Effects of Three Levels of Green Exercise, Physical and Social Environments, Personality Traits, Physical Activity, and Engagement with Nature on Emotions and Attention

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Abstract: The current study examined the effects of the three levels of green exercise on people’s psychological health using a randomized trial with a pretest and posttest design and further explored which variables of the physical environment (thermal comfort, noise, and air pollution), social environment (the number of companions and crowdedness), personality traits, physical activity (intensity and frequency), and engagement with nature may help explain experiences during the three levels of green exercise using a cross-sectional approach. Field studies were conducted to test the study’s hypotheses. The participants were 95 students from a technology university in Taiwan. The experiment comprised a 15-min green exercise in a park. No significant differences were found in emotions and attention between the three levels of green exercise. However, a 15-min green exercise of any level significantly improved emotions and attention. Furthermore, fatigue was significantly and negatively associated with daily transportation-related physical activity, agreeableness, and engagement with nature. Moreover, the total mood disturbance was significantly and negatively associated with engagement with nature and daily transportation-related physical activity. The degree of engagement with nature played a pivotal role in green exercise. This study provided the evidence that quantified engagement with nature is beneficial for quantified psychological health for the first time.

Keywords: Stress Reduction Theory; Attention Restoration Theory; the international physical activity questionnaire; the big five test; the profile of mood states; spatial span forward test; digit span backward test; actigraph; Intelligent Device for Energy Expenditure and Activity; social ecological perspective

1. Introduction

Globally, approximately 31% of adults lacked sufficient physical activity in 2008, around 3.2 million deaths each year are attributable to insufficient physical activity [1]. Moreover, three diseases that received the most attention globally are depression, cardiovascular disease, and AIDS in 2020. Among these, depression is the number one cause of human disability and number two cause of the overall burden of society. People in modern society certainly face increasingly serious challenges of physical and psychological health [2]. Research has shown that physical activity benefits not only physical health [3] but also psychological health [4]. The former certainly includes cardiovascular disease [5,6] and the latter particularly includes depression [7,8], as indicated by the results of meta-analyses. Studies have also shown that people engaging in physical activity require positive environmental stimulation to receive comprehensive benefits from their physical activity of choice [9]. For example, a laboratory study showed that sensory stimulation of visual, auditory, and olfactory of natural environments tended to improve emotions of participants conducting green exercise compared to sensory occlusion in terms of a reduction in tension, fatigue, and confusion and an increase in vigor [10]. Immersion in natural environments when taking physical activity is critical for people to receive benefits [11].
Two major theories explore the benefits of exposure to nature: The Stress Reduction Theory (SRT) [12] and the Attention Restoration Theory (ART) [13]. Both theories suggest that thousands of years of evolutionary processes taking place in nature has enabled mankind to respond adaptively to natural elements with beneficial responses [14]. SRT focuses on emotional and physiological recovery from arousal in response to stress [15], while ART emphasizes the benefits of exposure to nature on attention depleted by continuous use and is restored by temporarily not being used due to the ability of nature to fascinate humans [13]. In general, lack of attention decreases cognitive clarity and effective functioning, specifically which results in irritability, impulsiveness, impatience, reduced tolerance for frustration, and increased likelihood of taking risks [13,16–18]. ART sees humans as active and purposive restoration seekers, who take goal-directed behaviors to pursue restorative experiences, while SRT seems to emphasize more people’s direct, psycho-physiological responses to nature [19]. Though the focus of both theories is not on the physical activity, they provide theoretical foundations to explore the psychological health of physical activity taking in natural environments.

As such, “green exercise”, “a direct form of engagement that describes physical activity with a simultaneous exposure to nature” [20], may be a creative solution of the modern challenges of physical and psychological health. According to the degree of engagement with nature, green exercise can further be divided into the following three levels: (1) Viewing nature: This refers to people being visually involved with the environment, such as viewing it from a window or looking at “nature surrogates” (i.e., pictures, posters, and videos of nature); (2) being in the presence of nearby nature: This refers to people being accidentally or incidentally involved with the environment, but relatively passively because their primary interests are activities such as walking, cycling, and talking in a park, not nature itself; and (3) active participation and involvement with nature: This refers to people purposefully engaging with the environment, such as through gardening, farming, and camping [4,21]. Therefore, green exercise is easily practical in everyday life and does not necessarily require organized, planned, purposeful, special, and repetitive activities “out in the wild” to maintain or promote physical fitness, such as exercise or sports [22].

Current empirical research has largely focused on the first level of green exercise (viewing nature) [23]. Studies on the second level of green exercise (being in the presence of nearby nature) have primarily focused on walking or jogging [24,25]. As for studies focusing on the third level of green exercise (active participation and involvement with nature), emphasis has been placed on gardening activities, “nature experiences,” and “outward bound experiences.” Few studies have examined all three levels concurrently [26]. Only six studies [11,27–31] have been published on this subject, which compared only the effects of two levels of green exercise, but not all three. In brief, the second level of green exercise (being in the presence of nearby nature) was found to have more positive influences than did the first level of green exercise (viewing nature) in terms of energy [11,27] and relaxation [31]. The third level of green exercise (active participation and involvement with nature) was also found to have a greater effect of stress restoration than the first level of green exercise (viewing nature) [30]. Furthermore, research on green exercise has rarely considered the degree of engagement with nature or empirically examined its effects on people [26], even though the degree of engagement with nature is the criterion of the categorization of three levels of green exercise. Therefore, the first objective of the present study was to examine the effects of all three levels of green exercise on people’s psychological health to address the gap in the literature. Moreover, given that most studies have focused on the effects of engaging in the same activities in different environments, this study examined the effects on people’s psychological health when engaged in the three levels of green exercise in the same environment. The author was interested in the within-environment (i.e., the same environment) difference rather than the between-environment (i.e., different environment) difference. Specifically, this study explored whether and how different forms of physical activity in the same green space along with the three levels of engagement with nature affect emotions and attention [12,13].
In addition, scholars have suggested that weather should be considered when discussing green exercise [11], as well as noise and air quality [29], taking physical activity alone or with others [32], social interaction [33], duration and intensity of physical activities [34], and physical fitness [35]. As such, social ecologists have provided a comprehensive view of physical activity, arguing that physical activity is influenced by interactions among the physical environment, social environment, and the participants’ personality traits [36,37]. However, although green exercise is one type of physical activity, research on green exercise has not examined the influence of personality traits. Therefore, the second objective of this study was to address this gap in the literature by examining the influence of the physical environment, social environment, personality traits, physical activity, and particularly engagement with nature across all three levels of green exercise in the same environment, to explore which variables may help to explain people’s experiences during the three levels of green exercise. Specifically, the present study comprehensively examined the effects of thermal comfort, noise, and air pollution of the physical environment; the number of companions and crowdedness of the social environment; the personality traits of the participants; the intensity of the physical activities and the frequency of physical activities; and the degree of engagement with nature on emotions and attention during the three levels of green exercise. The investigated physical activities included the experimental green exercise as well as other physical activity performed in daily life. Nevertheless, to explore the mechanism of green exercise with respect to psychological health or the pathways of these various factors are beyond the scope of this study.

Based on the abovementioned objectives, this study proposed two hypotheses:

**Hypothesis 1 (H1).** Higher levels of green exercise have greater benefits to participants’ emotions and attention than lower levels of green exercise [11,27,30,31] and accordingly.

**Hypothesis 2 (H2).** The degree of engagement with nature has greater benefits for participants’ emotions and attention than does physical activity, physical and social environments, and personality traits [9,11].

However, these two directional hypotheses are arguable because no research has explored the effects of all of these factors simultaneously on participants’ psychological health. Given that this study explores the influence of the physical environment, social environment, physical activity, and personality traits on people’s psychological health, a literature review is provided below.

2. Physical Environment and Psychological Health

Environmental psychology often regards weather, noise, and air pollution as stressors in the physical environment [38,39]. Weather can affect people’s comfort in outdoor environments [40] as well as their satisfaction and recreational behaviors [41]. In general, weather changes people’s preference for natural environments [42,43]. Research on specific atmospheric conditions has shown that temperature, relative humidity, radiant temperature, wind speed, and thermal comfort affect people’s moods outdoors [28]. With the increasing awareness of the greenhouse effect, the thermal comfort of the outdoor environment has received increasing attention [44,45]. Research has also found that thermal comfort affects preferences, physiological responses, and attention [46]. Moreover, noise affects people’s emotions, mainly causing annoyance [39] and anger [47], general psychological processes such as attention and short-term memory [48], and even psychoneurotic disorders [49]. Air pollution also causes negative emotions [39] such as depression and mood disorder [50] and also influences attention [51]. The effects of particulate matter (PM) and ultrafine particulate matter on the brain and central nervous system have also received considerable attention in recent years [50]. Nevertheless, studies of the effects of outdoor thermal comfort [52,53] and recent exposure to air pollution [54,55] on psychological health remain inadequate.
3. Social Environment and Psychological Health

Crowdedness is often discussed in environmental psychology as a key stressor in the social environment [38,39]. Chen [56] defined a sense of crowdedness as having too much stimulation, too many restrictions on behavior, too much disliked social contact or interference, and inappropriate resources, all of which make people feel the high-density influence. People usually have negative emotions when in an overcrowded space, which affects their physical, cognitive, and behavioral responses [38]. Furthermore, an inverted u-shaped function between presence of people and perceived restorativeness has been found for urban parks. This suggests that having some people nearby is more beneficial for psychological health than a crowded space or an isolated space in the natural environment [57]. Human interaction in social environments also includes companions. Having companionship during activity can reduce a sense of isolation [58] and encourage a person to adhere to walking activities [59]. People generally experience greater enjoyment in outdoor group walks than when walking outdoors alone [60]. Three studies using self-report questionnaires investigated the intermediating relationships between social environment and green exercise with respect to psychological health. One study found that shortage of social support and loneliness partly mediated the relationship but not social cohesion or social contact [61]. The other found no such relationship in terms of social interaction, social cohesion, and loneliness [62]. Another found that social cohesion and loneliness mediated the relationship [63]. Given the inconsistent results and method bias of self-reports of these three studies [63], further explorations of the relationships between green exercise, social environment, and psychological health are needed.

4. Physical Activity and Psychological Health

The benefits of physical activity and exercise on psychological health include improving mood, anxiety, depression, self-perception, self-esteem, and cognitive functioning [4,33]. Meta-analyses further showed that exercise can be an effective healing treatment for depression [7,8] and is beneficial to cognitive functioning [64]. Attention is closely related to cognitive functioning particularly in terms of the ART [13]. Another meta-analysis further indicated that both during and following exercise, exercise-induced arousal improved cognitive performance such as speeded mental processing and enhanced memory storage and retrieval [65]. Moreover, a meta-analysis focusing on green exercise also showed that: (1) It significantly improved self-esteem and total mood disturbance (TMD), with a moderate effect size; (2) the improvements in self-esteem and mood, and the activity duration showed a u-shaped relationship; and (3) the relationship between the improvement in self-esteem and activity intensity showed a linearly negative correlation, whereas the improvement in mood and activity intensity showed a u-shaped relationship [66]. In addition to activity duration and intensity, the effects of green exercise on psychological health, particularly attention, of other factors of physical activity, such as physical fitness and activity frequency [35], have seldom been examined simultaneously.

5. Personality Traits, Physical Activity, and Psychological Health

Most researchers have argued that there is a significant correlation between the activity type that people engage in and their personality traits [67,68]. Extraversion was found to be positively correlated with exercise participation and regular exercise, and emotional stability was positively correlated with regular exercise [69]. It was found that those with greater personality traits of emotional stability, extraversion, openness to learning, agreeableness, cautiousness, and responsibility had greater motivation to exercise [70]. Meta-analyses also showed that: (1) Extraversion, conscientiousness, and openness all had a positive correlation with physical activity; (2) neuroticism had a negative correlation with physical activity [71,72]; (3) lower neuroticism and higher conscientiousness were correlated with more physical activity and with less physical inactivity and static behavior; and (4) extraversion and openness were correlated with more physical activity and less
physical inactivity. However, extraversion and openness are not related to most static behaviors such as watching television [73].

Individuals with some personality traits also tend to have a sense of belonging to the natural world. Studies showed that extraversion, agreeableness, conscientiousness, and openness were positively associated with the concept that nature and humanity are one, while neuroticism was negatively associated with that concept, as measured by various scales [74–76]. Specifically, openness was found to have the largest correlation with the Connectedness to Nature [74] and the Inclusion of Nature in Self [76]. Moreover, openness and agreeableness were found to have the largest and the second largest correlation, respectively, with the Nature Relatedness, Commitment to Nature, Connectedness to Nature, Connectivity with Nature, Emotional Affinity toward Nature, and Environmental Identity [75,76]. Therefore, people with the personality traits of extraversion, conscientiousness, openness, and agreeableness are more likely to take physical activity in natural environments.

Moreover, the relationship between personality traits and psychological health has long been hypothesized since the ancient Greece [77]. Meta-analyses showed that: In general, high levels of neuroticism and low levels of extraversion, conscientiousness, and agreeableness were positively related to mood disorders [78]; and, specifically, high neuroticism and low conscientiousness were positively related to depressive disorders [79]. Moreover, it was found that: (1) Extraversion and agreeableness were positively related to mental health [80] and optimism [81]; and (2) extraversion, agreeableness, and openness were positively related to vitality [82,83]. Nevertheless, personality traits, physical activity, and psychological health are seldom investigated simultaneously. Given that personality traits are related to both physical activity and psychological health, it is necessary to further examine which one has greater explanatory power for the psychological health effects of engaging in green exercise in the same natural environment.

6. Research Methods
6.1. Research Design

This study is part of a larger research project funded by a government agency. Although this research project involved human subjects, the funding agency did not require this research project to be submitted to the Institutional Review Board (IRB). Nevertheless, we (the author and research assistants) adhered to the Declaration of Helsinki on human research ethics revised in 1975, when conducting this study. H1 (differences in emotions and attention between three green exercise levels) was tested using a randomized trial with a pretest and posttest design in which each of the participants and his or her companions were randomly assigned to a real environment to engage in one of the three levels of green exercise as an experimental treatment. Thus, the unit of randomization was the individual participant. Given that we adopted a rigorous randomized trial to maintain the internal validity of this study, the participants were not allowed to choose their preferred activities of engagement with nature. H2 (greater effects of engagement with nature on emotions and attention than other factors) was further examined using a cross-sectional approach to collect additional data on the physical environment (thermal comfort, noise, and air pollution), the social environment (number of companions and crowdedness), and personality traits (Figure 1), which could not be controlled in this field study. The physical activity variables included activity intensity, limb activity, and activity frequency. The participants were not aware of their level of green exercise was designated. However, the research assistant was aware of the participant assignments and she also assessed the outcomes.
6.2. Experimental Procedure

Each participant’s experimental session lasted approximately 70 min, which included times for explaining the instructions, putting on physical activity instruments, reading and signing consent forms, completing questionnaires and scales (pretest), performing attention tests (pretest), calibrating instruments, taking the treatment, completing scales (posttest), performing attention tests (posttest), and removing the instruments, which were all conducted at the experimental environment (Figure 2). A research assistant was with the participants during the experimental procedures except for when the participants were taking the treatment. Before the official experiment, the research assistant had gone over the entire procedure three times with one male and two female volunteer students individual by individual to familiarize herself with the experiment. The same research assistant then conducted all experimental sessions to maintain the consistency of intervention and data collection, who also took photos and notes of the participants to make sure that each experimental condition was provided as planned.

**Figure 1.** Research structure.
### 6.3. Experimental Setting

The experimental environment was a forest park in Taichung, Taiwan, which spans 11.4 hectares. Overall, the park comprises 3.7 hectares of trees, which accounts for more than 30% of the total area. To ensure that the participants conducted the activities in the same location, a small area was assigned in the park as a common activity site for the experiment, which covered approximately 0.24 ha (56 × 67 × 15 × 80 m; Figures 3 and 4). The experiment was conducted from 2 December 2015 to 23 February 2016, 8 a.m. to 5 p.m., to fit the participants’ school schedules. The average temperature during this period was 20.50 °C (SD = 3.405).

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**Figure 2.** Timeline of the experimental procedure.

| Activity                                                                 | Duration |
|--------------------------------------------------------------------------|----------|
| Putting on Instruments (Actigraph, GPS watch, and IDEEA)                  | 13 min   |
| Filling in Questionnaires (informed consent and background information)  | 1 min    |
| Filling in Scales (The Big Five Test, IPAG, and POMS)                    | 10 min   |
| Taking Attention Test (SSF and DSB)                                      | 7 min    |
| Calibrating Instruments                                                  | 2 min    |
| Taking Experimental Treatment                                            | 15 min   |
| Filling in Scales (the degree of engagement with nature and POMS)        | 3 min    |
| Taking Attention Test (SSF and DSB)                                      | 7 min    |
| Filling in Questionnaire (physical condition and exercise frequency)     | 2 min    |
| Taking off Instruments                                                   | 10 min   |
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Figure 3. Aerial photograph of the experimental site.

Figure 4. Photographs of the experimental site at eye level, facing (a) east, (b) west, (c) south, and (d) north.

6.4. Experimental Treatment

The experimental treatment for each participant lasted 15 min for only one activity bout of one session, a time that was selected because studies have shown that one bout of 15-min green exercise is beneficial for physical and psychological health [11,84]. We randomly assigned each of the participants to one of three groups that corresponded to the three levels of green exercise based on a random number generator on the internet. That is, the interventions were administered individual by individual. The instruction given to the participants was that we would like to know their activity experience in the forest park. In the first-level group (viewing nature), participants were instructed to sit on a long chair and view the surrounding scenery. In the second-level group (being in the presence of nearby nature), participants were instructed to act freely (e.g., chatting, standing, walking, and jogging), but could not sit, lie, or rest. In the third-level group (active participation and involvement with nature), participants were instructed to collect at least seven natural elements that they considered special, such as stones, flowers, fruits, branches, leaves, and insects [26], similar to scavenging done by early humans [85]. Previous research
showed that this experimental treatment resulted in significant difference in the degree of engagement with nature and in the levels of physical activity between the three levels of green exercise [26]. These interventions did not cause important adverse events and/or side effects.

6.5. Participants and Companions

The participants were recruited from a technology university in Taiwan via flyers. For safety reasons and because this study explored the effects of physical activity on people in an outdoor environment, the inclusion criterion for participants was general good health. Exclusion criteria for participants were injuries, pain, asthma [60], or allergies (e.g., to sunlight, air pollution, and plants). We also encouraged the participants to invite their relatives and friends to accompany them. However, they could not bring their spouse or romantic partner [60]. This was because romantic relationships may have impacts on emotional and cognitive well-being [86]. The invited companions were not required to complete any questionnaire, wear any instrument, or provide any information. Given that the companions were at their own will to accompany the participants, the number of companions could not be controlled by this study. We recruited 101 Taiwanese college students as the participants, of which 95 (41 men and 54 women) were valid, with an average age of 20.47 years (standard deviation [SD] = 1.236), average height of 165.53 cm (SD = 8.805), average weight of 56.96 kg (SD = 11.391), and average body mass index of 20.67 (SD = 2.963). Furthermore, 39 participants were accompanied by between one and five companions.

In the end, 33 participants participated in the first-level activity (viewing nature), 13 of which brought companions; 31 participated in the second-level activity (being in the presence of nearby nature), 13 of which brought companions; and 31 participated in the third-level activity (active participation and involvement with nature), 13 of which brought companions. The results of statistical analyses showed no significant differences between the three participant groups in terms of college attended, years of study, with or without companions, companion types, age, height, weight, and body mass index, except for gender ($\chi^2 = 7.998$, $p = 0.018$, df = 2). Neither the participants nor their companions received compensation. Data from six participants were ruled invalid because their physical activity instruments recorded incomplete data. We did not exclude any participants, nor did we lose any of them during any stage of the experimental procedures. Since the participants attended only one activity bout of one session, their nonattendance days/rate was zero.

6.6. Research Variables and Measurements

The present study contained 2 major independent variables to examine H1 (differences in emotions and attention between three green exercise levels), 10 major predictor variables to examine H2 (greater effects of engagement with nature on emotions and attention than other factors), and 2 major dependent variables to examine both H1 and H2. A summary of these variables and their measurements is presented in Table 1.
Table 1. Research variables and measurements.

| Category                                      | Description                                                                 |
|-----------------------------------------------|-------------------------------------------------------------------------------|
| **Personality Traits (predictor variable)**   |                                                                                   |
| Personality characteristics                   | the self-reported Big Five Test (questionnaire)                                |
| **Social Environment (predictor variable)**   |                                                                                   |
| Number of companions                          | number of companions accompanying the participants in the green exercise (questionnaire) |
| Crowdedness                                    | the number of other people and vehicles during the green exercise (photo records) |
| **Physical Environment (predictor variable)** |                                                                                   |
| Thermal comfort                               | (physiologically equivalent temperature, PET; standard effective temperature, SET): environmental conditions (weather instruments: temperature, humidity, wind speed, and average radiant temperature); and human conditions (questionnaire: metabolic heat and clothing quantity) |
| Noise                                         | the mean value of environmental sound during green exercise (decibel meter)      |
| Air pollution                                 | SO$_2$, CO, O$_3$, PM$_{10}$, PM$_{2.5}$, NO$_X$, NO, and NO$_2$ (Air Quality Station) |
| **Daily Physical Activity (predictor variable)** |                                                                                   |
| Physical activity                             | self-reported Chinese version of the International Physical Activity Questionnaire (IPAQ), which assesses physical activity over the past 7 days (questionnaire) |
| Activity frequency                            | self-reported frequency of physical activity over the past 7 days (questionnaire) |
| **Experimental Treatment (independent and predictor variable)** |                                                                                   |
| Engagement with nature                        | self-reported degree of engagement with nature (questionnaire)                   |
| Physical activity                             | body movement speed (global positioning system watch, GPS), hand activity (MicroMini-Motionlogger Actigraph), limb activity, posture, posture change, gait, and energy expenditure (Intelligent Device for Energy Expenditure and Activity, IDEEA) |
| **Emotions and Attention (dependent variable)** |                                                                                   |
| Emotions                                      | the self-reported Profile of Mood States (POMS) and total mood disturbance (TMD) (questionnaire) |
| Attention                                     | spatial span forward (SSF) test and digit span backward (DSB) test              |

6.6.1. Three Levels of Green Exercise (Independent and Predictor Variable)

Engagement with nature refers to people’s external attention to [9] and involvement with nature in physical, psychological, and spiritual ways [26]. A questionnaire that included eight items (vision, hearing, smell, taste, touch, body and limbs, cognition, and spirituality) was used to measure the participants’ engagement with nature on a 7-point scale. A sample item is: To what extent was your interaction or engagement with nature in terms of vision. The higher the total score, the higher was the degree of engagement with nature [26].

In order to measure the physical activity during the experiment, we used a global positioning system (GPS) watch (Forerunner 405, Garmin, Taipei, ROC) worn on the participants’ nondominant hand to continually record their position, movement, and duration (4 Hz sample rate) of activity. The positioning accuracy was within 10 m. In combination with a geographic information system software (ArcGIS, Environmental Systems Research Institute, Redlands, CA, USA), we calculated the body movement speeds of the participants (total distance covered divided by time: m/s). In addition, we used a MicroMini-Motionlogger Actigraph watch (Ambulatory Monitoring Inc., Ardsley, NY, USA) with proportional integrating measure mode worn on the wrist of participants’ dominant hand to objectively record hand activity (16 Hz sample rate, 2–3 Hz bandwidth, no unit of measurement) [87]. The device has good reliability and validity [88,89]. By using an Intelligent Device for Energy Expenditure and Activity (IDEEA) 3 (MiniSun, Fresno, CA, USA), we continually measured participants’ limb activity (type %), posture (type %, m/m), posture change (number), gait (type %), and energy expenditure (kcal/m) during the experiment (64 Hz sample rate). The empirical results demonstrated that (1) the IDEEA accurately identified participants’ physical activity types with an accuracy of >98%. The correlation coefficient between estimated walking and running speeds and actual speed was 0.986 [90]. (2) The intraclass correlation reliability between the measured gait and force plate measurements was 0.784 (stride) and 0.998 (rhythm) [91]. (3) The IDEEA accurately estimated the energy consumed during physical activities, with an accuracy of more than 95% [92].
6.6.2. Personality Traits (Predictor Variable)

Personality traits refer to people’s unique characteristic patterns of thoughts, feelings, and behaviors [93], which we measured using the Chinese version of the Big Five Test. Huang [94] translated the Big Five Test, developed by John et al. [95], into Chinese. The Chinese version of the Big Five Test comprised of 44 questions on a 5-point scale, 16 of which were reverse items: The higher the score, the more apparent was the personality trait. Huang [94] also collected the data of 157 participants in Taiwan using a questionnaire to test the Chinese version of the Big Five Test. The results showed that it had good internal consistency reliability (Cronbach’s $\alpha = 0.75$), as did each personality trait dimension (Cronbach’s $\alpha = 0.80$ for extraversion, 0.71 for agreeableness, 0.78 for conscientiousness, 0.79 for neuroticism, and 0.77 for openness). Sample items include: I am an outgoing and sociable person; I like to cooperate with others; I make plans and follow through with them; I get nervous easily; and I am curious about many different things.

6.6.3. Social Environment (Predictor Variable)

Human interactions in social environments often include companions, who accompany individuals in their activities. We recorded the number of companions in the questionnaire. In addition, Manning et al. [96] suggested that research on the degree of crowdedness should be conducted using a visual method rather than the traditional method of asking respondents about the number of people they encounter. Therefore, panoramic photographs were taken every five minutes at the center of the experimental site to record the number of people and vehicles (i.e., cars, motorcycles, and bicycles). Thus, each participant had four sets of data on crowdedness from the beginning of the experiment to the end, whereas nonparticipants and vehicles were tallied only once.

6.6.4. Physical Environment (Predictor Variable)

Thermal comfort, which is defined as the condition of satisfaction provided by the thermal environment [97], comprises environmental conditions (temperature, relative humidity, wind speed, and average radiant temperature) and human conditions (metabolic heat and clothing quantity). This study followed Standard 55 of the American Society of Heating, Refrigerating and Air-Conditioning Engineers and Standard 7726 of the International Organization for Standardization [98] to measure the environmental conditions during the experiment using appropriate instruments (R.M. Young-41382 (measuring range: 0–100% sRH, accuracy at 23 °C: ±1% RH, response time: 10 s; calibrated measuring range: −50 to 50 °C, accuracy at 23 °C: ±0.3 °C, response time: 10 s), R.M. Young-03002 (wind speed range: 0–50 m/s, azimuth range: 360° mechanical, 352° electrical, wind speed accuracy: ±0.5 m/s, wind direction accuracy: ±5°, anemometer threshold: 1.1 m/s, vane threshold: 1.3 m/s), R.M. Young Company, Traverse City, MI, USA, and TRH-301 (range: 0–100% RH, 0–100 °C, accuracy: ±2% RH, ±0.3 °C, compensation: ±0.008% RH/°C, response time: <15 s), TECPEL Co. Ltd., New Taipei City, ROC) set up at the experimental site. We used questionnaires to survey the participants’ physical conditions (sex, height, weight, age, clothing, and physical activity) on site. Subsequently, we used RayMan software [99,100] to calculate two thermal comfort indices, physiologically equivalent temperature (PET) and standard effective temperature (SET).

In general, noise is unwanted sound. During the experiment, we measured the ambient sound volume in decibels (dBA) every five minutes at the center of the experimental site using a decibel meter (DT-805, (range: 30–130 dB, accuracy: ±1.4 dB, frequency: 31.5–8 kHz), SHENZHEN EVERBEST MACHINERY INDUSTRY CO., LTD., Shenzhen, China). Therefore, each participant had four items of data measured on noise from the start of the experiment to the end, and the mean value was then calculated.

Air pollutants are defined as substances in the air that directly or indirectly impair people’s health or environmental quality [101]. We adopted air quality data of the Taichung City Air Quality Station (Environmental Protection Administration, EPA) closest to the
experimental site. The data were collected hourly and included SO\textsubscript{2}, CO, O\textsubscript{3}, PM\textsubscript{10}, PM\textsubscript{2.5}, NO\textsubscript{x}, NO, and NO\textsubscript{2}.

6.6.5. Daily Physical Activity (Predictor Variable)

The physical activity of participants over the seven days before the experiment was measured using the Chinese version of the International Physical Activity Questionnaire (IPAQ), which features 27 questions that cover job, transport, housework, recreation, and sitting. The level of physical activity was calculated as frequency × time × metabolic equivalent per week. Liou [102] obtained approval of the World Health Organization (WHO) to translate the IPAQ into Chinese. A test found that: (1) The content validity index of the Chinese and English versions was more than 98%, (2) the internal rank correlation between the degree of similarity of the languages and meanings was 0.72–0.93, (3) the test-retest reliability was 0.78, and (4) the criterion validity with respect to the three-dimensional space accelerator was 0.31–0.52 [103]. Example questions included: Don’t count the walks you have mentioned about work and traffic. In the past seven days, how many days did you use walking as leisure or exercise, with each time lasting more than 10 min? When you use walking as leisure or exercise, how much time does this type of walking usually take up a day? Please consider again only those activities that lasted more than 10 min. In the past seven days, how many days did you do perform strenuous and moderately strenuous activities during your leisure time? How many hours do you usually spend a day doing strenuous and moderately strenuous leisure activities? Moreover, we used questionnaires to survey how many times the participants had engaged in physical activity in the seven days before the experiment. This was because extraversion was positively correlated with regular exercise, which was positively correlated with emotional stability [69].

6.6.6. Emotions (Dependent Variable)

Emotions are broadly defined as the feeling dimension of people [104], and in this study, they were measured using the Chinese version of the Profile of Mood States (POMS) both before and after the experimental treatment. Although moods last longer than emotions in general [105], mood states and emotions were viewed relatively equivalent in this study. Chang and Lu [106] used back translation to translate the POMS short form [107] into Chinese. The internal consistency reliability of the Chinese version was 0.71–0.93, and the total explained variance of validity was 65.56%. Moreover, exploratory factor analysis showed that it had good reliability and validity. Hsu et al. [108] then conducted confirmatory factor analysis to prove the construct validity of the Chinese version of the POMS, which included vitality, self-esteem, confusion, fatigue, anger, tension, and depression. Each question of the POMS was measured on a 5-point scale, and the higher the score, the stronger the emotion. Example questions included: Energetic, dignified, confused, fatigued, furious, nervous, and hopeless. In addition, we used TMD to assess the participants’ overall emotional state. We calculated the score from the sum of the five negative emotion scores in the Chinese version of the POMS, minus the scores of the two positive emotions, and added the constant 100 [109]. The higher the TMD score, the more disturbed, irritated, or disordered was each participant.

6.6.7. Attention (Dependent Variable)

Attention is the concentration of consciousness or the allocation of limited cognitive processing resources [110], which in this study was objectively measured using the spatial span forward (SSF) and digit span backward (DSB) tests from the Wechsler Memory Scale (third edition) both before and after the experimental treatment. The SSF is a visual memory span test conducted using a spatial memory span board, on which has 10 numbered small blocks. The research assistant touched blocks (from two to nine) in a specific order at a speed of approximately one second per block, and participants must then identify the blocks in the same order. When participants perform the DSB test, they must accurately reverse the order of the digital strings (from two to eight) dictated by the research assistant
and repeat them. The test was shown to have good reliability and validity [111]. Before the official test, participants were allowed two practice runs. Their attention was calculated as the maximum number of correct answers before two consecutive incorrect answers [112]. The higher the score, the greater was the participant’s attention.

6.7. Statistical Analysis

Statistical analyses were conducted using the PASW Statistics for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). The collected data did not have any missing values. Outliers were limited, only four for both fatigue pretest and posttest, two for tension pretest and three for tension posttest, four for both depression pretest and posttest, and one for both SSF pretest and posttest. Nevertheless, the analyses were by intent to treat. That is, all data were included for analyses after participant allocation. The estimate of treatment effect is generally conservative for intent to treat because of dilution due to noncompliant participants [113]. Appendix A Table A1 is the descriptive statistics and the distribution of the collected data. When the data did not meet the premises of statistical analyses, such as normality, homogeneity, sphericity, or covariance matrix, they were transformed [98].

H1, Higher levels of green exercise have greater benefits to participants’ emotions and attention than lower levels of green exercise, was examined using multivariate analysis of variance (MANOVA). MANOVA was used because it is a statistical test of more than one dependent variable based on their optimal linear combination [98]. That is, MANOVA can simultaneously consider the relationship of all dependent variables to examine whether a significant difference exists in the experimental treatment, and then, analyze whether the experimental treatment has significant differences in terms of individual dependent variables. Further, the observed power of the MANOVA was reported. The Bonferroni correction was used for post hoc pair comparisons because there were three levels of green exercise as the experimental treatment in consideration of the experiment-wise error-rate.

H2, the degree of engagement with nature has greater benefits for participants’ emotions and attention than does physical activity, physical and social environments, and personality traits, was examined using multiple linear regression analyses. Nevertheless, predictor variables that are highly correlated with others must be excluded to prevent collinearity and to fit the premises of the regression models [114]. Moreover, given that the a priori power for the determined sample size for the regression analyses is dependent on the number of the predictors, which should consider the collinearity problem, this study calculated the post hoc power using the predictors without the collinearity using the G*Power 3.1.9.2 program (Heinrich-Heine-Universität, Düsseldorf, Germany).

7. Results

7.1. Scale Reliability

We conducted internal consistency reliability analyses for the Big Five Test, IPAQ, POMS (both pretest and posttest), and the degree of engagement with nature. The results showed that (1) the Big Five Test had relatively acceptable reliability (Cronbach’s $\alpha = 0.65$), (2) the IPAQ had less than ideal reliability (Cronbach’s $\alpha = 0.574$), (3) the POMS had good reliability for the pretest and posttest (Cronbach’s $\alpha = 0.929$ and 0.880, respectively), and (4) the degree of engagement with nature had good reliability (Cronbach’s $\alpha = 0.765$) [115]. Since the internal consistency reliability of these scales was not very low, the data of these scales were not removed from the analysis.

7.2. Hypothesis 1 (Differences in Emotions and Attention between Three Green Exercise Levels)

We set the SSF, DSB, seven emotions in the POMS, and TMD as dependent variables; the levels of green exercise as an independent variable and independent factor; and the test time (pretest and posttest) as independent variables and a dependent factor (repeated measures) to conduct a two-way mixed-design MANOVA. The results of the MANOVA showed the following: (1) The interaction between green exercise levels and test time reached significance only in the SSF test and entailed a moderate effect size ($F_{(2,89)} = 3.700, p = 0.029$,
η_p² = 0.077); the 95% confidence interval (CI) for the difference did not include 0. Follow-up tests showed that for the second-level green exercise (being in the presence of nearby nature), the SSF posttest (M = 9.323) was significantly greater than the pretest (M = 8.774) with an observed power of 0.554, and the 95% CI for the difference did not include 0, whereas for the third-level green exercise (active participation and involvement with nature), the SSF posttest (M = 10.000) was also significantly greater than the pretest (M = 8.452) with an observed power of 0.975, and the 95% CI for the difference did not include 0. (2) The main effects of green exercise levels were nonsignificant (F(2, 89) ≤ 1.482, p ≥ 0.233, η_p² ≤ 0.032).

(3) The main effects of test time for SSF, vitality, confusion, fatigue, anger, tension, depression, and TMD all reached significance (F(1, 89) ≥ 5.704, p ≤ 0.019, η_p² ≥ 0.060) with observed powers at least greater than 0.656 and entailed at least a moderate effect size. Moreover, none of the 95% CIs for the difference included 0, and all posttests were greater than the pretests (Table 2; Appendix A Table A2).

Table 2. Summarized results of the two-way mixed-design multivariate analysis of variance.

| Effect Variable | F  | P   | η_p² | Observed Power | Mean (SD) | Mean Diff. | 95% Conf. Int. for the Diff. | Post hoc |
|-----------------|----|-----|------|----------------|-----------|------------|-----------------------------|----------|
| Treatment       |    |     |      |                |           |            |                             |          |
| Interaction     | 3.700 | 0.029 | 0.077 | 0.666 |            |           | Pre-Post −1.037 | 0.491   |
| L1              | 0.529 | 0.472 | 0.016 | 0.109 |            |           | Pre-Post −1.066 | −0.031  | Post > Pre |
| L2              | 4.686 | 0.038 | 0.135 | 0.554 |            |           | Pre-Post −2.328 | −0.768  | Post > Pre |
| L3              | 16.434 | 0.000 | 0.354 | 0.975 |            |           | Pre-Post −2.331 | −0.423  | Post > Pre |
| SSF Interaction | 16.521 | 0.000 | 0.157 | 0.980 |            |           | Pre-Post −1.231 | −0.423  | Post > Pre |
| Vigour          | 5.704 | 0.019 | 0.060 | 0.656 |            |           | Pre-Post −1.905 | −0.175  | Post > Pre |
| Confusion       | 65.739 | 0.000 | 0.425 | 1.000 |            |           | Pre-Post 3.102 | 5.116   | Pre > Post |
| Fatigue         | 62.562 | 0.000 | 0.413 | 1.000 |            |           | Pre-Post 2.996 | 4.957   | Pre > Post |
| Anger           | 3.615 | 0.000 | 0.256 | 1.000 |            |           | Pre-Post 0.919 | 1.949   | Pre > Post |
| Anxiety         | 68.100 | 0.000 | 0.433 | 1.000 |            |           | Pre-Post 1.457 | 2.381   | Pre > Post |
| Depression      | 16.616 | 0.000 | 0.157 | 0.981 |            |           | Pre-Post 0.368 | 1.069   | Pre > Post |
| TMD             | 79.864 | 0.000 | 0.473 | 1.000 |            |           | Pre-Post 10.334 | 16.243  | Pre > Post |

* Treatment L1 denotes Level 1 Green Exercise, L2 denotes Level 2 Green Exercise, and L3 denotes Level 3 Green Exercise. The significant results from the follow-up tests of the ANOVAs used a family-wise error rate of 0.05/10 = 0.005. *, *** in interaction denotes significance levels at 0.05, and 0.001, respectively.

7.3. Hypothesis 2 (Greater Effects of Engagement with Nature on Emotions and Attention Than Other Factors)

The predictor variables with collinearity were eliminated [114]. As a result, 23 predictor variables (the Big Five Test, IPAQ, the degree of engagement with nature, number of companions, activity frequency, MicroMini-Motionlogger Actigraph hand activity,
IDEEA all posture speed, IDEEA numbers for ascending and descending stairs, crowd- 
edness in terms of the number of vehicles, noise, O$_3$, SO$_2$, and two dummy variables for the three green exercise levels) were appropriate for conducting multiple linear regression analyses without collinearity. Next, we used the changed values (posttest values minus pretest values) of the SSF, DSB, TMD, and the seven emotions of the POMS as dependent variables to conduct multiple linear regression analyses. The results showed that: (1) Fatigue reached significance ($F_{(21,73)} = 1.761$, $p = 0.040$, $R^2 = 0.336$, $R^2$ Adjusted = 0.145) with a post hoc power of 0.981, the significant predictor variables were transportation-related physical activity (beta = −0.337, $t(94) = −2.96$, $p = 0.004$), agreeableness (beta = −0.234, $t(94) = −2.186$, $p = 0.032$), and the degree of engagement with nature (beta = −0.227, $t(94) = −2.126$, $p = 0.037$; Table 3; Appendix A Table A3). (2) The TMD reached significance ($F_{(21,73)} = 1.769$, $p = 0.039$, $R^2 = 0.337$, $R^2$ Adjusted = 0.147) with a post hoc power of 0.982; the significant predictor variables were the degree of engagement with nature (beta = −0.319, $t(94) = −2.994$, $p = 0.004$) and transportation-related physical activity (beta = −0.265, $t(94) = −2.332$, $p = 0.022$; Table 3; Appendix A Table A4).

Table 3. Results of multiple linear regressions (only significant relationships are shown).

| Predictor                      | Depend Variable: Fatigue |                |                |                | Depend Variable: TMD |                |                |
|--------------------------------|--------------------------|----------------|----------------|----------------|----------------------|----------------|----------------|
|                                | R (SE)                   | Beta           | $t$            | $p$            | R (SE)               | Beta           | $t$            | $p$            |
| Constant                       | 17.439 (14.95)           | 1.166          | 0.247          | 0.247          | 59.820 (44.039)      | 1.358          | 0.179          |
| Transportation-related physical activity | −0.046 (0.016)           | −0.337         | −2.96          | 0.004 **       | −0.107 (0.046)       | −0.265         | −2.332         | 0.022 *        |
| Engagement with nature         | −0.149 (0.070)           | −0.227         | −2.126         | 0.037 *        | −0.617 (0.206)       | −0.319         | −2.994         | 0.004 **        |
| Agreeableness                  | −0.348 (0.159)           | −0.234         | −2.186         | 0.032 *        |                      |                |                |                |

$F$, $**$ in interaction denotes significance levels of 0.05 and 0.01$^\circ$.

8. Discussion

The results did not support H1, which stated that higher levels of green exercise would have greater benefits to participants’ emotions and attention than would lower levels. Six studies have compared the effects of two levels of green exercise, with most finding varying effects between different environments [11,27,28,30,31]. However, no differences were found in terms of the effects within similar environments [11]. Therefore, future studies should examine whether different environments (i.e., between-environment difference), different levels of green exercise (i.e., within-environment difference), or the interaction between environments and green exercise levels have greater effects on people. Moreover, the classification of environments should not be limited to the dichotomy of natural and manmade environments [84]. More crucially, the present study found that regardless of the level of green exercise participants engaged in, as little as 15 min was beneficial for improving their emotions, such as vitality, confusion, fatigue, anger, tension, depression, and total mood disturbance, and attention in terms of spatial span forward test. This result is consistent with both other empirical research findings [11,28,84] and SRT [12] and ART [13]. This result demonstrates the importance of green exercise for psychological health, particularly with respect to its convenient practicality in daily life.

The results partially supported H2, which stated that the degree of engagement with nature would have greater benefits for participants’ emotions and attention than physical activity, physical and social environments, and personality traits. Fatigue was significantly and negatively associated with transportation-related physical activity, agreeableness, and the degree of engagement with nature (in a descending order) and the TMD was significantly and negatively associated with the degree of engagement with nature and
transportation-related physical activity (in a descending order). Therefore, when people engage in green exercise, the more direct and profound the interaction with nature is, the more likely it is to reduce negative emotions. This is the first time that empirical research has directly shown that quantified engagement with nature is beneficial for quantified psychological health (decreased fatigue and total mood disturbance). Furthermore, this is consistent with previous findings in that environmentally oriented activities [116], positive environmental stimuli [9], and immersion in natural environments [11] are crucial for people to receive benefits from physical activity. Therefore, green exercise should be considered a method of locking people’s physical activities and environments into an ongoing positive relationship [117]. Furthermore, engagement with nature appears to be the key to integrating people’s physical activities and environments.

H2 (greater effects of engagement with nature on emotions and attention than other factors) failed to find significant results related to attention. This may be because attention was measured by SSF and DSB, which are focused on working memory [112]. There is a broad consensus that attention and working memory are closely linked [118]. However, a recent systematic review study of ART indicated no current agreements on what constitutes a measurement of attention as proposed by the ART. Therefore, an optimal testing protocol of attention, in the view of the ART, should include working memory as measured by SSF and DSB [112], cognitive flexibility as measured by the Trail Making Test B [119], and alerting, orienting, and executive control as measured by the Attention Network Task [120]. Therefore, future research on the ART may need to apply a set of tests to measure attention [121].

H1 (Higher levels of green exercise have greater benefits to participants’ emotions and attention than lower levels of green exercise) and H2 (The degree of engagement with nature has greater benefits for participants’ emotions and attention than does physical activity, physical and social environments, and personality traits) appeared to be similar. However, H1 focused on examining the effect of the experimental treatment of the three green exercise levels operationalized simultaneously by not only types of physical activity but also levels of engagement with nature. This research found no significant differences between the three green exercise levels. By contrast, H2 focused on further exploring the effect of the physical environment, social environment, personality traits, physical activity, engagement with nature, and the three green exercise levels, respectively. This research found engagement with nature played an important role. While the results of the examinations of H1 and H2 appeared to be at odds at first, they were in agreement that the three green exercise levels as the dependent variable did not influence emotions and attention as indicated by MANOVAs and the three green exercise levels as the predictor variables were not significantly related to emotions and attention as indicated by multiple linear regressions. Therefore, engagement with nature may be more influential than the three green exercise levels. Alternatively, the types of physical activity used to operationalize the three green exercise levels may be too limited. For example, the first-level green exercise of viewing nature is not necessarily limited to sitting, standing still, or lying down. Additionally, the second-level green exercise of being in the presence of nearby nature can have various levels of physical activity, such as walking and jogging, which were found to have different effects on emotions and attention [84]. Future research on green exercise should further investigate the influence of physical activity and engagement with nature on people. The framework of green exercise proposed by Han and Wang [26], which includes the dimensions of the natural environment, physical activities, and engagement with nature, may serve as a guidance to further investigate the main effect of each dimension and the interactions of these three dimensions on people.

Surprisingly, physical activity related to transportation rather than physical activity in green exercise was associated with the reduction in negative emotions. The WHO [122] recommends at least 150 min of accumulated moderate-intensity physical activity each week, including leisure, occupation, transportation, household chores, play, games, sports, and planned exercise. Therefore, physical activity related to transportation possibly played
a pertinent role in relieving the negative emotions of participants in this study because they were college students who had engaged in little occupation, household chores, play, games, sports, or planned exercise. The means (and SDs in parentheses) for job, transportation, housework, recreation, and sitting in the IPAQ were 13.61 (46.37), 21.38 (36.02), 17.44 (107.73), 24.73 (37.97), and 17.07 (8.59), respectively. The physical activity level of transportation was the second highest and that of recreation was the highest. Nevertheless, given that the reliability of the Chinese version of the IPAQ was less than ideal (Cronbach’s $\alpha = 0.574$), the results in this study require replicating and may not be generalizable to other participant groups or regions.

Agreeableness refers to the degree to which a person is polite, trustworthy, friendly, and easy to communicate with [123]. A study found that agreeableness had a significant and negative correlation with burnout [124]. Another study found that agreeableness had a significant and negative correlation with fatigue but a significant and positive correlation with emotional stability [125]. Moreover, some researchers claimed that agreeable people have relatively high effortful control and are less likely to be influenced by mood-disordered outcomes [126]. However, because the abovementioned three studies were not focused on the relationships between agreeableness and emotions when performing green exercise, future studies may extend the focus from the effects of agreeableness in an interpersonal context to those of agreeableness in terms of the interaction between people and the environment.

The present study examined the effects on people engaged in three levels of green exercise in the same natural environment. The variance among the stressors in the environment, such as thermal comfort (PET: $M = 22.96^\circ C$, SD = 6.932; SET: $M = 14.760$, SD = 5.562), noise ($M = 47.83$ dBA, SD = 2.397), and degree of crowdedness ($M = 48.053$, SD = 20.746), may not be large enough to reveal their influence. Moreover, PET around $22^\circ C$ is regarded as slightly cool for the people in Taiwan [127] and 47 dBA is much lower than the standard (60 dBA) proposed by the Noise Control Act [128]. Different environments may have greater variances. Additionally, the air pollution was based on hourly data from an air quality station approximately eight km from the experimental site. Future studies should consider using on-site instruments to measure real-time air quality. Moreover, some scholar may argue that companions could confound the experimental treatment of the participants’ the degree of engagement with the natural environment. A previous study showed that both the interaction between the three-level green exercise and the presence of companions on engagement with nature and the main effect of the presence of companions on engagement with nature were not significant [26]. Although this study is the first to examine the effect of the number of companions on psychological health when engaging in green exercise without a dichotomy (i.e., the presence or absence of companions) [60,129,130], the variance in the number of companions was small ($M = 0.611$, SD = 0.96). Furthermore, the quality of such accompanying relationships should be considered in future studies, such as emotional support [39].

9. Conclusions

Engaging in 15 min of green exercise of any level improved participants’ emotions and attention. Therefore, people can easily choose viewing nature, being in the presence of nearby nature, or active participation and involvement with nature according to their convenience or physical ability in everyday life to enhance their psychological health. Policymakers, government officials, environmental planners and designers, and the general public should not only prevent the existing natural environments from destruction but also create more natural settings to allow people having more opportunities of viewing nature, being nearby nature, or active involvement with nature. Nonetheless, it should be noted that plants are generally regarded as a representation of nature [131,132]. Having plants nearby indoors or outdoors is certainly feasible. Plants can provide people many sensory stimulations, such as visual, olfactory, tactile, taste, and even auditory.
Moreover, the degree of engagement with nature played a pivotal role in green exercise. Engagement with nature is likely the crucial element of green exercise, which integrates people’s physical activities and environments into an ongoing positive relationship [117]. Studies on green exercise should consider the framework of green exercise proposed by Han and Wang [26] to further examine the effects of natural environment, physical activities, and engagement with nature on people. Moreover, a comprehensive view of the social ecology should be adopted to explore physical activity, which is an interaction among the physical environment, social environment, and participants’ personality traits [36,37], which may prove both useful and productive for green exercise to meet the increasingly serious challenge of physical and psychological health of the modern society [2].

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data are available on request from the corresponding author.

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**Appendix A**

### Table A1. Descriptive statistics and distribution of the collected data.

| Variable                              | Number | Min. | Max. | Mean  | S.D.  | Skewness | Kurtosis |
|---------------------------------------|--------|------|------|-------|-------|----------|----------|
| **Physiologically Equivalent Temperature** |        |      |      |       |       |          |          |
| Overall                              | 95     | 5.3  | 35.9 | 22.096| 6.932 | −0.117   | −0.34    |
| Level 1                              | 33     | 10.7 | 34.8 | 23.279| 6.137 | 0.208    | −0.594   |
| Level 2                              | 31     | 5.3  | 35.4 | 19.958| 7.64  | 0.162    | −0.514   |
| Level 3                              | 31     | 8    | 35.9 | 22.974| 6.706 | −0.406   | 0.342    |
| **Standard Effective Temperature**    |        |      |      |       |       |          |          |
| Overall                              | 95     | 2.8  | 26.2 | 14.76 | 5.565 | −0.092   | −0.78    |
| Level 1                              | 33     | 8.1  | 26.2 | 16.258| 4.774 | 0.321    | −0.622   |
| Level 2                              | 31     | 2.8  | 22.6 | 12.597| 6.261 | 0.161    | −1.267   |
| Level 3                              | 31     | 6.3  | 23.9 | 15.329| 5.09  | −0.107   | −0.862   |
| **Noise (dB)**                       |        |      |      |       |       |          |          |
| Overall                              | 95     | 44.13| 56.33| 47.83 | 2.397 | 0.8      | 0.595    |
| Level 1                              | 33     | 44.53| 56.33| 47.445| 2.602 | 1.509    | 3.037    |
| Level 2                              | 31     | 44.4 | 52.4 | 48.21 | 1.998 | 0.618    | −0.207   |
| Level 3                              | 31     | 44.13| 52.65| 47.86 | 2.544 | 0.373    | −0.878   |
| **Crowdedness -People**               |        |      |      |       |       |          |          |
| Overall                              | 95     | 22   | 412  | 114.737| 82.604| 1.627    | 2.17     |
| Level 1                              | 33     | 22   | 412  | 93.636| 74.833| 2.826    | 9.869    |
| Level 2                              | 31     | 42   | 344  | 128.774| 77.69 | 1.325    | 1.2      |
| Level 3                              | 31     | 30   | 346  | 123.161| 92.758| 1.284    | 0.454    |
| **Crowdedness -Automobile**          |        |      |      |       |       |          |          |
| Overall                              | 95     | 12   | 101  | 38.789| 17.367| 1.556    | 3.283    |
| Level 1                              | 33     | 13   | 94   | 40.121| 17.92 | 1.115    | 1.53     |
| Level 2                              | 31     | 14   | 87   | 37.129| 15.022| 1.31     | 3.231    |
| Level 3                              | 31     | 12   | 101  | 39.032| 19.288| 2.071    | 5.193    |
| **Crowdedness -Motorcycle**          |        |      |      |       |       |          |          |
| Overall                              | 95     | 0    | 27   | 5.295 | 5.345 | 1.48     | 2.356    |
| Level 1                              | 33     | 0    | 11   | 3.848 | 3.318 | 0.562    | −0.714   |
| Level 2                              | 31     | 0    | 27   | 5.226 | 6.344 | 1.928    | 3.945    |
| Level 3                              | 31     | 0    | 18   | 6.903 | 5.706 | 0.653    | −0.995   |
| Variable | Number | Min. | Max. | Mean | S.D. | Skewness | Kurtosis |
|----------|--------|------|------|------|------|----------|----------|
| **Crowdedness – Bicycle** | | | | | | | |
| Overall | 95 | 0 | 22 | 3.968 | 3.802 | 1.58 | 4.354 |
| Level 1 | 33 | 0 | 11 | 4.03 | 3.206 | 0.564 | −0.531 |
| Level 2 | 31 | 0 | 14 | 4.258 | 3.898 | 0.781 | −0.094 |
| Level 3 | 31 | 0 | 22 | 3.613 | 4.349 | 2.722 | 10.096 |
| **Crowdedness – Totalvehicle** | | | | | | | |
| Overall | 95 | 13 | 137 | 48.053 | 20.764 | 1.852 | 4.971 |
| Level 1 | 33 | 22 | 113 | 48 | 19.349 | 1.437 | 3.098 |
| Level 2 | 31 | 22 | 103 | 46.613 | 18.759 | 1.56 | 3.445 |
| Level 3 | 31 | 13 | 137 | 49.548 | 24.397 | 2.187 | 6.321 |
| **SO₂ (ppb)** | | | | | | | |
| Overall | 95 | 0.1 | 8.9 | 3.133 | 1.902 | 0.626 | 0.051 |
| Level 1 | 33 | 0.2 | 6.6 | 2.774 | 1.728 | 0.516 | −0.259 |
| Level 2 | 31 | 0.2 | 7.9 | 3.245 | 1.931 | 0.59 | 0.021 |
| Level 3 | 31 | 0.1 | 8.9 | 3.387 | 2.043 | 0.671 | 0.21 |
| **CO (ppm)** | | | | | | | |
| Overall | 95 | 0.3 | 1.5 | 0.671 | 0.29 | 1.335 | 0.952 |
| Level 1 | 33 | 0.33 | 1.4 | 0.646 | 0.256 | 1.595 | 2.415 |
| Level 2 | 31 | 0.3 | 1.5 | 0.658 | 0.288 | 1.322 | 1.379 |
| Level 3 | 31 | 0.4 | 1.47 | 0.707 | 0.327 | 1.193 | 0.165 |
| **NOₓ (ppb)** | | | | | | | |
| Overall | 95 | 13 | 93 | 31.495 | 16.892 | 1.627 | 2.331 |
| Level 1 | 33 | 13 | 73 | 27.742 | 14.276 | 1.594 | 2.496 |
| Level 2 | 31 | 14 | 93 | 32.207 | 19.531 | 1.908 | 3.553 |
| Level 3 | 31 | 18 | 71 | 34.581 | 16.472 | 1.282 | 0.272 |
| **NO (ppb)** | | | | | | | |
| Overall | 95 | 1.8 | 61 | 8.615 | 11.138 | 2.936 | 9.023 |
| Level 1 | 33 | 1.8 | 48 | 6.916 | 9.378 | 3.584 | 13.503 |
| Level 2 | 31 | 2 | 61 | 10.055 | 14.041 | 2.979 | 8.642 |
| Level 3 | 31 | 2.1 | 35 | 8.968 | 9.752 | 1.761 | 1.761 |
| **NO₂ (ppb)** | | | | | | | |
| Overall | 95 | 11 | 45 | 22.857 | 8.298 | 0.686 | −0.223 |
| Level 1 | 33 | 11 | 45 | 20.806 | 8.248 | 1.042 | 0.837 |
| Level 2 | 31 | 11 | 40 | 22.172 | 7.824 | 0.442 | −0.654 |
| Level 3 | 31 | 14 | 45 | 25.548 | 8.314 | 0.718 | −0.559 |
| **PM₁₀ (µg/m³)** | | | | | | | |
| Overall | 95 | 1.7 | 165 | 54.148 | 38.25 | 1.181 | 1.134 |
| Level 1 | 33 | 16 | 165 | 62.276 | 44.314 | 0.88 | −0.002 |
| Level 2 | 31 | 5 | 118 | 46.036 | 25.499 | 0.46 | 1.116 |
| Level 3 | 31 | 1.7 | 159 | 53.852 | 41.43 | 1.31 | 1.185 |
| **PM₂.₅ (µg/m³)** | | | | | | | |
| Overall | 95 | 2 | 80 | 29.047 | 18.44 | 0.942 | 0.126 |
| Level 1 | 33 | 2 | 72 | 30.621 | 20.754 | 0.763 | −0.638 |
| Level 2 | 31 | 3 | 58 | 25.799 | 14.129 | 0.565 | 0.014 |
| Level 3 | 31 | 7 | 80 | 30.821 | 19.98 | 1.063 | 0.234 |
| **O₃ (ppb)** | | | | | | | |
| Overall | 95 | 2.2 | 52 | 25.947 | 12.955 | −0.006 | −0.699 |
| Level 1 | 33 | 2.4 | 49 | 28.648 | 15.058 | −0.467 | −1.105 |
| Level 2 | 31 | 2.2 | 50 | 25.159 | 10.997 | −0.098 | 0.211 |
| Level 3 | 31 | 2.2 | 52 | 23.984 | 12.318 | 0.503 | 0.179 |
### Table A1. Cont.

| Variable                  | Number | Min. | Max. | Mean  | S.D.  | Skewness | Kurtosis |
|---------------------------|--------|------|------|-------|-------|----------|----------|
| **Movement Speed**        |        |      |      |       |       |          |          |
| (m/s)                     |        |      |      |       |       |          |          |
| Overall                   | 95     | 0.002| 1.446| 0.274 | 0.225 | 1.907    | 7.203    |
| Level 1                   | 33     | 0.002| 0.183| 0.068 | 0.037 | 1.283    | 2.817    |
| Level 2                   | 31     | 0.094| 1.446| 0.407 | 0.265 | 2.375    | 7.61     |
| Level 3                   | 31     | 0.174| 0.706| 0.362 | 0.119 | 0.874    | 1.137    |
| **Exercise Frequency**    |        |      |      |       |       |          |          |
|                          |        |      |      |       |       |          |          |
| Overall                   | 95     | 0    | 7    | 1.305 | 1.337 | 1.464    | 3.07     |
| Level 1                   | 33     | 0    | 4    | 1.182 | 1.185 | 0.947    | 0.193    |
| Level 2                   | 31     | 0    | 5    | 1.129 | 1.204 | 1.452    | 2.78     |
| Level 3                   | 31     | 0    | 7    | 1.613 | 1.585 | 1.551    | 3.438    |
| **Total Mood Disturbance**|        |      |      |       |       |          |          |
| – Pretest                 |        |      |      |       |       |          |          |
| Overall                   | 95     | 69   | 152  | 100.221 | 17.887 | 0.389 | −0.237 |
| Level 1                   | 33     | 70   | 131  | 99.758 | 15.379 | 0.026 | −0.473 |
| Level 2                   | 31     | 69   | 143  | 99.968 | 19.305 | 0.479 | −0.345 |
| Level 3                   | 31     | 73   | 152  | 100.968 | 19.386 | 0.484 | −0.102 |
| **Total Mood Disturbance**|        |      |      |       |       |          |          |
| – Posttest                |        |      |      |       |       |          |          |
| Overall                   | 95     | 60   | 137  | 87.484 | 14.923 | 0.604 | 0.176  |
| Level 1                   | 33     | 67   | 107  | 88.121 | 11.578 | −0.142 | −1.05   |
| Level 2                   | 31     | 66   | 137  | 88.032 | 17.678 | 0.678 | 0.195  |
| Level 3                   | 31     | 60   | 124  | 86.258 | 15.492 | 0.853 | 0.166  |
| **The Big Five – Extraversion** |    |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 16   | 37   | 25.705 | 4.199  | 0.321  | −0.169 |
| Level 1                   | 33     | 20   | 37   | 26.636 | 4.084  | 0.461  | −0.255 |
| Level 2                   | 31     | 16   | 33   | 24.645 | 4.071  | −0.014 | 0.036  |
| Level 3                   | 31     | 19   | 35   | 25.774 | 4.334  | 0.55   | −0.437 |
| **The Big Five – Agreeableness** |    |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 26   | 42   | 31.621 | 3.304  | 0.458  | 0.224  |
| Level 1                   | 33     | 26   | 42   | 31.273 | 3.859  | 0.842  | 0.585  |
| Level 2                   | 31     | 27   | 36   | 30.774 | 2.918  | 0.273  | −1.389 |
| Level 3                   | 31     | 27   | 41   | 32.839 | 2.721  | 0.309  | 1.816  |
| **The Big Five – Conscientiousness** |    |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 20   | 34   | 27.684 | 3.068  | −0.119 | −0.343 |
| Level 1                   | 33     | 20   | 34   | 27.424 | 3.527  | −0.189 | −0.467 |
| Level 2                   | 31     | 22   | 33   | 27.839 | 2.841  | 0.007  | −0.616 |
| Level 3                   | 31     | 22   | 34   | 27.806 | 2.833  | 0.06   | −0.14  |
| **The Big Five – Neuroticism** |    |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 17   | 29   | 24.221 | 2.799  | −0.363 | −0.314 |
| Level 1                   | 33     | 18   | 29   | 23.939 | 2.957  | −0.338 | −0.467 |
| Level 2                   | 31     | 18   | 29   | 24.806 | 2.272  | −0.711 | 1.481  |
| Level 3                   | 31     | 17   | 29   | 23.935 | 3.087  | −0.037 | −0.728 |
| **The Big Five – Openness** |    |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 23   | 46   | 33.947 | 4.234  | 0.055  | 0.162  |
| Level 1                   | 33     | 25   | 41   | 33.606 | 4.286  | −0.231 | −0.79  |
| Level 2                   | 31     | 27   | 44   | 33.581 | 4.089  | 0.305  | −0.119 |
| Level 3                   | 31     | 23   | 46   | 34.677 | 4.362  | 0.105  | 1.692  |
| **Companion**             |        |      |      |       |       |          |          |
|                           |        |      |      |       |       |          |          |
| Overall                   | 95     | 0    | 5    | 0.611  | 0.96   | 2.407  | 7.82    |
| Level 1                   | 33     | 0    | 5    | 0.697  | 1.262  | 2.602  | 7.043   |
| Level 2                   | 31     | 0    | 3    | 0.581  | 0.807  | 1.347  | 1.351   |
| Level 3                   | 31     | 0    | 2    | 0.548  | 0.723  | 0.952  | −0.378  |
| Variable                        | Number | Min. | Max. | Mean    | S.D.   | Skewness | Kurtosis |
|--------------------------------|--------|------|------|---------|--------|----------|----------|
| **Spatial Span Forward**       |        |      |      |         |        |          |          |
| Overall                        | 95     | 5    | 13   | 8.589   | 1.653  | −0.197   | −0.064   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 5    | 13   | 8.545   | 1.872  | −0.228   | 0.172    |
| Level 2                        | 31     | 6    | 12   | 8.774   | 1.586  | −0.246   | −0.51    |
| Level 3                        | 31     | 6    | 12   | 8.452   | 1.502  | −0.09    | −0.018   |
| **Spatial Span Forward**       |        |      |      |         |        |          |          |
| Overall                        | 95     | 4    | 14   | 9.368   | 1.863  | −0.061   | 0.513    |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 4    | 12   | 8.818   | 1.878  | −0.503   | 0.533    |
| Level 2                        | 31     | 5    | 14   | 9.323   | 1.869  | 0.118    | 0.85     |
| Level 3                        | 31     | 8    | 13   | 9.581   | 2.579  | −0.211   | −0.561   |
| **Digit Span Backward**        |        |      |      |         |        |          |          |
| Overall                        | 95     | 2    | 14   | 8.632   | 2.832  | 0.143    | −0.757   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 2    | 14   | 8.727   | 3.43   | −0.503   | −1.022   |
| Level 2                        | 31     | 4    | 13   | 8.355   | 2.288  | 0.191    | −0.743   |
| Level 3                        | 31     | 4    | 14   | 8.806   | 2.688  | 0.462    | −0.516   |
| **Digit Span Backward**        |        |      |      |         |        |          |          |
| Overall                        | 95     | 3    | 14   | 9.116   | 3.007  | −0.322   | −0.755   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 3    | 14   | 8.97    | 3.432  | −0.447   | −1.022   |
| Level 2                        | 31     | 3    | 14   | 8.066   | 2.96   | −0.046   | −0.747   |
| Level 3                        | 31     | 4    | 14   | 9.581   | 2.579  | −0.211   | −0.561   |
| **Engagement with Nature**     |        |      |      |         |        |          |          |
| Overall                        | 95     | 8    | 49   | 31.663  | 7.506  | −0.393   | 0.569    |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 19   | 49   | 31.606  | 6.451  | 0.576    | 0.779    |
| Level 2                        | 31     | 8    | 42   | 28.967  | 8.611  | −0.542   | −0.03    |
| Level 3                        | 31     | 20   | 47   | 34.419  | 6.530  | −0.338   | 0.275    |
| **International Physical Activity Questionnaire** | | | | | | | |
| Overall                        | 95     | 2    | 1093 | 94.224  | 132.479| 5.338    | 35.968   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 21.97| 268.5| 75.377  | 54.412 | 1.794    | 4.923    |
| Level 2                        | 31     | 2    | 1093 | 112.5   | 197.386| 4.415    | 21.589   |
| Level 3                        | 31     | 13.5 | 584.4| 96.011  | 111.679| 3.088    | 11.978   |
| **Profile of Mood States(Vitality)–Pretest** | | | | | | | |
| Overall                        | 95     | 0    | 22   | 11.895  | 6.356  | −0.229   | −0.837   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 1    | 22   | 12.424  | 6.892  | −0.197   | −1.207   |
| Level 2                        | 31     | 0    | 22   | 11.935  | 5.680  | −0.434   | 0.191    |
| Level 3                        | 31     | 0    | 22   | 11.290  | 6.553  | −0.181   | −0.992   |
| **Profile of Mood States(Vitality)–Posttest** | | | | | | | |
| Overall                        | 95     | 0    | 24   | 12.800  | 6.657  | −0.378   | −0.891   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 0    | 24   | 13.515  | 6.433  | −0.516   | −0.838   |
| Level 2                        | 31     | 23   | 12.161| 7.221   | −0.182 | −1.065   |          |
| Level 3                        | 31     | 24   | 12.677| 6.447   | −0.478 | −0.580   |          |
| **Profile of Mood States(Self-esteem)–Pretest** | | | | | | | |
| Overall                        | 95     | 0    | 16   | 8.474   | 3.590  | −0.562   | 0.013    |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 0    | 16   | 7.788   | 4.106  | −0.308   | −0.523   |
| Level 2                        | 31     | 0    | 14   | 8.774   | 3.364  | −0.679   | 0.283    |
| Level 3                        | 31     | 15   | 8    | 8.903   | 3.208  | −0.664   | 1.056    |
| **Profile of Mood States(Self-esteem)–Posttest** | | | | | | | |
| Overall                        | 95     | 0    | 16   | 8.600   | 4.106  | −0.347   | −0.635   |
| Green exercise                 |        |      |      |         |        |          |          |
| Level 1                        | 33     | 0    | 15   | 8.402   | 4.402  | −0.435   | −0.985   |
| Level 2                        | 31     | 0    | 16   | 8.742   | 4.313  | −0.278   | −0.571   |
| Level 3                        | 31     | 2    | 16   | 9.097   | 3.590  | −0.126   | −0.559   |
| Variable                                      | Number | Min. | Max. | Mean  | S.D.  | Skewness | Kurtosis |
|-----------------------------------------------|--------|------|------|-------|-------|----------|----------|
| **Profile of Mood States(Confusion)—Pretest** |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 23   | 7.168 | 5.635 | 0.586    | −0.517   |
| Green exercise                                | Level 1| 33   | 0    | 18    | 7.697 | 5.382    | 0.351    | −1.120   |
|                                                | Level 2| 31   | 0    | 23    | 7.290 | 6.548    | 0.693    | −0.527   |
|                                                | Level 3| 31   | 0    | 19    | 6.848 | 4.992    | 0.615    | −0.007   |
| **Profile of Mood States(Confusion)—Posttest**|        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 14   | 3.189 | 3.810 | 1.139    | 0.384    |
| Green exercise                                | Level 1| 33   | 0    | 12    | 4.212 | 3.621    | 0.516    | −0.619   |
|                                                | Level 2| 31   | 0    | 14    | 2.806 | 4.159    | 1.650    | 1.910    |
|                                                | Level 3| 31   | 0    | 12    | 2.484 | 3.520    | 1.475    | 1.174    |
| **Profile of Mood States(Fatigue)—Pretest**   |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 23   | 6.958 | 6.079 | 0.790    | −0.132   |
| Green exercise                                | Level 1| 33   | 0    | 14    | 6     | 4.054    | 0.096    | −0.852   |
|                                                | Level 2| 31   | 0    | 17    | 6.161 | 5.973    | 0.648    | −0.961   |
|                                                | Level 3| 31   | 0    | 23    | 8.774 | 7.584    | 0.556    | −1.012   |
| **Profile of Mood States(Fatigue)—Posttest**  |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 22   | 3.200 | 3.945 | 2.089    | 5.991    |
| Green exercise                                | Level 1| 33   | 0    | 12    | 2.788 | 3.059    | 1.176    | 1.158    |
|                                                | Level 2| 31   | 0    | 16    | 3.097 | 3.515    | 1.829    | 4.830    |
|                                                | Level 3| 31   | 0    | 22    | 3.742 | 5.092    | 2.100    | 4.989    |
| **Profile of Mood States(Anger)—Pretest**     |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 13   | 2.053 | 3.160 | 1.637    | 1.966    |
| Green exercise                                | Level 1| 33   | 0    | 10    | 1.818 | 2.789    | 1.791    | 2.443    |
|                                                | Level 2| 31   | 0    | 12    | 2.452 | 3.677    | 1.317    | 0.508    |
|                                                | Level 3| 31   | 0    | 13    | 1.903 | 3.037    | 1.984    | 4.665    |
| **Profile of Mood States(Anger)—Posttest**    |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 12   | 0.653 | 1.797 | 4.055    | 19.368   |
| Green exercise                                | Level 1| 33   | 0    | 7     | 0.606 | 1.391    | 3.441    | 14.028   |
|                                                | Level 2| 31   | 0    | 12    | 0.871 | 2.487    | 3.717    | 14.558   |
|                                                | Level 3| 31   | 0    | 5     | 0.484 | 1.338    | 2.935    | 7.760    |
| **Profile of Mood States(Tension)—Pretest**   |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 12   | 3.232 | 3.140 | 0.992    | 0.232    |
| Green exercise                                | Level 1| 33   | 0    | 11    | 3.273 | 3.034    | 0.802    | −0.198   |
|                                                | Level 2| 31   | 0    | 12    | 3.355 | 3.489    | 1.177    | 0.756    |
|                                                | Level 3| 31   | 0    | 10    | 3.065 | 2.977    | 0.962    | −0.044   |
| **Profile of Mood States(Tension)—Posttest**  |        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 8    | 1.379 | 2.105 | 1.492    | 1.127    |
| Green exercise                                | Level 1| 33   | 0    | 7     | 1.667 | 2.245    | 1.098    | −0.219   |
|                                                | Level 2| 31   | 0    | 8     | 1.516 | 2.264    | 1.553    | 1.510    |
|                                                | Level 3| 31   | 0    | 7     | 0.935 | 1.750    | 2.140    | 4.355    |
| **Profile of Mood States(Depression)—Pretest**|        |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 10   | 1.179 | 2.114 | 2.218    | 4.875    |
| Green exercise                                | Level 1| 33   | 0    | 10    | 1.182 | 2.338    | 2.406    | 5.915    |
|                                                | Level 2| 31   | 0    | 7     | 1.419 | 2.157    | 1.482    | 1.201    |
|                                                | Level 3| 31   | 0    | 9     | 0.935 | 1.843    | 3.176    | 12.113   |
| **Profile of Mood States(Depression)—Posttest**|       |      |      |       |       |          |          |
| Overall                                       | 95     | 0    | 7    | 0.463 | 1.236 | 3.332    | 11.737   |
| Green exercise                                | Level 1| 33   | 0    | 5     | 0.364 | 0.994    | 3.652    | 15.111   |
|                                                | Level 2| 31   | 0    | 7     | 0.645 | 1.539    | 2.989    | 9.720    |
|                                                | Level 3| 31   | 0    | 5     | 0.387 | 1.145    | 3.427    | 11.445   |
## Table A1. Cont.

| Variable                                      | Number | Min. | Max. | Mean | S.D. | Skewness | Kurtosis |
|-----------------------------------------------|--------|------|------|------|------|----------|----------|
| **Intelligent Device for Energy Expenditure** |        |      |      |      |      |          |          |
| **and Activity—All posture speed**            |        |      |      |      |      |          |          |
| Overall                                       | 62     | 0.202| 198.7| 75.543| 67.496| 0.276    | -1.338   |
| **Green exercise**                            |        |      |      |      |      |          |          |
| Level 2                                        | 31     | 0.202| 198.7| 72.054| 65.950| 0.358    | -1.285   |
| Level 3                                        | 31     | 0.206| 194.5| 79.033| 69.919| 0.205    | -1.404   |
| **Intelligent Device for Energy Expenditure** |        |      |      |      |      |          |          |
| **and Activity—Numbers for ascending and**    |        |      |      |      |      |          |          |
| **descending stairs**                         |        |      |      |      |      |          |          |
| Overall                                       | 62     | 0     | 566  | 82.677| 90.244| 2.732    | 12.392   |
| **Green exercise**                            |        |      |      |      |      |          |          |
| Level 2                                        | 31     | 3     | 245  | 74.935| 66.546| 0.988    | 0.305    |
| Level 3                                        | 31     | 0     | 566  | 90.419| 109.576| 2.846   | 11.384   |

## Table A2. Statistics of MANOVA.

| Effect                  | Value | $F$ | Hypothetical $df$ | Error $df$ | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power |
|-------------------------|-------|-----|-------------------|------------|------|---------------------|--------------------|-----------------|
| **Between-Subjects**    |       |     |                   |            |      |                     |                    |                 |
| Pillar’s Trace          | 0.983 | 506.890 | 9.000           | 81.000     | 0.000| 0.983               | 4562.009           | 1.000           |
| Wilks’ Lambda (A)       | 0.017 | 506.890 | 9.000           | 81.000     | 0.000| 0.983               | 4562.009           | 1.000           |
| Roy’s Largest Root      | 0.521 | 506.890 | 9.000           | 81.000     | 0.000| 0.983               | 4562.009           | 1.000           |
| **Time**                |       |     |                   |            |      |                     |                    |                 |
| Pillar’s Trace          | 0.248 | 1.289 | 18.000           | 164.000    | 0.201| 0.124               | 23.794             | 1.000           |
| Wilks’ Lambda (A)       | 0.767 | 1.279 | 18.000           | 162.000    | 0.208| 0.124               | 23.030             | 1.000           |
| Roy’s Largest Root      | 0.806 | 1.657 | 9.000            | 82.000     | 0.113| 0.154               | 14.915             | 1.000           |
| **Within-Subjects**     |       |     |                   |            |      |                     |                    |                 |
| Pillar’s Trace          | 0.819 | 14.601 | 9.000           | 81.000     | 0.000| 0.619               | 131.411            | 1.000           |
| Wilks’ Lambda (A)       | 0.381 | 14.601 | 9.000           | 81.000     | 0.000| 0.619               | 131.411            | 1.000           |
| Roy’s Largest Root      | 1.622 | 14.601 | 9.000           | 81.000     | 0.000| 0.619               | 131.411            | 1.000           |

| Parameter               | Overall 62 0.202 | 198.7 | 75.543 | 67.496 | 0.276 | 4562.009 | 1.000 |
|-------------------------|--------------------|-------|---------|--------|-------|----------|-------|
| **Green exercise**      | Level 2 31 0.202 198.7 72.054 65.950 0.358 | -1.285 |
| Level 3 31 0.206 194.5 79.033 69.919 0.205 | -1.404 |

### ANOVA

| Source       | Measure               | Type III Sum of Squares | df | Mean Square | $F$ | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power |
|--------------|-----------------------|-------------------------|----|-------------|----|------|---------------------|--------------------|-----------------|
| Spatial      | Sphericity Assumed    | 31.392                  | 1  | 31.392      | 16.521 | 0.000 | 0.157               | 16.521             | 0.980           |
| Span         | Sphericity Assumed    | 31.392                  | 1  | 31.392      | 16.521 | 0.000 | 0.157               | 16.521             | 0.980           |
| Forward      | Sphericity Assumed    | 31.392                  | 1  | 31.392      | 16.521 | 0.000 | 0.157               | 16.521             | 0.980           |
| Digit Span   | Sphericity Assumed    | 10.190                  | 1  | 10.190      | 3.274  | 0.074 | 0.035               | 3.274              | 0.433           |
| Backward     | Sphericity Assumed    | 10.190                  | 1  | 10.190      | 3.274  | 0.074 | 0.035               | 3.274              | 0.433           |
| Lower-bound  | Sphericity Assumed    | 10.190                  | 1  | 10.190      | 3.274  | 0.074 | 0.035               | 3.274              | 0.433           |
| Vitality     | Sphericity Assumed    | 49.690                  | 1  | 49.690      | 5.704  | 0.019 | 0.060               | 5.704              | 0.656           |
| Self-esteem  | Sphericity Assumed    | 0.521                   | 1  | 0.521       | 2.029  | 0.054 | 0.002               | 0.202              | 0.073           |
| Confusion    | Sphericity Assumed    | 775.588                 | 1  | 775.588     | 65.799 | 0.000 | 0.425               | 65.799             | 1.000           |
| Fatigue      | Sphericity Assumed    | 720.827                 | 1  | 720.827     | 62.562 | 0.000 | 0.413               | 625.62             | 1.000           |
| Anger        | Sphericity Assumed    | 94.422                  | 1  | 94.422      | 30.615 | 0.000 | 0.256               | 30.615             | 1.000           |
| Tension      | Sphericity Assumed    | 169.114                 | 1  | 169.114     | 68.100 | 0.000 | 0.443               | 68.100             | 1.000           |
| Depression   | Sphericity Assumed    | 23.737                  | 1  | 23.737      | 16.616 | 0.000 | 0.157               | 16.616             | 0.981           |
| Total Mood Disturbance | Sphericity Assumed | 8111.149               | 1  | 8111.149    | 79.864 | 0.000 | 0.473               | 79.864             | 1.000           |

**Note:** All postures are ascending and descending. The table above represents the MANOVA results for the study variables, including the effects of time and treatment on various parameters such as spatial span, digit span, vitality, self-esteem, confusion, fatigue, and anger. The significant values (Sig.) are indicated with p-values less than 0.05, and effect sizes (Partial Eta Squared) are provided to assess the magnitude of the effects.
| Source                  | Measure                  | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power |
|-------------------------|--------------------------|-------------------------|----|-------------|-------|------|----------------------|-------------------|----------------|
| **Spatial Span**        | Sphericity Assumed       | 14.062                  | 2  | 7.031       | 3.700 | .029 | .017                 | .140              | .666           |
|                         | Greenhouse-Geisser       | 14.062                  | 2  | 7.031       | 3.700 | .029 | .017                 | .140              | .666           |
|                         | Huynh-Feldt              | 14.062                  | 2  | 7.031       | 3.700 | .029 | .017                 | .140              | .666           |
|                         | Lower-bound              | 14.062                  | 2  | 7.031       | 3.700 | .029 | .017                 | .140              | .666           |
| **Digit Span Backward** | Sphericity Assumed       | 1.971                   | 2  | 0.986       | 0.317 | .072 | .007                 | .063              | .009           |
|                         | Greenhouse-Geisser       | 1.971                   | 2  | 0.986       | 0.317 | .072 | .007                 | .063              | .009           |
|                         | Huynh-Feldt              | 1.971                   | 2  | 0.986       | 0.317 | .072 | .007                 | .063              | .009           |
|                         | Lower-bound              | 1.971                   | 2  | 0.986       | 0.317 | .072 | .007                 | .063              | .009           |
| **Vitality**            | Sphericity Assumed       | 12.580                  | 2  | 6.290       | 0.722 | .049 | .016                 | .144              | .016           |
|                         | Greenhouse-Geisser       | 12.580                  | 2  | 6.290       | 0.722 | .049 | .016                 | .144              | .016           |
|                         | Huynh-Feldt              | 12.580                  | 2  | 6.290       | 0.722 | .049 | .016                 | .144              | .016           |
|                         | Lower-bound              | 12.580                  | 2  | 6.290       | 0.722 | .049 | .016                 | .144              | .016           |
| **Self Esteem**         | Sphericity Assumed       | 8.712                   | 2  | 1.429       | 0.729 | .072 | .007                 | .063              | .009           |
|                         | Greenhouse-Geisser       | 8.712                   | 2  | 1.429       | 0.729 | .072 | .007                 | .063              | .009           |
|                         | Huynh-Feldt              | 8.712                   | 2  | 1.429       | 0.729 | .072 | .007                 | .063              | .009           |
| **Confusion**           | Sphericity Assumed       | 11.322                  | 2  | 5.661       | 0.480 | .620 | .011                 | .960              | .126           |
|                         | Greenhouse-Geisser       | 11.322                  | 2  | 5.661       | 0.480 | .620 | .011                 | .960              | .126           |
|                         | Huynh-Feldt              | 11.322                  | 2  | 5.661       | 0.480 | .620 | .011                 | .960              | .126           |
| **Fatigue**             | Sphericity Assumed       | 34.975                  | 2  | 17.488      | 1.518 | .225 | .033                 | .036              | .015           |
|                         | Greenhouse-Geisser       | 34.975                  | 2  | 17.488      | 1.518 | .225 | .033                 | .036              | .015           |
|                         | Huynh-Feldt              | 34.975                  | 2  | 17.488      | 1.518 | .225 | .033                 | .036              | .015           |
| **Anger**               | Sphericity Assumed       | 1.459                   | 2  | 0.729       | 0.426 | .701 | .005                 | .047              | .086           |
|                         | Greenhouse-Geisser       | 1.459                   | 2  | 0.729       | 0.426 | .701 | .005                 | .047              | .086           |
|                         | Huynh-Feldt              | 1.459                   | 2  | 0.729       | 0.426 | .701 | .005                 | .047              | .086           |
| **Tension**             | Sphericity Assumed       | 2.086                   | 2  | 1.043       | 0.420 | .638 | .009                 | .047              | .086           |
|                         | Greenhouse-Geisser       | 2.086                   | 2  | 1.043       | 0.420 | .638 | .009                 | .047              | .086           |
|                         | Huynh-Feldt              | 2.086                   | 2  | 1.043       | 0.420 | .638 | .009                 | .047              | .086           |
| **Depression**          | Sphericity Assumed       | 2.576                   | 2  | 1.273       | 0.627 | .128 | .001                 | .001              | .001           |
|                         | Greenhouse-Geisser       | 2.576                   | 2  | 1.273       | 0.627 | .128 | .001                 | .001              | .001           |
|                         | Huynh-Feldt              | 2.576                   | 2  | 1.273       | 0.627 | .128 | .001                 | .001              | .001           |
| **Total Mood Disturbance** | Sphericity Assumed      | 97.650                  | 2  | 48.825      | 0.481 | .620 | .011                 | .961              | .126           |
|                         | Greenhouse-Geisser       | 97.650                  | 2  | 48.825      | 0.481 | .620 | .011                 | .961              | .126           |
|                         | Huynh-Feldt              | 97.650                  | 2  | 48.825      | 0.481 | .620 | .011                 | .961              | .126           |
|                         | Lower-bound              | 97.650                  | 2  | 48.825      | 0.481 | .620 | .011                 | .961              | .126           |
## Appendix B. Cont.

### Tests of Within-Subjects Effects

| Source       | Measure                      | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power |
|--------------|------------------------------|-------------------------|----|-------------|-------|-----|---------------------|-------------------|----------------|
| Time         | Spatial Span Forward         | Linear                  | 31.392 | 1 | 31.392 | 18.621 | 0.000 | 0.157              | 18.621            | 0.980          |
|              | Digit Span Backward          | Linear                  | 10.190 | 1 | 10.190 | 3.274  | 0.074 | 0.035              | 3.274             | 0.433          |
|              | Vitality                     | Linear                  | 49.690 | 1 | 49.690 | 5.704  | 0.019 | 0.060              | 5.704             | 0.656          |
|              | Self-esteem                  | Linear                  | 0.521  | 1 | 0.521  | 0.202  | 0.654 | 0.002              | 0.202             | 0.073          |
|              | Confusion                    | Linear                  | 775.588 | 1 | 775.588| 65.739 | 0.000 | 0.425              | 65.739            | 1.000          |
|              | Fatigue                      | Linear                  | 720.827 | 1 | 720.827| 62.562 | 0.000 | 0.413              | 62.562            | 1.000          |
|              | Anger                        | Linear                  | 94.422  | 1 | 94.422 | 30.615 | 0.000 | 0.256              | 30.615            | 1.000          |
|              | Tension                      | Linear                  | 169.114 | 1 | 169.114| 68.100 | 0.000 | 0.433              | 68.100            | 1.000          |
|              | Depression                   | Linear                  | 23.737  | 1 | 23.737 | 16.616 | 0.000 | 0.157              | 16.616            | 0.981          |
|              | Total Mood Disturbance       | Linear                  | 8111.149 | 1 | 8111.149| 79.864 | 0.000 | 0.473              | 79.864            | 1.000          |

### Tests of Between-Subjects Effects

| Source       | Measure                      | Type III Sum of Squares | df | Mean Square | F     | Sig. | Partial Eta Squared | Noncent. Parameter | Observed Power |
|--------------|------------------------------|-------------------------|----|-------------|-------|-----|---------------------|-------------------|----------------|
| Intercept    | Spatial Span Forward         | Linear                  | 14,926.764 | 1 | 14,926.764| 3499.120 | 0.000 | 0.075              | 3499.120          | 1.000          |
|              | Digit Span Backward          | Linear                  | 14,572.208 | 1 | 14,572.208| 1017.795 | 0.000 | 0.083              | 1017.795          | 1.000          |
|              | Vitality                     | Linear                  | 27,848.781 | 1 | 27,848.781| 363.517  | 0.000 | 0.803              | 363.517           | 1.000          |
|              | Self-esteem                  | Linear                  | 13,540.176 | 1 | 13,540.176| 490.236  | 0.000 | 0.846              | 490.236           | 1.000          |
|              | Confusion                    | Linear                  | 481.435  | 1 | 481.435| 137.690 | 0.000 | 0.607              | 137.690           | 1.000          |
|              | Fatigue                      | Linear                  | 4749.818  | 1 | 4749.818| 115.364 | 0.000 | 0.565              | 115.364           | 1.000          |
|              | Anger                        | Linear                  | 320.932  | 1 | 320.932| 30.822  | 0.000 | 0.257              | 30.822            | 1.000          |
|              | Tension                      | Linear                  | 1050.013  | 1 | 1050.013| 974.459 | 0.000 | 0.472              | 974.459           | 1.000          |
|              | Depression                   | Linear                  | 1025.440 | 1 | 1025.440| 79.423  | 0.000 | 0.009              | 79.423            | 0.115          |
|              | Total Mood Disturbance       | Linear                  | 1038.971  | 1 | 1038.971| 1025.440| 0.000 | 0.236              | 1025.440          | 1.000          |

* This means the interaction of time and treatment.
Table A3. Statistics of multiple linear regression analysis on fatigue.

| Model | R      | R Square | Adjusted R Square | Standard Error of the Estimate | Change Statistics |
|-------|--------|----------|-------------------|--------------------------------|-------------------|
|       |        |          |                   |                                | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1     | 0.580  | 0.336    | 0.145             | 4.5506                         | 0.336           | 1.761    | 21  | 73  | 0.040          |

ANOVA

| Model        | Sum of Squares | df | Mean Square | F     | Sig. |
|--------------|----------------|----|-------------|-------|------|
| Regression   | 765.732        | 21 | 36.463      | 1.761 | 0.040|
| Residual     | 1511.700       | 73 | 20.708      |       |      |
| Total        | 2277.432       | 94 |             |       |      |

Table A4. Statistics of multiple linear regression analysis on total mood disturbance.

| Model | R      | R Square | Adjusted R Square | Standard Error of the Estimate | Change Statistics |
|-------|--------|----------|-------------------|--------------------------------|-------------------|
|       |        |          |                   |                                | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1     | 0.581  | 0.337    | 0.147             | 13.4051                        | 0.337           | 1.769    | 21  | 73  | 0.039          |

ANOVA

| Model        | Sum of Squares | df | Mean Square | F     | Sig. |
|--------------|----------------|----|-------------|-------|------|
| Regression   | 6674.558       | 21 | 317.836     | 1.769 | 0.039|
| Residual     | 13,117.864     | 73 | 179.697     |       |      |
| Total        | 19,792.421     | 94 |             |       |      |

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