



HYGIENIC EVALUATION OF MICROCLIMATE CONDITIONS AND NOISE LEVEL AT THE TERRITORY OF UNIVERSITY HOSPITAL COMPLEX “HERATSI”

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Abstract

The problem of hygienic regulation of microclimate in southern cities is of great scientific interest related to the unfavorable influence of the excess heat on the human organism. The hot and dry climate causes overheating of the human organism and brings to a significant tension in functions of the thermoregulating apparatus. One of the most important sanitary-hygienic problems is to provide environmental conditions comfortable for the human health.

Creation of the artificial microclimate in southern cities and towns by means of rational greenery planting is of utmost importance. As an integral element of complex organization of public services and amenities and landscape organization of territories, greenery planting provides formation of the favorable environment with the active use of vegetative components.

From 2007 to 2010, large-scale reorganization of greenery planting was conducted in the clinics of Yerevan State Medical University (YSMU). As a result of complex evaluation of the physical, chemical, sociohygienic factors and elements of architectural planning in the clinics conditions, we worked out and implemented principles of greenery planting directed at restoration of hospital environment and making it esthetic.

The aim of the present work is to evaluate measures on rearrangement of greenery planting according to the microclimatic indices and the acoustic level at the territory of “Heratsi” hospital area and the zone attached to it.

Data obtained as a result of the investigation demonstrated that even small green space has impact on the microclimate decreasing the temperature and increasing relative humidity of the air and allows to testify that the rational planting at the medical preventive institution is able to reduce the noise level and provide a proper treating-preventive regimen in the hospital.

Keywords: greenery in hospitals, noise level, microclimate, psychoemotional comfort.

INTRODUCTION

Under conditions of intense urban expansion, the problem to maintain and improve the urban environment, to form conditions protecting the human health is becoming topical. Settlement gardening is one of the most effective measures for improvement and restoration of the urban environment according to both results, realization terms and the expenses [Neverova O., 2004].

In the south, the problem of microclimate hygienic regulation is of great interest related to the unfavorable influence of the redundant heat on the human or-

ganism. Creation of the artificial microclimate in southern towns with the help of rational plantations at their territory is of utmost importance.

The continental and dry climate of Yerevan, the capital of Armenia, is the main cause of unfavorable sanitary-hygienic conditions. Besides the climate, problems include absence of natural forest tracts, asphalt covering, dense building and site development. Protracted hot summer with the temperature increase up to 42°C at low humidity creates rather unfavorable hygienic conditions [Harutjunyan L., Shakharyan A., 1965; Aghajanyan G., 1983].

For many years, the hygienists have focused their attention to regulate the general square of green plantations per one person. Scientists' opinion on setting the norm significantly differs and fluctuates

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within 18-67 m^2 of urban plantations per 1 person [Goncharov N., 1977].

According to official data, for climatic conditions of Yerevan the green plantation area per 1 urban resident should be 28.8 m^2 . However, mass cutting down in early 1990s and the new tendencies in urban development resulted in increase of dense building, decrease of green areas and a sharp, 3-4 times, decrease in index of green plantations per one person. Today the index is equal to 4.5-5.0 m^2 ; it is 10 times less than the norm of 50 m^2 set up by the WHO resolution [Komarova N., 2006; Vardanyan J. et al., 2009; Vardanyan K., 2010; 2011].

Problems of greenery gain topical character related to the preventive-medical institutions, as there is a direct link between the hygienic conditions of hospitals and patients' health. In the contemporary understanding, the hygienic factor is an integral part of the whole complex of preventive-medical measures. The design of hospital environment demands profound scientific approach. The norms should be worked out considering the profile of the hospital and person's natural needs for greater comfort [Shtrejs A., 1967].

Long-term multilateral investigations revealed the important role of green plantations in improving the microclimate of urban territories and protecting the town against the noise. The investigation of town noise has shown that municipal transport is the most powerful and widespread source of noise among others. The struggle against noise is especially important in medical preventive institution, as the patient reacts more sharply to the noise, which influences the efficacy of the treatment and medical management [Karagodina I., 1979; Li H. et al., 2010].

Taking into account all the above mentioned, wide-range reorganization of greenery has been carried out in the Yerevan State Medical University (YSMU) clinics. As a result of complex assessment of chemical, architectural-planning, sociohygienic factors of hospital conditions, we worked out and introduced new principles of greenery planting directed to restore hospital environment and make it esthetic [Vardanyan K., Hayrapetyan A., 2010].

The present paper is one of the fragments of the scientific project on evaluation of measures directed to the greenery reorganization performed in the YSMU clinics.

The aim of this work is to evaluate rearrangement of plantations according to the microclimatic indices and the level of noise at and around the hospital areas.

MATERIAL AND METHODS

For comparative evaluation of microclimatic indices at the hospital territory measurements were done in two points: a) the open territory bare of vegetation (later it is marked as "1" in Table 1); b) territory planted with trees and gardens (later marked "2" in Table 1).

To give a relative evaluation of the noise level, we measured it in five points: Abovyan Street ("1" in Table 2); open not planted territory 15 m far from Abovyan Street ("2" in Table 2); planted territory 15 m far from Abovyan Street ("3" in Table 2); open not planted territory 45 m far from Abovyan Street ("4" in Table 2); public green space of the hospital 45 m far from Abovyan Street ("5" in Table 2).

The results of measured microclimate parameters were compared with the sanitary hygienic norms, on the base of which the evaluation of microclimatic indices and the noise levels on the hospital territory was conducted. The microclimatic indices and the acoustic levels at the studied territories were measured with devices corresponding to the state standard demands, registered and certified by the Republic of Armenia National Institute of Standards. Measurements were done in the morning (from 9:00 to 10:00) and in the evening (16:00-17:00) for 10 days during the hot season in September 2009 and July 2010.

To investigate the influence of planting on the acoustic pollution level in the hospital area a noise and vibration measuring instrument, sound level meter VShV-003 (Russia), was used. To measure the temperature and relative humidity of the air Assmann's aspiration psychrometer was implemented [Minkh A., 1967].

Noise levels evaluation was conducted through comparison of obtained values with the levels optimal and permissible for medical preventive institutions of Yerevan, according to the sanitary hygienic norms defined by Order of Ministry of Health of the Republic of Armenia of 2002 [Order No.138, 2002].

Statistical processing of obtained data was carried out with the help of personal computer using Microsoft Excel 2007 and XLSTAT 2009 programs. Student's *t*-criteria were used for comparing the average significance. Common indices of descriptive statistics were considered: arithmetic mean value, error of mean, confidential interval (95% CI). The following indices were used to describe results of the investigation: "mean value (M) \pm standard error of mean (m)". The difference in investigated parameters was considered significant at 95% probability ($P < 0.05$).

Table 1.

Air temperature and relative humidity at the hospital territory

| Microclimatic factor | Year | Time of day | Hospital territory | |
|-----------------------|------|-------------|--------------------|---------------|
| | | | Green zone (1) | Open zone (2) |
| Air temperature (°C) | 2009 | morning | 23.5±0.5* | 25.3±0.5* |
| | | evening | 29.4±0.4* | 31.9±0.2* |
| | 2010 | morning | 22.8±0.2* | 24.2±0.2* |
| | | evening | 33.2±0.3* | 35.2±0.3* |
| Relative humidity (%) | 2009 | morning | 58.0±0.9* | 40.7±0.7* |
| | | evening | 45.5±1.0* | 38.9±0.7* |
| | 2010 | morning | 57.8±0.8* | 38.9±0.7* |
| | | evening | 45.5±1.0* | 36.5±0.8* |

Notes: * $P < 0.001$

RESULTS

The analysis of data obtained in dynamics of 2-year investigation on microclimatic indices at the hospital territory, as well as the subsequent comparison of the results obtained at the territory of different sites of hospital area revealed higher values of considered indices at the open sites without vegetation. The comparison of microclimatic indices at open and planted areas of the hospital territory both in the morning and in the evening revealed a great difference.

Our investigations confirmed the results of earlier investigations [Harutyunyan L., Shakaryan A., 1965; Aghajanyan G., 1983; Wong N. et al., 2010 a; b] and demonstrated that in dense building conditions even insignificant plantations greatly improve the temperature regimen and decrease the noise level.

Data presented in Table 1 show that in 2009 and 2010 at morning measurements in green area the average temperature of the air was by 1.8 °C and 1.4 °C lower compared with the open area, correspondingly ($P < 0.01$). In the evening, in 2009 and 2010, the studied indices in the green area were, on average, by 2.5°C and 2°C lower compared with the results obtained in the open space ($P < 0.001$).

Yerevan differs in its continental climate and is characterized by a stable hot, dry summer that is of special interest for investigation in view of the unfavorable influence of excess heat on the human organism resulting in the organism overheating and tension in functions of thermoregulating apparatus.

Data presented in Table 1 show that in 2009 and

2010 in the morning at green area the relative humidity was on average by 17.3% and 18.9% higher compared with that at open area, correspondingly. In 2009 and 2010 in the evening, the indices at green area were on average by 6.6% and 9.0% higher compared with those obtained at the open area ($P < 0.001$), correspondingly.

Table 1 shows that the highest percent of relative humidity was observed in the morning at the green area.

Once being in the suburbs and in densely green area of Yerevan, the University Hospital “Heratsi” is currently in the centre of the city; moreover, it is surrounded by main motorways of Abovyan, Shari-manyan, Heratsi streets with a rather high level of acoustic pollution.

Mass survey and investigation on morbidity allowed to reveal the approximate border of unfavorable influence of the town noise. According to data of different authors, the beneficial conditions related to acoustic levels at the area of medical preventive institutions were defined within 35-50 dbA (Karagodzina E., 1979; Aghajanyan G., 1983).

Data on noise levels in different areas of the hospital and territories adjacent to the hospital were obtained in two-year dynamics. The analysis of data revealed higher indices in Abovyan Street, where the noise pollution was the highest. A significant difference was noted through comparison of results obtained in Abovyan Street with those obtained from the green area of the hospital and the public green space.

Data presented in Table 2 show that compared

Table 2.

The noise level in different areas

| Index | Year | Time of day | Testing place | | | | |
|-------------|------|-------------|--------------------|--------------------|---------------------|--------------------|------------------------|
| | | | Abovyan Street (1) | Open area 15 m (2) | Green area 15 m (3) | Open area 45 m (4) | Public green space (5) |
| Noise (dbA) | 2009 | morning | 76.0±0.4 | 68.0±0.4 | 64.0±0.4 | 62.0±0.4 | 52.0±0.4 |
| | | evening | 76.0±0.5 | 68.0±0.5 | 64.0±0.6 | 62.0±0.4 | 52.0±0.7 |
| | 2010 | morning | 77.2±0.4 | 72.0±0.8 | 66.4±0.4 | 62.0±0.4 | 52.0±0.4 |
| | | evening | 75.0±0.4 | 69.8±0.8 | 63.8±0.6 | 62.0±0.4 | 52.0±0.7 |

with the noise level in Abovyan Street (1) in 2009, the investigated indices were by 12.0 dbA and 24.0 dbA lower at green area (3) and in the public green space (5), correspondingly. In the evening, measurements at green area (3) and in the public green space (5) demonstrated that compared with the noise level in Abovyan Street (1) in 2009 the investigated indices, on average, were lower by 12.0 dbA and 23.0 dbA, correspondingly. In 2010, the same indices were lower by 11.2 and 23.0 dbA, correspondingly ($P<0.001$).

To study the influence of green plantations on the noise level, we compared the indices obtained at planted and not planted areas of the hospital territory, which are 15 m equally far from the main road.

When comparing the results obtained from green (3) and open areas (2), at point 3 during the morning investigations of 2009, the noise level was, on average, by 4.0 and 5.6 dbA lower, correspondingly. In the evening investigations of 2010, the studied index was by 4.0 and 6.0 dbA lower, correspondingly. When comparing the results obtained from the public green space (5) and 45 m open area (4) of the hospital area, at the same distance from the street both in the morning and evening investigations carried out in 2009 and 2010, the noise level was, on average, by 10 dbA lower. When comparing the results of the noise level obtained from the 45 m open area (4) and in Abovyan Street (1), both in the morning and evening investigations in 2009, the noise level in the public green space (5) was, on average by 14.0 dbA lower. In 2010 the

studied index was lower: in the morning by 15.2 dbA and in the evening by 13.0 dbA ($P<0.001$).

DISCUSSION

As obvious from the above mentioned, only the indices of acoustic level registered in the public green space, both in 2009 and in 2010, corresponded to the requirements of sanitary hygienic norms. In all other points they exceeded the maximum level of allowable norm (50 dbA).

We can conclude from the above mentioned that even small green planted areas influence on the microclimate alleviating the temperature and relative humidity of the air at the territory and allow to testify that the rational plantation at medical preventive institutions is able to reduce the noise level and provide a proper treatment and preventive regimen in the hospital.

The presence of a proper plantation corresponds to the traditional image of medical preventive institutions and, according to the international standards, it is considered to be an essential condition for the patient, who is restoring his/her health after receiving special medical aid.

Effective planting of greenery at medical preventive institutions directed to improving the external and internal hospital environment can be achieved only on the base of scientifically proved conception of greenery integrated into the program of city landscape gardening system development.

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