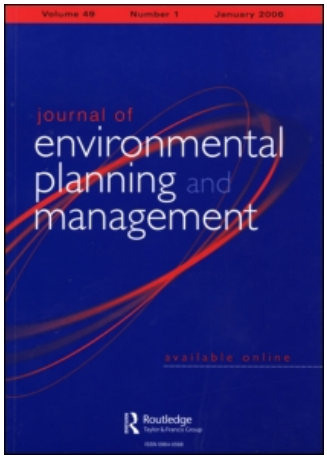

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Green Exercise in the UK Countryside: Effects on Health and Psychological Well-Being, and Implications for Policy and Planning

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ABSTRACT *There is evidence that contact with the natural environment and green space promotes good health. It is also well known that participation in regular physical activity generates physical and psychological health benefits. The authors have hypothesised that 'green exercise' will improve health and psychological well-being, yet few studies have quantified these effects. This study measured the effects of 10 green exercise case studies (including walking, cycling, horse-riding, fishing, canal-boating and conservation activities) in four regions of the UK on 263 participants. Even though these participants were generally an active and healthy group, it was found that green exercise led to a significant improvement in self-esteem and total mood disturbance (with anger-hostility, confusion-bewilderment, depression-dejection and tension-anxiety all improving post-activity). Self-esteem and mood were found not to be affected by the type, intensity or duration of the green exercise, as the results were similar for all 10 case studies. Thus all these activities generated mental health benefits, indicating the potential for a wider health and well-being dividend from green exercise. Green exercise thus has important implications for public and environmental health, and for a wide range of policy sectors.*

Introduction

There is evidence that contact with the natural environment can promote good health. This comes from a variety of disciplines, including psychology, environmental health, ecology, horticulture, landscape planning, leisure and recreation, public health, policy and medicine (Burgess *et al.*, 1988; Kellert & Wilson, 1993; Henwood, 2001; Frumkin, 2002, 2003; Maller *et al.*, 2002; Morris, 2003; Pretty *et al.*, 2003, 2005; St Leger, 2003; Tabbush & O'Brien, 2003; Wells & Evans, 2003; Pretty, 2004). The psychological value of green space has long been appreciated

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(Taylor, 1979; Rubinstein, 1997), and access to it has been associated with longevity and decreased risk of mental ill-health in Japan, Scandinavia and the Netherlands (Takano *et al*., 2002; de Vries *et al*., 2003). Kaplan *et al*. (1998) indicate that green space need not be remote wildlands, and they emphasise the value of parks and open spaces, street trees, vacant lots and backyard gardens, as well as the fields and forests. Local green space is also known to be important for children (Kaplan & Kaplan, 1989; Kahn & Kellert, 2002), with social play, concentration and motor ability all positively influenced by play in green space (Taylor *et al*., 2001).

The design of the built and natural environment matters for mental health (Freeman, 1984; Halpern, 1995; Kaplan *et al*., 1998). There have been attempts to establish whether there is a link between the urban environment and individual's mental health, and initial findings indicate that the prevalence of psychiatric morbidity is prominent in built-up urban areas and less incessant in rural domains (after adjusting for confounding variables) (Lewis & Booth, 1994; White & Heerwagen, 1998; de Vries *et al*., 2003). However, urban areas incorporating gardens or open spaces have a much-reduced prevalence of mental health problems. Local green space can be especially valuable in urban areas for promoting social contact and helping to bring people together (Ward Thompson, 2002) and giving rise to stronger neighbourhood ties (Kuo *et al*., 1998). The presence of trees appears to encourage more frequent use of outdoor space, and experience of nature reduces mental fatigue, diminishes sensations of stress and has positive effects on mood (de Vries *et al*., 2003). Grahn & Stigsdotter (2003) reported a significant relationship between the number of times an urban open green space was visited and reduced levels of stress. The incorporation of green space into the built environment is also known to increase the likelihood of taking both leisure and non-leisure based physical activity (Ross, 2000; Handy *et al*., 2002; Parks *et al*., 2003).

Thus, regular contact with nature and green space enhances mental health and positively influences psychological well-being. It is also extensively documented that participating in regular physical activity generates many physical and psychological health benefits (Scully *et al*., 1998). A range of critical physical health challenges, such as obesity, coronary heart disease and type II diabetes are known to be driven by diet, but also influenced by sedentary lifestyles. Levels of physical activity have dramatically declined over recent decades and consequently health has suffered. Therefore, the authors have hypothesised that there may be a synergistic benefit in adopting physical activities whilst at the same time being directly exposed to nature. We have called this 'green exercise' (Pretty *et al*., 2003, 2005).

There have been surprisingly few empirical studies to investigate the effect of nature and green space on health in the UK (Reynolds, 2002; Countryside Agency, 2003), and as yet the health benefits of green exercise activities have not been quantitatively compared to exercise or nature alone. The authors have previously shown that simply viewing pictures of pleasant (rural and urban) scenes enhances the positive influence of exercise on measures of self-esteem that are positively associated with mental health (Pretty *et al*., 2005). The aim of this research is to quantify the extent to which six different countryside activities (walking, cycling, horse-riding, fishing, canal-boating, conservation activities) at 10 locations in the UK have effects on the mental and physical health of participants. The specific hypothesis is that physical activity in the countryside at a range of energy intensity and times has at

least short-term positive effects on mental and physical health measures for participants. The effects may differ according to the mental and physical health status of participants prior to the activity, and according to duration of the activity.

Materials and Methods

Green Exercise Case Studies

There are a wide variety of green exercise initiatives in the UK, and several have provided qualitative evidence on health benefits. Initiatives can be of five types:

(1) *Geography based*: project in a specific area or region;
(2) *Issue based*: a project to address a particular health issue;
(3) *Habitat based*: a project with a conservation or particular habitat focus;
(4) *Activity based*: initiative for a particular sport or activity, e.g. mountain biking, fishing, walking;
(5) *Group based*: a project to target a specific group of people, e.g. those in coronary care, overweight, disabled, refugees, youth offenders or with learning difficulties.

Ten green exercise case studies were selected that included examples of each of these five categories and incorporated variations in intensity, duration, number of participants and environment. Projects were sampled from each region of the UK: two in Scotland, two in Wales, two in Northern Ireland and four in England (Table 1).

The Composite Questionnaire

Data were obtained in the field by means of a composite questionnaire. Section 1 contained questions to determine the physical and mental health of a participant at the time of sampling. Section 2 was designed to determine any changes to psychological health brought on by participating in green exercise. Section 2 was completed twice: before and after taking part in the activity. Table 1 highlights the duration of each activity, ranging from a minimum of 1 hour (mountain biking) to a maximum of 10 hours (fishing), which reflects the time interval between pre- and post-measurements.

Section 1 comprised three subsections:

(1) General physical health information was obtained using the Euroqol EQ-5D (2005) questionnaire which provides a simple descriptive profile and a single index value for health status. In the UK, a NHS Task Group has been set up to co-ordinate the testing of EQ-5D as an outcome measure for use by clinicians and managers.
(2) General psychological health was measured using the General Health Questionnaire (Goldberg, 1978). This is the industry standard for measuring psychological health (Goldberg & Williams, 1991), and was originally designed for use in London, and since translated into 38 languages and validated in over 50 studies.

Table 1. The 10 green exercise case studies

	Name and location of case study	Type and duration of activity	Environment	Management or organisation
1	Arnside & Silverdale Area of Outstanding Natural Beauty: Conservation Volunteers, Lancashire, England	Various types of formally organised practical conservation work: digging, scrub clearing (all day)	Varied: open countryside, fells, woodland, shoreline	Conservation volunteer group managed by AONB staff
2	Glentress Forest Recreation, Borders, Scotland	Mountain biking and walking: duration of visit varied from 1 hour to all day	Mixed and coniferous managed woodlands	A partnership: Forest and trails managed by Forestry Commission Scotland; 'The Hub' Mountain biking and Café facilities are run as a private business
3	Re-Union Canal Boats, Edinburgh, Scotland	Canal trip: boat trip lasted all day	Varied countryside along banks of Union Canal	Re-Union Canal Boats is a Social Enterprise
4	Close House Initiative, Herefordshire, England	Various outdoor activities: sessions vary from a morning or afternoon to a weekend camp	Mixed woodland	Charity: BODS Youth Work Initiatives
5	Walking the Way to Health Initiative (WHI), Ballymena, County Antrim, Northern Ireland	Walking: organised and led walks last for 1½ hours	Varied countryside: woodland, open country, shoreline, country parks etc	Walking the Way to Health Initiative (WHI): A UK initiative. For Ballymena a partnership between Northern Partnership for Physical Activity and Ballymena Borough Council
6	Horse riding, Lagan Valley, County Antrim, Northern Ireland	Horse riding: average duration 2 hours	Varied countryside: woodland, open country, shoreline, country parks etc	Lagan Valley Equestrian Group (part of British Horse Society Ireland)
7	Afan Forest Centre, Port Talbot, West Glamorgan, Wales	Mountain biking and walking: duration of visit from 1 hour to all day	Coniferous and mixed managed woodlands	Forest managed by Forestry Commission; Forest Enterprise Centre managed by FC and Neath and Port Talbot Council

(*continued*)

Table 1. (*Continued*)

	Name and location of case study	Type and duration of activity	Environment	Management or organisation
8	Torfaen Green Gym, Pontypool, Gwent, Wales	Various types of formally organised practical conservation work (digging, scrub clearing): session lasts 2½ hours	Varied countryside: woodland, open country, community gardens, community farm	Torfaen Green Gym: part of a nationwide Green Gym initiative managed by British Trust for Conservation Volunteers
9	Walking Out Project, Lincoln, England	Organised and led walks targeting specific groups: duration average 2 hours	Varied countryside: woodland, open country	Walking Out project is managed by the Ramblers Association
10	Layer Pit, Essex, England	Fishing: average duration of visit 10 hours	Managed lake	Layer Pit lake managed by Colchester Angling Preservation Society

(3) The level of physical fitness and lifestyle of respondents was evaluated using questions relating to the amount of physical activity at different levels undertaken daily, weekly, monthly, every six months or not at all. Light activities included using the stairs or walking for pleasure, moderate activity examples included gardening, housework and bowls, and vigorous activities included playing sports, running and swimming.

Section 2 measured two aspects of mental health:

(1) Self-esteem was measured pre- and post-activity using the Rosenberg Self-Esteem Scale (Rosenberg, 1989). According to Fox (2000), this is the best-validated and most conservative measure of self-esteem and has been used in various studies of the relationship between self-esteem and exercise (Mactavish & Searle, 1992; Desharnais *et al*., 1993; Palmer, 1995).
(2) Mood status was measured pre- and post-activity using the standardised, short form version of the Profile of Mood States test (POMS) questionnaire (McNair *et al*., 1984). According to Biddle (2000), the POMS is the dominant instrument for measuring mood in studies examining the relationship between mood and exercise. A meta-analysis by McDonald & Hodgedon (1991) examined the relationship between physical activity and mood, and demonstrated a clear relationship between exercise and lack of negative mood. The short version of POMS was used to minimise the amount of time required of participants. Reliability and validity of the shortened edition of POMS for use in sports settings was established by Grove & Prapavessis (1992). The six POMS subscales measured were anger-hostility, confusion-bewilderment, depression-dejection, fatigue-inertia, tension-anxiety and vigour-activity.

Sampling and Participants

Participants were accessed by using a stratified cluster sampling technique. Cluster sampling was used to select a random sample of case studies to represent the total population. A stratified sampling technique divided the population into mutually exclusive sub-populations (men and women) to ensure equal representation. Several on-site sampling approaches were used within each project. For organised group activities such as the Walking the Way to Health Initiative, conservation volunteers or Re-Union Canal Boats, questionnaires were administered to every member of the group to eliminate any selection bias. At projects where people accessed a specific area (e.g. Glentress Forest) to participate in activities independently or in informal groups, sampling took place at a central point such as the entrance/exit, car park or café/information centre. In this instance, all visitors entering the forest or car park on the particular day were approached. The organised weekly group activities were visited on the day that the group regularly met. In addition, two days were spent sampling visitors of specific areas who were participating in activities in informal groups or independently (e.g. Glentress Forest). Sampling took place during September – November 2004.

For ethical reasons, children, those with learning difficulties and individuals who had been referred to a project or scheme as part of a course of treatment for a health

condition (e.g. coronary heart disease, obesity, depression) were excluded from this study. It is important to note that as the participants were accessed on-site they were from a self-selected cohort. They had already chosen to conduct these green exercise activities and were, therefore, drawn from a generally healthy and active part of the population at large.

Estimation of Energy Expenditure

Energy expenditure during each of the 10 activities was estimated using standard tables (McArdle *et al*., 2001) and adjusted for each individual's self-reported body mass.

Results

Background Data on Participants

A total of 263 participants were sampled of whom 134 were male (51%) and 129 female (49%). The walking and horse-riding groups were predominantly female, whereas participants in the conservation, fishing and mountain biking activities were mainly male. Figure 1 shows the proportion of people participating in each of the activities.

The average age of participants was 47.8 $\pm$ 18.2 years, with ages ranging from 13 to 84 years. The most common age category for participants was the 61 – 70 years age group, primarily because of the predominance of the elderly in the two walking groups (Figure 2). The Close House project in Hereford reported the lowest mean age of 20 years, whereas the activities in both Glentress and Afan forests attracted the widest range of age groups.

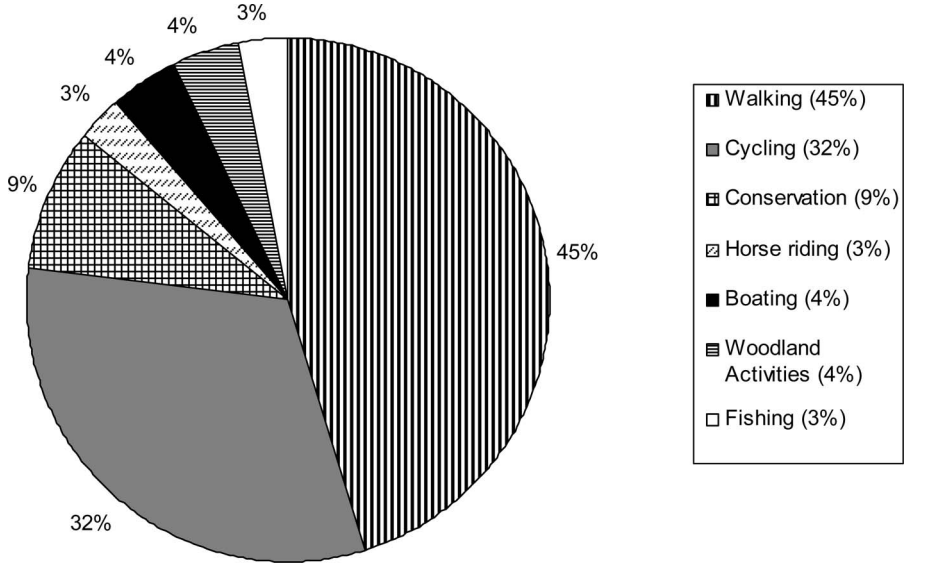

Figure 1. Proportion of participants taking part in each activity ($n = 263$).

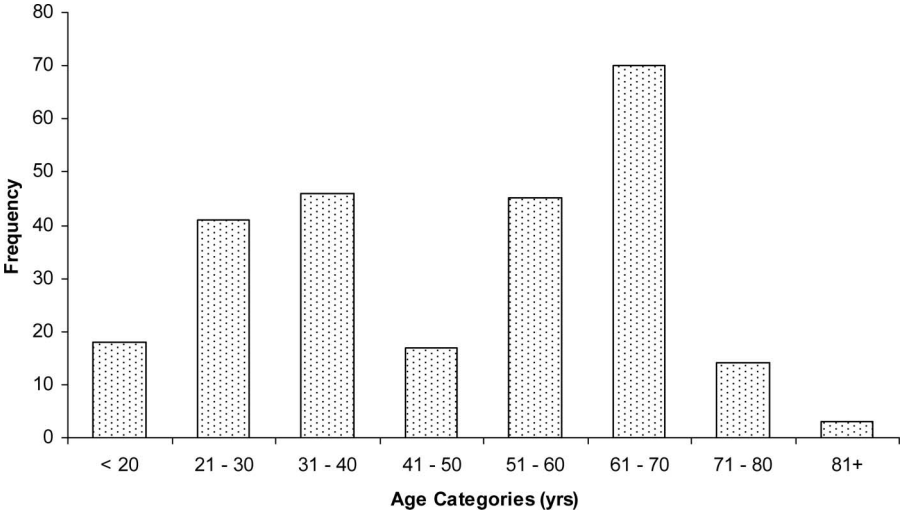

Figure 2. Number of participants in each age category.

The General Health Questionnaire (GHQ) provided an indication of the overall psychological state of the individual. The scores derived range from a minimum of 0, which represents excellent mental health to a maximum of 36, which implies a poor mental health state. The average score incorporating all participants was 8.73 ± 0.27 ($n = 234$). The values collected ranged from 0 to 29 and the most common score was 6. This indicates that this cohort of participants was generally in good health compared with the general population (Goldberg, 1978).

Effects of Green Exercise on Mental Health

Initially, a one-way between-groups analysis of variance was conducted to explore differences in the participants' mood and self-esteem scores prior to participating in the 10 green exercise activities. This did not reveal any significant findings, indicating that all participants had comparable psychological health states prior to activities.

A paired samples *t*-test was conducted to evaluate the impact of green exercise activities on participants' self-esteem and mood.

Self-esteem. There was a statistically significant improvement in self-esteem from pre-activity scores ($M = 18.40$, $SD = 4.64$) to post activity values ($M = 17.00$, $SD = 4.50$, $t(255) = 6.13$, $p < 0.0005$) (the lower the value, the higher the self-esteem). The η^2 statistic (0.13) indicated a large effect size (Figure 3: significant increase in self-esteem of 1.40; $p < 0.0005$).

Profile of Mood States (POMS) Subscale T-Scores

Data were gathered on the six mood measures assessed using the Profile of Mood States (POMS) questionnaire. Figure 4 shows the changes that occurred in each of

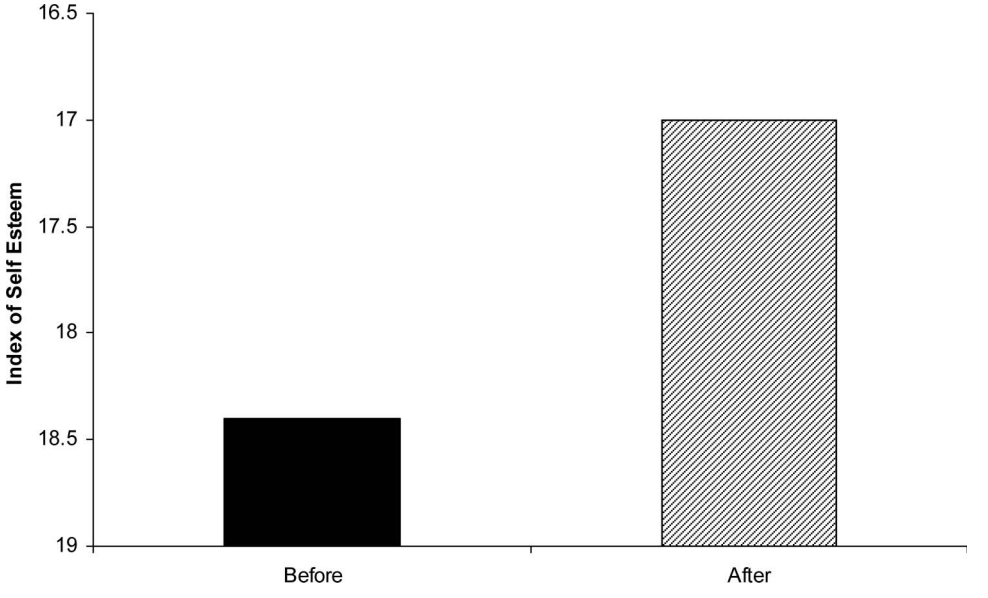

Figure 3. The amalgamated change in self-esteem for all participants following the activity. *Note*: The lower the value, the higher the self-esteem.

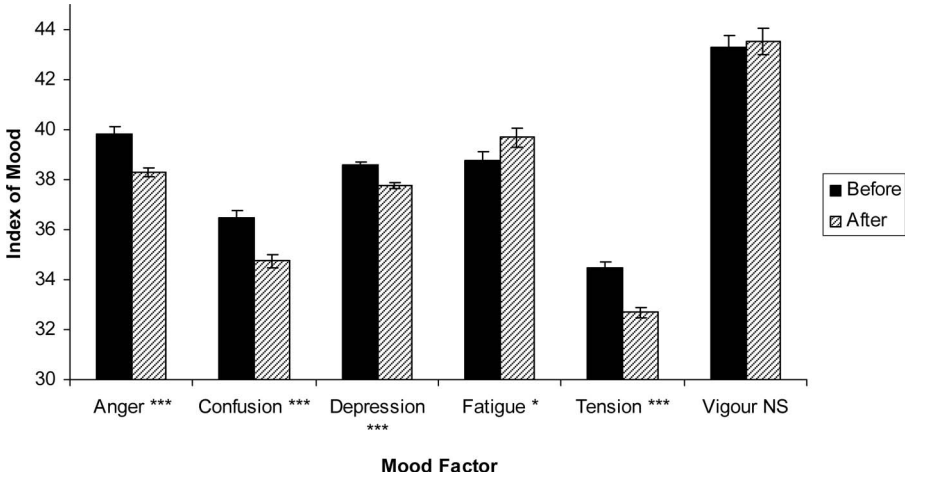

Figure 4. The amalgamated change in the six sub-scale mood factors for all participants following the activity.

the six measures (significance tested with 1-tailed *t*-test; $*p < 0.05$; $**p < 0.01$; $***p < 0.0005$). There were statistically significant reductions in:

- Anger-hostility (from $M = 39.85$, $SD = 3.88$ to $M = 38.28$, $SD = 3.01$, $t(250) = 8.05$, $p < 0.0005$) following the activity, with the η^2 statistic (0.21) indicating a large effect size.

- Confusion-bewilderment (from $M = 36.47$, $SD = 4.62$ to $M = 34.75$, $SD = 4.08$, $t(250) = 7.10$, $p < 0.0005$) post activity, with the η^2 statistic (0.17) indicating a large effect size.
- Depression-dejection (from $M = 38.58$, $SD = 2.42$ to $M = 37.78$, $SD = 1.81$, $t(250) = 6.77$, $p < 0.0005$), with the η^2 statistic (0.16) indicating a large effect size.
- Tension-anxiety (from $M = 34.46$, $SD = 4.25$ to $M = 32.68$, $SD = 2.91$, $t(250) = 8.70$, $p < 0.0005$) with the η^2 statistic (0.23) indicating a large effect size.

There was a statistically significant increase in fatigue-inertia (from $M = 38.78$, $SD = 5.26$ to $M = 39.69$, $SD = 6.05$, $t(250) = -2.29$, $p < 0.05$), with the η^2 statistic (0.02) indicating only a small effect size. The aggregate change in vigour-activity was not significant, primarily because some groups experienced an increase and others a reduction. Overall, the mean value increased from 43.27 ± 7.4 to 43.52 ± 8.2.

The subscale T-scores were further analysed using a one-way between-groups multivariate analysis of variance, which investigated the effects of the green exercise activities on mood. There was a statistically significant difference between the 'before' and 'after' activity mood scores on the combined dependent variables: $F(6, 502) = 13.39$, $p < 0.005$, Wilks' Lambda $= 0.86$, partial $\eta^2 = 0.14$. This second method of analysis supplements the initial findings reported using the paired samples *t*-tests and re-emphasises the influential effect of green exercise on mood state.

When the results for the dependent variables were considered separately, statistically significant differences were found in anger, confusion, depression and tension:

- Anger reached statistical significance, using a Bonferroni adjusted alpha level of 0.01: $F(1, 507) = 26.34$, $p < 0.0005$, partial $\eta^2 = 0.05$. Mean scores pre-activity ($M = 39.86$, $SD = 3.93$) were significantly higher compared to those after ($M = 38.27$, $SD = 3.00$).
- Confusion reached statistical significance, using a Bonferroni adjusted alpha level of 0.01 $F(1, 507) = 20.39$, $p < 0.0005$, partial $\eta^2 = 0.04$. Once again the mean scores before the green exercise activities ($M = 36.46$, $SD = 4.60$) were higher than after the activities ($M = 34.72$, $SD = 4.08$).
- Depression also reached statistical significance, using a Bonferroni adjusted alpha level of 0.01 $F(1, 507) = 18.05$, $p < 0.0005$, partial $\eta^2 = 0.03$. The green exercise activities significantly reduced mean scores ($M = 37.78$, $SD = 1.81$) in comparison to scores reported prior to activity ($M = 38.59$, $SD = 2.41$).
- Tension reached statistical significance, using a Bonferroni adjusted alpha level of 0.01 $F(1, 507) = 30.35$, $p < 0.0005$, partial $\eta^2 = 0.06$. Yet again the mean scores at the start ($M = 34.45$, $SD = 4.26$) exceeded those after the activities ($M = 32.67$, $SD = 2.90$).

Total Mood Disturbance (TMD). A Total Mood Disturbance (TMD) score was calculated to denote an overall assessment of emotional state. This method is regularly used because it provides an indicator of overall mood. It involved summing the POMS subscale T-scores of anger, confusion, depression, fatigue and tension and

then subtracting the T-score for vigour (McNair *et al*., 1984). A paired samples *t*-test reported a statistically significant decrease in TMD (from $M = 144.87$, $SD = 20.62$ to $M = 139.67$, $SD = 19.10$. $t(250) = 4.48$, $p < 0.0005$) following participation in the activities. The η^2 statistic (0.07) indicated a moderate effect size. Therefore, overall mood is significantly enhanced following participation in green exercise activities (Figure 5).

Analysis of individual case studies. A mixed between-within analysis of variance was conducted to establish whether participants' self-esteem and TMD were influenced by the type of green exercise activity undertaken. This analysis provides an indication of which green exercise activity was more effective in reducing TMD and improving self-esteem following participation (main effect for group). It also identifies whether there is a change in mood and self-esteem scores over the two time points that the data were collected (main effect for time) and whether the change in scores over time was different for the 10 case studies (interaction effect).

For self-esteem there was a statistically significant main effect for time (Wilks' Lambda $= 0.94$, $F(1, 246) = 16.18$, $p < 0.0005$) and the effect size was moderate (partial $\eta^2 = 0.06$), although there was not a significant finding for the main effect for group. Therefore, self-esteem scores significantly improved after participating in green exercise activities in comparison to values reported before. However, there was not a statistically significant interaction effect (Wilks' Lambda $= 0.96$, $F(9, 246) = 1.23$, $p > 0.28$, partial $\eta^2 = 0.04$), so the enhancement in self-esteem did

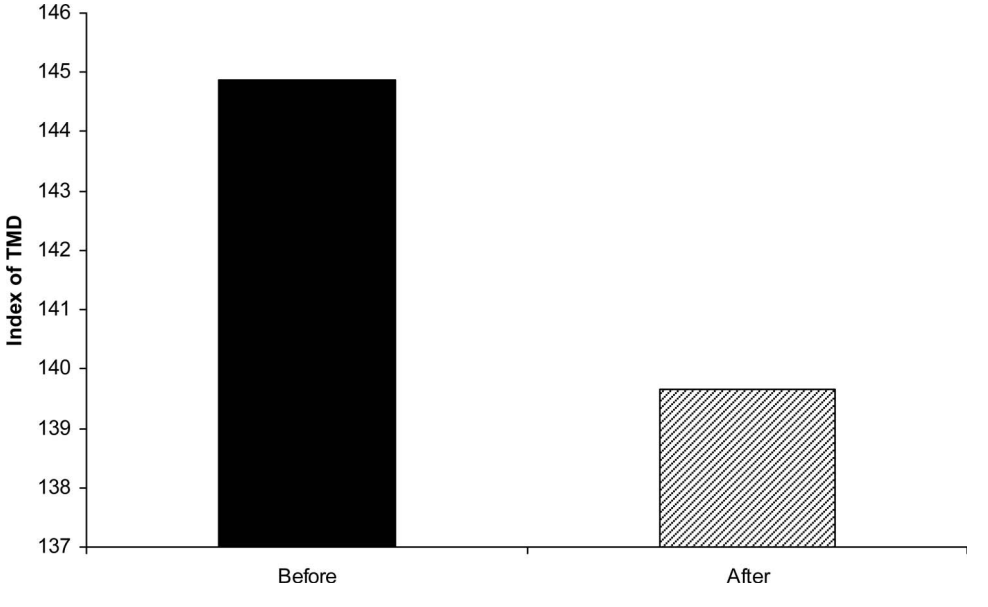

Figure 5. The amalgamated change in Total Mood Disturbance (TMD) for all participants following the activity. *Note*: The lower the score, the better the overall mood.

not vary depending on the location, duration, intensity and type of activity participants engaged in.

For TMD there was a statistically significant main effect for time (Wilks' Lambda = 0.97, F(1, 241) = 7.99, $p < 0.005$) and the effect size was small (partial $\eta^2 = 0.03$), but there were no significant differences in TMD scores for the 10 case studies (main effect for group). Therefore, participants TMD scores significantly decreased following participation in green exercise activities compared to the participants' mood state before. There was not a statistically significant interaction effect (Wilks' Lambda = 0.95, F(9, 241) = 1.44, $p > 0.17$, partial $\eta^2 = 0.05$), which means that the reduction in TMD scores following participation in the green exercise activities was similar for all of the 10 case studies.

It is concluded that there is only limited advantage in analysing the case studies separately, as there is no significant difference in their ability to influence self-esteem and mood. The key conclusion is that all these 10 green exercise activities, regardless of their type or level of intensity and duration, yield mental health benefits, despite their varying duration and intensity.

Effects of Green Exercise on Physical Health

The effects of green exercise activities on physical health were measured by calorie consumption. The 10 case studies selected represent a variety of activities that took place in diverse contexts with varying durations and intensities. Table 2 highlights the different amount of energy (MJ) used (1) per hour and (2) per visit according to the body weight of the participants (McArdle *et al.*, 2001).

It is evident from Table 2 that cycling at Glentress and Afan forest were the most vigorous activities, followed closely by horse riding in Lagan Valley. The activity that used the least calories per hour was the comparatively sedentary trip on the canal boat. Fishing is a fairly light pursuit, although the calories used per visit were greater because the average time spent fishing is three times that of the more vigorous activities. Plotting the calories used per hour and per visit against the change in self-esteem revealed no significant differences (Figures 6 and 7).

Table 2. Mean energy used by participants in each case study

Case study	Main activity	Mean energy used per hr (MJ)	Duration of activity (hrs)	Mean energy used per visit (MJ)
Arnside & Silverdale	Conservation	1.25	5	6.25
Glentress Forest	Mountain biking	2.53	4	10.12
Re-Union Canal	Boating	0.43	6	2.58
Close House	Woodland activities	2.15	6	12.9
Ballymena WHI	Walking	1.40	1	1.40
Lagan Valley	Horse riding	2.25	2	4.50
Afan Forest	Mountain biking	2.73	4	10.92
Torfaen Green Gym	Conservation	1.38	2.5	3.45
Walking Out Project	Walking	1.35	2	2.70
Layer Pit	Fishing	1.23	12	14.76

This implies that all intensities and durations of activity generate significant health benefits and not solely the time-consuming and vigorous activities. However, self-esteem did improve very slightly, but not significantly, as calories per visit increased, particularly with the all day activities (Figure 7).

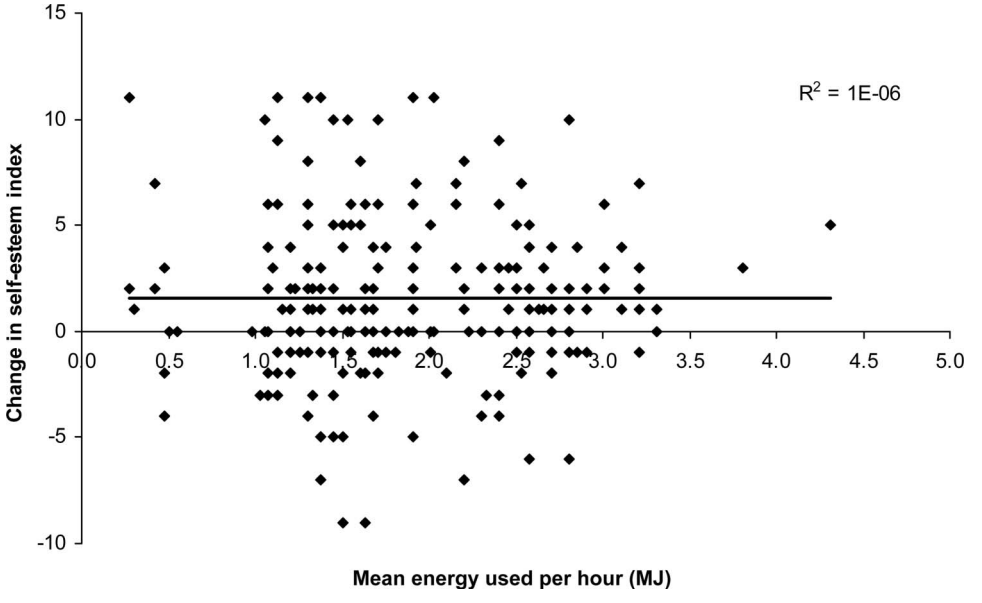

Figure 6. Effect of green exercise activities (mean energy used per hour) on changes in self-esteem.

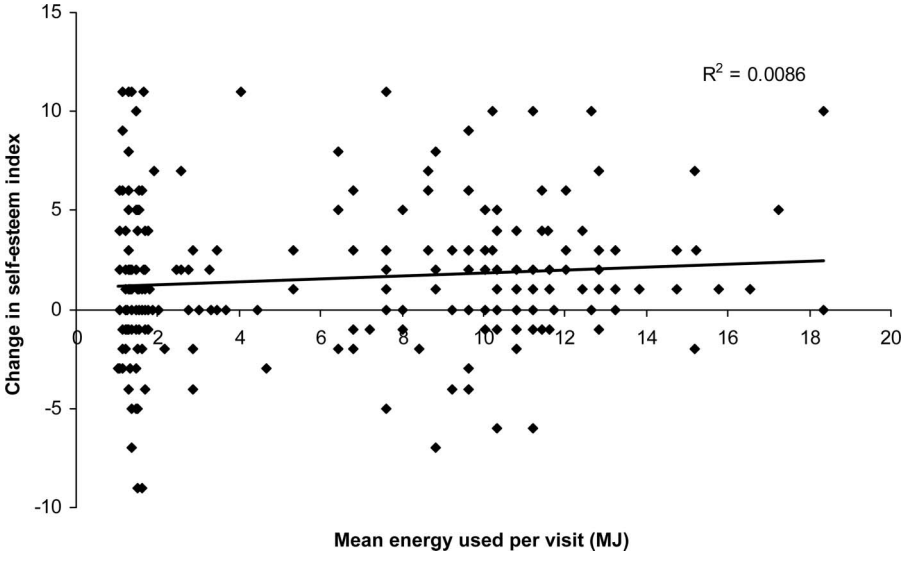

Figure 7. Effect of green exercise activities (mean energy used per visit) on changes in self-esteem.

Secondary Statistics

Additional statistical analysis was conducted to identify any differences in the health outcomes dependent on participants' age, gender and starting levels of self-esteem.

Age Differences

There were no significant differences reported between the various age categories.

Gender Differences

A mixed between-within analysis of variance was conducted to establish whether male and female TMD and self-esteem scores differed. There was a statistically significant main effect for time (Wilks' Lambda = 0.92, F(1, 249) = 21.54, $p < 0.0005$) and the effect size was moderate (partial $\eta^2 = 0.08$). This re-emphasises the finding that TMD scores significantly improve following participation in green exercise activities. The main effect for gender was not significant, so the TMD scores for males and females were comparable. However, there was a statistically significant interaction effect (Wilks' Lambda = 0.97, F(1, 249) = 6.88, $p < 0.01$) and the effect size was small (partial $\eta^2 = 0.03$). Figure 8 illustrates this interaction effect and shows that TMD scores change differently over time according to gender. Females experience a larger decline in TMD following participation in green exercise activities, resulting in an improved mood state.

There was a statistically significant main effect for time (Wilks' Lambda = 0.87, F(1, 254) = 37.45, $p < 0.0005$) and the effect size was large (partial $\eta^2 = 0.13$).

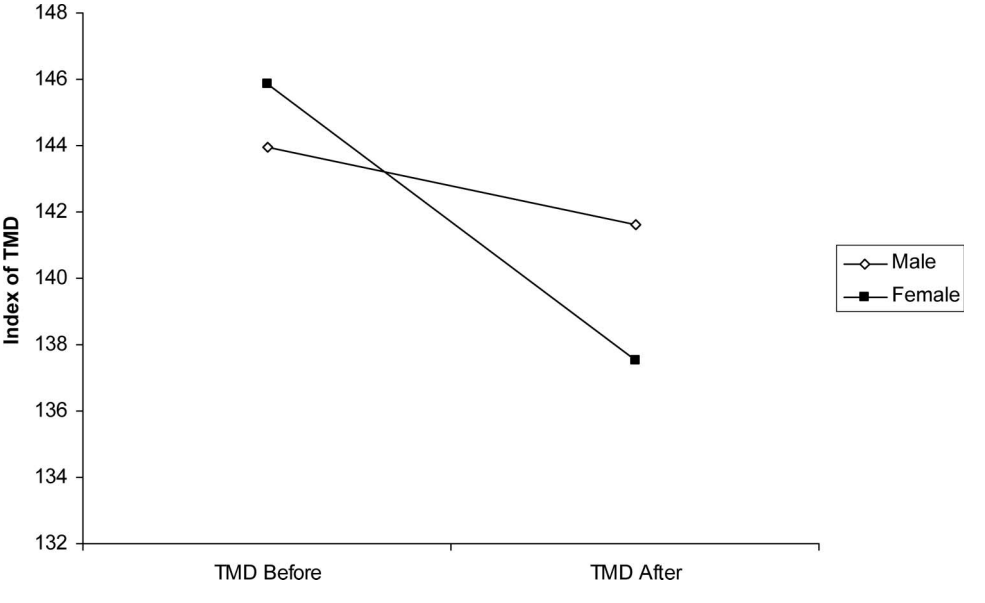

Figure 8. The interaction effect when comparing gender differences in the change in TMD scores following the activities. *Note*: The lower the score, the better the overall mood.

This corroborates the finding that self-esteem improves after engaging in green exercise activities. The main effect for gender was significant ($F = 9.52$, $p < 0.01$, partial $\eta^2 = 0.04$) as men have higher self-esteem ($M = 17.60$, $SD = 4.64$) than women ($M = 19.24$, $SD = 4.51$). However, the interaction effect was not significant (Wilks' Lambda $= 1.00$, $F(1, 254) = 0.05$, $p > 0.83$, partial $\eta^2 = 0.00$), as illustrated in Figure 9. This is because, although men's initial self-esteem scores were higher than women's, both self-esteem scores changed equally following participation in green exercise.

High and Low Self-esteem Groups

Participants' initial self-esteem scores reported prior to green exercise activities were also separated into high and low score categories. A score of 18.5 was the cut-off to create a high self-esteem group (i.e. scores < 18.5) of 127 participants and a low self-esteem group (i.e. scores > 18.5) of 132 participants. An independent samples *t*-test was conducted to compare the overall change in self-esteem scores for both of these groups. There was a statistically significant difference in the high self-esteem ($M = 0.32$, $SD = 3.32$) and low self-esteem groups ($M = 2.46$, $SD = 3.70$, $t(254) = -4.88$, $p < 0.0005$), whereby the η^2 statistic (0.09) indicated a moderate effect size. Therefore, participants with an initially poor self-esteem score enhanced their self-esteem scores more than those with initially high self-esteem values, following the activities. This implies that people with poor self-esteem would benefit even more from green exercise activities.

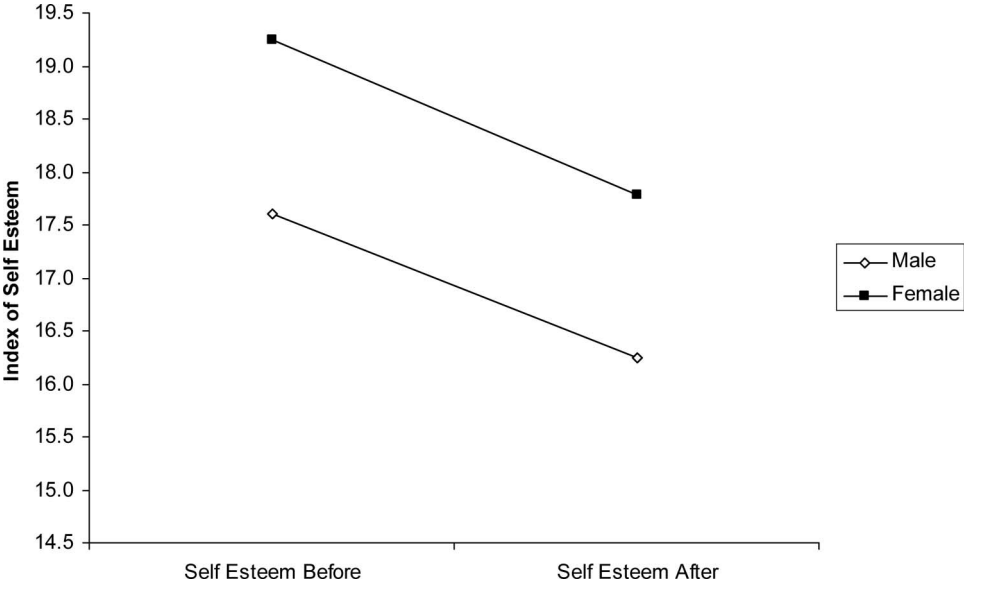

Figure 9. The main effects when comparing gender differences in the change in self-esteem following the activities. *Note*: The lower the value, the higher the self-esteem.

Discussion

Implications of Green Exercise Research

The aim of this study was to quantify the changes in health and psychological well-being following participation in green exercise activities. Although the participants in the 10 case studies were generally already healthy and active, there was still a significant improvement in their self-esteem and total mood disturbance (TMD) as a result of participating in the various green exercise activities. The subscale mood factors of anger-hostility, confusion-bewilderment, depression-dejection and tension-anxiety all significantly improved post-activity. These improvements in self-esteem and TMD were comparable for all of the 10 case studies. This is an important conclusion as it implies that all these green exercise activities, regardless of their type or level of intensity and duration, yield significant mental health benefits.

Barriers and Accessibility

The main limitation of this study was that the sample only included people who were already engaging in green exercise activities and were therefore already healthy relative to many in the general population. The sample did not include the habitually inactive group who are a lot harder to reach. This raises questions about why more people are not regularly taking exercise and visiting green space, if green exercise can have such a positive effect on their health. First, it is clear from participation rates that a large proportion of the UK population already engages in many forms of green exercise. However, health data indicate that a substantial proportion of the population is too sedentary, with more than 20% of adults now obese (body mass index >30 kg m^{-2}). It is thus clear that there are barriers to participation affecting different groups of people in different ways. The challenge for environmental and health policy makers is to find ways to reach sedentary and socially-excluded individuals.

A variety of factors act as important barriers to participation in activities in both local neighbourhoods and in the countryside (Brownson *et al.* 2001; CRN 2001):

(1) *physical constraints*: these include the distance of the green space from the home, the presence of obstacles (such as roads to cross) and the extent to which particular groups of adults and children are independently mobile.
(2) *social and cultural factors*: public spaces are sometimes seen as 'risky' and associated with crime (this fear of crime may affect people's willingness and ability to make the most of natural places), or are seen by some social groups as culturally inaccessible.

The use of green spaces also varies from site to site and some groups of people are more likely to use these places than others. For example, the numbers of teenagers and young adults using parks and open spaces generally outweigh the numbers of children under 5, older people and those from black and ethnic minorities. The CRN (2001) has identified four groups with low participation rates in countryside recreation as a whole: (1) young people; (2) low-income groups; (3) ethnic minorities; and (4) disabled people. The challenge facing all public agencies is to find ways to remove some of the many barriers to participation in green exercise.

Economic Benefits of Green Exercise

This research has shown that both exposure to nature and physical activity improves mental health and psychological well-being over a short period. Although it is not known whether this alone will lead to long-term improvements, it may be that behavioural and lifestyle changes could be provoked by such activities, leading to continuing re-exposure which would result in a healthier population. It is already known that there are substantial economic benefits of a physically healthier population (Wanless, 2002; DoH, 2004). The potential impact of emotional benefits and improved mental well-being has not been quantified but would be additional to the already recognised physical health and economic benefits. If these benefits are achieved through green exercise activities that might also provoke long-term changes in attitudes to nature and the environment in both rural and urban contexts, then wider support for pro-sustainability policies and practices is more likely to arise.

One of the central needs now is to ensure that the assessment of the value of green space and the countryside includes the potential health benefits to those both working in and visiting these areas. The farmed countryside is already being recognised as a multifunctional space, with its real economic value being more than just agricultural production (Rayment & Dickie, 2001; Pretty, 2002; National Trust, 2003; GHK, 2004). The same line of argument can also be made for the multifunctional value of urban green space. These are spaces not just valuable to local people for contemplation, dog-walking, sports and species conservation, but also because they contribute directly to the nation's health. The NHS budget is several hundred times larger than the amount spent on conservation and access to green spaces, yet spending on green space could also help to prevent some illness and so save the UK money.

Policy Implications

This research on the effects of green exercise has important policy implications for a range of rural and urban sectors. It is clear that a large number of people already use the countryside and urban/urban-fringe green space for leisure activities, from which they derive a health benefit. However, physical and mental health problems in the general population are on the increase. The two challenges are, therefore, (1) to increase the number of people taking part in green exercise, including especially those social groups suffering the most ill-health through sedentary lifestyles and those currently not accessing the countryside for recreation and leisure; and (2) to increase the rate of use by those people already participating in green exercise. These can be addressed through improved provision and access, and by wider recognition of the benefits of green exercise. Exposure both to nature and green space and to physical activity should be a central part of the policies and strategies of a large number of organisations. There are thus implications for recreation providers, agricultural managers and policy makers, schools, planners and developers, the health sector, social and mental health service providers, environmental managers and the sports and leisure industry.

Concluding Comments

From the range of case studies examined for this research, the study concludes that green exercise generates mental health benefits regardless of the level of intensity, duration or type of green activity undertaken. Green exercise has important implications for public and environmental health. A fitter and emotionally more content population would clearly cost the economy less as well as reducing individual human suffering. In today's world where sufferers of stress and mental ill-health are more commonplace, nature can act as a vital health resource. Mental ill-health is already problematic in the UK with at least one in six individuals suffering at any one time. Depression and mixed anxiety are more commonplace, with incidence rising from 7.8% in 1993 to 9.2% in 2000. The associated public health costs are thus growing, with £3.8 billion of the NHS annual expenditure used in the treatment of mental illness and a further £0.68 billion used for personal social services expenditure. With the resulting costs incurred due to lost outputs, and the increased expenditure on the provision of care, the importance of regular access to nature is paramount. This research shows that improvements to mood and self-esteem can occur, and as depression and depression-related illness is estimated to become the most pronounced source of ill-health by 2020 (WHO, 2001), the need to encourage regular participation in green exercise activities becomes ever more important for addressing mental ill-health.

Obesity and related conditions already cost more in public health terms than smoking (Kenkel & Manning, 1999; Lang & Heasman, 2004), and will overtake smoking as industrialised countries' largest source of mortality in a decade if current trends persist. Thus increasing support for and access to a wide range of green exercise activities for all sectors of society should produce substantial economic and public health benefits. There is an important challenge in identifying barriers and developing innovative solutions for all social groups, particularly those who feel excluded from green space.

However, there is a distinct tension between these conclusions and existing drivers of economic development in both rural and urban regions. In urban areas, green spaces are often removed to keep down maintenance costs, and there is often a perception that well-vegetated places offer more opportunities for criminals and drug-dealers to hide. In rural areas, modern agricultural and housing development continues to put pressure on spaces where people can enjoy green exercise opportunities. There are many areas of policy reform that could help increase the uptake of green exercise activities, although it is clear that there is a need for more detailed and comprehensive economic analyses to indicate exactly what benefits green exercise can bring to these sectors.

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