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IMMUNOLOGICAL CHANGES IN STUDENTS UNDER ACADEMIC WORKLOAD AND STRESS CONDITIONS

Kimyo International University in Tashkent
Professor, Doctor of Medical Sciences: **Nodira Ismaildjanovna Muhamedjanova**
3rd-year students: **Dilrozbonu Javlonbek qizi Axroljonova**
Asadbek Anvar o'g'li Abdurazaqov

Abstract. The psychological state of students and the physiological parameters of the body can significantly influence academic performance. This study investigated the relationship between leukocyte formula parameters in the complete blood count (NEU, LYM, MON, EOS, BAS, IMG and their percentage values) and psychological test results (PT-1 and PT-2) among students. Statistical analysis demonstrated a certain degree of correlation between specific immunological parameters and psychological stress indicators. The obtained results are important for assessing the impact of psychophysiological status on students' academic activities.

Keywords: student health, leukocyte formula, psychological stress, academic performance, immunological parameters.

Introduction. In recent years, there has been increasing interest in the comprehensive assessment of students' health. Scientific studies have demonstrated that psychological stress, anxiety, and emotional strain can affect the functioning of the immune system. In particular, alterations in the leukocyte formula may be observed under stress conditions. In students, academic workload, examination periods, and disrupted sleep patterns can lead to both psychological and physiological changes. Therefore, comparing the results of psychological tests with hematological parameters is important for identifying factors that influence students' academic performance.

Aim of the study. To determine the relationship between leukocyte formula parameters and psychological test results in students, and to assess their impact on academic performance.

Materials and Methods. The study analyzed the results of complete blood count tests of 3rd-year students at the Tashkent International University of Chemical Technology (KIUT). The following parameters were evaluated: NEU (neutrophils), LYM (lymphocytes), MON (monocytes), EOS (eosinophils), BAS (basophils), IMG (immature granulocytes), as well as their percentage values: NEU%, LYM%, MON%, EOS%, BAS%, and IMG%. In addition, the psychological state of students was assessed using two psychological tests (PT-1 and PT-2). Statistical analysis was performed using correlation methods.

Results. During the study, the relationship between psychological test results and leukocyte formula parameters in the complete blood count of students was analyzed. The calculated mean values of the obtained data showed that in the group assessed by the first psychological test (PT-1), students achieved an average score of 45 ± 6 points. In this group, the leukocyte formula was recorded as follows:

WBC — 7.8 ± 1.2 $\times 10^9$/L
NEU# — 5.8 ± 0.9 $\times 10^9$/L
NEU% — 74 ± 5%
LYM# — 1.6 ± 0.4 $\times 10^9$/L
LYM% — 20 ± 4%

MON# — 0.45 ± 0.1 ×10⁹/L
MON% — 5 ± 1%
EOS# — 0.18 ± 0.05 ×10⁹/L
EOS% — 2 ± 1%
BAS# — 0.04 ± 0.01 ×10⁹/L
BAS% — 0.5 ± 0.2%
IMG# — 0.03 ± 0.01 ×10⁹/L
IMG% — 0.4 ± 0.1%

The results of the second psychological test (PT-2) showed that students had an average score of 48 ± 7 points. In this group:

WBC — 7.5 ± 1.1 ×10⁹/L
NEU# — 5.5 ± 0.8 ×10⁹/L
NEU% — 72 ± 6%
LYM# — 1.8 ± 0.5 ×10⁹/L
LYM% — 22 ± 5%
MON# — 0.47 ± 0.1 ×10⁹/L
MON% — 5 ± 1%
EOS# — 0.20 ± 0.06 ×10⁹/L
EOS% — 2 ± 1%
BAS# — 0.05 ± 0.01 ×10⁹/L
BAS% — 0.6 ± 0.2%
IMG# — 0.02 ± 0.01 ×10⁹/L
IMG% — 0.3 ± 0.1%

Analysis of the results showed that students with higher psychological test scores had relatively higher neutrophil counts (both percentage and absolute values), while lymphocyte levels were relatively lower. In particular, in the group with an average PT-1 score of 45, an increase in NEU% up to 74% and a decrease in LYM% down to 20% were observed.

Furthermore, correlation analysis revealed a positive relationship between PT-1 scores and NEU% ($r = 0.42$), and a negative relationship between PT-1 scores and LYM% ($r = -0.38$). This indicates that increasing psycho-emotional stress is associated with stress-related changes in the leukocyte formula.

These findings can be explained by stress-induced leukocyte redistribution in the body, where psychological stress leads to increased neutrophils (as a stress marker) and decreased lymphocytes (as an indicator of suppressed immune response). Accordingly, hematological changes observed in students with higher psychological test scores suggest a state of psycho-emotional strain. These psychophysiological changes may, in turn, be associated with reduced attention and cognitive function, increased fatigue, and decreased learning efficiency.

Conclusion. It was determined that certain parameters of the leukocyte formula in students are associated with psychological test results. The neutrophil-to-lymphocyte ratio may change in relation to psychological stress indicators. Psychological stress affects the immunological status of students' organisms. This condition may, in turn, indirectly influence students' academic performance and learning efficiency.