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Physiological and Psychological Health Benefits of Urban Green Space in Kuala Lumpur: A comparison between Taman Botani Perdana and Jalan Bukit Bintang

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ABSTRACT

This study explores physiological and psychological effects of urban green space by using measurements and self-reported psychological responses to an urban park compared to a city environment. Participants of this study were 20 homogenous male students. Taman Botani Perdana, an urban park in Kuala Lumpur, and Jalan Bukit Bintang, a commercial district in the city centre were chosen as the study areas for this study. On the first day, the participants went to Taman Botani Perdana, and to Jalan Bukit Bintang on the second day. In both areas, the participants were instructed to walk along a given route for 20 minutes. Saliva samples were collected before and after walking in both areas along with blood pressure measurements. Self-reported physiological responses were measured before and after each walking session. Results indicated that salivary cortisol concentration significantly increased in the city, whereas no significant change was found in the urban park. Diastolic blood pressure significantly reduced after walking in the urban park. In terms of psychological responses, Total Mood Disturbance among the participants were significantly lower when they were in the urban park compared to the city. Meanwhile, the Positive and Negative Affect Schedule (PANAS) showed that positive effect significantly increased after walking in the urban park, whereas the participants' positive effects significantly reduced after walking in the city. These results indicate that urban green space has positive benefits physiologically and psychologically compared to urban environment.

Keywords: Urban green space, restorative environments, salivary cortisol, scientific evidence, stress

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INTRODUCTION

Urban green space is defined as all publicly owned and publicly accessible open space with a high degree of cover by vegetation such as parks, woodlands, nature areas and other green spaces (Schipperijn et al., 2010). Urban green space is often considered as essential for urban dwellers because the benefits provided by them are extensive. Green spaces within urban settings are believed to be experiencing pressures and threats as a result of urban growth. Therefore, there is a prevalent concern that urban sprawl and rapid expansion of cities occurring all over the globe can isolate urban dwellers from direct contact with nature (Willson, 1984). These concerns are more dominant in developing countries where cities lack proper development planning especially in terms of landscapes. The United Nations (UN) has estimated that more than 50% of the world's population are already living in urban areas and this percentage is forecasted to rise rapidly over the coming years (United Nations, 2014). This leads to more expansion of cities to provide housing, employment opportunities, roads and other infrastructures that may further degrade the natural environment.

In today's society, people face various pressures from work, noise pollution, and other stressors. This phenomenon drives people to seek for relief and physical activities through outdoor recreation in restorative environments. Urban sprawl has also been directly linked to increment of obesity rates (Ewing et al., 2008). With obesity, risks of other diseases such as cardiovascular diseases, hypertension, diabetes and certain cancers increase many folds (Ramachandran & Snehalatha, 2010). For urbanites, urban green spaces provide the most ready access to restorative environments (Maller et al., 2006). Urban green spaces also act as a platform for people to exercise and be inspired to be more physically active. In an urban environment, the main contribution to the enhancement of quality of life, in terms of perceived health conditions and environmental quality, as well as affective and cognitive attachment to the place of residence, is thus provided by urban green spaces and their availability and accessibility (Conedera et al., 2015).

Willson (1984)'s "biophillia" hypothesis states that humans possess a deep-seated biological need for connections and contact with nature, which can be understood as living systems other than that of human beings. This is where the role of urban green spaces comes into hand. As more areas are given way for urbanisation and development, humans are starting to lose contact with nature. In addition, from the social and political contexts, the roles of urban green spaces, particularly park and recreation settings, have also been related to other goals such as environmental preservation, community and economic development, rather than merely focusing on public health.

The use of urban green spaces is defined in general as any sort of visits to an urban green space, without looking at the duration of stay, motivation of visit or activity done (e.g., passing through on the way to a

destination is also taken as use) (Ewing et al., 2008). Hence, any sort of interaction with an urban green space is considered as use, as the many benefits of an urban green are passive, or in other words, intangible. These passive benefits are of, or closely related to, emotional or psychological responses of people. Chiesura (2004) stated that despite their intangible and immaterial nature, these services (of urban parks) provided clear benefits to people, whose loss can have serious socio-economic consequences.

Existing studies on the restorative effects of urban green spaces have been extensive throughout the years. Studies utilizing objective measurements for stress in relation to natural environments have been on the rise only in the past decade in more developed countries such as in the US (Beil & Hanes, 2013), the EU (Roe et al., 2013; Triguero-mas et al., 2017; Thompson et al., 2012) and Japan (Lee et al., 2011). A study by Lee et al. (2011), compared the response of 12 participants exposed to a forest setting and an urban setting in a 3-day field experiment. Salivary cortisol and pulse rate decreased significantly in the forest setting compared to the urban setting.

Although many researchers have hypothesised that the level of physical activity increases well-being (Mansor et al., 2012; Nor Akmar, 2012), in developing countries such as Malaysia there is no clear indication as to how beneficial physical activity is in urban green spaces based on the objective data as it is lacking. Thus, the gap in this knowledge needs to be addressed to obtain a better understanding of the benefits of urban green spaces, which may be useful in public health and urban green space planning and management. Furthermore, studies on stress levels have always been limited to questionnaires that are either in the form of open-ended questions, or ratings and scales. Meanwhile, experimental tests on stress need to be done in order to provide solid objective data.

MATERIALS AND METHODS

Study Area

Figure 1. A view on Jalan Bukit Bintang (left) and Taman Botani Perdana (right)

The field experiment was done in two different sites to compare the physiological effects of two different environments. The first site, Taman Botani Perdana Kuala Lumpur, is situated near the city centre of Kuala Lumpur, with an approximate distance of 3 kilometres. It is a famous urban park that is frequented by urbanites to spend their leisure time. The second site, Jalan Bukit Bintang, is a typical urban area situated in the heart of Kuala Lumpur. It is a busy and hectic commercial area full of motorised vehicles and tall buildings. Each site was chosen from a range of sites with specific environmental characteristics. Both of the sites chosen were man made however, Taman Botani Perdana has a higher vegetation concentration when compared to the more built environment of Jalan Bukit Bintang. The distance between Universiti Putra Malaysia, which serves as the starting point to both of the sites, were approximately similar.

Subjects

A total of 20 males students were recruited from the Faculty of Forestry, University Putra Malaysia. At the recruitment stage, those who have mental disorder, whether current or past, were screened and excluded. The age range of the participants was set to be 23.1 years old on average. Before conducting the experiment, all of the participants were briefed and thoroughly explained about the objectives of the study and the procedures involved. They were also required to sign a written consent form. The consent form states that all data collected from participants were to be strictly used for research purposes.

Procedure

Before arriving at the study sites, all the participants were briefed and explained once again about the objectives of this study. They were also instructed not to smoke, consume alcoholic beverages and eat prior to the collection of their saliva samples. This was done to ensure that the saliva collected was not affected by other external factors. The study sites were also visited on a weekday and the experiments were conducted at a similar time frame (i.e., 0900 to 1100 hours).

The subjects travelled to both sites via bus, and before initiating the study a short briefing was held. Next, the saliva samples of the participants were collected, this was followed by their blood pressure reading. A questionnaire form, containing Profile of Mood States (POMS) and Positive and Negative Affect Schedule (PANAS), was distributed for the participants to complete. After the data collection, the participants were asked to walk along a predetermined route and take in the surrounding for approximately 20 minutes. At the end of the walk, the participants were asked to rest for 15 minutes so as to mitigate any physiological effects after the physical activity. The participants' saliva samples were collected again, and this was followed by taking their blood pressure reading. The POMS and PANAS test was also done

right after that. In addition, the Restoration Outcome Scale was also given to the participants to respond to. Figure 1 briefly describes the experimental design of this study.

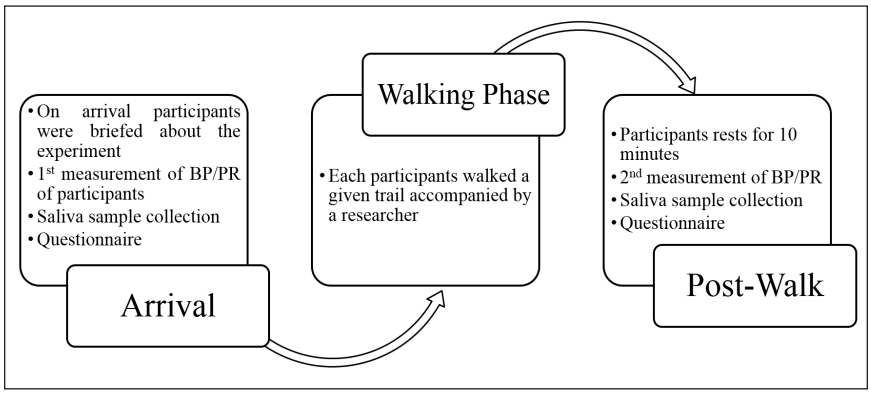

Figure 2. The experimental design

Measurements

The first physiological index measured was salivary cortisol. Salivary cortisol was used in this study as a biomarker for stress. Saliva sampling was done as it is simple and non-invasive unlike venipuncture. The saliva samples were collected and stored in cryo-vial tubes and later analysed by using the ELISA kit in a laboratory. In both the sites, the saliva samples were collected two times; before walking in the environment and after the walk.

The next physiological index measured was blood pressure. Systolic and diastolic blood pressures were measured using a portable blood pressure monitoring device. These data were collected in the same period when the saliva samples were obtained. Before the measurement was done, the equipment was calibrated and checked to minimise errors.

The psychological indices used in this study were the Profile of Mood States (POMS) by et al. (1971), Positive and Negative Affect Schedule Watson et al. (1988) and Restoration McNair Outcome Scale (ROS) by Korpela et al. (2008). All three tests were prepared in Bahasa Malaysia and English to better suit the participants.

Statistical Analysis

The physiological and psychological measurements were used to compare the urban setting and park setting. A total of 20 samples were analysed in this study. A paired t-test was used to analyse the physiological and psychological effects between the urban green space and the city. The statistical differences were considered as significant at $p > 0.05$. In addition, correlation analysis was also used to determine the relationship strength between the variables measured.

RESULTS AND DISCUSSION

Physiological Responses to Both Environments

Based on data presented in Figure 3, in the city setting, salivary cortisol levels showed significant increases in value among the participants compared to before the value of 1.75 ± 1.00 µg/dl and after at 2.33 ± 1.04 µg/dl ($p < 0.05$). In the after period, the participants' cortisol levels showed a significant difference with that of the UGS setting, which is lower than the City (UGS: 0.89 ± 0.55; City: 2.33 ± 1.04; $p < 0.05$). However, no significant differences were found between UGS and City for the before period, as well as between the before and after period in the UGS setting.

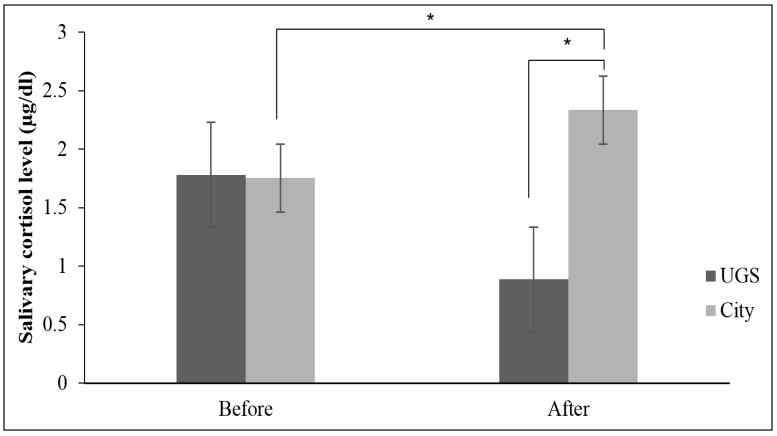

Figure 3. Comparison of the mean values of salivary cortisol levels between urban green space and the city before and after walking. * indicates significance at p<0.05 verified by paired t-test. Values are means ± standard error

Based on data given in Figure 4, blood pressure readings showed a significant decrease in value among the participants in UGS for diastolic pressure (Before: 77.9 ± 5.53; After: 70.5 ± 10.05; $p < 0.05$). Diastolic pressure also showed a significant difference between UGS and City in the after period, with the UGS participants showing lower values than the City (City: 76.6 ± 10.69; $p < 0.05$). Nonetheless, no significant differences were shown in diastolic blood pressure in the before period between the two environments. Similarly, the pulse rates also showed significantly lower value in UGS compared to City among the participants in the after period (UGS: 66.8 ± 10.71; City: 72.4 ± 13.71; $p < 0.05$). Diastolic blood pressure, however, did not show any significant difference in the before period at both UGS and City. Similarly, systolic blood pressure did not show any significance in both the before and after periods in both the environments.

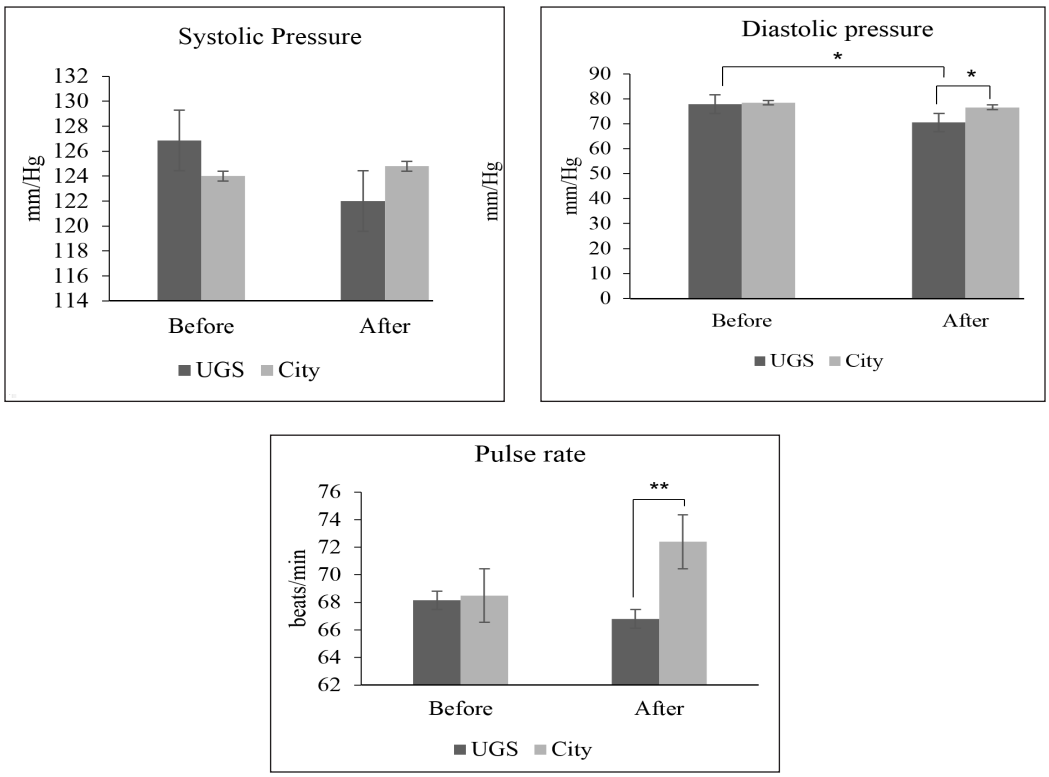

Figure 4. Mean comparison of systolic blood pressure, diastolic blood pressure and pulse rate in both Urban Green Space and City. Bars with (*) indicate significant differences between groups at p 0.05

Psychological Responses to Both Environments

Table 1 shows the Restoration Outcome Scale. The participants in the UGS setting reported a higher score for all the six statements in the scale compared to the score for the City setting. It is important to note that all the six items were highly significant in difference ($p < 0.001$).

Table 1
Descriptive of ROS statements and the p-value comparison between Urban Green Space and City outcomes

Statement	UGS		City		p-value
	M	SD	M	SD	
I feel calmer after being here.	5.65	1.531	2.75	1.376	< 0.001
After visiting this place I feel restored and relaxed.	5.85	1.226	2.65	1.373	< 0.001
I get enthusiasm and energy for my routines from here.	5.5	1.1	2.85	1.021	< 0.001
My concentration and alertness clearly increase here.	5.6	1.095	2.65	1.252	< 0.001
I can forget everyday worries here.	5.7	1.261	2.55	1.191	< 0.001
Visiting here can be a way of clearing and clarifying my thoughts.	5.75	1.410	2.85	1.040	< 0.001

M = mean, SD = standard deviation. Significance at p<0.05

When comparing between UGS and City setting, the data presented in Figure 5 for Profile of Mood states tests indicated significant differences between all the six subscales in the after period – tension (UGS: 2.2 ± 0.97; City: 12.3 ± 2.40; $p < 0.05$), depression (UGS: 2.8 ± 1.10; City: 10.3 ± 2.18; $p < 0.05$), anger (UGS: 2 ± 0.99; City: 10.45 ± 2.27; $p < 0.05$), fatigue (UGS: 4.1 ± 1.13; City: 12.25 ± 1.76; $p < 0.05$), confusion (UGS: 3.35 ± 1.01; City: 8.55 ± 1.64; $p < 0.05$), and vigour (UGS: 23.55 ± 1.43; City: 13.65 ± 1.76; $p < 0.05$). Total Mood Disturbance scores only showed significant difference in the after period between the UGS and City settings (UGS: - 9.71 ± 5.4; City: 40.2 ± 10.87; $p < 0.05$). In the before period, however, only vigour showed a significant difference between UGS and City (UGS: 20.4 ± 1.54; City: 15.9 ± 1.93; $p < 0.05$). Moreover, tension ($p < 0.05$) and confusion ($p < .05$) decreased significantly in the UGS setting. However, tension ($p < 0.05$), depression ($p < 0.05$), anger ($p < 0.05$), fatigue ($p < 0.05$), and confusion ($p < 0.05$) increased significantly after a walk in the City setting. There were no significant differences between the before and after period for the TMD scores in both settings.

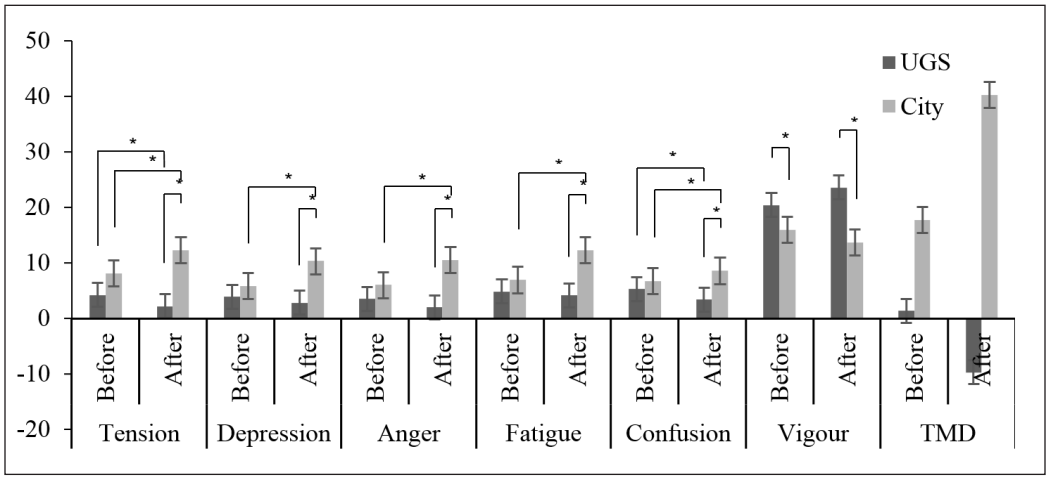

Figure 5. Comparison between the mean values of Profile of Mood States subscales at two measurement periods in both Urban Green Space and City. TMD; Total mood disturbance. (*) indicates significance at $p<0.05$

The participants, when walking in the UGS setting, showed an increase in positive subscales (Figure 6) – interested (Before: 3.45 ± 0.17; After: 4.10 ± 0.14; $p < .01$), excited (Before: 3.25 ± 0.20; After: 3.75 ± 0.14; $p < 0.05$), strong (Before: 3.00 ± 0.24; After: 3.85 ± 0.17; $p < 0.01$), proud (Before: 2.75 ± 0.26; After: 3.95 ± 0.18; $p < 0.01$), determined (Before: 2.70 ± 0.22; After: 3.45 ± 0.21; $p < 0.05$), and active (Before: 3.15 ± 0.23; After: 3.95 ± 0.15; $p < 0.01$). In contrast, when walking in the City area, three positive subscales decreased – interested (Before: 3.00 ± 0.26; After: 2.35 ±

0.28; $p < 0.05$), enthusiastic (Before: 3.20 ± 0.22; After: 2.40 ± 0.29; $p < 0.05$), and proud (Before: 3.00 ± 0.26; After: 2.10 ± 0.25; $p < 0.01$). When comparing data for both study areas, only the subscale "interested" during the after period showed a significant difference ($p < 0.01$).

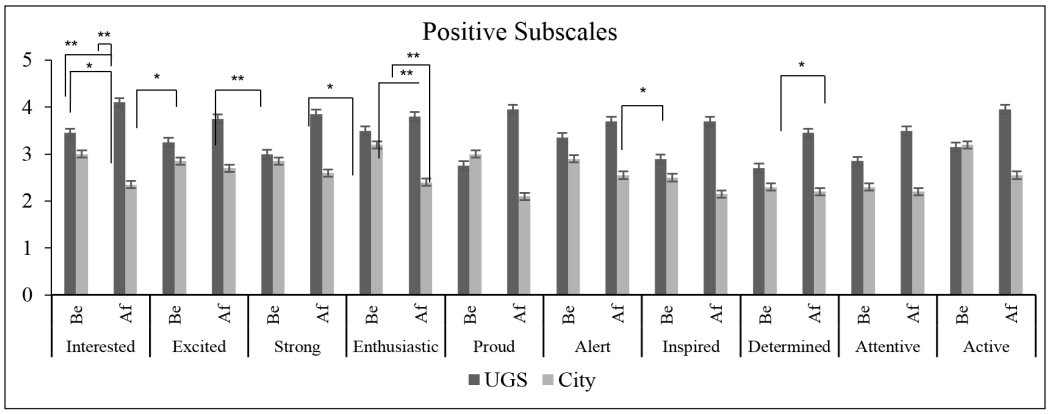

Figure 6. Mean value comparison of positive subscales at two measurement periods in both Urban Green Space and City. Values are mean ± standard error, $n = 20$; ** p<0.01; * p<0.05; significant differences via paired *t*-test

In terms of negative subscales (Figure 7), only the subscale "jittery" decreased significantly after the participants had walked in the UGS setting (Before: 1.7 ± 0.27; After: 1.10 ± 0.07; $p < 0.05$). When comparing both sites, two negative subscales showed a significant difference in the after period – distressed ($p < 0.01$), and irritable ($p < 0.01$). No other subscales showed any significant differences for the before and after periods or between the urban green space and city.

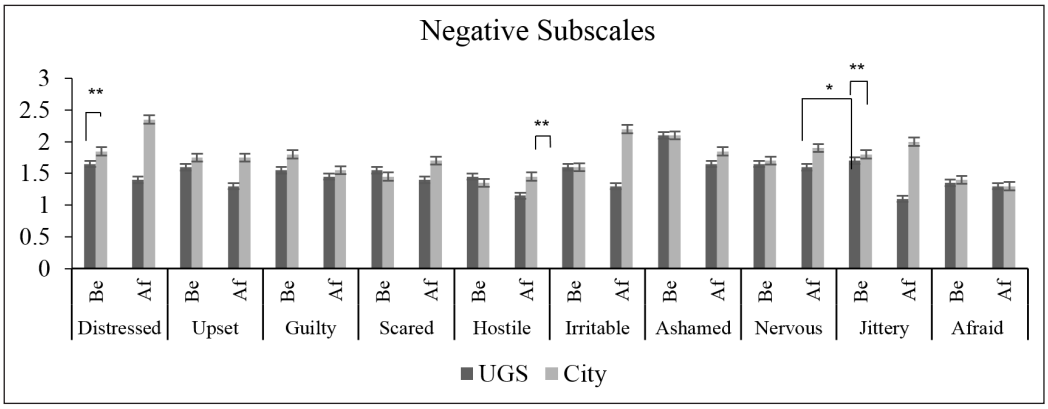

Figure 7. Mean value comparison of negative subscales at two measurement periods in both Urban Green Space and City. Values are mean ± standard error, $n = 20$; ** $p<0.01$; * $p<0.05$; significant differences via paired *t*-test

When summing the scores of the positive and negative subscales (Figure 8), a significant difference can be found at the city setting for both the positive and negative subscales. Positive attitudes decreased (Before: 28.10 ± 1.58; After: 23.80 ± 2.18; $p < 0.05$), while negative attitudes increased (Before: 16.80 ± 1.51; After: 18.05 ± 1.75; $p < 0.05$) after the walk in the City. In the UGS setting, however, only positive attitudes increased (Before: 30.09 ± 1.26; After: 37.75 ± 1.41; $p < 0.01$). There was no significant difference in the negative attitudes after walking in the UGS setting. When comparing both the study sites, only negative attitudes showed a significant difference between before ($p < 0.01$) and after ($p < 0.05$) periods.

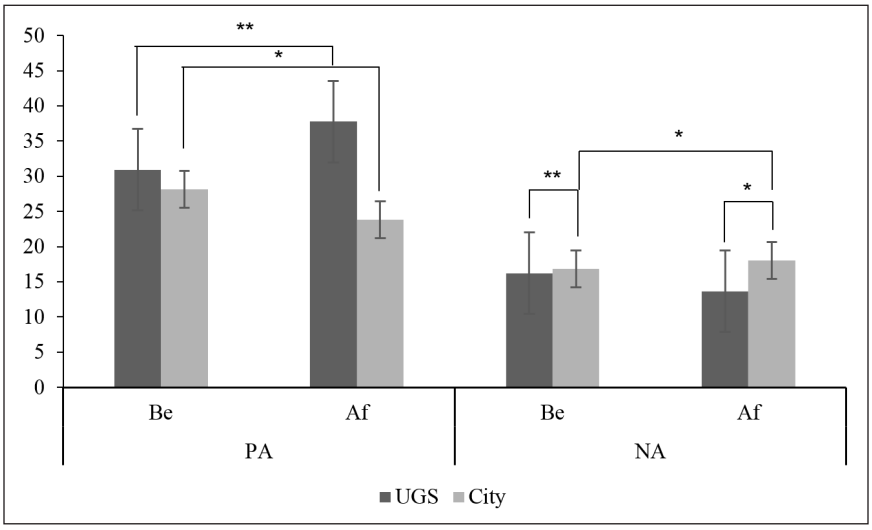

Figure 8. Comparison mean values between positive and negative affect scores in both Urban Green Space and City. Mean ± standard error; $n = 20$; $^{**}p<0.01$; $^{*}p<0.05$; significant differences via paired *t*-test

Even though salivary cortisol changes in UGS did not show any significance in the results of this study, when compared to the City, a significant lower value of cortisol concentration was observed after the walking phase. This is in line with the findings of a study done by Triguero-mas et al. (2017) in Spain which showed lower values of salivary cortisol among participants in green environment when compared to urban environment. Our findings on salivary cortisol changes were not in agreement with a study done by Beil and Hanes (2013) which showed no significant reduction or otherwise in salivary cortisol concentration. A study by Lee et al. (2011) is also not in agreement with our findings as the study done in Japan showed no significant difference in salivary cortisol in the after period. Significantly lower salivary cortisol levels in the UGS compared with the City could be interpreted as the participants feeling relaxed or less stressed in the UGS setting (Lee et al., 2011).

The findings also indicated that walking in the urban green space positively affects users in terms of stress responses. Pulse rate among the participants after walking in the urban green space showed a significant decrease compared to that of the City. This was also observed in the diastolic blood pressure, in which after the walk in the city, the participants were found to have higher pressure readings compared to when they were in the urban green space. The results obtained from the diastolic blood pressure reading corroborates with that of Hartig et al. (2003) which revealed that the subjects who walked in the natural environment had a significant difference in their diastolic blood pressure readings compared to those walking in an urban environment.

Meanwhile, the ROS test clearly showed that the participants felt a higher level of restorative-ness in the urban green space when compared to the city. The second statement of the ROS test "After visiting this place, I feel restored and relaxed" showed the highest mean value among the participants in the urban green space and when compared to the city, a large gap could be seen. This finding suggests that the urban green space gives a sense of relaxation as well as restoration. This is in agreement with a previous study by Tyrväinen et al. (2014) which showed an increased feeling of restoration in green environments and their decrease in a built urban setting.

Furthermore, the POMS test indicates a clear distinction between the restorative effects of UGS and City as the participants' TMD in the UGS is negative, while this is positive TMD for the City. This finding shows that the participants were in a better state of mood in the urban green space as tension and confusion decreased significantly after the walk. A significant difference in the vigour scores could also be seen when comparing both the study areas with the participants showing a higher level of vigour scores for both before and after periods in the UGS. Hence, it is clear that the UGS intensifies the state of positive mood and decreases the intensity of negative mood state. This further suggests that constructed natural environments such as UGS can be beneficial in the emotional aspect of individuals. The findings of the POMS test are partly consistent with the previous studies (Lee et al., 2011; Li et al., 2007).

In summary, positive moods increase in the urban green space setting compared to the city. On the contrary, negative moods decrease in the urban green space when compared to the city. The increase in the positive moods in urban green space is in line with some previous studies (Hartig et al., 2003; Tyrväinen et al., 2014), and this shows that the urban green space has a positive impact on emotions. The findings also indicated the participants felt greater negative emotions in the city after walking.

Limitations of the Study and Recommendations for Future Works

Our research contains several limitations. First, the subjects were only limited to male students. This means the results can only be extrapolated to young male adults of the same age group. Second,

the study areas were only limited to two types of environment (an urban park and a commercial area in the city). Third, due to budget constraints, we could only afford to collect a limited number of saliva samples. This means that a further understanding of how cortisol changes throughout the day among subjects could not be fully ascertained.

With regards to the limitations of our research, it is recommended that future studies have more diverse subjects, which include more age groups and also female respondents. Next, varying the study areas to include other forms of environment such as an urban forest could provide better insights into the effects of urban green space on individuals. Finally, the saliva samples need to be collected throughout the day to further understand how use of urban green space can affect users' stress levels.

CONCLUSION

The results of this study show the possible effects of urban green space in stress reduction and attention restoration. Physiologically, cortisol levels and blood pressure are much more stable in the urban green space when compared to the city. Lower cortisol levels indicated that the participants felt more at ease or relaxed in the urban green space, whereas this resulted in an increase in cortisol level for the city area, indicating that the participants were feeling stressful after walking in that environment.

The higher positive mood and emotions in the urban green space compared to the city indicates the calming psychological effects of urban green space. Total mood disturbance between urban green space and city showed a significant difference in the mean score. In particular, UGS could be seen to reduce the negative emotions but elevate positive emotions, as seen in the PANAS test. This finding is the opposite for the city as negative emotions were shown to have increased among the participants, while their positive emotions decreased.

The support given from the physiological results further gives strong evidence that urban green space plays an important role in individuals' stress and restoration. This is somewhat lacking in the field of study. The urbanites' important access to urban green space is also reinforced by the results of this study. Evidently, being in urban environments increases stress. This justifies the need for proper planning of urban green spaces such as parks in densely populated cities of Malaysia. As urban parks would be the most readily accessible nature area for urbanites, it could be seen as a preventative medicine for chronic stress. The findings of this study can be used as a reference for urban planners to establish urban green spaces in densely populated areas.

However, the results of the study were derived from only 20 young male subjects who are physically and mentally fit. Therefore, the results might not be suitable to be used as a reference for other age groups and gender. Nevertheless, the study results can coin a presumption that urban green space has its own physiological and psychological benefits.

ETHICAL APPROVAL

This study was approved by the Ethic Committee for Research Involving Human Subjects, Universiti Putra Malaysia.

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