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ANALYSIS OF THE IMMUNE STATUS OF MUSEUM EMPLOYEES TO ASSESS THE LEVEL OF DAMAGE TO THEIR HEALTH

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Abstract

The purpose of this paper was to assess the immune status of employees in a Romanian museum and to improve the risks assessmentf for occupational diseases. The analyzes were performed before the pandemic and involved 58 museum employees: 49 women and 9 men. Simple radial immunodiffusion plates were used to determine IgA, IgM, IgG immunoglobulins and C3 and C4 components of the complement system. A 96-well ELISA kit was used to determine IgE. The results of the immersion objectives (100x) analysis for leukocyte formulas showed changes compared to reference values for 95% of the volunteers, in at least one of the five analyzed indicators. Most values outside the reference range were lymphocytes (37 cases), monocytes (36 cases) and eosinophils (22 cases), In the case of the immunogram 29 cases for IgA, 51 cases for IgM and 46 cases for IgE had values outside the references, which may indicate allergic reactions. These results contribute with relevant data for risk assessment. Admitting the importance and the limitations of existing EU and national legislation, the results of this study and other similar research are a source of potential improvements in the legal framework, for example by better reflecting the allergenic effects of biological agents.

Keywords*: Risk assessment; Immune status; Workers; Museum, Allergies*

Introduction

Worldwide, almost 320 000 workers die each year from occupational infectious diseases, of which 5000 in the EU [1]. According to data from the European Agency for Safety and Health at Work (EU-OSHA) that quotes a 2015 study, an increasing proportion the EU workers (13%, which is 1.5 times more than in the previous 10 years) are exposed to infectious agents at work [1].

EU-OSHA studies identified 5 occupational groups that are considered to be most exposed to biological agents: animal-related occupations, waste and wastewater management, healthcare, agriculture and occupations involving travel or exposure to travelers [1].

It is not clear if the travel related workers in the mentioned study, include thouse in museums. Turists travelling locally, or all over the world can transmit microbial infectious agents while visiting museums. Besides, there are also artifacts, museum objects that can be serious sources of biological contamination. Their state of degradation, age, or even the nature

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of their materials can influence the development of microorganisms, despite the measures taken to preserv them. All these make museum workers prone to exposure to biological risk [2, 3].

Worldwide, in 2017 there were over 55,000 museums in 202 countries [4]. In 2018, Romania reports, according to the European Group on Museum Statistics (E.G.M.U.S.), a number of 787 museums, of which 266 museums of art, archeology and history [5].

The Bureau of Labor Statistics USA estimates a 7% increase in jobs for museographers, archivists and cleaners by 2024, unlike anthropologists and archaeologists, where it is estimated to increase by 4% and historians by only 2% [6].

The density and type of microorganism's present/developed in the museum depend on several factors, such as: the presence of organic objects, temperature, humidity, air currents and last but not least the presence visitors [7].

As per the EU Directive 2000/54/EC (Chapter I, Article 3) for "any activity likely to involve a risk of exposure to biological agents, the nature, degree and duration of worchers' exposure must be determined in order to make it possible to assess any risk to the workers' health or safety and to lay down the measures to be taken" [8].

A biological risk assessment based only on the level/quantity of micro-organisms (CFU/m^3) present in the work environment may not be sufficient, since this method quantifies only viable microorganisms [9].

The aim of this study was to analyze the immunological status of museum employees. The results can be used to better assess biological risks and the degree of impairment of health.

Experimental Part

The study was carried out in a museum with over 150 rooms, built at the end of the 19th century, in an area with forests and reach vegetation. It is one of the most visited museums in Romania, by local and international tourists. It hosts permanent collections of paintings, furniture, various textiles, decorative pieces and books. The climate in this area is cold and humid, the average annual temperature is 8°C and the average humidity varies between 71% and 76% (Website Weather Underground https://romanian.wunderground.com).

Following previous research, which aimed to assess the level of microbiological contamination of air in the museum in seasonal dynamics, it was found that it is very high for mesophilic microorganisms, especially in summer when they registred $1.4x10^4 CFU/m^3$ mesophilic, $350CFU/m^3$ hemolytic, $3x10^3 CFU/m^3$ fungi (CFU being colony forming units) [10].

The group of volunteers participating in the study consisted of 58 museum employees, of which 49 were women, with an average age of 46 years and 9 were men with an average age of 39. From the Observation Conservation Department were 35 employees; from the TESA Department were 12 and 11 employees from the Technical Department (maintenance). The working hours are 8 hours a day, 5 days a week.

The same working group was evaluated before by the authors, in a study on the composition of the cultivable microbiota that colonized their skin and mucosa of the upper respiratory tract. The results indicated that dysbiosiswas the most common disease/effect. The study also isolated species of Staphylococci resistant to Penicillin and Cefoxitin [11].

Materials

Leukocyte formula

For venous blood sampling, 21G butterfly-type microperfusers with K3EDTA hematology vacutainer holder, 2ml with purple plug and 6ml red biochemistry vacutainer were used.

Immunogram

The samples were collected in special vacutainers, without anticoagulant. For the IgA, IgM, IgG and C3 and C4 components were used simple radial immunodiffusion plates (I.D.R.S.) of Bioscience. For determine IgE was used a 96-well ELISA kit. The ELISA strips were read with the Biochrom EZ Read 400.

Methods

To make the leukocyte formula, blood smears were made on 1mm thick glass slides. A volume of approximately 30µL of blood was used for each smear, which was evenly distributed in a single motion (using another slide) over the entire surface. The reading area in the middle varied between 10-15mm. After a first air drying of the preparations, a fixation with pure methanol was performed. May-Gruwald Giemsa stained blood smears were examined under an optical microscope with a 100x immersion objective. Results were compared to the biological reference range, specified by the used working technology for the quantification of the leukocyte population [12].

Regarding the immunogram, after inoculation of 5µL of the sample, the plates were incubated in a humid chamber and then read after 72 hours for IgA and IgG, while for IgM at 48 hours (time required for diffusion of Ags). The diameter of the precipitation rings was then measured with an accuracy of 0.1mm, as stated in the prospectus of the immunodiffusion plates. The interpretation was made according to the instructions given by the producer of the immunodefusion plates.

Results and discussion

Leukocyte formulas

As a result of the analysis of the quantification of the leukocyte populations, it was observed that they showed changes compared to the reference values for 95% of the volunteers participating in this study, for at least one of the indicators analyzed as presented in Table 1.

Table 1. Cases recorded outside (below/above) the biological reference range (bio.ref.)

Leukocyte formula	Biological reference range	Number ofcases	
		< bio.ref.	> bio.ref.
Lymphocytes	20-30 %	4	33
Monocytes	2-8 %	-	36
Eosinophils	0,2-2 %	15	7
Neutrophils	50-70 %	6	6
Basophils	1 %	-	3

Most values outside the reference range were eosinophils (22 cases), monocytes (36 cases) and lymphocytes (37 cases). A distribution of these cases by women/men may not be very relevant given the large difference between the number of participating women (49) and

the number of men (9). It might be noted, however, that of the 9 men, 7 had higher monocyte counts and 8 had higher lymphocyte counts. Also, the highest value for eosinophils belongs to a man. Mild eosinophilia is often present in individuals with allergic conditions such as allergic rhinitis and asthma. The literature states a correlation between eosinophilia and the degree of spongiosis in acute dermatitis or acute exacerbations of chronic disease [13].

Immunological test results

Following evaluation of the concentration of antibodies or immunoglobulins belonging to IgA, IgM, IgG classes, as well as components C3 and C4 together with the results obtained for IgE, it was observed that none of the participants had all indicators in the biological reference range as presented in table 2.

Table 2. Cases with imunoglobulin indicatorrs level outside the biological reference range (bio.ref.)

Immunoglobulin indicators	Biological reference range	Number of cases	
		<bio.ref.	> bio.ref.
IgM	75-300 (mg/dl)	51	-
IgA	90-400 (mg/dl)	25	4
IgG	600-1650 (mg/dl)	31	-
IgE	60<100 (UI/ml)	13	33
C3	80-160 (mg/dl)	16	9
C4	20-40 (mg/dl)	33	-

Some observations are mentioned in the Laboratory Corporation of America Guide, 2015 [7], namely: - no cross-reactions between IgA, IgM and IgG are known; - an IgE value recorded in the reference range does not exclude the existence of allergic diseases; - There have been regsitered cases of anorexia nervosa, uremia and celiac disease and associated with low C3 levels.

IgM class antibodies are associated with the primary immune response and are commonly used to diagnose acute exposure to an immunogenic antigen, such as a pathogen or toxin [14].

The biological role of IgE is complex and is related to its ability to influence the functioning of some cells of the immune system (PMN leukocytes or granulocytes) involved in the pathogenesis of allergies and consecutive chronic inflammation [15]. Increased serum IgE can be caused by allergies, certain infections and immune disorders [16].

There are epidemiological studies that suggest that elevated IgE levels are also common in subjects with acute coronary events [17].

Conclusions

The research in this study complements previous studies that have focused on the same museum and the same working group of volunteer workers.

From the analysis of the leukocyte formula, it was found that a proportion of 62% of the tested employees had monocytosis, 57% of them lymphocytosis, and in 29% of cases, both parameters were abnormal; this information may indicate possible chronic, bacterial or fungal infections.

Regarding immunological indicators, results indicate possible allergic reactions of the museum employees, considering that 57% of those tested presented values above the reference values for IgE. The results of research in this area show that the investigated staff has varying degrees of impairment of health.

Occupational diseases with immunological substrate are emerging diseases that affect workers in different environments or sectors of activity. Occupational exposures to biological agents in the workplace can cause inflammation, allergies, infections or other potentially harmful immune responses. Exposure to a variety of biological agents can trigger or worsen immune diseases such as contact dermatitis, respiratory diseases, including rhinitis, asthma, and hypersensitivity pneumonia.

Admitting the importance, but also the limitations of existing legislation, as well as the need for efforts to improve it, it follows that the analysis of the results of this study and other similar research is a source of potential improvements in the legal framework and specific practices.

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References

[1] * * *, European Agency for Safety and Health at Work (EU-OSHA), *Summary-Biological agents and prevention of work-related diseases: a review*, 2020, https://osha.europa.eu/en.

[2] O. Florescu, I.C.A. Sandu, P. Spiridon-Ursu, I. Sandu, *Integrative Participatory Conservation of Museum Artefacts. Theoretical and Practical Aspects*, **International Journal of Conservation Science**, **11**(1), 2020, pp. 109-116.

[3] O. Florescu, P. Ichim, L. Sfica, A.L. Kadhim-Abid, I. Sandu, M. Nanescu, *Risk Assessment of Artifact Degradation in a Museum, Based on Indoor Climate Monitoring-Case Study of "Poni-Cernatescu" Museum from Iasi City*, **Applied Sciences-Basel, 12**(7), 2022, Article Number: 3313, DOI: 10.3390/app12073313.

[4] G. Saur, *Museom of the World*, **19th Edition of the Museums of the World**, 2012.

[5] * * *, EGMUS-The European Group on Museum Statistics, 2019, https://www.egmus.eu/en/statistics/

[6] * * *, U.S. Bureau of Labor Statistics; *Archivists, Curators and Museum Workers*; **Employment Projections program**, 2015.

[7] B. Gutarowska, J. Skora, K. Zduniak, D. Rembisz, *Analysis of the sensitivity of microorganisms contaminating museums and archives to silver nanparticles*, **International Biodeterioration & Biodegradation**, **68**, 2012, pp. 7-17.

[8] Directive 2000/54/EC - *biological agents at work*, European Parliament and of the Council.

[9] S. Viegas, C. Viegas, A. Oppliger; *Occupational Exposure to Mycotoxins: Current Knowledge and Prospects*, **Annals of Work Exposures and Health**, **62,** 2018, pp. 923–941.

[10] I. Scarlat, V. Lăzăr, R. Ștepa, C.M. Chifiriuc, L.M Ditu, M. Haidicu, *Seasonal monitoring of microbiological air contamination from a museum as a study case*; **8th International Conference on Manufacturing Science and Education – MSE 121**, 2017.

[11] I.P. Scarlat, R. Stroe, L.M. Diţu, C. Curuţiu, E.R. Chiurtu, I. Stănculescu, M.C. Chifiriuc, V. Lazăr, *Evaluating the role of the working environment on to skin and upper respiratory tract microbiota of museum workers*, **Romanian Biotechnological Letters, 25**(6), 2020, pp. 2103-2106.

[12] * * *, ICUB Laboratory. Specific references of the work technology used. Catalog 2010.

[13] D. Simon, L.R. Braathen, H.-U. Simon, *Eosinophils and atopic dermatitis*, **European Journal of Allergy and Clinical Immunology**, **59**, 2004, pp. 561-570.

[14] H.W. Schroeder, L. Cavacini, *Structure and function of immunoglobulins*, **The Journal of Allergy and Clinical Immunology, 125**, 2010, pp. 41-52.

[15] A. Matucci, A. Vultaggio, E. Maggi, I. Kasujee, *Is IgE or eosinophils the key player in allergic asthma pathogenesis? Are we asking the right question*, **Respiratory Research, 19**(1), 2018, Article Number: 113. doi: 10.1186/s12931-018-0813-0.

[16] A.Y. Joshi, V.N. Iyer, T.G. Boyce, J.B. Hagan, A.M. Park, R.S. Abraham, *Elevated serum Immunoglobulin E (IgE): when to suspect hyper-IgE syndrome-A10-year pediatric tertiary care center experience*, **Allergy Asthma Proceedings, 30**(1), 2009, pp. 23-27. doi: 10.2500/aap.2009.30.3193.

[17] D. Unal, A. Gelincik, A. Elitok, S. Demir, M. Olgac, R. Coskun, M. Koacaaga, B. Colakoglu, S. Buyukozturk, *Impact of high serum Imunogloblin E levels on the risk of atherosclerosisin humans*, **Asia Pacific Allergy, 7**, 2017, pp. 74-81.

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