Article

The Effects of Exercise and Social Interaction in Different Natural Environments on the Mental Health of Urban Residents

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Abstract: Background Together with the rapid development of China's economy, the number of urban residents suffering from depression and psychological disorders has been increasing as a result of the general increase in life stress. As a consequence, this study investigates the effects on users' mental health through exercise and social interaction in three different outdoor natural landscapes, and provides theoretical and practical guidance for urban landscape planning and design. **Methods**: In this study, pre- and post-DASS21 (depression, anxiety and stress) data were obtained by using the DASS21 scale (used to assess depression, anxiety, and stress) to test a population of users performing simple exercise and social interactions in three natural environments, and the data scale values were statistically analyzed using SPSS. **Results**: (1) In the natural outdoor environment within the community, there was a relationship between the outdoor environment and perceived atmospheric temperature, with (single) and (group) perceived outdoor temperatures in the community having smaller effects on the mood of community residents; (2) After analyzing the data by descriptive statistics ($p < 0.05$), it was found that there was a slight change in the mean scores both before the participants climbed Yuelu Mountain and after they reached the summit; the mean scores of stress, anxiety, and depression decreased after they reached the summit, and the condition improved; (3) There was a slight change in the mean of both scores before the departure to and after the return from the Tongguan Kiln attractions, with a slight improvement in the condition after the return of the stress and depression mean scores. **Conclusions**: Enhancing social relationships through exercise and social interaction in a natural environment in different populations significantly increases the benefits for mental health (depression, anxiety, and stress) and assists recovery from stress-related mental disorders. Different landscape types and landscape attribute characteristics have different effects on urban residents' preferences and mental health. Rich natural landscapes, providing green exercise environments, and t social interactions have positive effects on the mental health of urban residents. Especially in environments where the change in altitude is around 200 m, climbing is very beneficial to psychological emotions.

Keywords: natural environment; mental health; stress; depression; anxiety; social interaction

1. Introduction

Modern society has isolated people from their natural environment, and the fast pace of urban life and fierce competition, along with various aspects of interpersonal relationships, has led to a general imbalance in social development, hindering the balanced adaptation of individuals and society as a whole in physical, psychological and social terms [1–3]. The rapid socio-economic growth of China and its cities has made it possible for us to enjoy the conveniences of modern life while various stresses have increased, affecting the mental health of the population and causing different degrees of psychological problems [4]. According to the World Health Organization, about 4.3% of the world's population suffers from depression. More than 350 million people suffer from depression, making it the fourth most common illness in the world, and it is growing rapidly. The three groups with the

highest risk of developing depression are young people, pregnant/postpartum women, and older adults. Depression and anxiety disorders can cost the economy more than a trillion dollars a year [5,6]. The WHO predicts that depression will be the number one disease burden globally by 2030. Some 90 million people suffer from depression in China, with approximately 280,000 people committing suicide each year [7], and fewer than 10% of those suffering from depression seeking medical treatment.

The quality of the urban green environment can provide benefits to human health [8], especially for reducing stress and improving physical and mental health [9–13]. The study found that people walking from cities to green spaces had reduced patterns of brain activity associated with excitement and busyness and that their brains were somehow quieter as they traversed the park [14,15]. Interacting with nature may be most effective for people in a depressed mood [16], and for people who exhibit depressive symptoms, a walk in nature will yield more working memory boosts than it will in a healthy person [17]; interaction with nature leads to a better mood, and depression and major mental fatigue are relieved by exposure to the natural environment [18–21].

The outdoor natural environment, outdoor cultural attractions in the community, and outdoor mountains are essential recreational activity places for people living in the city. Few studies have focused on the role that the type and quality of the natural environment may have on mental health [22]. The outdoor natural environment in the community is the most frequently exposed activity space for urban residents; Outdoor mountains are rich in natural resources; different types of visual space and scenic features exist in different mountain locations, the environment gives a sense of comfort, and because of their topographical characteristics, they allow urban residents to be more active. Outdoor cultural attractions are usually large, with unique local characteristics and human landscapes, as well as landscapes that meet people's aesthetic needs [23]. Many studies have focused on how urban green spaces can reduce stress and improve mental health, but relatively little is known about the effects of human physical activity, social interaction, and natural space features on health promotion in different outdoor landscape natural environments. Therefore, there is a need to examine how different urban outdoor natural environments can benefit and improve mental health.

This study investigates the effects on users' mental health of exercise and social interaction in three different outdoor natural landscapes, and provides theoretical and practical guidance for urban landscape planning and design. In the study, pre- and post-DASS21 (depression, anxiety, and stress) data were obtained by using the DASS21 scale (used to assess depression, anxiety, and stress) to test a population of users performing simple exercises and social interactions in three natural environments, and the data scale values were statistically analyzed using SPSS. Our research may help to address the need for interdisciplinary, integrated mental health promotion, as well as the prevention and treatment of mental disorders. It provides both theoretical and practical guidance for landscape planning and design oriented to the mental health of urban residents.

2. Methods

Natural landscapes have a positive impact on people's physical and mental health, with many data showing an association with a reduced risk of psychological distress, stress-reducing symptoms, and clinical anxiety [9,24–28]. In the psychological theory of stress healing, it is believed that the natural environment can reduce stress and enhance positive emotions from the perspective of emotional arousal [29]; In attention restoration theory, it is believed that people perceive the attraction in the natural environmental landscape through their own attention, thus restoring autonomous attention and direct attention [30,31]. These are consistent with the strong correlation between physical experience and mental states in embodied cognition theory, where the natural landscape influences physical perception and the body improves mood, thinking, and social interaction (Figure 1).
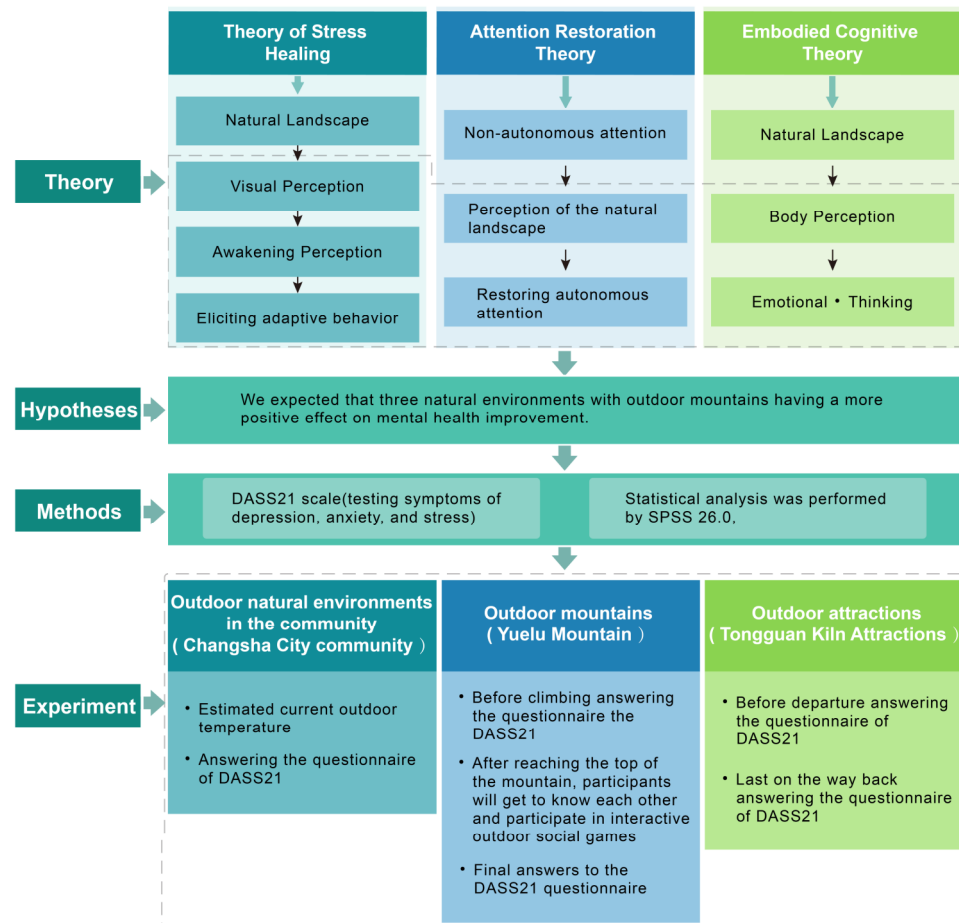
Figure 1. The System Framework of Proposed Method.

This study explored the different types of outdoor natural environments available in Changsha, Hunan Province, China, as a natural therapy measure to improve mental health. We are in three different natural environments in Changsha (e.g., outdoor natural environments in the community, outdoor mountains, and outdoor attractions): The outdoor natural environment in the community, Yuelu Mountain and Tongguan Kiln attractions were studied separately for different populations [32–35]. In this study, pre- and post-DASS21 (depression, anxiety, and stress) data were obtained by using the DASS21 scale (used to assess depression, anxiety, and stress) to test a population of users performing simple exercises and social interactions in three natural environments, and the data scale values were statistically analyzed using SPSS. We examined the relationship between stress, anxiety, and depression and these three types of natural environments, and examined the possibility that exercise and social interaction in urban areas based on different types of outdoor natural environments could provide solutions for people with mental health problems. This study assists planners and landscape designers to provide solutions for developing healthy environments through targeted optimization and the provision of more green exercise environments. The aim is to provide attractive natural public spaces and social interaction spaces for diverse and benign social activities to help improve the mental health of the urban population.

The Hypotheses of the Study:

1. We expected that there would be differences in mental health improvement between natural environments, with outdoor mountains having a more positive effect on mental health improvement.
2. We hypothesized that outdoor mountains would cause more significant improvements in stress, anxiety, and depression after the experiment.

3.   We expected that outdoor mountains and outdoor cultural attractions would have an improving effect on mental health.

3. Experiment

3.1. Participants

Experiment 1 had 29 community residents volunteer for this field study. The experimenter approached 15 people in the community who were active alone (single person) and 14 people who were active with another person (group) and asked if they would like to participate in a brief study. A total of 33 young and middle-aged volunteers (urban white-collar occupations) in Experiment 2 and 42 university student volunteers in Experiment 3 volunteered to participate in this field study [36].

3.2. Study Sites

The study was conducted in Changsha City, Hunan Province, China, and three different types of natural environments (outdoor natural environments in the community, outdoor mountains, and outdoor attractions) were selected as the study sites. Experiment 1 represents the outdoor natural environment in the community, and was conducted in a large community (with 2294 residential households) in a natural outdoor environment space in the Tianxin District of Changsha City, which has a convenient transportation location and a green, ecologically pleasant living environment. Experiment 2 represents outdoor mountains, and was conducted on Yuelu Mountain, which is rich in natural resources comprising 174 families, 559 genera, and 977 species of plants, and has a large number of precious and endangered tree species, as well as old and valuable trees. Experiment 3 was conducted in Changsha Tongguan Kiln attractions, attractions with the distinctive characteristics of the integration of natural landscape, historical relics, recreation, and leisure (Figure 2).

Figure 2. Location of Changsha City, Hunan Province and photographs of three study sites: (**A**) Natural environmental space within the Changsha City community; (**B**) Natural environmental space of Yuelu Mountain; (**C**) Natural environment space of the Tongguan Kiln attractions.

3.3. Experimental Design

The study randomly selected participants from within the community, Yuelu Mountain, and Tongguan Kiln attractions (Figure 3), where participants from Yuelu Mountain used the DASS21 scale for self-testing for depression, anxiety, and stress before climbing the

mountain and after reaching the summit, and participants from Tongguan Kiln attractions used the DASS21 scale for self-testing for depression, anxiety, and stress before leaving and after their return.
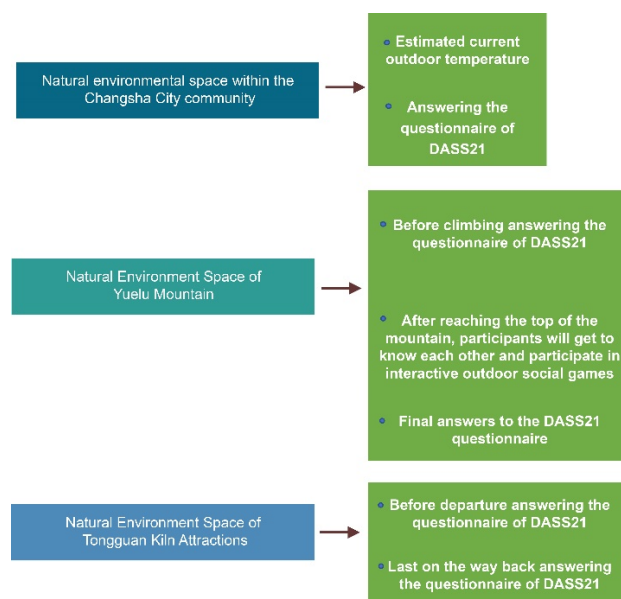

Figure 3. The experiment design.

3.3.1. Experiment 1

Experiment 1 (field study) observed whether there was a relationship between the outdoor natural environment and mood within the community of Changsha, Hunan Province. Specifically, we believe that individuals in the natural outdoor environment within a community (e.g., residents moving alone) would perceive the surrounding temperature to be lower than the actual ambient temperature. On the other hand, groups in a natural outdoor environment within a community (e.g., residents moving around with another person) would perceive the surrounding temperature to be higher than the actual ambient temperature [37,38].

The experimental time was in the afternoon (4:00 pm–5:00 pm). After obtaining their consent, the experimenter asked the subjects to estimate the current outdoor temperature [39]. To give them a baseline, we told participants that the normal atmospheric temperature was 17.4 °C. We did not provide participants with the actual room temperature, but the measured temperature was 16.9 °C. To prevent hypothetical speculation, we told participants that this information had been requested by the community's maintenance staff. After the participants provided their answers, we expressed our appreciation for the time given to participate.

3.3.2. Experiment 2

Upon arrival at the experimental site, Yuelu Mountain, participants completed two studies. In the first part, they filled out the DASS21 scale before climbing the mountain and started climbing at 2:50 pm after completing it [40–42]. In the second part, after reaching the summit at 4:00 pm, all participants got to know each other and participated in outdoor social interactive game activities. In the first round of the game, with all participants in a circle, they took turns to report the number, from the numbers 1, 2 and 3 to count up; participants who counted to a number containing 7 such as 17 or 27 needed to clap once; a slow response was punished. In the second round of the game, we increased the difficulty: participants were put in a circle, with people taking turns to report the number; from the numbers 1, 2 and 3 to count up, participants who counted to a multiple of 7 such as 14 or 21 needed to clap once; a slow response was again punished. The game ended with the completion of the DASS21 scale and the participants descended the mountain at 4:36 pm.

3.3.3. Experiment 3

The experiment was conducted at the Tongguan Kiln attractions in Changsha, and participants completed two studies before arriving at the experiment site. In the first part, participants filled out the DASS21 scale before departure at 8:30 am. They arrived at the site after a long walk, and after the second part of the tour they were to meet at 3:10 pm for the return trip and to fill out the DASS21 form at the end.

3.3.4. Materials of This Study

Psychological Measures

The study used the DASS21 scale, and the normative data presented here are the only ones derived specifically from the DASS-21 items and are based on a large sample broadly representative of the general adult population. It is shorter and therefore more accessible to people with short attention spans, but still sufficiently reliable [43]. The Depression Anxiety Stress Scale (DASS21) is a self-report instrument that measures depression, anxiety, and stress. The DASS21 is designed in such a way that the questionnaire contains 21 questions and three subscales with seven phrases describing how participants have been feeling over the past week. Depression ("I don't seem to feel any pleasure or relief at all"), anxiety ("I worry about occasions where I might panic or make a fool of myself"), and stress ("I find it hard to calm myself down"). The assessment is carried out using a four-point scale (not conforming, sometimes conforming, often conforming, and always conforming). This study used the official version of the DASS21 translated into Chinese. The DASS21 is one of the most commonly used instruments to assess unpleasant emotional feelings and it is currently one of the most popular measures for testing symptoms of depression, anxiety, and stress in clinical and non-clinical studies. The DASS21 is ideal for empirical research as it provides a psychometric aid for clinical diagnosis and a rapid and effective subject screening tool for relevant studies [44].

3.4. Data Analysis

A one-way ANOVA method and correlation analysis method were used to analyze the data. The data were analyzed after descriptive statistics to establish the psychological changes before and after. Additionally, the Depression Anxiety Stress Scale (DASS-21) was used to analyze psychological changes. Statistical analysis was performed by SPSS 26.0, and p values < 0.05 were considered statistically significant.

4. Results

4.1. Experiment 1 Results

Estimates of the atmospheric temperature were lower for people who were alone outdoors in the Experiment 1 community (single person) than for people who were with another person (group) (M low = 15.19 °C (SD = 2.09) vs. M high = 16.24 °C (SD = 2.44)). In addition, those in the community who were outdoors alone (single person) provided estimates that were lower than the actual outdoor temperature (16.9 °C), while those who were with another person (group) provided estimates that were close to the actual outdoor temperature (16.9 °C). The results, therefore, suggest that there is a relationship between the natural outdoor environment and perceived atmospheric temperature within the community.

In Experiment 1 we calculated the stress effect size (Cohen d = 0.30), anxiety effect size (Cohen d = 0.30), and depression effect size (Cohen d = 0.33). For Experiment 1 where people in the community were outdoors alone (single person), the mean and standard deviations are presented in Table 1 (Figure 4). The mean score for the stress subscale is 1.362, close to 1. A score of 1 on the original scale = non-conformity, which indicates that the stress level of the community residents is normal and close to non-conformity as a result of this research. The mean score for the anxiety subscale is 1.219, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the community has a normal level of anxiety, close to non-conformity, as a result of this research. The

mean score on the depression subscale was 1.362, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the community residents are normal and close to non-conformity in terms of depression as a result of this study. For people who are active with another person (group), the mean and standard deviations are presented in Table 2 (Figure 5). The mean score on the stress subscale is 1.459, close to 2. A score of 2 on the original scale = sometimes compliant, which suggests that the stress level of the community residents is relatively normal and close to sometimes compliant as a result of this study. The mean score for the anxiety subscale is 1.296, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the community has a normal level of anxiety, close to non-conformity, as a result of this research. The mean score for the depression subscale is 1.255, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the community residents are normal for depression and close to non-conformity as a result of this study.

Table 1. Mean and standard deviation of the DASS21 scale for people who are alone outdoors in the community (single person).

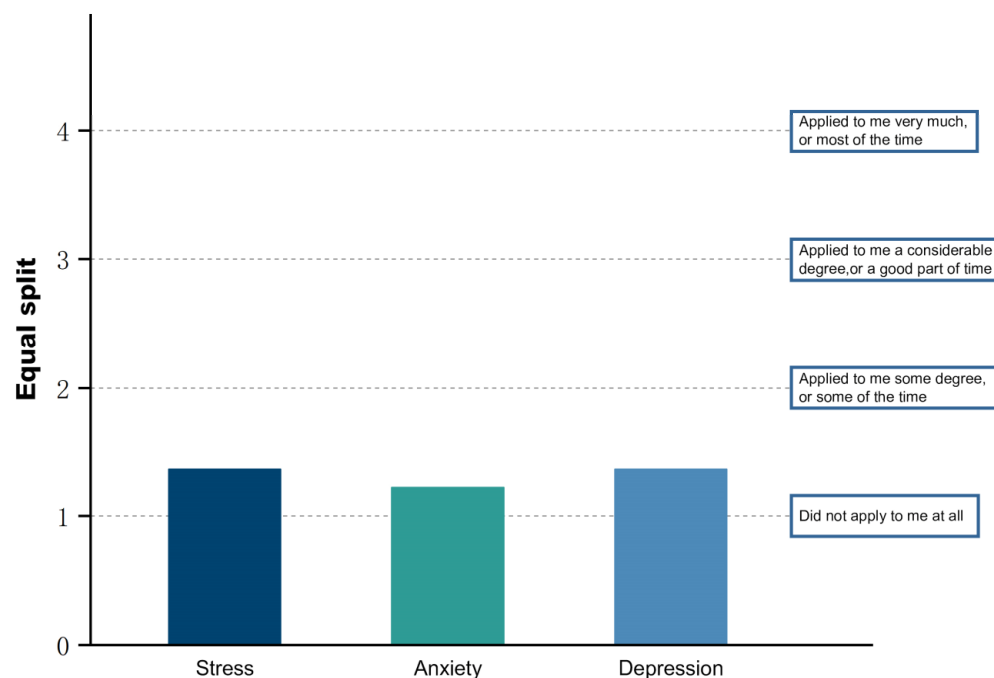|	N	Min	Max	Mean	SD
Stress	15	1.00	2.00	1.362	0.32785
Anxiety	15	1.00	1.71	1.219	0.23453
Depression	15	1.00	2.00	1.362	0.33226

Figure 4. Equal split for Intra-community (single person) DASS21 scale mean.

Table 2. Mean and standard deviation of the DASS21 scale for people in the community who are active with another person (group).

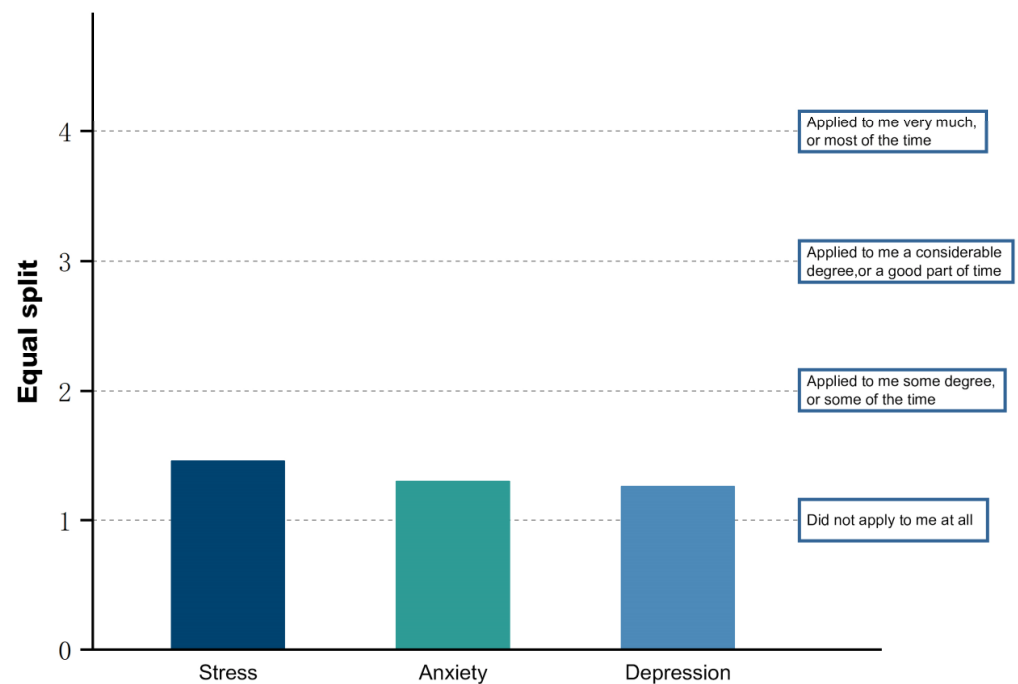|	N	Min	Max	Mean	SD
Stress	14	1.00	2.00	1.459	0.32758
Anxiety	14	1.00	2.00	1.296	0.28276
Depression	14	1.00	2.00	1.255	0.30782

Figure 5. Equal split for Intra-community (group) DASS21 scale mean.

4.2. Experiment 2 Results

In experiment 2 we calculated the stress effect size (Cohen d = 0.42), anxiety effect size (Cohen d = 0.17), and depression effect size (Cohen d = 0.40)., The mean and standard deviations (Figure 6) are presented in Table 3 before the participants climbed Yuelu Mountain in Experiment 2. The mean score for the stress subscale was 1.623, which is close to 2. A score of 2 on the original scale = sometimes compliant, which suggests that the participants' stress levels were more normal and closer to the sometimes compliant status through this research. The mean score for the anxiety subscale was 1.364, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the participants' anxiety level was normal and close to non-conformity as a result of this research. The mean score on the depression subscale was 1.455, close to 2. A score of 2 on the original scale = sometimes compliant, which suggests that the participants' depression level was more normal and closer to the sometimes compliant status as a result of this study. The mean and standard deviations (Figure 7) are presented in Table 4 when the participants reached the summit of Yuelu Mountain, and the final mean score for the stress subscale is 1.433, close to 1. A score of 1 on the original scale = non-conformity, which suggests that the participants' stress level is normal and close to non-conformity through this research. The mean score for the anxiety subscale was 1.303, which is close to 1. A score of 1 on the original scale = non-conformity, which means that the participants' anxiety level was normal and close to non-conformity for this study. The mean score for the depression subscale was 1.294, which is close to 1, and 1 on the original scale = non-conformity, which means that the participants' depression level was normal and close to non-conformity.

4.3. Experiment 3 Results

In experiment 3 we calculated the stress effect size (Cohen d = 0.27), anxiety effect size (Cohen d = 0.01), and depression effect size (Cohen d = 0.19). Before the completion of Experiment 3, the mean and standard deviations (Figure 8) are presented in Table 5, and the mean score of the stress subscale is 1.674, which is close to 2. A score of 2 on the original scale = sometimes compliant, which shows that the participants' stress level is more normal and closer to the ometimes compliant status through this research. The mean score of the anxiety subscale was 1.480, which is close to 2. A score of 2 in the original scale = sometimes compliant, which indicates that the anxiety level of the participants through this study is

more normal and closer to the sometimes compliant state. The mean score of the depression subscale was 1.510, which is close to 2. A score of 2 on the original scale = sometimes compliant, which indicates that the participants' depression level is more normal and closer to the sometimes compliant status throughout this study. The mean and standard deviations (Figure 9) are presented in Table 6 for when the participants arrived back at the Tongguan Kiln attractions in Changsha, and the mean score of the final stress subscale is 1.544, which is close to 2. A score of 2 on the original scale = sometimes compliant, which shows that the participants' stress level is more normal and closer to the sometimes compliant status through this research. The mean score of the anxiety subscale was 1.483, which is close to 1. A score of 1 on the original scale = non-conformity, which indicates that the participants' anxiety level was normal and close to non-conformity through this study. The mean score of the depression subscale was 1.422, which is close to 1. A score of 1 on the original scale = non-conformity, which indicates that the participants' depression level was normal and close to non-conformity through this study.
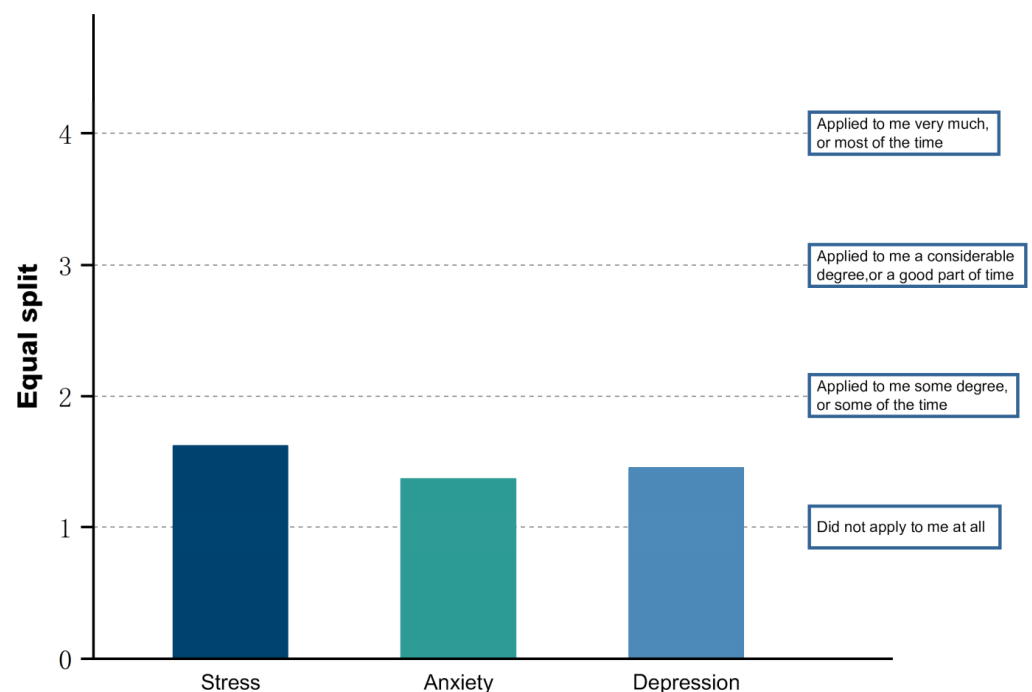

Figure 6. Equal split for pre-climbing DASS21 scale mean.

Table 3. Mean and standard deviation of the DASS21 scale before climbing Yuelu Mountain.

	N	Min	Max	Mean	SD
Stress	33	1.00	2.57	1.623	0.48684
Anxiety	33	1.00	2.43	1.364	0.34086
Depression	33	1.00	2.71	1.455	0.43515

Table 4. Mean and standard deviation of the DASS21 scale after reaching the summit of Yuelu Mountain.

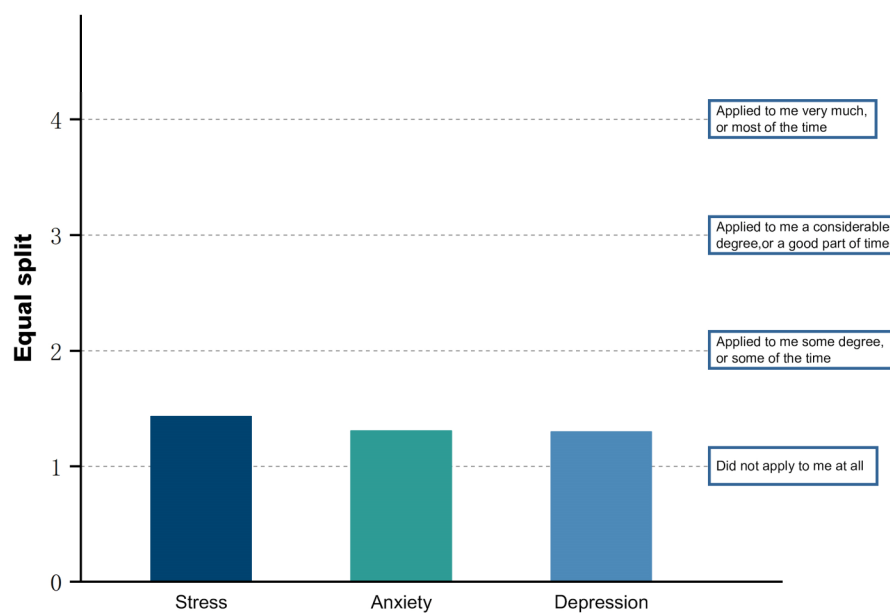|	N	Min	Max	Mean	SD
Stress	33	1.00	2.29	1.433	0.41876
Anxiety	33	1.00	2.29	1.303	0.37416
Depression	33	1.00	2.43	1.294	0.35882

Figure 7. Equal split for DASS21 scale mean after reaching the summit.

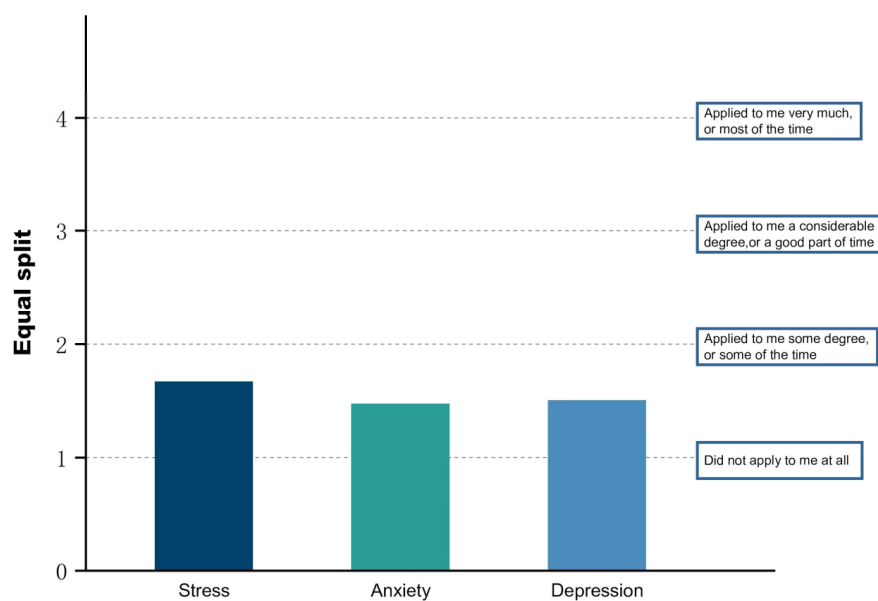**Figure 8.** Equal split for before departure DASS21 scale mean.

Table 5. Before departure DASS21 scale means and standard deviation.

	N	Min	Max	Mean	SD
Stress	42	1.00	2.86	1.674	0.47672
Anxiety	42	1.00	2.57	1.480	0.41956
Depression	42	1.00	2.71	1.510	0.47553

Table 6. Mean and standard deviation of DASS21 scales after a return.

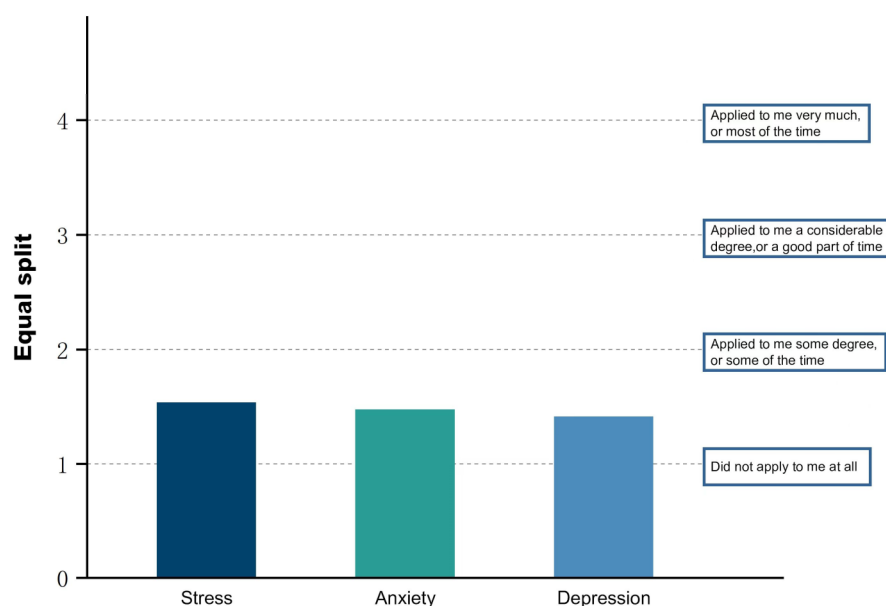|	N	Min	Max	Mean	SD
Stress	42	1.00	2.71	1.544	0.49712
Anxiety	42	1.00	3.14	1.483	0.52032
Depression	42	1.00	2.57	1.422	0.43600

Figure 9. Equal split for on return DASS21 scale mean.

5. Discussion

This study investigated how three different types of outdoor natural environments improved mental health for different populations, comparing the results obtained by participants in different areas. Experiment 1 was consistent with previous studies showing that social interactions were associated with feelings of warmth [45]. The results indicate that the social characteristics of the outdoor natural environment in the community influence the perception of environmental temperature. Specifically, when people in the community are outdoors alone (single person), it results in individuals under-estimating the actual ambient temperature outdoors, while when they are active with another person (group), it results in individuals being relatively close to the actual ambient temperature outdoors. In summary, the results of this field study establish a link between the outdoor natural environment within the community and the perception of the outdoor ambient temperature.

The results of Experiment 1 showed that in the outdoor natural environment within the community, the perceived temperature of people who are alone outdoors in the community (single person) and those who are active with another person (group) indicated that there were no significant differences in the three dimensions of emotion and in emotion as a whole. Community people who are alone outdoors (single person) and those who are with another person (group) perceive that the outdoor temperature has little effect on the mood of community residents. In the outdoor natural environment in the community, we do not need to give separate responses for people who are alone outdoors in the community (single person) and people who are with another person (group); perceiving different outdoor temperatures when developing countermeasures to promote a good mood can be applied to all community residents as a whole.

In Experiment 2, we tested whether there was a relationship between the outdoor natural environment and mood. The results of Experiment 2 showed that there was a significant positive correlation before climbing Yuelu Mountain and after reaching the summit in this study. After descriptive statistics to analyze the data, it was found that there was a slight change in the mean value of both scores before climbing Yuelu Mountain and after participants reached the summit. Stress, anxiety, and depression were all reduced after reaching the summit, and conditions improved slightly. The results of Experiment 3 showed that there was a significant positive correlation before participants' departure to the Tongguan Kiln attractions in Changsha and after their return. Following descriptive statistics to analyze the data, it was found that there was a slight change in the mean value

of both scores before departure and after return; after returning, stress and depression were both reduced and the situation was slightly better [46].

The data show that mountain climbing and social interaction have a positive impact on stress, anxiety, and depression. In a study of the Depression Anxiety Stress Scale (DASS21), it was found that participants on Yuelu Mountain experienced significantly less stress, anxiety, and depression after mountain climbing and improving social interaction compared to participants in activities in the natural environment within the community. Stress and depression decreased after group activities at the Tongguan Kiln attractions. Compared to the other two experiments, during mountaineering on Yuelu Mountain, where participants were urban white-collar workers, the Depression Anxiety Stress Scale (DASS21) changed significantly with increased exercise and social interaction, and depression, anxiety, and stress improved significantly, suggesting that the richness of the natural landscape combined with the visual aesthetics in landscapes with an altitude difference of 200 m or more helped with depression, anxiety, and stress. During the experiment, the total restoration brought on by the natural environment of Yuelu Mountain was more obvious than in the green areas in the other two experimental sites. Therefore, the natural environmental space of Yuelu Mountain used in the current experiment may be more likely to help treat stress, anxiety, and depression than the natural environment within the community or the natural environment of the Tongguan Kiln attractions.

In addition, interventions using different outdoor natural environments, such as Yuelu Mountain and the Changsha Tongguan Kiln attractions, as mental health promotion or therapeutic environments showed positive results [47,48]. Exercise on outdoor mountains can play a key role as a mental health-promoting environment or resource, especially in urban areas where exercise and socially interactive play in outdoor natural environments are widely accepted as effective means of preventing or treating poor mental health and specific conditions in certain groups. The natural landscape on outdoor mountains is considered to be very healing given the rich sensory experience of sight, sound, and smell. With the change in seasons, natural scenery presents rich visual colors, and the sound of birds, wind, and water in the natural landscape provides aural enjoyment and makes people feel relaxed. Fresh air and floral and herbal scents also provide a calming and enriching experience.

This study still has some limitations. First, the number of samples used in it is relatively small, which will be addressed by using a broader population in the future. Another limitation of this study is that only three types of urban natural environments were selected, and more types of urban natural environments should be examined in the future. In addition, the physiological recovery of urban residents in different types of natural environments needs to be further studied.

6. Conclusions

This paper demonstrated that exposure to different types of urban outdoor natural environments and different groups of people enhances social relationships through movement and social interaction in natural environments, significantly increases benefits for mental health (depression, anxiety, and stress) and is beneficial for recovery from stress-related mental disorders. In particular, our experimental results show that being in different urban natural environments has a positive effect on people's feeling on well-being. Climbing mountains, especially, shows more positive effects on improving mental health by reducing stress, anxiety, and depression, in particular for working adults. Thus, the importance of the type of green exercise environment, the choice of the configuration of natural spaces, and the atmosphere of social interaction spaces on improving the mental health experience should be considered before by landscape designers. It is recommended that natural landscapes and green exercise environments should be provided as much as possible to increase the social interactions, and more importantly, to improve the mental health of urban residents. While in environments where the change in altitude is around 200 m, it is recommended that the path to the summit of these small mountains be increased in order

that people can release their stress through climbing. Our research may help address the need for interdisciplinary, integrated mental health promotion, prevention, and treatment of mental disorders. It provides both theoretical and practical guidance for landscape planning and design oriented to the mental health of urban residents.

Author Contributions: Y.S. proposed the idea of this paper and wrote most of the text including the literature review, methods, results, discussion, and conclusions. X.L. performed the theoretical and data analysis and edited the paper. Y.S. and X.L. contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Hunan Agricultural University Biomedical Research (Lun Audit Section 202 No. 88 and Approval date 11 October 2021).

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

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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