Walking for Wellness project and the befriender role* (Natural England Commissioned Report No. 118). Peterborough, UK: Natural England.

Steptoe, A. (2000). Stress, social support and cardiovascular activity over the working day. *International Journal of Psychophysiology, 37,* 299–308.

Stuart, E. A. (2010). Matching methods for causal inference: A review and a look forward. *Statistical Science, 25,* 1–21.

Stuart, S. M. (2005). Lifting spirits: Creating gardens in California domestic violence shelters. In P. F. Barlett (Ed.), *Urban place: Reconnecting with the natural world* (pp. 61–88). Cambridge, MA: MIT Press.

Tabachnick, B. G., & Fidell, L. S. (2013). *Using multivariate statistic*s (6th ed.). Boston, MA: Allyn and Bacon.

Tennant, R., Hiller, L., Fishwick, R., Platt, S., Joseph, S., Weich, S., Parkinson, J., Secker, J., & Stewart-Brown, S. (2007). The Warwick-Edinburgh Mental Well-being scale (WEMWBS): Development and UK validation. *Health and Quality of Life Outcomes, 5,* 63. doi:10.1186/1477-7525-5-63.

Thoemmes, F. (2012). *Propensity score matching in SPSS.* Retrieved August 14, 2013, from http://arxiv.org/pdf/1201.6385.pdf

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M. H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science and Technology, 45,* 1761–1772.

Toohey, A. M., McCormack, G. R., Doyle-Baker, P. K., Adams, C. L., & Rock, M. J. (2013). Dog-walking and sense of community in neighborhoods: Implications for promoting regular physical activity in adults 50 years and older. *Health & Place, 22,* 75–81.

Tucker, J. M., Welk, G. J., & Beyler, N. K. (2011). Physical activity in US adults: Compliance with the physical activity guidelines for Americans. *American Journal of Preventive Medicine, 40,* 454–461.

UCLA: Statistical Consulting Group. (2013). *What types of weights do SAS, stata and SPSS support?* Los Angeles, CA: Statistical Consulting Group. Retrieved February 22, 2013, from http://www.ats.ucla.edu/stat/stata/faq/weights.htm

van den Berg, A. E., & Custers, M. H. G. (2011). Gardening promotes neuroendocrine and affective restoration from stress. *Journal of Health Psychology, 16,* 3–11.

van den Berg, A. E., Maas, J., Verheij, R. A., & Groenewegen, P. P. (2010). Green space as a buffer between stressful life events and health. *Social Science & Medicine, 70,* 1203–1210.

Villalba van Dijk, L., Cacace, M., Nolte, E., Sach, T., Fordham, R., & Suhrcke, M. (2012). *Costing the Walking for Health programme.* (Natural England Commissioned Report No. 099). Peterborough, UK: Natural England.

Walking for Health. (2010). *MBE for Health Walk founder.* London: Walking for Health. Retrieved July 5, 2013, from http://www.walkingforhealth.org.uk/news/2010/01/mbe-for-health-walk-founder

Walking for Health. (2013a). *The case for Walking for Health: A briefing for scheme coordinators.* London: Walking for Health. Retrieved July 4, 2013, from http://www.walkingforhealth.org.uk/sites/default/files/caseforsupportbriefing-final.pdf

Walking for Health. (2013b). *Our database.* London: Walking for Health. Retrieved July 5, 2013, from http://www.walkingforhealth.org.uk/running-health-walks/monitoring-and-evaluation/our-database

Walking for Health. (2013c). *Walking works: Making the case to encourage greater uptake of walking as a physical activity and recognise the value and benefits of Walking for Health.* London: Walking for Health. Retrieved October 10, 2013, from http://www.walkingforhealth.org.uk/sites/default/files/Walking%20works_LONG_AW_Web.pdf

Ward Thompson, C., Roe, J., Aspinall, P., 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, 105,* 221–229.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54,* 1063–1070.

Wells, N. M., & Evans, G. W. (2003). Nearby nature: A buffer of life stress among rural children. *Environment and Behavior, 35,* 311–330.

Wensley, R., & Slade, A. (2012). Walking as a meaningful leisure occupation: The implications for occupational therapy. *The British Journal of Occupational Therapy, 75,* 85–92.

Williams, D. M., Dunsiger, S., Ciccolo, J. T., Lewis, B. A., Albrecht, A. E., & Marcus, B. H. (2008). Acute affective response to a moderate-intensity exercise stimulus predicts physical activity participation 6 and 12 months later. *Psychology of Sport and Exercise, 9,* 231–245.

Wood, A. M., Maltby, J., Gillett, R., Linley, P. A., & Joseph, S. (2008). The role of gratitude in the development of social support, stress, and depression: Two longitudinal studies. *Journal of Research in Personality, 42,* 854–871.

World Federation for Mental Health. (2012). *Depression: A global crisis. World Mental Health Day, October 10, 2012.* Occoquan, VA: World Federation for Mental Health. Retrieved August 7, 2014, from http://wfmh.com/wp-content/uploads/2013/11/2012_wmhday_english.pdf.

World Health Organization. (2008). *The global burden of disease: 2004 update.* Geneva, Switzerland: World Health Organization. Retrieved August 14, 2013, from http://www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf

World Health Organization. (2013). *Cardiovascular diseases (CVDs)* (Fact sheet number 317). Geneva, Switzerland: World Health Organization. Retrieved March 22, 2013, from http://www.who.int/mediacentre/factsheets/fs317/en

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