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A Behavioural Analysis of Outdoor Thermal Comfort: A Comparative Analysis between Formal and Informal Shading Practices in Urban Sites

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Abstract: This study calls for the integration of context-based socio-cultural habits and learning from local practices in providing outdoor thermal comfort in conservation areas. These parameters have direct impacts on outdoor activities, especially in hot arid climates. The study took place in two nearby locations one renovated and all external shadings removed to provide visual vistas to monuments while on the same street, no more than 1500 m apart, local shading practices were left in places. Sun-exposed as opposed to shaded sites were compared for subjective thermal comfort and outdoor activity, via structured interviews, observations, and wide-ranging micrometeorological measurements. The aim was to investigate psychological factors, including overall thermal comfort and perception, in addition to environmental parameters, such as solar radiation intensity and thermal adaptation. The analysis illustrates the importance of shading as a dominant factor in achieving thermal comfort on the urban scale, with a neutral temperature in summer of 29.9 °C and 29.2 °C for shaded and sun-exposed locations, respectively. The results suggest people may be more willing to tolerate higher temperatures in shaded rather than sun-exposed locations. Moreover, cultural constraints and context-based behaviour proved to have some influences on people's levels of adaptation and their thermal behaviour.

Keywords: human behaviour; outdoor thermal comfort; thermal sensation vote; physiological equivalent temperature

1. Introduction

With half of the global population living in urban areas, it is prudent to understand the influences of urban microclimatic influences on human behaviour. [1–4]. Designing comfortable urban spaces is important in urban planning [3,5], human health and wellbeing [6], reduced indoor energy consumption [7,8] and contributions to the local economy. Therefore, greater attention needs to be given to design and creation of outdoor public spaces as places of rest, walking, and for increasing commercial and creative activities. However, in cities with a severe climates, the quantity and frequency of outdoor pastimes are affected by the amount of discomfort felt when people are exposed to the microclimatic context [3,4,9], For example, on a summer's day in a hot arid urban climate, the thermal context can lead to lethargy and people preferring to remain indoors, and only venture outside for key activities such as commuting or commercial tasks. At the same time, non-compulsory activities such as walking, sightseeing or socialising become less favourable.

Gehl [10], in his influential book *Life between Buildings: Using Public Space*, showed that local sun or shade conditions can have a significant effect on whether people choice of venturing outdoors. Recently, several field studies on outdoor thermal comfort in various spaces and climates have suggested that the outdoor context has a broader "comfort zone" in comparison to the indoor, as more extreme thermal stimuli appear to be tolerated [11,12]; this is in addition to behavioural adjustments which a person might make upon feeling dissatisfied with an uncomfortable condition [13–15]. Such adaptation suggests a "give and take" connection with the environment, as the person is more proactive about the thermal stressors [16].

This 'give and take' relationship appears in different forms including physiological acclimatisation, and psychological and behavioural adaptation [17–19]. Physiological adaptation suggests changing the inner systematic reactions arising from continual exposure to a stimulus, and eventually causing a slowly reduced stress from the exposure [17]. Psychological adaptation refers to people's responses to an external stimulus based on the information they have for that stimulus. In this way, thermal awareness of a space is affected by psychological factors, which can, in turn, affect this perception [17], including the expectation and experience someone has of the space, climate or time of exposure.

Behavioural adaption involves all the physical changes someone can make to adjust an environment to their needs, and there are two types: reactive and interactive [20,21]. Reactive changes are personal, for example, by changing clothing layers, posture or location, while interactive ones involve changes to the environment to enhance comfort; this might include opening windows, installing mechanical ventilation, using fans or installing shading devices. Having said this, it is not normally practical to interactively adapt in a public outdoor space to create thermal comfort, as we are usually unable to change the environment. In this context, people's responses to outdoor microclimates can be passive compared to when they are an in indoor climate [1,22].

In this paper, a unique case study is analysed where half the occupants in a street had the chance to be interactive and apply their own settings for thermal adaptation, while the other half could not make any adjustments. This created two interesting yet contrasting urban features located within the same spine. This study identified the participants' thermal adaptation techniques, including their psychological and behavioural adaptations, using subjective and objective comfort measures to assess the psychological and environmental parameters impacting thermal comfort. To achieve the study's aim, the objectives were:

- To assess the pedestrians' thermal perception and preferences for the two contrasting urban spaces;
- To investigate the effect of thermal adaptation on human thermal sensation for the two locations;
- To identify the key factors for outdoor thermal comfort in hot arid environments.

1.1. Study Context and Justifications

The study was conducted in Cairo, Egypt. This city is categorised as having a hot arid climate (BWh) on the Koppen–Geiger classification, involving a large diurnal temperature variation and sparse rainfall [23]. Cairo is located between latitude 26°50′ N to 30°45′ N. The case study of Al-Muizz Street is in central Cairo, and has been a world heritage site since 1979 for its Islamic medieval architecture [24]. Al-Muizz Street was selected because of the following.

- The street piloted Egypt's first large pedestrian scheme in 2010. Such areas promote longer-term use, allowing for better examination of pedestrian thermal comfort in urban streets.
- The street's two contrasting urban features are less than 1500 m apart. Half the street has been restored and pedestrianised but the other has yet to undergo restoration.
- A previous study investigated the street and reported changing behaviour and forms of adaptation to the microclimate among the inhabitants, based on observation [25]. The study's methodology considered the spine as one case study and the analysis was performed in summer and winter, without investigating the impact of different shading scenarios and the interactive adaption on the pedestrians' thermal comfort.

- Different attributes can be clearly seen in the unrenovated side where the street occupants adopt different methods of shading (Figure 1), representing interactive behaviour, to avoid the strong solar radiation in summer. In the renovated parts, new regulations prohibit spontaneous urban shading, resulting in the occupants remaining indoors during the day and relying on air-conditioning; this represents reactive behaviour, and, according to numerous studies, this often leads to altered use of open space [1,22].

Figure 1. The different local interventions for shadings between the two sites, including the unrenovated part on the right and the renovated on the left.

1.2. Site Urban Properties

The examined spine was founded in 969 AD and presents a compact urban structure which reflects the distinctive climatic conditions that is easily recognised on the 15 degree north–south orientation and the narrow and irregular streets pattern with a continues changing of geometric parameters, height-to-width ratio (H/W), along the spine. Table 1 presents the physical urban properties of the locations including the street width, aspect ratio, ground albedo and materials.

Table 1. Measuring location urban properties.

	Street Width (m)	Aspect Ratio H/W	Ground Albedo	Ground Cover
Non-renovated	4.80	H/W = 1.3	0.17	Bare ground
	6	H1/W = 0.6; H2/W = 0.5	0.17	Bare ground
	7	H/W = 1.5	0.15	Mix basalt/bare ground
Renovated	6	H1/W = 1.8; H2/W = 1.4	0.11	Basalt
	2.4	H1/W = 3.8; H2/W = 4.2	0.11	Basalt
	3	H/W = 1.3	0.11	Basalt

2. Methodology and Data Collection

To quantify the impact of the two urban contexts on thermal perception and behaviour, the study took place within the same spine at a close distance of less than 1500 m, in sun-exposed and shaded sites; these are referred to as renovated and non-renovated, respectively (Figure 2). Due to the nature of the study, field measurements, subjective surveys and site observations were employed to evaluate thermal comfort in these outdoor spaces [5].

Figure 2. The two study locations on Al-Muizz Street, Cairo, Egypt.

2.1. Field Measurements

Field measurements were taken at the two sites twice a year in summer and winter to evaluate thermal comfort across a range of microclimate conditions. The monitoring of meteorological variables occurred alongside the user perception surveys. The data collection was conducted in the hottest week between 26 June and 2 July for summer, and between 19 and 25 December as the shortest daylight period in winter (U.S. Department of Energy, 2012). A portable multi-sensor weather station collected data on meteorological variables, as recommended by the American Society of Heating, Refrigerating and Air-Conditioning Engineers Standard (ASHRAE) [26], including air temperature, relative humidity, solar radiation and wind speed. Globe temperature was taken with a 25 mm black globe thermometer made of copper, externally mounted and placed at 1.1 m height, and calibrated to gather equivalent measurements as a standard 150 mm globe; this is the average height of an adult's centre of gravity [27]. Every session lasted for around ten minutes in order to achieve stability with the measurements of the climatic conditions.

2.2. Questionnaire Survey

A questionnaire was conducted alongside the field data gathering, and respondents well acquainted with the area of study were interviewed; the represented sample was comprised mainly of locals residing or working in the area. The questionnaire had three parts. The first was on demographic information (e.g., age and gender); the subject's activity (reclining, sitting, standing, walking) and their attire were noted and converted to Clo-units [28]. Metabolic rate and clothing layers were estimated on the ASHRAE fundamentals [29]. The second section recorded short-term thermal history, such as previous activity and place (indoors/outdoors, sun/shade) before the survey, and time outside, in addition to the number of times and reasons for visiting the location. These data were taken to be able to examine how familiar subjects were with the place, in order to evaluate how physically and culturally adapted the participants were. The third part requested participants to judge their existing thermal perception and preference, with the ASHRAE 7-point thermal sensation vote (TSV) scale (−3, cold; −2, cool; −1, slightly cool; 0, neutral; 1, slightly warm; 2, warm; 3, hot). The study also used the McIntyre preference scales (right now I want to be "cooler", "no change" or "warmer"), and directly assessed thermal acceptability (acceptable/unacceptable), as well as general thermal comfort (uncomfortable/comfortable). Participants were also requested to state the amount of sensation and inclination they had for wind and sun on a three-point scale of "I want wind/sun to be weaker", "no change" and "I want wind/sun to be stronger". Finally, subjects were requested to give suggestions or comments about personal thermal comfort and the microclimate in outdoor spaces.

2.3. Data Processing

Three hundred and twenty people were interviewed (160 each in summer and winter, split equally between renovated/unrenovated part of the street), of which 32.2% were women and 67.8% were men. The majority were between 16 and 24 years of age (41.3%), followed by the age group between 35 and 44 years of age (20%) and 17.2% for the age group between 25 and 34 years of age, then 13.4% of 45–54 years old and 8.2% for over 55. Most of the sample was comprised of people who had direct and regular contact with Al-Muizz Street; 39.1% worked in the area; 23.4% were meeting people; 24.1% lived in the street and 13.4% were doing other activities such as shopping. The majority of the sample are used to visit the place on a frequent basis varying between, people who visited the place few times a day (31.95%), while some visited a few times each week (45.6%), others a few times per month (18.8%) and only (3.8%) of the total sample are used to visit a few times each year (3.8%), with an outdoor duration of over 20 min. From the observations, seven clothing units (Clo) and four metabolic rates were estimated based on ASHRAE standards 55-2009 [29], and used in RayMan to measure the subjects' individual physiological equivalent temperatures (PETs) [30].

3. Results and Discussion

3.1. Thermal Sensation Votes

Al-Muizz Street has diverse zones, with the renovated and unrenovated parts having distinct urban characteristics and varying levels of adaptation concerning people's comfort settings. To explore the participants' thermal perception, the study compared the percentage frequency distribution of thermal sensation votes (TSVs) and calculated PETs for both locations in summer and winter (Figure 3). According to Fanger's theory [31], only TSVs of −1, 0 and +1 illustrate adequate thermal contexts, and, therefore, these were included in the data analysis.

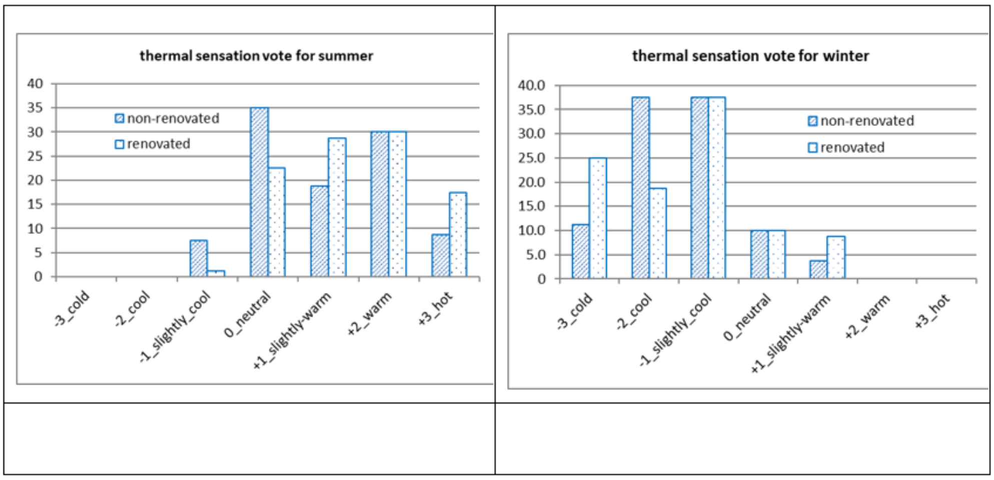

Figure 3. Subjective thermal sensation votes (TSVs) in the two different parts of Al-Muizz.

In summertime, a higher percentage of persons in the unrenovated (shaded) area (61.3%) tolerated the thermal environment, in comparison to 52.6% in the renovated (sun-exposed) site (Figure 3). In winter, the findings were slightly different as there were more satisfied people in the renovated (sun-exposed) location (56.5%) compared to the unrenovated (shaded) (51.5%). This may be related to the levels of short and long wave solar radiation fluxes at both locations, where there is a lack of direct solar radiation in the unrenovated site due to the local adaptions to the microclimate. These local settings affect the mean radiant temperature underneath, and, according to Nikolopoulou [20] (1998) and Butera [32], mean radiant temperature and air temperature can have a stronger effect on outdoor thermal comfort. Therefore, shade seems to alleviate heat stress during summer, but may cause more discomfort during winter.

These findings correlate well with studies in a hot desert climate by Middel et al. [33] and Lin et al. [34] for a hot humid climate; both studies stated that with a low sky view factor thermal comfort in summer may improve, but in winter it may have a negative effect. Therefore, a further investigation was made by selecting only those respondents who voted for the three central TSV categories, and then we estimated the percentage preferring more shade or more sun or no change (Figure 4), in order to assess how they perceived the solar radiation. In summer, 61.2% preferred no change in the shaded (unrenovated) part versus 31% in the sun-exposed (renovated) site, whereas nearly 70% wanted more shade in the renovated site compared to 36.7% in the unrenovated. In winter, almost 50% of those in the sun-exposed location in the renovated part wanted no change, compared to 36.6% in the shaded site in the unrenovated part, where 56.1% preferred to have more sun against 33.3% for the renovated segment. The same conclusion as above can, therefore, be drawn, as the shaded site may enhance the microclimate and people's thermal perception during the summer, but have a negative effect during winter.

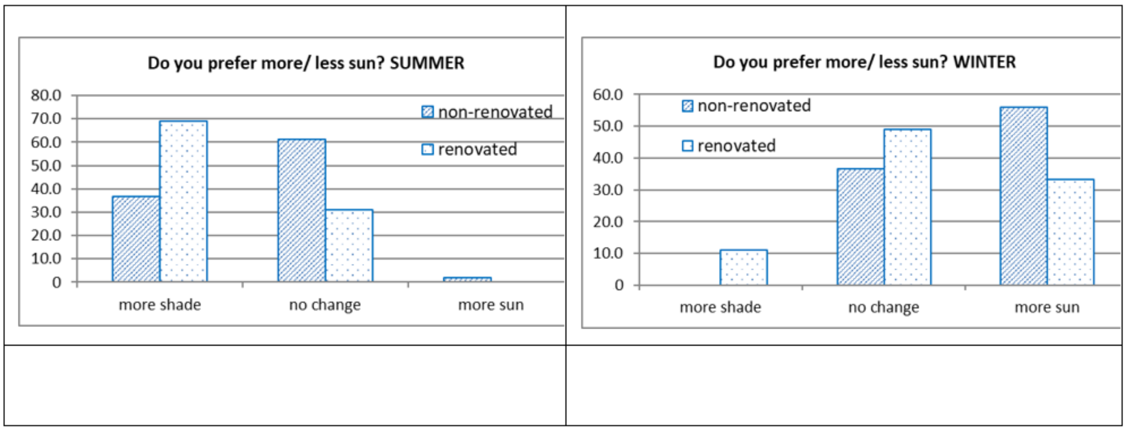

Figure 4. The percentage of preference votes for more shade, no change or more sun in the two parts of Al-Muizz.

3.2. Thermal Perception and Neutral PET

As illustrated in Figures 5 and 6, the trend in the users' TSVs varied at the two locations within the same seasons. This change in TSVs within the location was also explored with the ordinal logistic regression model (OLRM), the most common method of modelling the relationship between thermal sensation and other factors. A simple linear regression was fitted for the mean TSV for every 1 °C degree PET interval (Figures 3 and 4); two equations were created for both locations for summer and two for winter. The correlations between the mean thermal sensation votes (MTSVs) and PET are:

$$\text{MTSV (summer shaded)} = 0.1611\ (\text{PET}) - 4.816$$

$$R^2 = 0.9156$$

$$\text{MTSV (summer sun-exposed)} = 0.1052\ (\text{PET}) - 3.066$$

$$R^2 = 0.9127$$

$$\text{MTSV (winter sun-exposed)} = 0.1268x - 3.105$$

$$R^2 = 0.8887$$

$$\text{MTSV (winter shaded)} = 0.0856x - 2.0231$$

$$R^2 = 0.8537$$

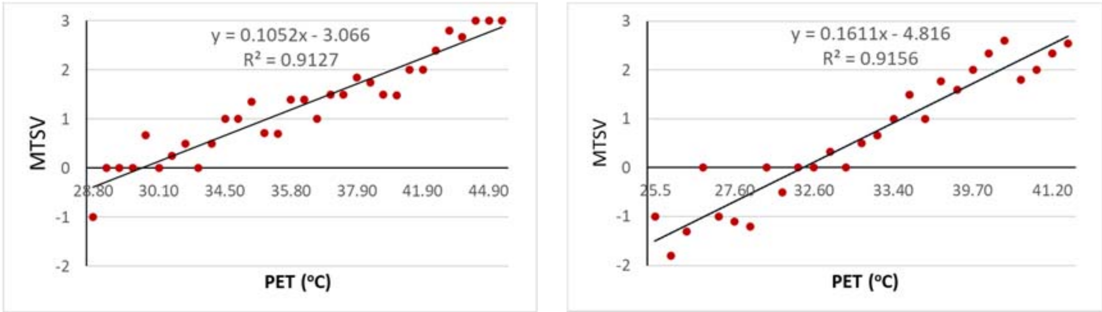

Figure 5. Correlation between physiological equivalent temperature (PET) and thermal sensation in summer between the two sites, including the renovated on the left and unrenovated on the right. MTSV = mean thermal sensation vote.

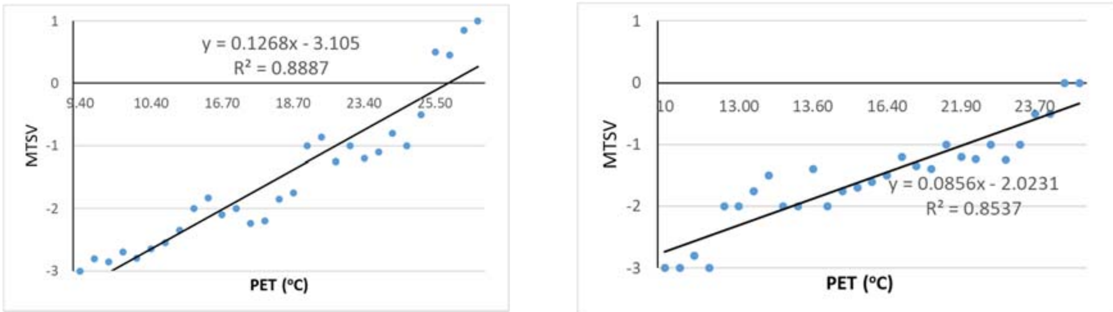

Figure 6. Correlation between PET and thermal sensation in winter between the two sites, the renovated on the left and unrenovated on the right.

Neutrality was derived by solving the MTSV of zero. Neutral PET is the thermal point at which thermal neutrality is felt (i.e., neither cool nor warm), and this was derived by solving the MSTV of zero in the previous equations. The linear regression indicated a strong relationship between perceived comfort and PET in all cases, as the R^2 varied between 0.91–0.85. In summer, neutral PET for shaded and sun-exposed locations was between 29.9–29.2 °C, respectively. This may suggest that the participants accepted a higher temperature in the shaded locations more willingly than in the sun-exposed ones. In winter, neutral PET for shaded versus sun-exposed locations was 23.6–24.5 °C, which may highlight that in the cool season the sample appeared to accept a higher temperature in the sun-exposed location compared to the shaded.

In line with previous studies in the same climatic context, these findings state that people exposed to the sun have a greater tendency to overestimate air temperature regardless of season, while people in shade tend to underestimate it, indicating the importance of solar access as a driver of thermal comfort [33]. This finding may also resonate with the psychological schemata (long-term perceptions) that people develop in their minds. The experience factor may indicate that the reason why the sample felt comfortable is likely to be less related to the existing temperature than to the general atmosphere, and to the difference in levels of perceived control of thermal comfort between the two parts. According to Nikolopoulou and Steemers [17], people able to exercise more control over their source of discomfort can accept wide variations, and their negative emotional responses are much decreased. This resonates with the case of the unrenovated part, where they can adjust different settings to adapt to the intense solar radiation in summer. Several studies have proven that human behaviour, including avoidance of, or preference for, places and events, is guided by these schemata and, to a lesser degree, by the actual situation [35–37].

3.3. Correlation between TSVs and Environmental Factors

To explore the correlation between TSVs and the other environmental parameters considered in this study, air temperature, wind velocity and solar exposure were recorded to identify the most key impact on outdoor thermal comfort. TSVs for these parameters were all recorded and analysed using the Spearman Rank Order Correlation Coefficient, which quantifies the strength and direction of the association between two variables measured on at least an ordinal scale [38]. Table 2 presents this correlation analysis, and it can be seen that sun exposure had the most significant influence on TSVs, with a correlation coefficient of 0.660. This was followed by air temperature (correlation coefficient 0.45) and wind velocity, which had less impact on TSV, accounting for a small correlation coefficient of −0.159. The findings indicate that TSVs seemed to increase with an increase in people's perception of sun exposure, followed by air temperature, but decreased with an increase in wind speed.

Table 2. Correlation analysis of TSVs.

		TSV	Air Temperature	Wind Speed	Sun Exposure
TSV	Correlation	1	0.45 [a]	−0.159 [a]	0.660 [a]
	coefficient sig. (2-tailed)	-	0.000	0.000	0.000
	N	160	160	160	127

[a.] correlation is significant at the 0.01 level (2-tailed).

4. Non-Environmental Factors

In addition to thermal sensation and perception, the questionnaire also considered other non-environmental variables such as behavioural adaptation, short-term thermal history and physical activities. The results for each variable are presented next.

4.1. Behavioural Adaptation

According to de Dear and Brager, [39] people undertake behavioural adjustments when they are dissatisfied with an uncomfortable condition; these adjustments can be classified as personal, environmental and cultural adjustments [14]. Therefore, the respondents were asked to rank five different behavioural actions they would prefer to undertake should they feel dissatisfied with their outdoor thermal condition (Figure 7). The cross-tabulation analysis revealed that seeking shade was the dominant behaviour choice in summer, which almost half the respondents chose. When comparing shade seeking as a choice between genders, surprisingly, for every four males, only one female sought shade as the main thermal adaptive choice. This might be due to some cultural constraints and context-based behaviour which separates men and women in this old district, and, therefore, the females may have deliberately chosen to walk in the unshaded parts of the street to avoid physical proximity to men, who most of the time occupy the shaded parts of the street.

This context-based behaviour appeared again concerning a reduction in clothing layers, which was the second thermal adaptive choice for men (15%), but the last choice for women (<2.0%). The latter choice may again be explained by the cultural constraints and religious beliefs of the old district, where women cover their bodies and hair when outside; moreover, it is unacceptable to wear light, revealing clothes and, therefore, most of their clothes were either dark in colour or layered. These factors may have had a great impact on the levels of thermal adaptation, especially in hot climates.

The amount of clothing in correlation with PET was further clarified with a simple linear regression for each gender, as in Figure 8. A relation between PET and clothing level was found in that the level of clothes increased gradually with any increase in PET. However, these correlations were much stronger for males than females, for whom clothing reduction is limited and other actions are required to adapt to high temperatures.

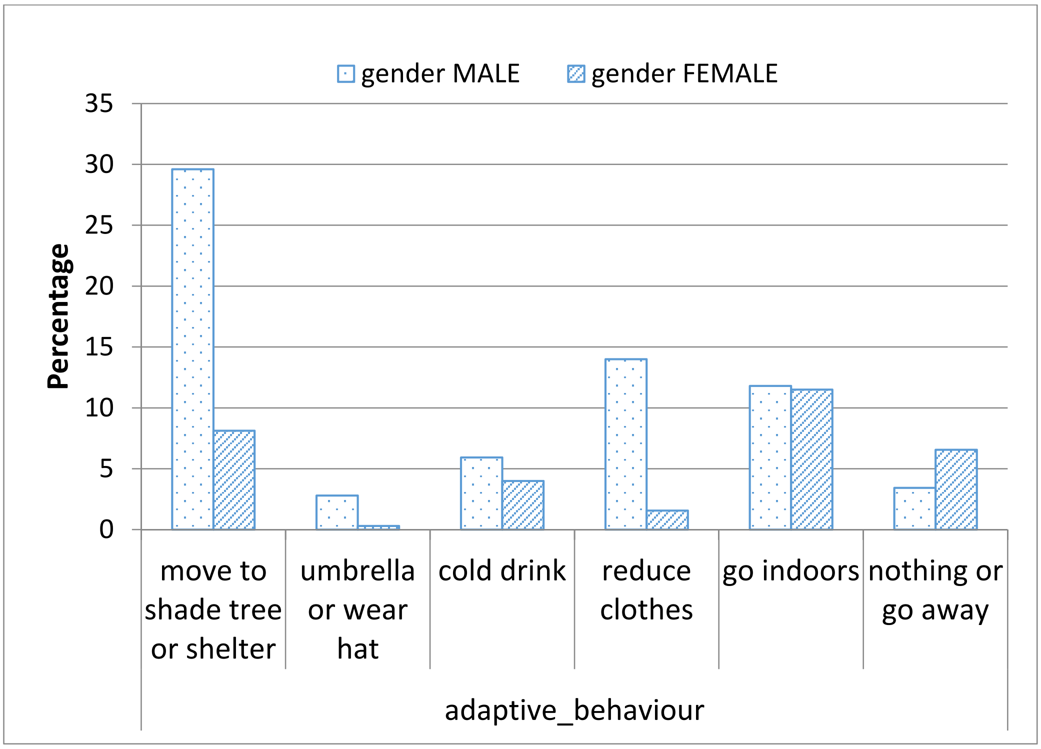

Figure 7. Percentage of males and females who adopted adaptive behaviours.

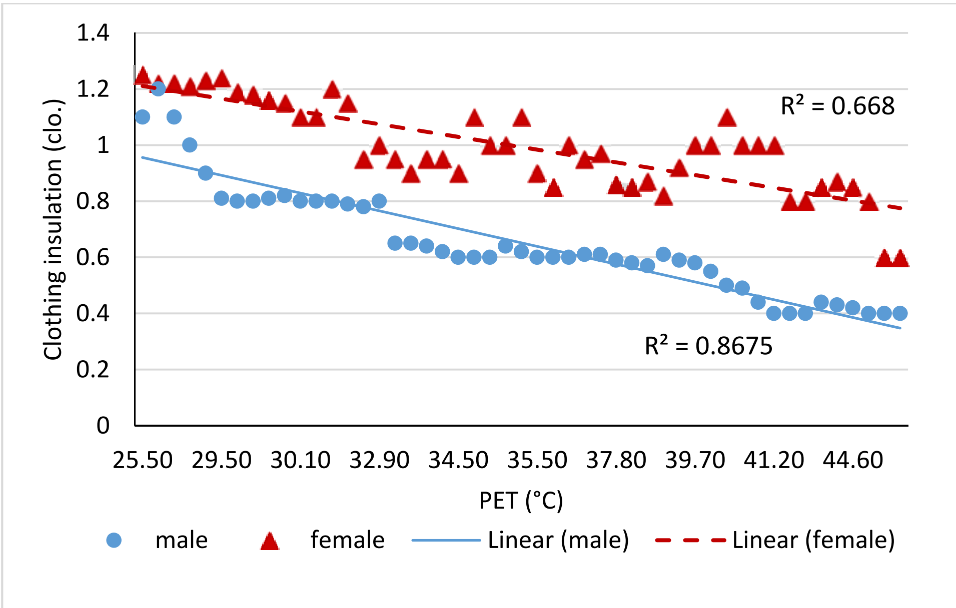

Figure 8. Regression model for levels of clothes for males and females correlated with PET.

Regarding the behavioural adjustment of staying inside, the same percentage of men and women (12%) voted for this strategy as a means to manage their thermal environment. This action was valid for those living and working in the street, and might be referred to as a perceived control mechanism, in that the respondents had a good degree of control over the source of their discomfort.

4.2. Air-Conditioning and Thermal Perception (Short-Term Thermal History)

Air conditioning is widely used in the renovated part of the street since new regulations limit property owners' adaptive behaviour. According to Hoppe's view on previous environment [40], if a subject stays in an air-conditioned (AC) space, this can make a great difference to their thermal sensation experience. Therefore, to examine the effect of air conditioning on human thermal sensation, the participants first had to state how long they had been outdoors, choosing from three answers: less than 2 min, between 2 and 10 min and more than 10 min. They were then asked to say whether they had been indoors (air conditioned or not) before reaching the location of the survey; respondents were split into AC and naturally ventilated (NV) groups and the results were analysed separately. Simple linear regression was conducted to determine the neutral temperatures for each group to clarify the difference in their thermal perception. The regression models of each group are plotted in Figure 9. By calculating the neutral temperature between the two groups, a slight difference of 0.5 was reported, where the neutral temperature was 29.1 °C for the AC group and 29.6 °C for the NV group. These findings imply that the respondents who had been in NV spaces prior to the survey were more tolerant of the outdoor heat stress, while those in AC spaces were still influenced by the cool and stable environment provided by the mechanical ventilation, and this gave them more time to adapt to the urban environment.

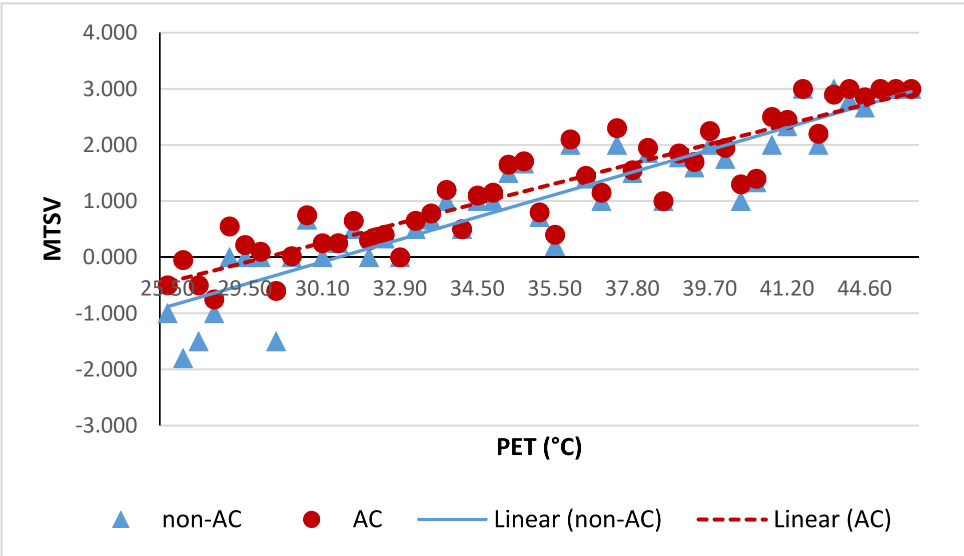

Figure 9. Regression model for air-conditioned (AC) and naturally ventilated (NV) respondents.

4.3. Physical Activities

The respondents were asked about their physical activities immediately before the interview. According to the interviewer's observations, in summer the main activities were sitting (40%) and walking (39%), while in winter walking was more common (45%) compared to sitting (28.8%). By applying a one-way analysis of variance (ANOVA), it was shown that, with the same PET, respondents who had been doing more physical activities had a notably warmer TSV. As presented in Figure 10, the overall correlation of the TSVs and metabolic rate was R^2 = 0.84, indicating that 84% of the variance in subjective thermal sensation can be explained by variation in physical activity.

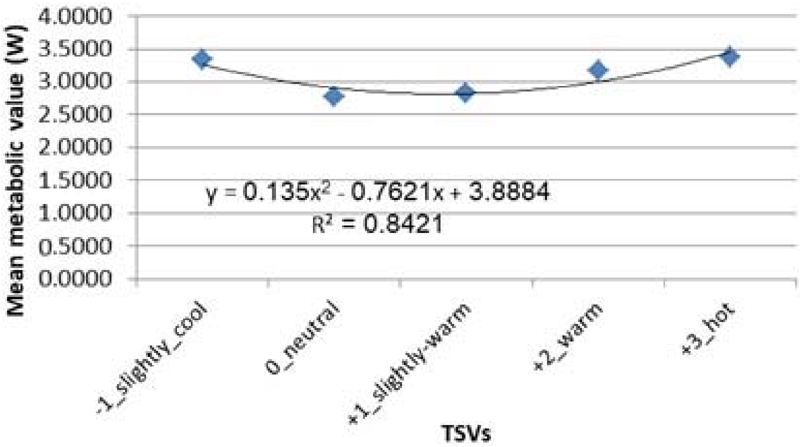

Figure 10. Adjusted correlation between TSV and physical activities in outdoor conditions.

5. Conclusions

The aim of this study was to examine pedestrians' thermal perception and adaptation in outdoor urban spaces for two distinct urban spaces in winter and summer, and to identify the key microclimate factors for outdoor thermal comfort in a hot arid region. The study employed site observation and field measurements for two sites located on the same spine. One location is shaded by various local interventions while the other is unshaded. The study showed that there was a slight variation in PET between the shaded and unshaded locations for both seasons, which recorded a difference of 0.7 °C and 0.9 °C, respectively. This may indicate that people are likely to accept a higher temperature in a shaded location compared to a sun-exposed one during summertime, while in winter the opposite is true as people appear to prefer a higher temperature in the sun-exposed location compared to the shaded one. These findings support the results of other research regarding the twin necessities of considering psychological adaptation in the design of outdoor urban spaces, and increasing the usage of these spaces [15,41]. Regarding the dominant environmental parameters, solar radiation was found to be the most important driver for the hot arid climate, with a correlation coefficient of 0.660.

The analysis of non-environmental variables, such as behavioural adaptation, showed that some cultural constraints and context-based behaviour in the old district of this case study may have affected people's thermal behaviour and levels of adaptation, such as the choice of females to walk in the sun-exposed areas to avoid any physical proximity with men. Again, cultural constraints and context-based behaviour appeared between genders in reducing clothing layers to adapt to the uncomfortable range of PET, as most of the women preferred to maintain what is regarded as respectful clothing with a number of clothing layers even in summer. This is based on the religious belief of the need to cover their bodies and hair when outside, regardless of the level of thermal discomfort they are exposed to. Concerning short-term thermal history, the analysis shows that the subjects from NV settings were more tolerant of outdoor heat stress as they reported lower TSV than subjects from an AC environment. Additionally, the physical activity analysis shows that those with a higher metabolic rate had a significantly warmer thermal sensation.

Finally, regarding the extent to which subjective human parameters affect pedestrian assessment of the outdoor environment of shaded and sun-exposed locations, all the examined meteorological, psychological and non-environmental parameters were significantly correlated with the TSV. The findings also shed light on the importance of shading in improving people's overall outdoor thermal comfort experience, as they seem to adapt physiologically and psychologically to the shaded microclimate conditions based on their experience and perception.

Based on the above, in regards to the rehabilitation of the urban site, which is an essential process to preserve the historical heritage in the area, it seems that the spatial planning of the urban renovation process was mainly focusing on the physical aspects through providing visual angles for visitors and tourists to enjoy the surrounding monuments without any incorporation of the inhabitants' outdoor thermal comfort such as providing some shaded spots. Results show that, the inhabitants appear to be more tolerant to higher thermal sensations in the morning when they have the chance to create interactive physical changes to the surrounding environment to enhance the microclimate conditions. All the shading techniques used at the non-renovated sites are temporary and adaptable, so with little effort, it can easily be removed at night to accelerate the heat release. However, this behaviour was not observed and this might be explained due to the close proximity between the two sites; therefore, most of the occupants spend their night-time at the renovated site enjoying its advantages of open vistas and restaurants and its better thermal conditions at night.

Urban conservation or development is a social and cultural dynamic exercise, the prolongation or disruption of which depends on the interrelation of many factors including the space and environment [42]. According to Hamza et al. [43], traditional practices of heritage conservation narrowly concentrating on building fabric are increasingly being criticised and challenged to include more comprehensive approaches focusing on the liveability of the urban site. Compared to the use of the un-renovated part and its occupants use of the spine, the renovated part followed common practices of urban conservation where new design regulations prohibit spontaneous urban shading and failed to provide any other solutions, leading to occupants remaining indoors during the day and relying on air-conditioning; this represents reactive behaviour which often leads to altered use of open space [1,22]. Consequently, the spatial planning proposal seems to lack a responsive climatic approach and poor interdisciplinary socio-physiological understanding of local thermal needs that prolong the outdoor use of space. [5,44], in-depth analysis to integrate the inhabitants' needs and their own experimentation with shading techniques, based on trial and error in dealing with the surrounding microclimate, can present valuable lessons in understanding local culture and socio-physiological responses to local urban climate. This study calls for future urban development plans to include local analysis of the microclimate and context based socio-cultural thermal comfort factors to determine the best possible designed environments to sustain longer outdoor space use.

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