The Relationship of Physical Activity and Human Comfort in Urban Park

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Abstract

Urban parks offer the ideal locations and opportunities for activities to improve human psychological wellbeing. This study investigates the people's perception of their physical activities at the Shah Alam Lake Garden, Malaysia. A total of 438 respondents were interviewed about their perception on their activities and their sensation of the hot and humid microclimatic conditions. The paper explores the psychological and physical mechanisms involved in outdoor activity and weather assessment.

Keywords: Physical activity; outdoor thermal comfort; urban park; hot and humid

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1.0 Introduction

The optmization of outdoor spaces is crucial for a healthy lifestyle. Outdoor spaces is not only limited to individuals but the community as well. Outdoor parks and green spaces are essential for a community's wellbeing and interaction. Parks and green spaces should not only provide a place to recreate, but create the opportunity for psychological revitalization of daily life.

Additionally, exercising outdoors creates greater enjoyment and satisfaction. Climate conditions varied the preference of the physical outdoor activity due to the constant changes of outdoor climatic conditions. When planning for sustainable green space, provision for human comfort and reducing heat stress have become more a predominant focus. Previous studies described thermal comfort as a fundamental parameter and discussed how heat stress/thermal discomfort affected outdoor activities (Kariminia & Ahmad, 2013; Kariminia, Ahmad, Ibrahim & Omar, 2010; Vanos, Warland, Gillespie, & Kenny, 2010). These studies explained the implication of heat stress in human life. Yet many studies have suggested the provision of extra-shaded areas through the use of trees, covered walkways, and the use of low energy material helps in a very complex urban form (Doulos, Santamouris, & Livada, 2004; Emmanuel, Rosenlund, & Johansson, 2007; Shahidan, Jones, Gwilliam, & Salleh, 2012). Although evidences of studies on thermal adaptation in outdoor open spaces are aplenty for temperate climates (Kariminia et al., 2013, Kariminia et al, 2011), there are still few literatures on the outcome of studies in tropical climates.

Thus, this study examines the relationships between microclimatic conditions and physical activities performed in an urban park. Data was gathered through random sampling of individual interviews of respondents doing various activities at the park. The paper aims to define the psychological and physical implementations involved in outdoor activity. The quantitative study comprised of fieldwork interviews using questionnaire survey, observations and weather data collection.

2. Literature Review

Open spaces offer opportunities for physical activity. Likewise, physical activity is important for maintaining physical fitness and can contribute positive attributes by promoting physiological well-being.

2.1 Physical activity and open spaces

Physical activity in the outdoor environment not only supported an improved lifespan, greater well-being and led to fewer symptoms of depression, it also provided improved capability for individuals to function better at work and home (Lafortezza, Carrus, Sanesi, & Davies, 2009). Ahmad, & Nordin (2011)explored the use of the outdoor spaces near low cost flats in Malaysia and found that they support various domestic, social and hideaway

activities for the flat community.Open spacesare social space that are accessible to the public. These spaces are significant community assets and places for people to participate in leisure activities in heavily populated urban areas (Nasir, Ahmad & Ahmed, 2013).

2.2 Human comfort in outdoor recreation area

Human comfort or thermal comfort can be defined as a condition in which individuals prefer neither warmer nor cooler temperatures i.e., the preferred temperature. The concept of thermal comfort is closely related to thermal stress. Many researchers have explored ways to predict the thermal sensation of people in their environment based on the personal, environmental and physiological variables that influence thermal comfort. As a result, several mathematical models that simulate occupants' thermal response to their environment have been developed.

Numerous studies have been done to show factors of human comfort in outdoor settings (Lin, de Dear, Matzarakis, & Hwang, 2009; Ying, Lin, & Hwang, 2011; Zambrano, Malafaia, & Bastos, 2006). These studies indicated that thermal comfort in the outdoor environments received diverse effects from each thermal parameter in different seasons and settings.

The outdoor conditions of hot and humid climates do not encourage daytime outdoor activities (Nasir, Anuar, Darus, Jaini, & Salleh, 2012). However, the concept of thermal adaptation proved otherwiseby Nasir, Ahmadand Ahmed (2012, 2013). Figure 1 shows how the Thermal Sensation Vote (TSV) and Physiological Equivalent Temperature (PET) proved adaptation is practised whenrespondents adapted to a higher range of thermal conditions (21.1 - 39.4°C of PET) compared to the comfortable range of PET (18 – 23 °C) in Europe. Almost 70% of the respondents perceived thermal comfort psychologically and adapted better to the outdoor conditions even when the PET was higher (Nasir, Ahmad, et al., 2012).

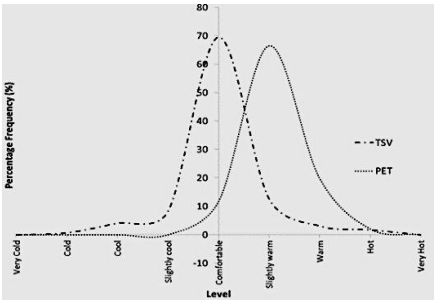

Figure 1: Percentage Frequency (%) on TSV and PET
(Nasir, Ahmad, et al., 2012)

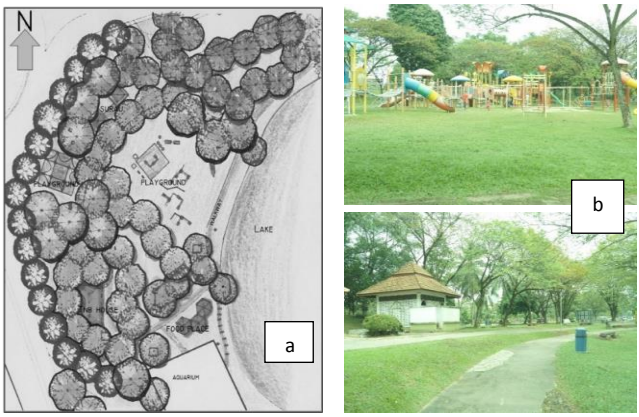

Figure 2: a) Sketches plan of the study area (not to scale) b) View of the study area

3.0 The Setting

3.1 Study area

The site is at the Shah Alam Lake Garden, Selangor, Malaysia (3°5'00"N, 101°32'00"E) and the size of the study are is approximately 2 acres. The chosen location for the field study is surrounded by *Samanea saman* (rain tree) and *Pterocarpus indicus* (Angsana) as the greenbelt that shaded the area and the ground is covered with graminoid of *Axonopus compresus* (common grass) (Figure 2). There is also a playground within the perimeter and picnic spots. A total of 438 respondents were interviewed about their perception on their activities and their sensation of microclimatic conditions. The microclimatic conditions were measured simultaneously using portable weather data instruments in 10-minute intervals. The section of the study site is shown in Figure 3.

Figure 3: Section of the microclimate study site (not to scale)

3.2 Microclimate condition

The local climate is equatorial, which is hot and humid. The relative humidity on site was high, between 50% and 99%. A portable weather station with probes for air temperature, relative humidity and wind speed, positioned 1.5 m from the ground was used for data collection. The measurements were taken on the 70, 99, 127, 134, 142 and 161st day of the year respectively. The measurement days were carefully chosen, by referring to the weather forecast for the weekend by excluding rainy days. The data was collected between 0700 and 1900 hrs each day at 10-min intervals with the total N of 438. The measured microclimate parameters were Air Temperature (T_a), Relative Humidity (RH), and calculated Heat Index (HI) as shown in Table 1.The trends of the climate condition (12 hours) during data collection are shown in Figure 4.

Table 1: Measured microclimate parameter

	N	Min	Max	Mean	Std. Deviation
Air Temperature (°C)	438	24.3	34.2	28.933	1.9682
Relative Humidity (%)	438	52.0	99.9	75.067	11.5581
Heat Index (°C)	438	25.0	46.0	33.769	4.5502

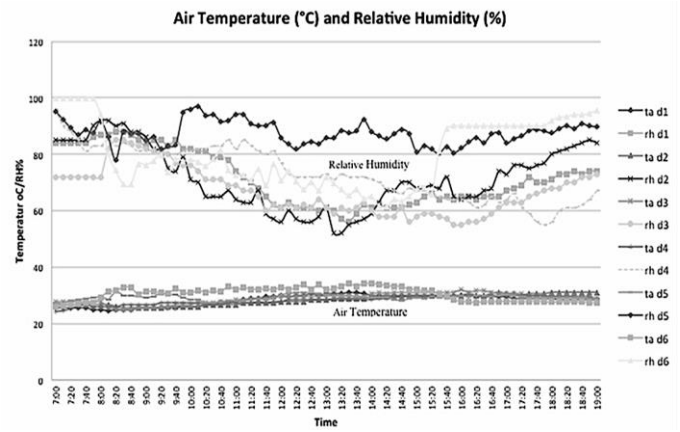

Figure 4: Meteorological trends in the study area during data collection

3.3 Interview sheets and observation

The interviews were conducted simultaneously with the microclimatic measurements. The questions consisted of demography (age, gender, activities, frequencies and origins) the reason(s) for being at the park and time spent outdoors. The respondents were asked to

express their feelings and preferences regarding wind, air temperature, humidity, brightness, and the overall condition suitability with the microclimate. On average, 73 interviews were conducted daily during the measurement. The park's physical features and user behavioural pattern were observed. Table 2 shows the summary of the demographic information.

Table 2: Summary of demographic information

	Profile's	Frequency (N)	Percent (%)
Gender	Male	162	37
	Female	276	63
Age Group	Below 15	4	0.9
	16-24	66	15.1
	25-44	309	70.5
	45-64	59	13.5
	Above 65	0	0
Origin	Live in the neighbourhood	148	33.8
	Far from neighbourhood	281	64.2
	Foreigners	9	2.1
Frequency of attendance	Daily	6	1.4
	5-6 days a week	5	1.1
	3-4 days a week	16	3.7
	1-2 days a week	92	21.0
	A few time in a month	162	37.0
	A few times in a year	90	20.5
	First time	64	14.6
	Others	3	0.7
Condition before the interview	Shade	404	92.2
	Sun	34	7.8

4.0 Results and Discussions

4.1 Activities

During the interview session, the respondents were observed then asked what activities they participated in prior to the interview as activities could influence the metabolic rate. A person doing more vigorous activities would generate a higher metabolic rate. A person doing strenuous activity would feel warmer than those resting or sitting. Hence, it is important to estimate the metabolic rate in the study for further discussion.

The location where the respondents were before participated in the interview were observed to indicate whether they were under the sun or shade. If the respondents were under the sun, they may respond differently than those under the shade prior to the interview.Figure 5 shows the correlation between the activities that the respondents were engaged in before the interview session.

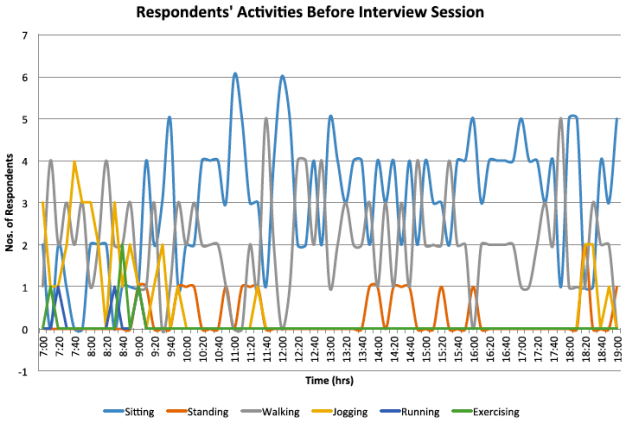

Figure 5: Respondents' activities before the interview session

Sitting was the majority of the respondents' activity before the interview session. Sitting also happened to be the most popular activity at the park throughout the day. Jogging and running were done during early morning and late afternoon. Perhaps the respondents preferred to jog and run when the air temperature was not at its peak. Walking was an activity that occurred throughout the day.

Table 3 shows the correlations between the time of the day (hrs), activity and Heat Index (HI). There was a significant association between time and the time (hrs), $r = -0.291$, $p < 0.001$ and between Heat Index, $r = 0.302$, $p < 0.001$. This seems to represent the fact that respondents were at ease correlated with the period they were doing the activity and the condition of the Heat Stress.

Table 3: The correlations between Time (hrs), Activity and Heat Index

		Time	Activity	Heat Index
Time	Pearson Correlation	1	-.291**	.302**
	Sig. (2-tailed)		.000	.000
	N	438	438	438

Activity	Pearson Correlation	-.291**	1	-.164**
	Sig. (2-tailed)	.000		.001
	N	438	438	438
Heat Index	Pearson Correlation	.302**	-.164**	1
	Sig. (2-tailed)	.000	.001	
	N	438	438	438

4.2 Thermal Sensation Vote (TSV)

The respondents' thermal sensation (TS) was obtained using the seven-scale (cold, cool, slightly cool, comfortable, slightly warm, warm and hot) vote. The respondents were asked about their preference of sensation during the interview session. The data collected were analysed, where the TSV was compared with activity and Heat Index (HI). The results are shown in Figure 6.

There was no significant link between time spent at the park and the respondents' sensation as shown in Figure 6. This seems to represent the fact that the respondents' comfort did not relate with the period they were active at the park. Based on this odd ratio, the time when the respondents felt comfortable did not correlate to the time spent in the park.

Then, the correlation between thermal sensation value (TSV) and Heat Index (HI) was investigated. The results shown in Figure 7 prove that there is no correlation between thermal sensation value (TSV) and Heat Index (HI). The coefficient of determination as shown in R^2 = 0.01035 is an extremely low value, hence, no relationship is determined between TSV and HI.

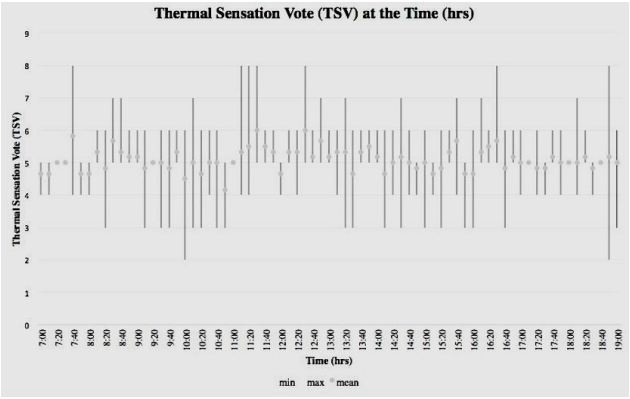

Figure 6: Thermal Sensation Vote (TSV) according to the time (hrs) spent at the park

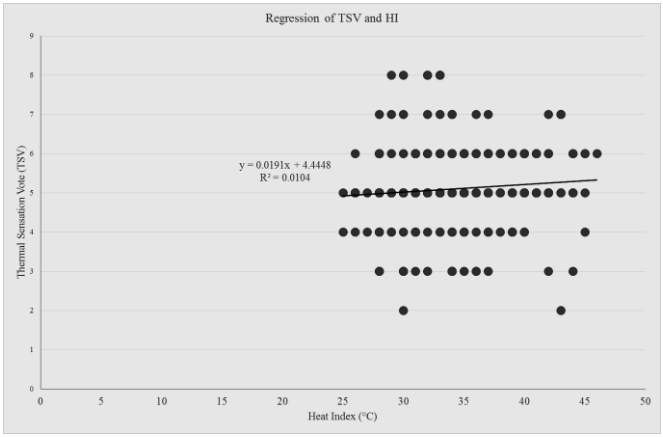

Figure 7: The regression on Heat Index based on TSV

Then, the relationship between TSV and the activities of the respondents was examined and the results are shown in Figure 8. The majority of the respondents were sitting before the interview session, and they were comfortable in that position. The next most reported activity was walking, followed by jogging and standing. These activities were normal activities observed at the park. For all activities, the majority of the respondents deemed the thermal condition to be comfortable, followed by slightly warm (Figure 8).

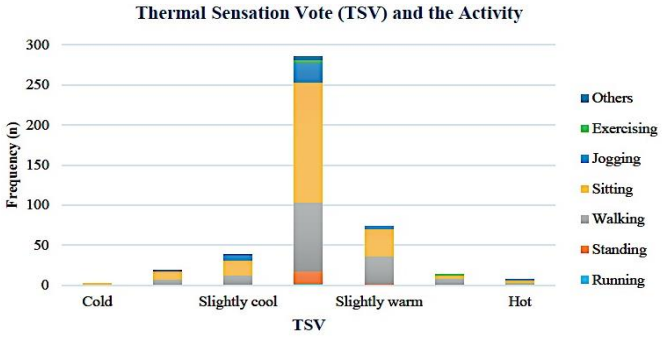

Figure 8: TSV and the Activities

However, it is interesting to note that very few respondents were running and exercising. This had to do with the location of the field study, which was near the children playground, hence attracting more parents and guardians with children. The joggers and

those who exercise could be using other areas of the parkfor their recreational activities and thus not captured as respondents when the random sampling was conducted.

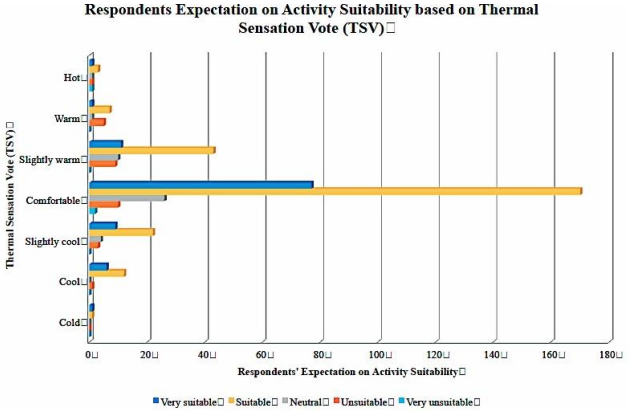

Figure 9: Thermal Sensation Vote (TSV) on the Activity Suitability Preferences based on the Condition

Finally, the relationship between the thermal sensation vote (TSV) and the activity suitability preferences of the respondents were investigated based on the actual microclimate condition. The results is analysed and shown graphically in Figure 9.

The respondents agreed that the condition they sensed is the condition suitable for them to do the activity. This can be interpreted that the respondents came to the park with high expectation on the microclimate condition of the park. They may associate the park as a comfortable place and proceeded to have that perception when going to the park. Hence, the respondents found the thermal condition acceptable even when the mean air temperature were almost 29^{o}C, almost 3 degrees above the neutrality temperature and maximum air temperature was recorded as high as 34^{o}C, some 6.9 degrees above the neutrality temperature.

5.0 Conclusion

A significant proportion of the differences in the number of the respondents' activities and duration was accounted by human thermal comfort index. The results suggested that the context in which environmental physical activity relationships should be interpreted and this provided essential information for designers and recreationists in proposing the ideal urban parks setting.

This results confirmed that the correlation between human thermal comfort and preference of activity in the particular microclimatic condition was a significant relationship.

It was found that comfortable conditions were related to physical activity in shaded settings, as they were perceived.

The results also confirmed that respondents were comfortable in relation to the time they were doing the activity and the condition of the Heat Stress. There was no connection between time spent at the park and the respondents' sensation. There was no correlation between thermal sensation value (TSV) and Heat Index (HI). For all activities, the majority of the respondents deemed the thermal condition to be comfortable, followed by slightly warm. The respondents agreed that the condition they sensed was the condition suitable for them to do the activity.

The findings also indicated that the time of day influences activities, yet activities did not influence sensations of comfortableness. The Heat Index/Heat Stress also did not impact this sensation, as respondents chose comfortable in whatever condition. The findings proved that respondents practiced the thermal comfort adaptation process when doing outdoor activities as they sensed better microclimatic conditions than what were measured. The results showed in this instance how Malaysians thought about their microclimatic condition and adapted to it effortlessly.

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References

ANSI/ASHRAE Standard 55. (2004). *Thermal Environmental Conditions for Human Occupancy*. Atlanta: American society of heating, refrigerating, and air-conditioning engineers.

Aziz, A., Ahmad, A., & Nordin, T. (2011). Flats Outdoor Space as a Vital Social Place. *Asian Journal of Environment-Behaviour Studies*, *3*(7), 13–24.

Doulos, L., Santamouris, M., & Livada, I. (2004). Passive cooling of outdoor urban spaces. The role of materials. *Solar Energy*, *77*(2), 231–249.

Emmanuel, R., Rosenlund, H., & Johansson, E. (2007). Urban shading - A design option for the tropics? A study in Colombo, Sri Lanka. *International Journal of Climatology*, *27*(14), 1995–2004.

Kariminia, S., Ahmad, S.S., Ibrahim, N. (2013) Landscape attributes, microclimate and thermal comfort of an urban square in moderate and dry climate. *Advanced Materials Research* (Vol. 610-613), 3780-3784.
Kariminia, S., & Ahmad, S. S. (2013). Dependence of Visitors' Thermal Sensations on Built Environments at an Urban Square. *Procedia - Social and Behavioral Sciences, 85*(2013), 523-534.

Kariminia, S., Sh Ahmad, S., Ibrahim, N., & Omar, M. (2010). Outdoor thermal comfort of two public squares in temperate and dry region of Esfahan, Iran. *2010 International Conference on Science and Social Research (CSSR)*. pp 1266-1271.

Kariminia, S., Ahmad S. S., Omar and Ibrahim, N. (2011) "Urban Outdoor Thermal Comfort Prediction for Public Square in Moderate and Dry Climate". *2011 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA2011). Langkawi, Malaysia*. pp 306-311.

Lafortezza, R., Carrus, G., Sanesi, G., & Davies, C. (2009). Benefits and well-being perceived by people visiting green spaces in periods of heat stress. *Urban Forestry & Urban Greening*, *8*(2), 97–108. doi:10.1016/j.ufug.2009.02.003

Lin, T.-P., De Dear, R., Matzarakis, A., & Hwang, R.-L. (2009). Prediction of thermal acceptability in hot-humid outdoor environments in Taiwan. *The seventh International Conference on Urban Climate*.

Nasir, R. A., Ahmad, S. S., & Ahmed, A. Z. (2013). Physical Activity and Human Comfort Correlation in an Urban Park in Hot and Humid Conditions. *Procedia - Social and Behavioral Sciences*, *105*(2013), 598-609.

Nasir, R. A., Ahmad, S. S., & Ahmed, A. Z. (2012). Psychological Adaptation of Outdoor Thermal Comfort in Shaded Green Spaces in Malaysia. *Procedia - Social and Behavioral Sciences*, *68*(2012), 865–878.

Nasir, R. A., Ahmad, S. S., & Zain-Ahmed, A. (2013) Perceived and Measured Adaptative Thermal Comfort at an Outdoor Shaded Recreational Area in Malaysia. *Advanced Materials Research* (Vol. 610-613), 1083-1086.

Nasir, R. A., Anuar, A. N. A., Darus, F. M., Jaini, N., & Salleh, S. A. (2012). The Climatology Effects on Outdoor Recreation Perception and Activity in Shah Alam. *Procedia - Social and Behavioral Sciences*, *49*(2012), 193–201.

Rothfusz, L. P., & Headquarters, N. W. S. S. R. (1990). The heat index equation (or, more than you ever wanted to know about heat index). *NWS Southern Region Technical Attachment, SR/SSD*, 23–90.

Shahidan, M. F., Jones, P. J., Gwilliam, J., & Salleh, E. (2012). An evaluation of outdoor and building environment cooling achieved through combination modification of trees with ground materials. *Building and Environment*, *58*(0), 245–257. doi:http://dx.doi.org/10.1016/j.buildenv.2012.07.012

Steadman, R. G. (1979). The assessment of sultriness. Part I: A temperature-humidity index based on human physiology and clothing science. *Journal of Applied Meteorology*, *18*, 861–873.

Vanos, J., Warland, J., Gillespie, T., & Kenny, N. (2010). Thermal comfort modelling of body temperature and psychological variations of a human exercising in an outdoor environment. *International Journal of Biometeorology*, 1–12. doi:10.1007/s00484-010-0393-2

Ying, C.-H., Lin, C.-H., & Hwang, R.-L. (2011). The thermal comfort level of activities on public outdoor space. *Consumer Electronics, Communications and Networks (CECNet), 2011 International Conference on* (pp. 5449–5452).

Zambrano, L., Malafaia, C., & Bastos, L. E. G. (2006). Thermal Comfort Evaluation in Outdoor Space of Tropical Humid Climate. (PLEA2006, Ed.) *23rd Conference on Passive and Low Energy Architecture*. Geneva, Switzerland.