

SOME ENVIRONMENTAL COMFORT PARAMETERS IN HEALTH FITNESS CENTRES

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ABSTRACT

This study shows the problems related to several interior environmental quality factors (acoustics, temperature and humidity) in Health fitness centres. Ninety-nine rooms for group gymnastics, cardio fitness and weight training were analysed within thirty health fitness centres in Portugal by measuring the temperature, relative humidity and noise levels. The values found show the inadequacy of the interior conditions in many of the health fitness centres. In the worst cases, noise levels of 100 dB(A) were measured that clearly state a dangerous environment for professors and users.

Keywords: Fitness Centres, Acoustics, Temperature, Humidity

INTRODUCTION

The modern style of life make the individuals more sedentary and in need (and in search) of physical exercise. The modern society has also become one of consumption and also for the area of physical activities, we see an increase of the commercial offer regarding health fitness centres. The quality of these new health fitness centres becomes one factor in the choice or use of these private services by the public. The accentuated growth of health fitness centres provides the emergence of some with less than ideal quality service concerning the interior environmental quality parameters.

The acoustic and higrathermic environments of this kind of space may be inadequate, originating physiological problems. The exposition to high noise levels can cause difficulties in the execution of the physical exercise and can even be a danger for the health resulting in reduction of the hearing sensibility. Another negative aspect will be the effect of the noise in other systems than the ear: pulse acceleration, blood pressure increase, heart overload, muscular tensions, alterations in the nervous system causing alterations of behaviour (mental breakdown, headaches, insomnias, nervous depressions, anxiety, etc.). The acoustic problems of these installations constitute one of the main goals of this work because there are spaces where the PA (public address) systems install strong noise levels.

Table 1– Sample of rooms used.

Type	Number of rooms tested
Group Gymnastics	57
Cardio-fitness	12
Weight training	12
Mixed (Cardio-fitness + Weight training)	18
Total	99

METHODOLOGY

The experimental analysis of this study was done using a sample of ninety-nine rooms of thirty Health fitness centres situated in the metropolitan area of Oporto (Portugal) [Barreira 2003]. Taken as representative of this kind of spaces, these places were measured for noise levels, relative humidity and temperature. Of these evaluated health fitness centres, fifty-

seven rooms were destined to group gymnastics classes and other activities as Martial Arts, Yoga, etc. Beyond these, twelve rooms of weight training and twelve rooms of cardio fitness were also evaluated as eighteen mixed rooms (weight training and cardio in the same space) (Table 1).

DATA COLLECTION

Regarding the Acoustics, the noise inside each activity room was characterized by the evaluation of the noise levels (L) of the interior environment created by the recorded music used during the classes (or activities).

The group fitness classes can be divided in three phases and the noise levels were measured in these three moments (a class with these characteristics has the gross duration from 50 to 60 minutes):

- Warm Up with a duration between 5 to 8 minutes (Lw);
- Choreography (main part of class) with a duration around 45 minutes (Lm);
- Cool Down with a duration between 5 to 8 minutes (Lc).

In the Warm Up and in the Cool Down the sound levels are habitually inferior than in the main part of the class. However, this difference is usually not significant. In this way, the students will be approximately a hour under music with elevated sound pressure levels, being the worst situation for the professor that can be in that environment for three to four hours (actually a significant number of students remain more than a hour in a health fitness centre, in two consecutive classes).

Regarding the temperature and the humidity, the values were measured in two moments of evaluation (but all during the same month of September): before the class begin and immediately after the class finished (always in non-occupied rooms).

In the weight training and cardio fitness rooms, just one moment of evaluation for the three parameters (acoustics, temperature and humidity) was used. They were measured during the main schedule of classes (when much of the rooms were occupied).

ACOUSTIC RESULTS - ROOMS OF GROUP GYMNASTICS

The summary for the noise levels (L) obtained in the three moments of evaluation concerning the three phases in the classes (warm up: Lw; main part: Lm; and cool down: Lc) in 57 rooms is shown in Table 2.

It is verified that in almost all of the health fitness centres the Lm is bigger than the Lw, what does signify that during the class the noise level increases.

It was also observed that the noise levels during the warm up and the cool down parts of the classes are less noisy than in the main part (on average 4 to 8 dBA) being the noise levels in the cool down part the lesser noisy. On average:

$$Lm = Lw + 4 \text{ (dBA);}$$

$$Lc = Lm - 8 \text{ (dBA).}$$

The noise levels in the main part of class are higher because this is the most intense part of the class where the professor tries to motivate more the students. The choreography is almost complete providing autonomy and causing an increase in the enthusiasm of the professor and students.

In the warm up, the class is flowing in terms of intensity so, a gradual increase of the cardiac frequency and of corporal level must exist. Therefore, the music is not so elevated.

The cool down is the part where a diminution of the cardiac frequency should exist. The students try to control the breath relaxing by suitable exercises and so the noise levels decrease significantly (on average, 8 dBA), providing the students a physical and psychological calm mood.

It was found that 63% of the rooms for group gymnastics presented noise levels equal or above 90 dB(A) and that 6% of the rooms had values above 100 dB(A) in the main part of the class. Therefore, the users and the professors are usually under very high noise levels.

If the professors are under such noise levels during 60 minutes, what will be the daily accumulated noise exposure after teaching, for instance, three classes of 60 minutes hours (LEP,d3h) - a normal situation? It was found that in 47% of the cases the LEP,d3h is above 85 dB(A). Regarding the daily exposition to five hours of classes (LEP,d5h), 42% of the cases surpasses the 85 dB(A), and 37% surpasses the 90 dB(A). By the European Community (and Portuguese) legislation, 85 dB(A) is considered the "level of action" for ear protection and that 90 dB(A) is the dangerous "limit value".

Table 2 – Summary for the Acoustics. Rooms for group gymnastics (oriental and martial arts classes are excluded). Lglobal (Sum of Lw, Lm and Lc - duration of 60 min.); LEP,d3h (daily noise exposure level considering three hours of classes a day); LEP,d5h (daily noise exposure level considering five hours of classes a day).

Parameter (dBA)	Minimum	Median	Mean	Maximum	St. deviation
<i>Lw</i>	72.0	88.0	87.0	98.0	4.7
<i>Lm</i>	80.0	90.0	91.0	100.0	5.5
<i>Lc</i>	68.0	82.0	83.0	94.0	6.5
<i>Lglobal</i>	73.3	89.7	90.4	99.3	5.4
<i>LEP,d3h</i>	69.4	85.4	86.2	95.0	5.4
<i>LEP,d5h</i>	71.4	87.6	88.4	97.3	5.4

The study shown that 26% of the rooms are in a critic zone, therefore after three hours of classes (noise exposure), they provide an exposition over 90 dB(A) and they can be the cause of future hearing problems. Bigger problems may arise for those who teach five classes during a day, where 33% of the rooms have a risky noise exposure. These professors can get, in the short-term, partial levels of deafness, and physical or psychological consequences that can cause problems of various orders, socially or physiologically.

In specific rooms for martial arts or oriental classes (Judo, Karate, Yoga, Taichi, etc.) the noise levels are on average smaller 13 to 20 dB(A) and identical in the three moments of evaluation (table 3). The reason for these low noise levels relates with the characteristics of these modalities, where the concentration and technical severity are fundamental. The music assumes here only an environmental characteristic, maintaining itself with a low and constant noise level. It was found that the noise level never surpasses the not dangerous level of 80 dB(A).

Regarding all measured data, in most of the health fitness centres the legal "level of action" for the personal daily noise exposure in the rooms of group gymnastics, 85 dB(A) - value from which an intervention is required - was surpassed.

The 57 rooms analyzed reveal, in general, noise levels that clarify a risky exposition for the professor that teaches during an extensive period of time being dangerous for his/her ear and also for students that remain many hours in that environment. Most of these centres can be harmful because they surpass the 80 dB(A) that can be stipulated as the minimum comfort. The exception are the martial arts or oriental classrooms where the measured values are around the 70 dB(A) and where only one room reached the maximum of 82 dB(A).

Before this panorama of almost general non-fulfilment of the minimum requirements of comfort, we suggest equivalent maximum noise levels for all the persons exposed to the noise in classes of a health fitness centre. All the health fitness centres should have values not higher as 85 dB(A) during each phase of class and never instantaneously bigger than 90 dB(A). Regarding the LEP,d it is suggested that the personal daily noise exposure should not be higher than 80 dB(A).

These noise levels can be reached lowering the sound “volume” from the music equipment, and by the placement of acoustic correction in the rooms (sound absorbent materials).

Table 3 – Noise levels of the five oriental and martial rooms. Lw – phase of warm up; Lm – main phase of class; Lc – phase of cool down. Lglobal (Sum of Lw, Lm and Lc - total duration of 60 min); LEP,d3h (daily noise exposure level considering three hours of classes a day); LEP,d5h (daily noise exposure level considering five hours of classes a day).

<i>Parameter (dBA)</i>	<i>Lw</i>	<i>Lm</i>	<i>Lc</i>	<i>Lm-Lw</i>	<i>Lc-Lm</i>	<i>Lglobal</i>	<i>LEP,d3h</i>	<i>LEP,d5h</i>
Mean value	70	71	70	1.0	-2.0	71	68	69
Median	72	72	72	0	0	72	68	70
Stand. deviation	6.2	5.0	6.5	1.8	2.6	5.2	4.4	4.9

ACOUSTICS RESULTS - ROOMS OF CARDIO FITNESS AND WEIGHT TRAINING

The situation is very similar in these two types of rooms (cardio-fitness and weight training) (Table 4). Beyond the music this kind of spaces has diverse equipment of cardio exercises that contribute for the increase of the room noise. In general, the noise levels in the rooms for Cardio-Fitness or for Weight Training do not surpass the 80 dB(A). Most of the health fitness centres had noise levels between 64 dB(A) and 73 dB(A), what is well within the rule previously suggested of 80 dB(A) considered as the acoustic minimum comfort. However, two centres had noise levels extremely high (92 dB(A)). These two values are explained because the room of gymnastics was very near to the room of cardio-fitness and of weight training, being open spaces without any kind of partition between them. To solve this kind of problem it would be enough to have a partition (perhaps in double glass) to reduce the noise levels transmitted from one room to another. All of the health fitness centres have environment music in this kind of rooms, and the noise levels increase by the use of the machines of cardio-fitness. However these noise levels, save the exceptions referred previously, do not offer any problems (given the maximum 80 dB(A) suggested rule).

Table 4 – Summary from the acoustics in the thirty rooms of Cardio Fitness (CF) and of Weight Training (W). Lglobal (considered one entire class); LEP,d3h (daily noise exposure level considering three hours of classes a day); LEP,d5h (daily noise exposure level considering five hours of classes a day).

<i>Parameter (dBA)</i>	<i>Minimum</i>		<i>Median</i>		<i>Mean</i>		<i>Maximum</i>		<i>St. deviation</i>	
	<i>CF</i>	<i>W</i>	<i>CF</i>	<i>W</i>	<i>CF</i>	<i>W</i>	<i>CF</i>	<i>W</i>	<i>CF</i>	<i>W</i>
<i>Lglobal</i>	64.0	62.0	72.0	72.0	73.1	72.2	92.0	90.0	6.0	5.9
<i>LEP,d3h</i>	62.0	60.9	68.2	68.2	69.4	68.6	87.7	85.7	6.0	5.4
<i>LEP,d5h</i>	62.9	61.4	70.1	70.1	71.3	70.4	90.0	88.0	5.8	5.7

HIGROTHERMIC RESULTS - ROOMS FOR GROUP GYMNASTICS

In each room the temperature was measured before and immediately after a class and the summary of values obtained are displayed in the table 5. The values of temperature are between the 17.5 °C and the 26.5 °C. It was found that the values of the room temperature measured before the beginning of the class are smaller on average around 1 °C than after the term of the class. However, in 6% of the health fitness centres the temperature after the term of the class is slightly smaller perhaps due to a manual control of the temperature by a system of air-conditioned.

The table 5 presents mean values of temperature (after class) of 22.8 °C (in most of the health fitness centres the temperatures were around the 22 to 23 °C). For this kind of activities these temperatures can be considered slightly excessive.

The table 5 also indicates the levels of relative humidity found in the 57 rooms in two moments of evaluation: before the class begin and immediately after the class has finished but always with the empty rooms.

The levels of relative humidity tracked before the beginning of the class are, in 98% of the cases, smaller than after class (on average, around 0.09). In some health fitness centres very high levels of relative humidity (94%) were found, what happens due to the elevated transpiration that the persons emanate after a class with a cardio-vascular objective. As the body heats, the sweat increases and as consequence, increases the relative humidity in the room.

The relative humidity is very small in some health fitness centres (with an absolute minimum of 44%) what is explained for the kind of modalities carried out. This happens where does not exist a high level of transpiration (case of the Yoga and Taichi classes) or in the classes constituted by slower routines where it does not permit elevated levels of relative humidity (like Judo or Karate) by mechanisms that exist to reasonable control the relative humidity in the rooms.

Very high levels of relative humidity can cause physical ailment and are able to put in danger the physic integrity of the user. If the room reaches exaggerated levels of humidity and if does not exist good equipment of ventilation for renewal of the air, the mirrors can became steamed up not permitting the viewing of the movements, the floor can became slippery limiting the activities, etc.

A significant part of the values (37% of the total) of relative humidity found after the class finished, are over 80%, and in four health fitness centres (7% of the total) values over 90% were found.

Table 5 - Group gymnastics rooms – Summary of the temperatures (T) and relative humidity (RH) in the rooms.

<i>Parameter</i>	<i>Minimum</i>		<i>Mean</i>		<i>Median</i>		<i>Maximum</i>		<i>St. deviation</i>	
	<i>T(°C)</i>	<i>RH(%)</i>	<i>T(°C)</i>	<i>RH(%)</i>	<i>T (°C)</i>	<i>RH(%)</i>	<i>T (°C)</i>	<i>RH(%)</i>	<i>T (°C)</i>	<i>RH(%)</i>
<i>Before</i>	17.5	44	21.9	70	22.0	71	25.0	86	2.1	8.7
<i>After</i>	19.1	47	22.8	74	23.0	78	26.5	94	1.7	8.9
<i>Difference (=b-a)</i>	-	-	-0.9	-9	-0.8	-8	-	-	1.2	6.7
<i>Mean (= (b+a)/2)</i>	-	-	22.4	74	22.7	75	-	-	1.8	8.1

HIGROTHERMIC RESULTS - ROOMS FOR CARDIO-FITNESS AND WEIGHT TRAINING

In the cardio-fitness and weight training rooms, the temperature varies between the 19 and the 25 °C and half of the health fitness centres present values of temperature over 23 °C, what perhaps, for this kind of activity can be considered a little high. Concerning the relative humidity levels the average of values is 74%, reaching in six health fitness centres (36% of the total) values over 80%. This happens due to the elevated level of transpiration that persons emanate during cardio vascular activities. This occurs because of the gradual increase of body temperature, which increases sweating, which in consequence increases the levels of relative humidity of the room.

Despite of these elevated temperatures, this kind of activity is considered as an individual program, which has pauses, contrary to the cardio-fitness were the objective is cardio vascular and the training is characterized by continuous activity, resulting in elevating a little more the body temperature than in a neuro-muscular training activity.

Table 6 - Temperature and relative humidity (CF- Cardio-fitness rooms, W - Weight training rooms).

Parameter	Temperature (°C)		Relative Humidity (%)	
	CF	W	CF	W
Minimum value	19.4	19.4	43	43
Maximum value	25.0	25.7	84	84
Mean value	22.8	22.9	74	74
Median	23.0	23.0	76	76
Standard deviation	2.0	1.7	9.0	8.8

CONCLUSIONS

In general, the health fitness centres present high noise levels in the rooms for group gymnastics. In 63% of the cases they surpass even the 90 dB(A) daily legal limit (for professors) and in 6% the values are above the very dangerous level of 100 dB(A). Around half of the health fitness centres disregard the legislation for the protection of workers in the daily levels of noise exposure (for professors). The values found can put in risk the hearing health of professors (and users) in 26% of the rooms.

In the rooms for cardio-fitness or for weight training the noise levels are much smaller, in general between 64 and 73 dB(A) that is around 20 dB(A) less than in the classes of group gymnastics.

The health fitness centres present values of temperature and relative humidity moderately elevated in the rooms of group gymnastics (temperatures above of 23 °C were found in 28% of the cases and relative humidity above the 60% were found in 88% of the rooms), slightly above of the recommended levels.

On average the relative humidity increased during the classes of gymnastics in around 0.09. However ascents over 0.20 were detected in 10% of the health fitness centres.

The need for written rules relative to criteria and parameters in the health fitness centres was shown and some maximum limit values were suggested (Table 7).

Table 7 – Proposal for maximum limit values in health fitness centres.

AREA	PARAMETER	MAXIMUM LIMIT VALUE
Acoustics	Daily sound exposure levels ($L_{EP,d}$)*	80 dB(A)
	Sound levels (each class)	85 dB(A)
	Reverberation time (500 – 1000 Hz)	1.5 s
Thermic	Temperature	16 °C to 18 °C (Winter)
		20 °C to 23 °C (Summer)
Humidity	Relative humidity	50% to 60%
Ventilation	Number of air renovations per hour	1.5 to 2.0 (Winter)
		2.0 to 2.5 (Summer)

* $L_{EP,d}$ – noise level of a daily exposition

REFERENCES

Barreira, Carla C. S., *Parâmetros de Qualidade e Conforto Ambiental em Centros de Condição Física*, M.Sc. thesis, FCDEF, University of Porto, 2003.