74 - ANALYSIS OF THERMAL COMFORT IN A GYM OF PHYSICAL ACTIVITIES: A CASE STUDY

ANDRÉ LUIZ SOARES
VIVIAN MACHADO
ANTONIO AUGUSTO DE PAULA XAVIER
Universidade Tecnológica Federal do Paraná, Ponta Grossa, Paraná, Brasil
andresoares03@hotmail.com

1. INTRODUCTION

The habit of physical activities is one of the most important tools for maintaining the health of human beings throughout their lives. According to Saba (2001), the practice of physical activities on a regular basis leads to benefits in both the physiological aspect, but also the psychological aspect of the human being, being highly recommended.

The habit of physical exercise is built over time and should be encouraged from childhood and adolescence. Adolescence is a critical phase for human health because it is a phase where physical activity can be decisive in the lifestyle of an individual, which will reflect in their adulthood (TROST, OWEN, BAUMAN, SALLIS & BROWN, 2002). For this, there are several alternatives, such as a variety of individual and team sports, as well as gyms and bodybuilding, present in large numbers today, and facilitating access to physical activities in large centers.

The choice for gyms originates from several factors such as esthetics, health, fitness, stress relief, weight control, other factors enter (BIDDLE apud TAHARA, SCHWARTZ & SILVA, 2003). In addition to personal goals, academies eventually became a quick and accessible alternative in urban centers, offering in an single space for exercise equipment throughout the body, and aerobic activities, martial arts and other services being sought by men and women various ages.

In the Federal University of Technology - Paraná (UTFPR), Campus Ponta Grossa, venue of the present study, are offered courses Undergraduate, Postgraduate and also technical education linked to high school. Due to these factors, the age group of university students varies, but the youngest students enter the institution by the age of 14 years old. Through institutional programs, physical activity is stimulated by the offer of sports such as football, soccer, basketball, volleyball, handball, swimming, gymnastics and bodybuilding in the gym of the institution itself, without charging users, and supervised by professionals and students of Physical Education.

The environment in which physical activities are performed can affect the performance of users, and in some cases, affect their health. The UTFPR gym, Campus Ponta Grossa, is located on the second floor of a shed, and only works during the day, from 9:30 to 17:30 uninterruptedly. There are some basic variables that characterize the analysis of an environment, such as light level, noise level and temperature.

The human being seeks to maintain its body temperature constant. To perform maintenance on its temperature, there are biological mechanisms that help humans maintain the ideal temperature, which is 37 ºC ± 2 ºC, ie between 35 ºC to 39 ºC (IIDA, 2005). Temperatures outside this range (hypothermia and hyperthermia) may cause serious risks to health if immediate steps are not taken to cause the temperature to return to its ideal range.

In the case of high temperatures, humans may exhibit the following symptoms: hyperthermia, dizziness, dehydration, skin diseases, psychoneuroses, falls and fainting hypovolemia or sodium deficiency (COUTINHO, 1998). Other symptoms such as dizziness, nausea, irritability and sleepiness are warnings that the human body is weakened due to the environment they are in and also due to its activity. According to ISO 8996 (2004), the activity carried out at a gym can be considered a moderate activity metabolic rate, with a value of 165 W / m² (ranging from 130 to 200 W/m²). Thus, the body generate a moderate amount of internal heat, the environment can affect health even more and may lead users to physiological consequences.

This paper aimed to assess the environment of the gym of UTFPR, Campus Ponta Grossa, from the thermal point of view. Measurements of environmental variables relevant to thermal comfort were performed, as well as users of the gym answered questionnaires about their thermal sensation and preference, in order to know how they feel about the environment of the gym. In Figure 1 below, there is an overview of the academy object of this study.



Figure 1 - Overview of the gym analyzed (Source: Authors, 2012)

2. OBJETIVES

2.1. Main Objective

The main objective of this study was to evaluate the environment of the gym of UTFPR, Campus Ponta Grossa, in terms of thermal comfort, by applying the method of Predicted Mean Vote (PMV), standardized by ISO 7730 (2005), and applying questionnaire to the users the gym.

2.2. Secondary Objectives

This study has the following secondary objectives:

- Analyze the environment of the gym and divide it into sub-areas for the implementation of thermal analysis;
- Measure in all secondary areas the environmental variables needed to implement the method of the Predicted Mean Vote (PMV): air temperature (ºC), relative humidity (%), air velocity (m/s) and globe temperature black (ºC) (ISO 7730, 2005);
- Apply questionnaire to users the gym regarding their preferences and thermal sensations in a 7-point scale standardized by ISO 7730 (2005);
- Calculate the Predicted Mean Vote (PMV) for each user of the gym, in each of the secondary areas;

3. METODOLOGY

Before taking measurements of environmental variables, the gym area was divided into three sub-areas, using as criteria for separating the location and equipment in the area. In Area 1 are performed aerobic exercises, in Area 2 are performed exercises for the upper body, and in Area 3 are performed exercises for the lower limbs. In Figure 2, below, we see the division of areas the gym.

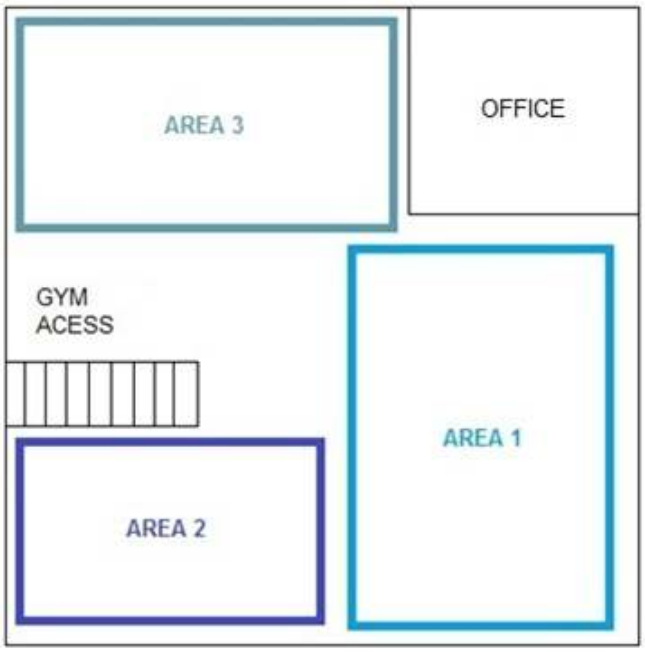

Figure 2 - Division of areas for environmental analysis of the gym (Source: Authors, 2012)

To carry out the environmental measurements it was used a device called Confortímetro Sensu, developed by the Federal University of Santa Catarina (UFSC). This device is able to measure the following variables: air temperature (ºC), relative humidity (%), air velocity (m/s) and black globe temperature (°C). Measurement results can be tracked in real time through a computer attached to the equipment, which also records the measured values every minute of operation. In Figures 3, 4 and 5 below, there is the three areas in which the area of the gym is divided for these measurements.



Figures 3, 4 and 5 - Areas of the gym for the measurements: Areas 1, 2 and 3, aligned from left to right, respectively (Source: Authors, 2012)

Each site was measured for one hour, and during the first 20 minutes of each measurement the values obtained were not recorded due to the high thermal inertia of the black globe thermometer. During the 40 minutes following each measurement, the values obtained for the four environmental variables were recorded in a computer for later analysis.

All users present at the gym were invited to answer a semi structured questionnaire as soon as they finished their physical activities. This questionnaire contained three questions: what clothes are you wearing, what is your thermal sensation and preference. Through the first question answers it was obtained the thermal insulation of clothing for each person, in accordance with ISO 9920 (2007), a value needed for the calculation of the PMV and classified as a personnel variable. The

following questions made use of the scale shown in Tables 1 and 2 below.

Hot	3
Warm	2
Slightly warm	1
Neutral	0
Slightly cool	-1
Cool	-2
Cold	-3

Well warmer	3
Warmer	2
A little warmer	1
This way	0
A little more refreshed	-1
Refreshed	-2
Much more refreshed	-3

Tables 1 and 2 - Scale of thermal sensation (left) and thermal preference (right) (Source: Authors, 2012)

Finally, it was calculated the Predicted Mean Vote (PMV) through the free software Analysis CST, developed by the Federal University of Santa Catarina (UFSC), and for this it was used the arithmetic mean of 40 minutes for each measurement of the environmental variables. The result of the calculated PMV is an index ranging from -3 to +3, and represents the thermal sensation and it is presented the same manner as the scale of thermal sensation (Table 1). The value obtained by calculation was then compared to the values established by ISO 7730 (2005), which normalizes the calculation of PMV.

4. RESULTS

Following are the environmental data obtained for each area of the gym analyzed, and also the calculated PMV. To calculate the Predicted Mean Vote it was used the arithmetic mean of each environmental variable.

T air (ºC)	V air (m/s)	T globe (ºC)	RU (%)	**PMV**
29,21	0,16	29,64	26,33	**2,37**

Table 3 - Results for Area 1 (Source: Authors, 2012)

AREA 2				
T air (ºC)	V air (m/s)	T globe (ºC)	RU (%)	**PMV**
29,04	0,14	29,17	27,28	**2,30**

Table 4 – Results for Area 2 (Source: Authors, 2012)

AREA 3				
T air (ºC)	V air (m/s)	T globe (ºC)	RU (%)	**PMV**
30,95	0,17	31,57	24,87	**2,80**

Table 5 – Results for Area 3 (Source: Authors, 2012)

According to ISO 7730 (2005), there are three categories of thermal environments. In category A, the environment is acceptable if less than 6% of occupants are dissatisfied, and PMV is between -0.2 <PMV <0.2. In category B, so that the environment is acceptable, the rate of unsatisfied should be less than 10%, and the PMV -0.5 <PMV <0.5. Finally, in category C the number of unsatisfied should be less than 15%, with PMV between -0.7 <PMV <0.7.

Therefore, it is concluded that the environment of the gym does not offer state of thermal comfort, and the results of the calculated PMV are off the limits stipulated by ISO 7730 (2005) in all possible categories. The Area 3 showed the worst results, with a PMV of 2.8, close to the maximum limit stipulated by the method. This is because of the geographical orientation of the windows, which are facing west, so that the area receives direct sunlight all afternoon. Regions 1 and 2 showed smaller results of PMV, but still off the limits stipulated (such regions do not receive direct sunlight). In all three areas, according to the scale of thermal sensation, the thermal sensation is characterized between "Hot" and "Very Hot".

The thermal sensation reported by the 28 users interviewed the gym, the real PMV, showed better results, with a PMV of 1.82, but was still a result outside the limits stipulated. All users claimed to feel hot, at different levels of the scale in Table 1. Regarding thermal preference, only 5 users wanted to keep the temperature at which they were, while 82.14% of users have wanted that the temperature were reduced at different levels according to the scale in Table 2.

5. CONCLUSION

This study aimed to analyze the gym of the Federal University of Technology - Paraná, Campus Ponta Grossa, which is offered to students to perform physical activities through institutional programs.

The metabolic rate due to activity gym is considered moderate, but in conjunction with an environment that does not provide good thermal conditions, it can lead users of the gym to suffer physiological effects, such as hyperthermia, dizziness, dehydration, skin diseases, psychoneuroses, falls, fainting hypovolemia or sodium deficiency, nausea, irritability and drowsiness.

To assess the environment of the gym, measurements of environmental variables needed to calculate the Predicted Mean Vote (PMV), standardized by ISO 7730 (2005), were performed. The results showed that the three sub-areas of the gym does not offer thermal comfort, featuring PMV values between 2.3 and 2.8, which according to the scale of thermal sensation, are characterized between "Hot" and "Very Hot", making the environment thermally unsuitable.

Finally, through questionnaires voluntarily answered by users of the gym, it was reported that all users were feeling different levels of heat, and 82.14% of users wanted the temperature to be reduced so that they can perform their physical activities comfortably by the thermal point of view.

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Rua Julio de Castilhos, 21 – Centro
CEP: 84010-220, Pontta Grossa – PR

ANALYSIS OF THERMAL COMFORT IN A GYM OF PHYSICAL ACTIVITIES: A CASE STUDY

ABSTRACT

The academies became an option in urban centers that offer in the same physical space equipment to exercise the whole body, aerobic activities, martial arts and other services being sought by men and women of various ages, stimulating the practice of physical activities, which has a direct influence on the lifestyle of adults. This metabolic condition combined with a thermally unsuitable environment can generate physiological consequences on users of gyms, such as hyperthermia, dizziness, dehydration, skin diseases, psychoneuroses, cataracts, fainting hypovolemia or sodium deficiency, nausea, irritability and drowsiness. This study aimed to assess the environment of academia Federal University of Technology - Paraná, Campus Ponta Grossa, through the thermal point of view, and applying the method of Predicted Mean Vote (PMV), standardized by ISO 7730 (2005). The results showed that all areas of the gym are inadequate from the standpoint of heat, so that PMV values were obtained ranging between 2.3 and 2.8, which according to the scale of thermal sensation, are characterized between "Hot" and "Very Hot". At the end of their activities, users of academia were invited to answer a questionnaire regarding the environment of the academy, and the conclusion was that 82.14% of users want the temperature to be reduced so that they can perform their physical activities in a comfortable thermal point of view.

KEYWORDS: Gym, Thermal Comfort, Physical Activity.

ANALYSE DU CONFORT THERMIQUE DANS UNE L'UNIVERSITÉ TECHNOLOGIQUE FÉDÉRALE DU PARANÁ: UN ÉTUDE DE CAS

RÉSUMÉ

les académies sont devenues une option dans les centres urbains qui offrent dans un même espace physique des équipements pour exercer le corps entier, en plus des activités aérobiques, arts martiaux et autres services demandés par les hommes et les femmes d'âges divers, encourageant la pratique d'activités physiques, qui a une influence directe sur la vie adulte. En raison du niveau d'activité physique effectuée sur ces sites, le taux métabolique des utilisateurs est considéré comme modéré, en créant un chaleur à l'intérieur à un taux de 165 W/m². Cette condition métabolique combinée avec un environnement termiquement inadéquat peut générer des conséquences physiologiques sur les utilisateurs, comme l'hyperthermie, étourdissements, déshydratation, maladies de la peau, psiconeuroses, avoir un bandeau, évanouissement d'hypovolémie ou déficit ou de sodium, nausées , irritabilité et de somnolence,. Cette étude visait à évaluer l'environnement de l'Académie de l'Université Technologique Fédérale du Parná à Ponta Grossa, à travers le point de vue thermique et en appliquant le Vote Moyen Prévisible (PMV),normalisé par l'ISO 7730 (2005). Les résultats obtenus ont démontré que tous les domaines de l'Académie sont inadéquates sur le point de vue thermique, parce que les valeurs de PMV ont été obtenues en faisant varier entre 2,3 et 2,8, qui, selon l'échelle de sensationt hérmique, sont classésentre "Chaud" et "Très Chaud". À la fin de leurs activités, les utilisateurs de l'Académie ont été invités à répondre un questionnaire se rapportant à l'environnement de l'Académie, et la conclusion obtenue est que 82,14 % des utilisateurs veulent que la température soit réduite, afin qu'ils puissent exercer leurs activités physiques confortablement du point de vue thermique.

MOTS-CLÉS : Académie de activités physiques, Confort Thermique, L'activité physique.

ANÁLISIS DE CONFORT TÉRMICO EN UN GIMNASIO DE ACTIVIDADES: UN ESTUDIO DE CASO.

RESUMEN

Los gimnasios se convertieron en una opción en los centros urbanos que se ofrece en el mismo espacio físico, equipo para ejercitar el cuerpo entero, actividades aeróbicas, artes marciales y otros servicios buscados por hombres y mujeres de diversas edades, la práctica de actividades estimulantes físicas, que tienen una influencia directa en el estilo de vida de los adultos. Debido al nivel de actividad física realizada en estos sitios, la tasa metabólica de los usuarios se considera moderada, lo que genera calor internamente a una velocidad de 165 W / m². Esta condición metabólica sumada a un ambiente térmico inadecuado puede generar consecuencias fisiológicas en los usuarios del mundo gimnasial, tales como la hipertermia, mareos, deshidratación, enfermedades de la piel, psiconeurosis, cataratas, hipovolemia desmayo o deficiencia de sodio, náuseas, irritabilidad y somnolencia. Este estudio tuvo como objetivo evaluar el entorno de la comunidad académica de la Universidad Federal Tecnológica del Paraná, Campus Ponta Grossa, a través del punto de vista térmico, y aplicando el método del valor teórico voto Medio (PMV), estandarizado por la norma ISO 7730 (2005). Los resultados mostraron que todas las áreas de la instalación del gimnasio son inadecuadas desde el punto de vista de calor, de manera que se obtuvieron valores de PMV que oscila entre 2,3 y 2,8, que, según la escala de sensación térmica, son caracterizadas entre "caliente" y "muy caliente". Al final de sus actividades, los usuarios del gimnasio fueron invitados a responder un cuestionario sobre el medio ambiente en el gimnasio, y fue obtenida la conclusión de que 82,14% de los usuarios desean que la temperatura se redusca de modo que ellos puedan realizar sus actividades físicas de manera cómoda en el punto de vista térmico.

PALABRAS CLAVE: Gimnasio, Confort Térmico, Actividad Física.

ANÁLISE DO CONFORTO TÉRMICO EM UMA ACADEMIA DE ATIVIDADES FÍSICAS: UM ESTUDO DE CASO

RESUMO

As academias tornaram-se uma opção nos centros urbanos que oferecem em um mesmo espaço físico equipamentos para exercitar todo o corpo, além de atividades aeróbicas, artes marciais e outros serviços, sendo procurada por homens e mulheres de várias idades, estimulando a prática de atividades físicas, o que possui influência direta no estilo de vida de adultos. Devido ao nível de atividade física executada nesses locais, a taxa metabólica dos usuários é considerada moderada, o que gera calor internamente a uma taxa de 165 W/m². Essa condição metabólica aliada a um ambiente inadequado termicamente pode gerar consequências fisiológicas nos usuários da academia, como hipertermia, tontura, desidratação, doenças de pele, psiconeuroses, cataratas, desfalecimento por hipovolemia ou déficit de sódio, náusea, irritabilidade e sonolência. Este trabalho buscou avaliar o ambiente da academia da Universidade Tecnológica Federal do Paraná, Campus Ponta Grossa, através do ponto de vista térmico, e aplicando o método do Voto Médio Estimado (PMV), normalizado pela ISO 7730 (2005). Os resultados obtidos demonstraram que todas as áreas da academia encontram-se inadequadas do ponto de vista térmico, de modo que foram obtidos valores de PMV variando entre 2,3 e 2,8, o que de acordo com a escala de sensação térmica, são caracterizadas entre “Quente” e “Muito Quente”. Ao fim de suas atividades, os usuários da academia foram convidados a responderem um questionário referente ao ambiente da academia, e a conclusão obtida foi de que 82,14% dos usuários desejam que a temperatura seja reduzida, para que possam executar suas atividades físicas de maneira confortável do ponto de vista térmico.

PALAVRAS-CHAVE: Academia, Conforto Térmico, Atividade Física.