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Evaluation of microclimate in regional hospital in Berat .

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Abstract: *Berati Hospital plays a very important role to petition the region for some highly specialized services offered. For this reason should study all factors of the internal environment of the hospital to have a comfortable standard but also for better manage infrastructure resources.*
The aim of this study is to investigate the most important parameters of the microclimate, for the right operational of the micro climatic environment conditions in regional hospital Berat.
Methods: An observational study, punctual, descriptive was applied to estimate the parameters of the microclimate in the premises of the regional hospital Berat. Indoors microclimate parameters which were evaluated are, ambient temperature, relative humidity, lighting and air movements.
Results: The internal temperature of the environment appears to be within the norm. Relative humidity values appear to be concentrated in the upper limit of the recommended rates in many hospital environments. Very high values ranging from 0571-1001 m / s (Va.) resulting in the emergency area, laboratory and inpatient rooms in the third floor. Lighting hospital environment appears to be the norm.
Discussion: The Berati Hospital for the shows that meet the conditions of a thermal comfort should be taken a number of measures in building infrastructure, to equip with central heating and cooling ventilation and circulation disciplining staff and visitors.
Keywords*: Micro climate, thermal comfort, (Va.)*

I. Introduction

City of Berati is one of the most important cities in Albania regarding its location but even historical and cultural values it represents. Every year increase the number of local and foreign visitors visiting the city of Berati and the economy is developing from cultural tourism sector. The climate of the district is typically Mediterranean, with annual average temperature 15.9 degrees C. The average temperature of the coldest month is 7.2 degrees C and the average temperature of the hottest months 28.2 degrees C. Lower absolute temperature was -12.2 degrees C and a maximum 47.1 degrees C. The average annual precipitation is 928 mm, mainly in the winter months.[12] The city of Berat is well ventilated and the air is cleaner thanks to the greenery within the city and surrounding hills. The hospital of Berat plays a very important role for the whole region and even recently is visited by patients from other cities for some highly specialized services that it offers. For this reason we should study all factors of the internal environment of the hospital to be comfort of standards of hospital building but also to manage better physical infrastructure resources.
The aim of this study is to investigate the most important parameters of the microclimate, for the right operational of the micro climatic environment conditions in regional hospital Berat.

II. Specific objectives

a. Measuring of air temperature values in regional hospital environment Berat and comparison with their appropriate values.
b. Measuring of average humidity values in regional hospital environment Berat and comparison with the values of international standards.
c. Measuring of lighting (lux) in hospital environment.
d. Measuring and calculation of speed of air moves in hospital environment.
e. Evaluation of the heating system.
f. Evaluation of the ventilation system.
g. Evaluation of the air conditioned system for cooling.

III. Methods and materials

An observation point descriptive study was applied to estimate the parameters of the microclimate in the environment of the regional hospital Berat. Microclimate parameters indoors which we considered reasonable to assess are, the environment temperature, relative humidity, lighting and air movements. Except

measurements to assess these parameters are observed other indicators that influence the microclimate parameters such as: heating system, cooling system and ventilation system. [2,3,4]

Measurement of temperature

For measuring of air temperature thermometers were placed in such a way as over them not act any external factor winger which can affect in change of real air temperature. Measuring of air temperature in hospital environments and in the interior of apartments in general made at an average level of 1-1.3 meters from the floor. Measurements made at different positions of the environment, in the hospital corridor are made at the beginning of the corridor, in the middle of the corridor and at the end of the corridor . In hospitalization rooms done at the beginning of the room near the door, over the patient's bed and in the middle of the room, in the surgical halls made at the beginning of the hall, in the middle of the hall over the manipulation bed and at the end of hall. In every closed place made in three or more positions measurements of air temperature. Measurements were performed with 615 Testo thermohigrometer. [2,3,6, 13]

Measurement of relative humidity

Relative humidity measurement is made with 615 Testo thermohigrometer and the measurement method is the same as with the air temperature measurement. By the fact that the device used for measurement is a thermohigrometer, positions of measurement of relative air humidity and air temperature are the same.[4,6,13]

615 Testo Thermohigrometer

615 Testo is a compact thermohigrometer for measurements of air conditions of environment, such as temperature and relative humidity indoors as houses, offices, warehouses, etc. 615 Testo as instrument has integrated within the serve to measure humidity and temperature, measurements realizes with battery and calibration protocol.

Measurement of the speed of air movement

Measurement of the speed of air movement conducted through a dry katathermometer with alcohol. Positions of measurements were as in the case of temperature and humidity measurements, but in the case of katathermometer measurements were repeated 2-3 times for each position and was chosen the average value observed by katathermometer [7,8,13]

Measurement of light

Measurement of light in regional hospital Berat conducted with 545 Testo luxmeter. Measurements to determine the lighting on the hospital environments conducted according to the rules of luxmeter measurements, measurements performed 1 meter from the floor and in some areas of the environment. In those environments that had lightning, it was in offices or desks, patient beds or manipulation beds in surgery rooms, lighting measurements are made exactly in these positions. For each environment described whether is natural or artificial lighting. [7,13]

Evaluation of heating, cooling and ventilation

As very important elements influencing factors on microclimate are observed cooling system, heating and ventilation in the regional hospital in Berat. Inspection of these systems is done in collaboration with field engineers and their maintenance personnel.[2]

IV. Results

The hospital of Berat is a regional institution that contains some buildings and was founded in 1960. The total surface of all buildings result to be 8826 m^2 and has an avarage report S/V= 0.92. The total surface of he hospital that has a heating system results to be 7386 m^2.

This hospital was built in 1960, under a centralized economy, aiming that the big health centers can offer better service and fulfill better the needs of community than the small ones.

Nowadays, because of the big socio-economical changes in this region, there is evident decresion also in the usage rate:

- the maximal bed capacity per patient is **266**
- The avarage number of patients is **142**

The surface per bed/patient results around 33/62 m^2. If we accept a norme of 7-7.5 (m^2/patient), then the total usefull surface of the hospital would have been 2000 m^2. This would lead to a higher energy efficiency used for heating and refrigeration. In this contect could be reorganized the system of the services in all buildings of the hospital. During the inspection it was noticed that there could be possible some new arrengaments in order to have a better energy efficiency in:

- Central building of the hospital,
- emergency,
- Laboratory of analysis

- laundry
- Kitchen etc

This hospital has been under reconstruction twice and there was included also the heating system.

4.1 The assessment of micro clime and conditions of health institutions (temperature, wetness, lighting, air circulations)

Table 1

The first floor

The hall is divided in two parts. In the right hall you can find obstetrical service. There are 16 patients room. The main door was opened. There was both artificial and natural lighting. The heating system was central with furnace but it was switched off. The measurements were done on 05/02/ 2011 at 14^{00}.

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 22 ^{0}C	L R 56 %,	Va 0.417 m/s	44lux
The middle of the hall	t 23 ^{0} C	L R 53 %,	Va 0.518 m/s	65lux
The end of the hall	t 24 ^{0} C,	L R 52 %,	Va 0.684 m/s	50lux

Neonatology

2 rooms with 2 baby beds each. There is one incubator. There were both artificial and natural lighting, furnace heating system, hot water with boiler. The door was opened.

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beds	t 23 ^{0} C	L R 58 %,	Va 0.518 m/s	49lux
The middle of the room	t 22^0 C	L R 58 %,	Va 0.417 m/s	38lux
The end of the room	t 22^0 C,	L R 56 %,	Va 0.417 m/s	131lux

The hall of the birth room and the surgery room in the obstetric ward. The door was opened, natural lighting, furnace heating. The hall had 5 rooms. The measurements were done on 03/02/2011 at 11^{30}

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 20 ^{0}C	L R 55 %,	Va 0.148 m/s	47lux
The middle of the hall	t 22^0 C	L R 58 %,	Va 0.249 m/s	15lux
The end of the hall	t 22^0 C,	L R 56 %,	Va 0.249 m/s	5lux

The birth room

There are two beds in the room, both artificial and natural lighting, central heating system, hot water with boiler. The door was opened. There were 2 birth beds and one patient bed.

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
Birth bed 1	t 21 ^{0}C	L R 58 %,	Va 0,192 m/s	43lux
Birth bed 2	t 21^0 C	L R 60 %,	Va 0,192 m/s	86lux
Baby bed	t 23^0 C,	L R 61 %,	Va 0,518 m/s	38lux
Patient bed	t 22^0 C,	L R 60 %,	Va 0,249 m/s	65lux

The hall of the surgery room, natural lighting, without heating system, closed door

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
In the middle of the room	t 23 ^{0}C	L R 62 %,	Va 0,192 m/s	9 lux

Surgery room, closed door, one surgery bed, central heating system and air conditioning, both natural and artificial lighting.
The measurements were done on 05/02/ 2011 at 12^{15}

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
Surgery bed	t 25 ^{0}C	L R 64 %,	Va 0,572 m/s	8840lux
The middle of the bed	t 24^0 C	L R 59 %,	Va 0,471 m/s	265 lux
The surgery table	t 24^0 C,	L R 65 %,	Va 0,471 m/s	9302 lux

The hall of the laboratory examination rooms. There are 11 rooms without heating system and opened doors. There is artificial lighting.

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 20 ^{0}C	L R 51 %,	Va 0,604 m/s	44lux
The middle of the hall	t 22^0 C	L R 51 %,	Va 0,872 m/s	65lux
The end of the hall	t 20^0 C,	L R 51 %,	Va 0,604 m/s	50lux

The laboratory hall has artificial lighting, 6 rooms, central heating system, closed doors

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 21 ^{0}C	L R 52 %,	Va 0,683 m/s	118lux
The middle of the hall	t 21^0 C	L R 51 %,	Va 0,683 m/s	149lux
The end of the hall	t 21^0 C,	L R 51 %,	Va 0,683 m/s	43 lux

The laboratory room

Natural lighting , air conditioning and central heating system, opened doors, 2 persons

Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 24 ^{0}C	L R 53 %,	Va 0,884 m/s	55lux
The middle of the room	t 24^0 C	L R 52 %,	Va 0,884 m/s	112lux

The end of the room	t 24^0 C,	L R 52 %,	Va 0,884 m/s	85 lux
The emergency hall 9 rooms, natural lighting , without heating system, opened door				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 20 ^{0}C	L R 52 %,	Va 0.604 m/s	213lux
The middle of the hall	t 20^0 C	L R 51 %,	Va 0.604 m/s	10lux
The end of the hall	t 19^0 C,	L R 52 %,	Va 0,571 m/s	11lux
The emergency room Opened door, 4 beds, both natural and artificial lighting, central heating system				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The patient's bed	t 20 ^{0}C	L R 55 %,	Va 0.604 m/s	160lux
The middle of the room	t 20^0 C	L R 57 %,	Va 0.604 m/s	99lux
The second floor Surgery service				
The surgery hall 33 rooms , central heating system, both natural and artificial lighting, closed doors				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 19 ^{0}C	L R 55 %,	Va 0.319 m/s	72lux
The middle of the hall	t 19^0 C	L R 54 %,	Va 0.319 m/s	144lux
The end of the hall	t 19^0 C,	L R 54 %,	Va 0.319 m/s	26lux
Surgery room, second floor Artificial lighting, both central and air conditioning heating system. Closed doors and windows without respiration system				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 20 ^{0}C	L R 55 %,	Va 0.373 m/s	105lux
The middle of the room	t 21^0 C	L R 56 %,	Va 0.429 m/s	73lux
Surgery bed	t 21^0 C,	L R 55 %,	Va 0.429 m/s	8822lux
The end of the room	t 20 ^{0}C	L R 55 %,	Va 0.373 m/s	13lux
The third floor Pathology and intensive care				
The pathology hall Closed doors, both artificial and natural lighting, central heating system and 19 rooms				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 19 ^{0}C	L R 54 %,	Va 0.314 m/s	10lux
The middle of the hall	t 20^0 C	L R 54 %,	Va 0.373 m/s	212lux
The end of the hall	t 19^0 C,	L R 54 %,	Va 0.314 m/s	25 lux
The bursary room, the third floor Natural lighting system, opened door, central heating system and heater, 1 person				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 20 ^{0}C	L R 54 %,	Va 0.373 m/s	32lux
The middle of the room	t 22^0 C	L R 54 %,	Va 0.622 m/s	52lux
The end of the room	t 22^0 C,	L R 54 %,	Va 0.622 m/s	58lux
Patient room, the third floor 6 beds, natural lighting, central heating system, closed door, 3 persons				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 23 ^{0}C	L R 70 %,	Va 0.827 m/s	14lux
The middle of the room	t 23^0 C	L R 70 %,	Va 0.827 m/s	16lux
The patient's bed	t 23^0 C,	L R 70 %,	Va 0.827 m/s	16lux
The end of the room	t 23^0 C,	L R 68 %,	Va 1.001 m/s	113lux
Intensive care hall 7 room,closed door, no heating system, both artificial and natural lighting				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 19 ^{0}C	L R 53 %,	Va 0.314 m/s	32lux
The middle of the hall	t 18^0 C	L R 52 %,	Va 0.244 m/s	79lux
The end of the hall	t 18^0 C,	L R 52 %,	Va 0.244 m/s	95lux
The intensive care room Both artificial and natural lighting, central heating system and heater, without respiration, 5 persons, 3 beds.				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 24 ^{0}C	L R 59 %,	Va 1.001 m/s	81lux
The middle of the room	t 24^0 C	L R 58 %,	Va 1.001 m/s	55lux
The end of the room	t 24^0 C,	L R 56 %,	Va 0.827 m/s	116lux

The fourth floor, Pediatric service				
The pedantry hall 30 rooms, both natural and artificial lighting, opened door, without heating system				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the hall	t 18 ^{0}C	L R 56 %,	Va 0.325 m/s	25lux
The middle of the hall	t 18^0 C	L R 56 %,	Va 0.325 m/s	62lux
The end of the hall	t 17^0 C,	L R 57 %,	Va 0.269 m/s	79lux
The pediatric patients rooms, Both artificial and natural lighting, central heating room, 2 beds, 5 persons, closed door.				
Place of measurements	Temperature	Relative wetness	Air circulations	Lighting
The beginning of the room	t 20 ^{0}C	L R 60 %,	Va 0.500 m/s	110lux
The middle of the room	t 21^0 C	L R 59 %,	Va 0.648 m/s	170lux
The end of the room	t 21^0 C,	L R 59 %,	Va 0.648 m/s	181lux

	Value below the norm
	Value over norm

4.2 Heating system

The heating system of the hospital is a system with two tubes. The thermal system is created by two furnaces which work with solar panels (HFO) with a maximal power of 730 (kW). The furecans are useful for both heatnig system and for the hygenic water system (DHW).

The temperatures of the hot water in despatch and return should be 70 and 50 (˚C). The heating system was reconstructed durig the building's reconstruction. There were done some changes during the reconstruction in 1995:

- Reconstruction of the furnace's room
- Substutute of the heating radiators.

However, there are some important parts of the heating system that were not reconstructed like: central magistrals, columns and the systems of measurements, control and regulation.

It was noticed that there were some missing radiators in the hospital. There were 15 missing radiators and 50 brocked down.

4.3 Ventilation system

In the hospital of Berat there is lack in air conditioning systems (HVAC). So, there is not used a mechanic ventilation system. The airing in the hospital ambience is done naturaly by opening the windows and doors. This way of airing results to be very ineficcient and with very hightenergy loss.

4.4 The system of hygenic hot water (DHW)

As it was mentioned above the hygienic water is done in the thermal central in 3 boilers.

There are 3 baliers used for this aim with a volume 2000 liters each, ensuring a total amount of water 6000 liters. There is a lack in the measurements and the control of the used water and the quality of water supply in different hospital services. The water temperature is 45-50 ˚C. In the future there could be used the solar panels for heating the hygenic water.

4.5 Air conditioning system: cooling

There is a lack in the air conditioning system. To fulfill the needs, usually during summer, in some rooms there are used air conditioners type split

V. Discussion

1 – Even the microclimate parameters of the indoor environment like: temperature (t), relative wetness (LR), speed of air movement (Va), generally are according to the indoor environment normative values, it is noticed that:

a - The temperature in the indoor environments of the hospital is not uniform and there is a difference between the temperatures of the rooms, halls and other service ambiences. The variability of the temperature values between different ambiences of the hospital is from 17^0 ne 25^0 C, meanwhile the variability in the temperature values in the same ambience are normal.

b- The hermetic indoor environments of the hospital are not guaranteed equally everywhere. The main doors, the hall doors and the room's and hall's windows often stay opened.

c- The furnace of the hospital is not working all the time to guarantee an uniform temperature in all environments of the hospital and the water temperature of radiators often is lower than it should be.
d- In the ambiences of staff's, patients, laboratories, cabinets, etc rooms there are used all the time local alternative heating equipment's with different powers.

2 – The relative air wetness is according to the norms and usually goes from 51% to 70%.

3- The moving air parameters in the indoor ambiences of the hospital of Berat are noticed to be more vacillate than other micro clime parameters. It is important to emphasize that the air movements varies from 0.148 m/s to 1.001 m/s (this values is over the allowed hygienic norms). The values over norms where assessed in important ambiences like: intensive care, neonatology, surgery room, laboratory, etc. This can influence badly in the patients health.

4 - The lighting of the indoor ambiences is realized by the luminescent lumps. Lighting in the rooms was assessed under natural lighting. Meanwhile the assessed values of the: halls, surgery rooms, intensive care rooms represent the artificial lighting. It variegates from 9 lux to 213 lux. Meanwhile in the surgery rooms it is 265 lux and in the surgery bad it varies from 8822 lux to 9302 lux.

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