







Article

When Urban Environment Is Restorative: The Effect of Walking in Suburbs and Forests on Psychological and Physiological Relaxation of Young Polish Adults

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Abstract: Background and Objectives: Physical activity, recreation and walks successfully counteract negative symptoms of stress in people, especially in large cities, and have many positive psychological and physiological effects. There are many studies showing that contact with nature plays an important role in the regeneration of the human body. The city is not without green enclaves such as forests, parks or greenery along the streets. However, it is not entirely clear how the different physical characteristics of the urban space affect mood improvement, increase of positive feelings, vitality level, etc. Materials and Methods: In the study, two urban environments (apartment and green suburbs) were used, as well as two forests (coniferous and deciduous) to measure the impact of these environments on human physiological and psychological relaxation during a walk in a randomized experiment. The participants of the experiment were 75 young adult Poles studying in the largest Polish agglomeration, Warsaw. Before each experiment, the physiological and psychological state of the participant was measured indoors (pre-test). Four psychological questionnaires were used in the project (Profile of Mood States; Positive and Negative Affect Schedule; Restorative Outcome Scale; Subjective Vitality Scale), and physiological measurements (heart rate, blood pressure) before and after the short walking program were evaluated. Results: As a result of the analyses, it was shown that both staying in an urban environment with greenery and staying in a forest environment have a positive effect on the physiological and psychological relaxation of the subjects. A short walk in the suburbs was no less attractive than a walk in the forest in fall. The above indicates that various places with urban vegetation can be successfully used for recreation, just as in a forest where forest bathing is practiced. This indicates that different places with urban greenery can be successfully used for recreation, as can the forests where forest bathing is carried out.

Keywords: forest bathing; forest therapy; positive and negative affect schedule; profile of mood states; restorative outcome sale; restoration; subjective vitality scale

1. Introduction

The burden of diseases of civilization resulting in disability or premature deaths is rapidly increasing worldwide. The World Health Organization (WHO) considers around 23.1 million deaths annually (circa (ca.) 10% of deaths) and 8.3 million disabilities to be the consequence of lack of physical activity [1]. Diseases of civilization also include, but are not limited to, heart and vascular diseases, mental illnesses, obesity, diabetes, and cancer. The causes for diseases of civilization might be attributable to industrialization, urbanization, environmental pollution, noise, and ionizing radiation, etc., as well as the lack of physical activity, lack of relaxation and work under stress [2]. One way to counteract diseases of civilization is by undertaking outdoor activities. The WHO points out that the minimum regular duration of physical activity should be at least 60–90 min daily [3]. One third of adults in Europe do not reach the recommended level of physical activity [4]. The simplest form of physical activity, which does not require any preparation or equipment as well as bearing a low risk of injury, is walking. Walking 30 min per day followed by short minute breaks during work time is linked to numerous health benefits, such as lowering arterial pressure, decreasing stress and increasing metabolism [1]. Regular walking soothes the mind and releases endorphins, and it also has a good impact on sleep quality [1]. Counteracting circulatory disorders is also currently of great importance. In Poland [5], these diseases are the main cause of death, resulting in 43.5% of deaths in 2017. Cardiac incidents are one of the most important death factors in the world [6]. It is possible to counteract many cases of circulatory disorders, like infarct, stroke or heart failure, by eliminating the risk of cardiac–arterial factors and by undertaking physical activity.

More and more evidence can be found for the positive influence of physical activity on people's health, comfort and vitality (e.g., [7]). This influence can be measured using psychometric methods, such as Profile of Mood States Questionnaire (POMS), Positive and Negative Affect Scale (PANAS), Restorative Outcome Scale (ROS) and Subjective Vitality Scale (SVS) [8]. Short visits to natural sites help to restore and sustain mental well-being [9–11] as well as reduce stress levels [12,13]. Son and Ha [14] argued that increasing contact with nature helps to improve social and emotional interactions in modern society. Bang et al. [15] proved that physical activity in the forest has a positive effect on self-esteem and social interaction for children. Previous studies showed that people's moods and positive emotions improve in natural environments [9,10,16,17].

Despite intensive research on the role and significance of nature in the process of restoration of the human organism, it is not entirely clear what kind of physical characteristics the environment should have to restore the balance between human physical and mental conditions [18]. There are a significant number of studies indicating that physical activity in natural environments can bring more benefits for people's health than physical activity in any other place [19–21]. Korpela et al. [22] has also shown that the restoration process in natural environments, especially in forests, is much more stable than in urban parks or other open recreational areas in cities. Hartig [12] and Lee et al. [23] determined that natural surroundings reduce stress more effectively. Ulrich [24], while examining patients' behavior in hospitals, concluded that sick people placed in rooms with natural scenery behind the windows recovered faster than those placed in rooms with windows facing built-up areas (walls). Bielinis et al. [25] also showed the positive effect of forest bathing (one hour, and forty-five minute walks) on the mental health and well-being of people who are treated in a psychiatric hospital for affective or psychotic disorders. On the other hand, Takayama et al. [26] showed that the feeling of vigor and positive emotion, along with the feeling of subjective revival and vitality, is stronger in forest areas (after the combined effect of walking and watching) than in urban areas.

Simkin et al. [18] suggested that, following numerous studies, there is still a gap in knowledge of the effect of various types of forest on the speed, range, and steadiness of the restorative process. Based on the results of social preference studies concerning different forest features (age, type, closure, and density of trees and shrubs) it is suggested that not all types of forests are equally effective for one's well-being. Until now, despite various attempts to determine the preferred forest type for recreation, it has not been shown which is the most beneficial forest type. As an example, numerous studies have

suggested that the best forest type for recreational purposes is the mixed forest [27–34]. Other studies do not allow such clear conclusions [35,36]. Within the city, there may also be spaces that are highly desirable for recreation, but also spaces whose quality does not guarantee the comfort of living.

The high quality of dwelling places is reflected by the real estate prices. Attractive dwelling places are characterized by large green areas. Finnish research conducted by Tyrväinen and Miettinen [37] showed that the direct location of an apartment in the forest raises its value by 6%, while forest-viewed houses were by 4.9% more expensive than others. Donovan and Butry [38] observed that trees separating the house from the street or growing up to 30.5 m from the house contribute to raising the price of the property by 3% of its value. Research by Anderson and Cordell [39], Mansfield et al. [40], and Melichar et al. [41] showed that the longer the distance to a park or forest, the lower the price of a property. Urban areas thus exhibit restorative characteristics. However, as in the case of forests, there is a lack of knowledge on which different physical characteristics of urban space have an impact on improving mood, increasing positive feelings, vitality level, etc. The goal of this work is therefore to examine the restorative/renewing effects of short walks in four different spaces: a quarter of apartment buildings on both sides of a wide arterial road with trees growing alongside (apartment suburbs); a quiet community of detached houses surrounded by vegetation (green suburbs); urban forest with a majority of coniferous trees (coniferous forest); and urban forest with a majority of deciduous trees (deciduous forest). The comparison of the meaning of these areas to the restorative process allows gaining of objective information on the optimal conditions for recreation in urban spaces.

The hypotheses of the work were as follows:

I. All four locations have restorative features. Short-distance walks within their ranges contribute to improving mood and increasing positive emotions and vitality and simultaneously reducing the negative emotions.

II. A short program of walks influences the change of parameters connected with blood circulation in the body. Walking, a popular physical activity, reduces pulse and arterial blood pressure.

III. The restorative effect achieved in the natural scenery of urban forests is higher than the effect achieved in spaces of greater anthropogenic pressure.

2. Materials and Methods

2.1. Participants

Seventy-five students of the Warsaw University of Life Sciences—SGGW (WULS-SGGW) participated in the study. Volunteer students who agreed to participate in the research were informed about the study goals as well as the procedure of its conduct prior to the beginning of the experiment. Participants in the research were young adults aged 19–24. Unhealthy adults with mental or physical diseases or metabolic syndromes were excluded from the study. Participants were divided into two groups: A (45 participants) and B (30 participants). Fifteen participants in group B were not able to join the study. The participants from group A were then divided into group A1 (23 persons), which carried out a short program of walks in the urban area, among single-family buildings with lots of greenery, and group A2 (22 persons), at the same time walking in the urban environment, where multi-family buildings dominated and the share of greenery was smaller. The participants of group B were also divided into two groups: B1, with 17 people (carrying out a short walking program in the Kabaty Forest), and B2, with 13 people (carrying out a short walking program in the Sobieski Forest).

All operations undertaken in the research were in accordance with the ethical standards of the Polish Committee for Ethics in Science and the Declaration of Helsinki from 1964 with further amendments.

2.2. Study Sites

The experiment was conducted both indoors and outdoors. The current mental condition of Group A members, before going outdoors (pre) and after their return (post), was determined in two adjacent didactic rooms at the University of Life Sciences in Warsaw. The mental condition of group B1,

before leaving and after returning, was determined in the educational room of the forester's lodge in the Sobieski Forest in Warsaw (pre and post), whereas the current mental condition of the participants from group B2 was determined in the didactic room of the Nature and Forest Education Center of the Warsaw Urban Forests in Powisin (pre and post).

The outdoor experiment was conducted in four different sceneries. Group A1 achieved a short recreational program in an urban environment with a noticeably higher level of noise, the presence of a wide two-lane street, dominating apartment blocks and a smaller share of green space (Figure 1(A1) and Figure 2(A1)). This area was coded as apartment suburbs. The rest of the group A participants (group A2) started, after preliminary examinations, a short walking program in the scenery of urban housing, which can be described as a quiet community with detached houses and green areas (Figure 1(A2) and Figure 2(A2)). This environment was coded as green suburbs. Both urban areas were placed close to the WULS-SGGW Campus in the southern part of Warsaw.



Figure 1. The map of experimental locations: (A1) apartment suburbs, (A2) green suburbs, (B1) coniferous forest, (B2) deciduous forest.



Figure 2. Photos: (A1) apartment suburbs, (A2) green suburbs, (B1) coniferous forest, (B2) deciduous forest.

Simultaneous to the research conducted on urban scenery, the participants from group B1 spent time on the territory of the Sobieski Forest, the second-largest forest complex in Warsaw, located in the eastern part of the city (Figure 1—B1). The species composition is dominated by pines accompanied by oaks and a share of younger birches and a multitude of limes (Figure 2—B1). This environment was coded as a coniferous forest. Meanwhile, the B2 group carried out a recreational program in one of Warsaw's urban forests, the Kabaty Forest, the largest forest complex within the city's boundaries (900 ha), located in the southern part of Warsaw and a nature reserve (Figure 1—B2). This forest is dominated by broadleaved species, with an old forest, 120–160 years old, and numerous types of trees, such as oaks, pines, and beeches (Figure 2—B2). This environment was coded as a deciduous forest.

The green ratio analysis carried out in the Promovolt application for the presented photographs (Figure 2) showed that the largest percentage of green was at location A1 (green color: 12.62%) and the smallest at location B2 (green color: 0.0%). Green suburbs (Figure 2—A2) had 10.5 percent greenery, while coniferous forest (Figure 2—B1) had 0.58%.

Meteorological data on the day of research (29 November 2019) was collected from the meteorological station located at the WULS-SGGW Campus (location: 52°09'37.37'' N, 21°03'11.92'' E). The outdoor temperature on that day was 9.2 °C at 10 a.m. in urban areas while it was 8 °C in the

forest. The atmospheric pressure was 999 hPa, the south-west wind speed 15 km/h, and air humidity 79%. Medium clouds appeared without precipitation. The temperature in the examination rooms was on average 21.8 °C. The levels of sound and light intensity were measured using smartphone iPhone Xs Max by “Sound Meter” and “Light Meter” applications, which turned out to be perfect devices comparable to professional laboratory appliances for sound analyses [8]. Measurements inside the buildings were carried out once, while outside (both in the urban environment and in the forest) several measurements of sound and light were taken, in the middle of straight road sections and at crossings with other routes. The mean sound level (\pm SD) measured with the sound level meter indoors amounted to 58.12 ± 11.26 dB, while the mean sound levels in urban housing areas were 73.33 ± 23.18 (apartment suburbs) and 57.36 ± 6.18 dB (green suburbs); in forest areas they were 53.24 ± 14.26 dB (coniferous forest) and 66.43 ± 4.13 dB (deciduous forest). The mean light intensity indoors measured with the “light meter” amounted to 176.33 ± 47.80 lx (light was switched off in the examination room), whereas the mean light intensities in urban housing areas amounted to 1839.25 ± 370.84 lx (apartment suburbs) and 1969.33 ± 719.66 lx (green suburbs); in forest areas, the result was 448 ± 53.12 lx (coniferous forest) and 360 ± 58.12 lx (deciduous forest). The levels of sound and light intensity were measured multiple times in randomly chosen points within the scope of the four areas during the experimental procedure.

2.3. Procedure

The physiological and psychological condition of the participants was measured in rooms, before the walk and just after its end. Measurements of pulse and blood pressure of all participants in the study were performed at the same time. Both groups (group A and group B) undertook separate, half-hour walks (2.0 km) in spatially various locations: apartment suburbs (group A1), green suburbs (group A2), coniferous forest (group B1), and deciduous forest (group B2). Each participant walked a few meters distance from the others to have the chance to relax and act according to the researcher’s instructions. The participants were not allowed to use mobile phones during the study, neither could they talk to each other, drink energy drinks or smoke cigarettes.

2.4. Measurements

Physiological indicators taken into consideration in the study were parameters related to the blood circulation in the body. These were measured twice by remote blood-pressure gauges just before and just after the field experiment. The pulse frequency of the participants (in bpm), systolic blood pressure (SYS) and diastolic blood pressure (DIA), both in mmHg, were measured with a blood pressure monitor (Microlife BP A1 Basic). Measurements have been taken in a sitting position. After the measurements, the relative value of the mean arterial pressure (MAP) was calculated as $((2 \times \text{DIA}) + \text{SYS})/3$.

Four psychological questionnaires were used to measure the influence of the short recreation period as a walk on the participants.

(I) The Polish version of D. Watson’s and L.A. Clark’s Positive and Negative Affect Schedule (PANAS) elaborated by Brzozowski [42] (PANAS) was used to evaluate the feelings of participants. It is composed of 20 questions of which the same number refer to positive and to negative feelings. Each question was evaluated with a Likert five-point scale (1—strongly disagree, 5—strongly agree). The credibility and validity of the PANAS questionnaire are high [43]; moreover, this questionnaire has already been applied in many studies [6,18,26,44].

(II) Another applied test was the Restorative Outcome Scale (ROS). This contains six items, each of which is evaluated by the participants by a seven-point Likert scale (1—very unlikely, 7—very likely). In the research, we used the scale modified for forest-related experience by Takayama et al. [26]. The modified scale was adapted to the Polish language [44]. According to Korpela et al. [16,22], it is a credible tool to evaluate the level of restorative outcome. This tool has been used previously concerning regenerative features of the forest environment [18,26,44].

(III) For the evaluation of vitality, the Subjective Vitality Scale (SVS), which reflects feelings of energy, vitality, and well-being, was used, namely, the version with four items (e.g., “I feel alive and vital” or “I look forward to each new day”), adjusted for research in forest areas [26]. Four items were evaluated by the participants with the use of Likert’s seven-point scale (1—very unlikely, 7—very likely).

(IV) The 65-position version of the Profile of Mood States questionnaire (POMS). The Polish adaptation of the questionnaire (originally compiled by D.M. McNair, M. Lorr, L.F. Droppelman) was performed by Dudek and Koniarek [45]. POMS is a credible and contemporary measure of mood state, used previously for the evaluation of the forest environment’s effect on individuals’ moods [8,26,46]. It is a tool that measures six subscales of mood state: confusion or bewilderment, fatigue, anger or hostility, tension or anxiety, depression or dejection, and vigor. For each question, a five-point Likert scale was used to estimate the mood state of the participants from 0 (strongly disagree) to 4 (strongly agree).

The PANAS, ROS, SVS, and POMS questionnaires allow various time frames to be used, but, in this study, as in earlier studies [8,44], the used time frame was “at this particular moment”.

2.5. Data Analysis

Raw data retrieved from psychological questionnaires and physiological measurements were used for statistical analysis purposes. To compare the measurements of the pre-test and post-test, a paired *t*-test was used. The distribution of data was similar to the normal distribution. A parametric, two-way mixed-model ANOVA was conducted to analyze the interactions and main effects of the POMS, PANAS, ROS, and SVS scores as pre–post indicators of the psychological restorative effect of exposure to four different urban green spaces. After ANOVA, post-hoc comparisons using Tukey’s HSD test were conducted. Statistical analyses were accomplished with the use of SPSS Statistics Version 24 (IBM, Armonk, NY, USA). The analyses considered the results for which “ $p > 0.05$ ” was statistically significant in both the ANOVA and post-hoc tests.

3. Results

3.1. Physiological Indices

3.1.1. Results of the Analysis of Variance

In this experiment, three physiological indices were measured: systolic blood pressure (SYS), diastolic blood pressure (DIA), and pulse. The results of two-way mixed-model ANOVAs are presented in Table 1. No significant interactions have been identified for any of the physiological indicators, but there was a significant difference between the sites and the time of measurement for SYS and DIA. There were no significant effects in the case of pulse.

Table 1. Results of mixed-model ANOVA for physiological variables, degrees of freedom and F statistics.

| | DF | SYS | DIA | Pulse |
|-------------|----|-----------|---------|-------|
| Site | 3 | 4.55 ** | 5.18 ** | 2.33 |
| Time | 1 | 13.91 *** | 8.78 ** | 1.05 |
| Site × Time | 3 | 0.24 | 1.85 | 1.80 |

SYS—systolic blood pressure, DIA—diastolic blood pressure, *** $p < 0.001$, ** $p < 0.01$.

3.1.2. Post-Hoc Test Results

The effects of post-hoc analysis conducted after ANOVA are shown in Table 2, marking means with small letters to show that they are different to means with different letters. In the case of SYS, there was a significant difference between pre and post time points; before stimulation this parameter was higher. The DIA was also significantly higher in the pre-test. No significant differences have been found in the case of pulse rate.

Table 2. Means and SD of physiological measures in four places during the experiment.

| Site | Measures | Time | Apartment Suburbs | | Green Suburbs | | Coniferous Forest | | Deciduous Forest | | Mean | SD |
|-------|----------|------|-------------------|-------|---------------|-------|-------------------|-------|------------------|-------|---------|-------|
| | | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| SYS | pre | | 134.77 | 13.51 | 131.13 | 17.39 | 124.00 | 21.95 | 119.59 | 15.03 | 128.35a | 17.44 |
| | | post | 128.59 | 21.57 | 124.57 | 13.26 | 119.38 | 16.87 | 110.47 | 11.67 | 121.65b | 17.51 |
| | | | 131.68a | 18.06 | 127.85a | 15.65 | 121.69ab | 19.32 | 115.03b | 14.04 | 125.00 | 17.74 |
| DIA | pre | | 79.86 | 11.25 | 80.30 | 10.08 | 72.62 | 11.06 | 69.53 | 6.58 | 76.40a | 10.81 |
| | | post | 77.86 | 10.21 | 73.96 | 11.73 | 72.46 | 9.48 | 66.41 | 9.29 | 73.13b | 11.00 |
| | | | 78.86a | 10.67 | 77.13a | 11.28 | 72.54ab | 10.09 | 67.97b | 8.08 | 74.77 | 11.00 |
| Pulse | pre | | 87.45 | 13.40 | 90.39 | 15.07 | 76.15 | 11.75 | 83.18 | 13.34 | 85.43 | 14.30 |
| | | post | 86.82 | 14.51 | 84.26 | 14.66 | 77.69 | 13.44 | 83.06 | 12.29 | 83.60 | 13.96 |
| | | | 87.14 | 13.81 | 87.33 | 15.02 | 76.92 | 12.39 | 83.12 | 12.63 | 84.51 | 14.11 |

3.2. Psychological Indices

3.2.1. Results of the Analysis of Variance

The results of two-way mixed-model ANOVAs with two factors (site differences and time differences) are presented in Table 3. In the case of the positive aspect of PANAS, there was no significant effect or interaction. In the case of the rest of psychological indicators (the negative aspect of PANAS, ROS, SVS, all subscales of POMS) significance for effects of “time” was found. Only in the case of one subscale of POMS was the effect of “site” significant. There were no significant interactions between “site” and “time” effects for any psychological indicators.

Table 3. Results of mixed-model ANOVA for psychological variables, degrees of freedom and F statistics.

| | DF | PANAS | | ROS | SVS | POMS | | | | | |
|-------------|----|----------|-----------|-----------|---------|-----------|------------|-----------|-----------|-----------|-----------|
| | | Positive | Negative | | | Tension | Depression | Anger | Fatigue | Confusion | Vigor |
| Site | 3 | 1.66 | 1.33 | 0.47 | 0.15 | 3.07 * | 0.62 | 2.27 | 0.78 | 1.01 | 0.67 |
| Time | 1 | 0.63 | 12.70 *** | 14.61 *** | 7.44 ** | 44.97 *** | 23.57 *** | 12.35 *** | 34.87 *** | 10.47 ** | 13.71 *** |
| Site × Time | 3 | 0.27 | 0.15 | 0.46 | 0.48 | 0.70 | 0.80 | 0.66 | 0.33 | 0.55 | 0.68 |

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

3.2.2. Post-Hoc Test Results

Post-hoc analysis after ANOVAs of means and standard deviations (SD) are shown in Tables 4 and 5. The same letters after means, or no letters at all, indicate where there is no difference between means. There were no significant differences between all means for the positive aspect of PANAS. The level of negative aspect PANAS was significantly lower in the post-test, after exposition to sites. The level of ROS was significantly higher in the post-test, after exposure to settings. The level of SVS was also higher after exposure to settings (pre-test vs. post-test). In the case of the POMS scale, there were six subscales and almost all have a lower level of values after exposure to settings (pre-test vs. post-test). The exception is vigor subscale, which is a measure of positive mood; this indicator significantly increased after stimulation by settings in the post-test. The only significant difference from all measured indicators in this research for the “site” effect was for the “tension” subscale of POMS. The level of “tension” was the highest in apartment suburbs, lower in green suburbs, even lower in coniferous forest, and the lowest level was for deciduous forest.

Table 4. Means and SD of psychological measures in four places during the experiment (for PANAS, ROS and SVS scales).

| Site | Measures | Time | Apartment Suburbs | | Green Suburbs | | Coniferous Forest | | Deciduous Forest | | Mean | SD |
|----------------|----------|------|-------------------|------|---------------|------|-------------------|------|------------------|------|-------|------|
| | | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| PANAS Positive | pre | | 3.00 | 0.57 | 3.05 | 0.55 | 2.51 | 1.01 | 3.06 | 0.99 | 2.95 | 0.78 |
| | post | | 2.95 | 0.60 | 3.12 | 0.75 | 2.65 | 1.02 | 3.19 | 1.09 | 3.00 | 0.85 |
| | | | 2.98 | 0.58 | 3.08 | 0.65 | 2.58 | 1.00 | 3.13 | 1.03 | 2.97 | 0.81 |
| PANAS Negative | pre | | 1.58 | 0.41 | 1.57 | 0.55 | 1.52 | 0.67 | 1.36 | 0.43 | 1.52a | 0.51 |
| | post | | 1.46 | 0.43 | 1.42 | 0.51 | 1.33 | 0.51 | 1.19 | 0.20 | 1.37b | 0.44 |
| | | | 1.52 | 0.42 | 1.50 | 0.53 | 1.42 | 0.59 | 1.28 | 0.35 | 1.44 | 0.48 |
| ROS | pre | | 4.08 | 1.14 | 4.42 | 1.00 | 4.04 | 1.55 | 4.51 | 1.34 | 4.28a | 1.22 |
| | post | | 4.58 | 0.96 | 4.67 | 1.27 | 4.67 | 1.46 | 4.89 | 1.26 | 4.69b | 1.20 |
| | | | 4.33 | 1.07 | 4.55 | 1.14 | 4.35 | 1.51 | 4.69 | 1.30 | 4.48 | 1.22 |
| SVS | pre | | 4.42 | 1.34 | 4.37 | 1.50 | 3.96 | 1.87 | 4.18 | 1.79 | 4.27a | 1.57 |
| | post | | 4.55 | 1.17 | 4.75 | 1.56 | 4.52 | 1.54 | 4.72 | 1.72 | 4.64b | 1.46 |
| | | | 4.48 | 1.25 | 4.56 | 1.52 | 4.24 | 1.70 | 4.43 | 1.75 | 4.45 | 1.52 |

Table 5. Means and SD of psychological measures in four places during the experiment (for POMS subscales).

| Site | Measures | Time | Apartment Suburbs | | Green Suburbs | | Coniferous Forest | | Deciduous Forest | | Mean | SD |
|------------|----------|------|-------------------|------|---------------|------|-------------------|------|------------------|------|-------|------|
| | | | Mean | SD | Mean | SD | Mean | SD | Mean | SD | | |
| Tension | pre | | 1.22 | 0.63 | 0.99 | 0.73 | 0.94 | 0.67 | 0.62 | 0.48 | 0.96a | 0.66 |
| | post | | 0.78 | 0.61 | 0.58 | 0.51 | 0.44 | 0.59 | 0.37 | 0.29 | 0.57b | 0.53 |
| | | | 1.00a | 0.65 | 0.79ab | 0.65 | 0.69ab | 0.67 | 0.49a | 0.41 | 0.77 | 0.63 |
| Depression | pre | | 0.70 | 0.49 | 0.62 | 0.48 | 0.84 | 0.89 | 0.57 | 0.43 | 0.67a | 0.56 |
| | post | | 0.58 | 0.45 | 0.47 | 0.60 | 0.55 | 1.03 | 0.32 | 0.31 | 0.48b | 0.61 |
| | | | 0.64 | 0.47 | 0.55 | 0.54 | 0.70 | 0.96 | 0.45 | 0.39 | 0.58 | 0.59 |
| Anger | pre | | 1.12 | 0.65 | 0.79 | 0.35 | 0.85 | 0.56 | 0.96 | 0.67 | 0.93a | 0.57 |
| | post | | 0.97 | 0.41 | 0.70 | 0.35 | 0.56 | 0.52 | 0.74 | 0.49 | 0.76b | 0.45 |
| | | | 1.04 | 0.54 | 0.74 | 0.35 | 0.71 | 0.55 | 0.85 | 0.59 | 0.85 | 0.52 |
| Fatigue | pre | | 1.45 | 0.89 | 1.37 | 0.96 | 1.49 | 1.04 | 1.87 | 1.06 | 1.53a | 0.98 |
| | post | | 1.05 | 0.86 | 1.01 | 1.04 | 1.08 | 0.78 | 1.33 | 0.86 | 1.10b | 0.90 |
| | | | 1.25 | 0.89 | 1.19 | 1.01 | 1.29 | 0.92 | 1.60 | 0.99 | 1.32 | 0.96 |
| Confusion | pre | | 1.11 | 0.54 | 1.11 | 0.69 | 0.92 | 0.70 | 0.81 | 0.70 | 1.01a | 0.65 |
| | post | | 0.92 | 0.62 | 0.80 | 0.52 | 0.64 | 0.42 | 0.71 | 0.61 | 0.79b | 0.55 |
| | | | 1.02 | 0.58 | 0.95 | 0.62 | 0.78 | 0.58 | 0.76 | 0.65 | 0.90 | 0.61 |
| Vigor | pre | | 2.00 | 0.75 | 2.14 | 0.65 | 1.75 | 1.13 | 2.21 | 1.05 | 2.05a | 0.87 |
| | post | | 2.45 | 0.64 | 2.29 | 0.72 | 2.18 | 1.03 | 2.51 | 1.00 | 2.37b | 0.82 |
| | | | 2.23 | 0.72 | 2.22 | 0.68 | 1.97 | 1.09 | 2.36 | 1.02 | 2.21 | 0.86 |

4. Discussion

The aim of this study was to check how urban areas with urban greenery affect the physiological and psychological characteristics of the subjects. Checking how urban forest areas affect respondents was another goal. Significant results were obtained and are discussed.

4.1. Physiological Effects

4.1.1. Blood Pressure

The present study has shown that even a short recreation period, like a walk, influences change in blood pressure. The lowering of SYS and DIA pressures was observed after the walk. Therefore, our research confirms what has been known before [47–51]: short walking programs are crucial for

prophylaxis, especially in the field of regular pressure and cardiac work. Wheeler et al. [47] revealed that, in the case of both men and women, the level of systolic arterial pressure after physical exercise (walking on a running track) and breaks between sitting was comparable to the level expected to be achieved by taking blood pressure medications. Walks and other physical activities lower the risk of death due to cardiac diseases and strokes [47]. Numerous studies show that short leisure time in open nature causes the reduction of blood pressure [8,52,53]. The results indicate that, in the case of blood pressure, the lowest, most desirable values of blood pressure were observed in the deciduous forest, as compared to other sites.

Furthermore, we conducted our research off-peak, when the noise intensity was low. The comparable effect of walks in housing areas with green spaces to walks in forest areas demonstrated that it is not only parks and green squares or coherent green areas in cities that provide profitable leisure conditions. Since studies on corrective results concerning variations of green areas along streets are limited, valuable information can be obtained from the research on landscape preferences of the road users. The abovementioned research was conducted by, e.g., [54–59]. These studies showed that vegetation along streets raises their scenic value. Akbar et al. [57] drew attention to the necessity of including green places along streets as similar as possible to natural forms. Pynnönen et al. [58] indicated that the most attractive roads are those which include open spaces or high-vegetation areas. The dimension was only discussed in the study of [56], on how the character of the street affects drivers' stress level. Parsons et al. [56] showed that roads in natural scenery are not as tiring and stressful as those that pass through urbanized areas. In future studies, emphasis should be put on the search for a model of vegetation along streets that would have the greatest potential for the restoration of urban inhabitants: pedestrians, cyclists, as well as drivers of different vehicles (cars, buses).

4.1.2. Pulse Rate

One of the symptoms of living under stress is a higher pulse rate, which might have a negative impact on human health and well-being [60]. Definitely, a short walking program might be a useful tool in combating stress, as indicated by previous research [8,61]. Nevertheless, our study did not determine that walks in the short walking program statistically significantly influenced the participants' pulse rate. We also did not observe any changes in this range concerning the place of the walk. It might have been because participants of our study were students, professionally inactive and childless. There are many studies confirming that students are a group of people who can be under a lot of stress. Students face a wide range of ongoing stressors related to academic demands [62], resulting in many having mental health problems such as depression and anxiety, sleep disorders and substance use [63]. In our view, in the Polish context, students are less affected than other adults by long-term stress-provoking factors due to their lack of job-related or family obligations. However, this thesis would have required in-depth research. The pulse rate reduction was often observed in previous studies on the topic of forest recreation [8,52,53,64]. However, participants in these studies were adults aged 35–53 [64] or older [53]. Likewise, the experiment of Bielinis et al. [8] was participated in by both students and professionally active people. In further studies, it is worth considering demographic factors, which might give more detailed information on the effects of restoration due to short walks, which are more apparent in some groups (e.g., professionally active people), less noticeable in other (e.g., young people, students).

4.2. Psychological Effects

4.2.1. Positive and Negative Affect Schedule (PANAS)

The results of our research show that short walks help minimize negative emotions. The level of negative emotions measured by PANAS was significantly lower after the short walking program, whereas the level of positive emotions did not change. Previous studies also proved that recreation lowers the level of negative emotions [11,18]. Additionally, research on recreation in the forest

environment showed that this intervention has an impact on the participants' well-being [52,53,65,66]. The studies of Tyrväinen et al. [11] indicated that the positive aspect of PANAS increased in a forest environment and was reduced in urban environment. However, the effect on PANAS's positive aspect was not observed in these studies, as high noise levels were observed in all four environments (the object of the study was the vicinity of a large European city), which may have influenced the achievement of higher PANAS positive values under these conditions, but this requires further research on this issue.

Bielinis et al. [44] indicated that the level of positive emotions decreased after observing an urbanized landscape with a simultaneous rise of negative feelings. Likewise, Jung et al. [67] concluded that negative emotions were generally lower in the forest than in the city. Takayama et al. [26] compared the forest and urban areas and claimed that the level of negative feelings was indeed lower and the level of positive feelings was significantly higher after spending time in the forest (total effect of walking and observing) than the result of recreation in urban areas. Recreation in the forest facilitates more effective recreation than physical activity undertaken in the city. Our study did not determine whether the type of surroundings significantly influenced the change in mood of the experiment's participants. Both in the two locations amidst urban housing (apartment and green suburbs) and in the two forest areas (coniferous and deciduous), the level of positive and negative feelings remained similar. However, the urban areas in [26] were considerably different from the urban areas provided in our research. They conducted research in an urban area, along major communication roads in the city center or around the main railway station. Our research took place away from the city center, in one of the newest, most peripheral suburbs of Warsaw, which is more off-peak. This means not only limited traffic but also a lower noise intensity. It is highly feasible this was the reason for not observing any major differences in the affect indicators measured by the PANAS test before and after the short walks in urban space and in the forest. In future research on the impact of recreation on people's health, it is worth highlighting the character of the urban area, especially the share and character of urban vegetation. This has a significant meaning, especially because, not only in Poland but also in other regions of Europe and the world, the majority of people reside currently in cities [68]. Urbanization and lack of physical activity have led to growing physical and mental health problems among urban communities. These problems clear the way to reduce work efficiency and increase absence, as well as increase expenditure on health care systems. The possibility of reversing these tendencies might be seen in the promotion of an active lifestyle and the development of green infrastructure.

4.2.2. Restorative Outcome Scale (ROS)

A short walking program, as our study proved, has a restorative effect. The scale values of the ROS results after accomplishing the program of short walking were significantly higher than those before the walk. The findings of various studies have shown that values in the ROS scale grow as a result of recreation in forest areas [8,18,44,69]. Takayama et al. [26] indicated that both walking and the overall effect of walking and watching during a short period in the forest explicitly evoked the feeling of subjective restoration (ROS). Conversely, a fall in ROS points was noticed after the overall effect of walking and watching in urban areas in comparison to the evaluation before the experiment. Our research did not confirm this. We did not notice any significant difference in ROS parameters achieved by the participants strolling in housing places or in the forest. According to Takayama et al. [26], the possible reason for different ROS values achieved after recreation in the city and in the forest might be the crowds and/or many factors associated with urban areas that could negatively affect the feeling of subjective restoration. In our research, though the urban area had a higher noise level than the forest, it was not a troublesome level. This is surely the reason for the similar range of ROS factor values after a walk in an urban area and in the forest. Furthermore, this situation might be derived from the demographic factors. We consider that more obvious differences in the level of influence of the space type (*suburbs/forest*) on restoration might be the result of research undertaken among older people or more professionally active people. Hartig and Staats [70] reported

that tired people have a stronger urge to regenerate than people with a fresh mind. This shows a stronger positive influence of the natural environment compared to the urban environment on mentally exhausted people. Moreover, surveys of landscape preferences show that age might be an important factor. Surveys on landscape preferences can be useful in this respect, as effective regeneration takes place in a surrounding considered attractive. For example, Yang and Kang [71] proved, in studies concerning sound in a landscape, that youth and older people might evaluate sounds differently. The more advanced they are in age, the less tolerant people are to sounds associated with human activity. Indeed, 80% of interviewed older people preferred the calm and natural sounds of nature in urban squares (birds singing, water murmuring, etc.). Young people showed less interest in a high level of naturalism in the surroundings; they are more tolerant of sounds connected with human activity (buzz of voices, traffic in the city, etc.). Therefore, it is important not only from the public health point of view but also from the view of urban planning to understand how various types of space influence the restoration of city inhabitants.

4.2.3. Subjective Vitality Scale (SVS)

Vitality is a notion that can be estimated objectively through physiological reactions or subjectively through psychological reactions [72]. In the present research, subjective methods were used, similar to in the research of Bielinis et al. [8] or Takayama et al. [26]. The obtained results indicate that short walks cause an arousing feeling of vitality among the participants. Previous studies conducted in forest environments proved that recreation contributes to the rise in feelings of vitality [11,44,73]. However, our results contradict the findings of Takayama et al. [26], who claimed that a significant rise in the feeling of subjective vitality (SVS) can be observed only after walks in the forest. The level of vitality acknowledged in our research as an effect of walking in suburbs did not vary from the level achieved after walking in a forest. We believe that a huge amount of vegetation, a relatively low level of noise and a lack of crowds are sufficient to raise vitality level after a short walking program in suburbs to a comparable value to after recreation in forest. In future studies, it is worth concentrating on the type and duration time of the relaxation. It is feasible that a longer recreation period or recreation that requires more physical activity than walking (jogging, cycling) in the forest or other natural environments will make it possible to achieve a considerably higher level of vitality than after walking in urban areas. Research in this matter is crucial because a high vitality level influences human productivity, which is relevant to society.

4.2.4. Profile of Mood States Questionnaire (POMS)

The results showed that a short walking program has a positive impact on mood state. After recreation time, results showed lower values for the indicators of tension, depression, anger, confusion and fatigue, and a rise in values relating to vigor. Previous studies concerning short 15-min recreation periods in a forest environment confirmed the same observation [44,52,53,73]. We noticed that the place of recreation has a crucial meaning concerning the indicator of tension. This indicator's value was significantly higher in the context of urban areas than in the forest. The highest level of tension was observed among the group that walked in a housing area with an arterial road. The value of the indicator in the case of walks in the detached house quarter was slightly lower. The value of this parameter has also been changed by the forest environment. A higher value was noted among the group walking in a coniferous forest, a lower value in the deciduous forest. In the last case (deciduous forest), the lowest value was noticed, which was almost twofold lower than in apartment suburbs. Inhabitants of big cities, used to crowds and noise, may feel insecure in this kind of space, especially when they are walking alone without making contact with others. Therefore, the measured level of tension of the participants walking in suburbs was considerably higher than of those walking in the forest. For the forest, there were differences observed with possible relations to vegetation type. The deciduous forest (lowest level tension indicator) is characterized by a more open space than the coniferous forest. The reason why the improvement in tension on POMS is greater than in the

deciduous forest is that the leaves fall off due to the influence of the season and so participants will be more psychologically stable, which is confirmed by the study of Bielinis et al. [74].

Our research was conducted in fall, when the trees and shrubs were already leafless, which makes the space broader and strengthens the feeling of safety, and therefore guarantees a lower feeling of tension. Future research should consider the different seasons of the year. It seems that apart from the management type of the forest (natural forest, managed forest), the vegetation character concerning the season might have a significant meaning in the restorative process of the human. It is also important to note that the presence of green areas [75] increases the physical activity of people having access to these areas, which is closely related to our research.

5. Limitations

The greatest limitation in our work was the noticed lack of an interaction effect between the experimental variants. This resulted from the fact that the experimental variants had an equally positive effect on the physiological and psychological values of the participants, compared to the default state, which is staying indoors. The suburbs with vegetation had a similar impact on the study's participants to the forest. In all four places, there was a certain level of noise, so this could also have been the meaningful factor, responsible for the similar properties of the four observed environments.

Another limitation of the study is the fact that we concentrated on psychological effects straight after the experiment, excluding potential long-term effects. This remains a topic for future research. An additional limitation was the fact that the experiment was conducted on a group of Polish adults, i.e. students without professional obligations and families, and professionally inactive. This means that our results might be specific to this particular group. We have examined only the impact of short walks; other forms of recreation demanding more physical activity might lead to different, clearer results for parameters. Moreover, we eliminated the stress factor related to traveling to the recreation place. Just after leaving the building, the participants began the recreation program. The research was conducted only in one season—late fall. We chose this on purpose, as it is the time of the year which most negatively affects the psyche of Polish people. The days are short, access to sunlight becomes limited, and the weather is changeable. The end of fall is considered gray and sad, which might trigger depression or bad moods. Our research was conducted during weather characterized by average cloudiness, without precipitation, and with thermal conditions typical of this time of year in Poland. Perhaps, more sunshine or a higher temperature could contribute to the relaxing effect of short walks on the analyzed psychological and physiological parameters. Continuing the research in other seasons might produce different results.

6. Conclusions

In the study, two urban environments (apartment and green suburbs) were used, as well as two forests (coniferous and deciduous) to measure the impact of these environments on human physiological and psychological relaxation during a walk in a randomized experiment. Before each experiment, the physiological and psychological state of the participants was measured indoors (pre-test). The conducted analyses showed that both walking in the suburbs and in the forest with fall scenery have a positive effect on the physiological and psychological relaxation of participants.

Most of the analyzed psychological coefficients changed significantly after a walk in a given environment, compared to the pre-test, but only the mood aspect of “tension” changed significantly depending on the type of place (urban and forest environment), so it can be concluded that these psychological aspects also changed depending not only on the time of the study but also the place.

The study also showed that, in case of blood pressure, the deciduous forest was more effective in lowering it. The above indicates that various places with urban vegetation can be successfully used for recreation; just as for forests where forest bathing is practiced, the deciduous forest environment may be slightly more beneficial for this type of recreation. Visitors to city fragments that are overgrown with urban greenery can benefit from walking in these areas, so walking in these areas is recommended.

Similarly, walking in forest areas can have a positive effect on people walking in these areas, therefore walks in forests are recommended for maintaining the mental and physical health of their users.

It is also important to note that the effect of physical activity and the effect of green areas were integrated in the conducted research. When these two factors are considered together, then the effectiveness of the walk in both the urban and forest environments is combined and a general conclusion is reached that physical activity and activity in urban greenery and suburban forests can positively influence the psychological and physiological parameters of the study participants.

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