

EFFECTS OF X-RAY EXPOSURE ON WHITE BLOOD CELL AND SYSTEMIC INFLAMMATORY INDICES IN OCCUPATIONALLY EXPOSED HEALTHCARE WORKERS: A PILOT STUDY

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Understanding inflammatory responses to low-dose ionizing radiation in healthcare workers is essential for occupational health protection.



BACKGROUND

Increasing attention in contemporary research has been directed toward subtle inflammation induced by ionizing radiation (IR), which arises as a consequence of cellular damage rather than infection. Damaged cells release danger-associated molecular patterns, activating the immune response and initiating an inflammatory cascade. This process may lead to alterations in hematological parameters and systemic inflammatory indices, which serve as indicators of the intensity of this response.

OBJECTIVE

To investigate the possible effects of occupational low-dose X-ray exposure on white blood cell subpopulations and systemic inflammatory indices in healthcare workers.

MATERIALS & METHODS

Data were obtained from mandatory periodic medical examinations of 66 healthcare workers occupationally exposed to IR, conducted in January 2026 at the Serbian Institute of Occupational Health. Workers were divided into two exposure groups according to their annual effective dose: <1 mSv and ≥1 mSv. The routine complete blood count analysis and the following systemic inflammatory indices were evaluated: neutrophil-to-lymphocyte ratio (NLR), derived neutrophil-to-lymphocyte ratio (dNLR), platelet-to-lymphocyte ratio (PLR), lymphocyte-to-monocyte ratio (LMR), systemic immune-inflammatory index (SII), and systemic inflammatory response index (SIRI). Data distribution was assessed using the Kolmogorov-Smirnov test. Continuous variables were expressed as median (min-max or interquartile range) and compared using the Mann-Whitney U test. The Spearman rank correlation test was performed to evaluate associations between inflammatory indices and radiation dose, age, sex, annual effective dose, and duration of occupational exposure as independent variables. All analyses were performed using SPSS version 27 (IBM Corp., Armonk, NY, USA).

RESULTS



66
healthcare
workers



Median age
43 years
(range 23–63)



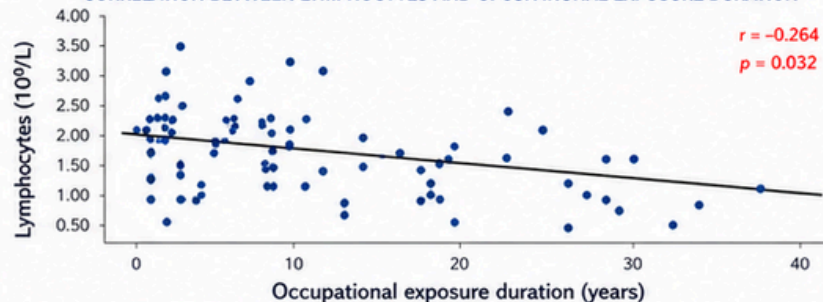
Median occupational
exposure
10 years
(range 1–37)

COMPARISON BETWEEN EXPOSURE GROUPS

Parameter	Group (<1 mSv) n = 36	Group (≥1 mSv) n = 30	p-value*
Haematological parameters			
WBC (10×10 ⁹ /L)	5.30 (3.22–10.50)	6.16 (3.72–10.82)	NS
Neutrophils (10×10 ⁹ /L)	2.75 (1.56–6.69)	3.20 (1.73–7.75)	NS
Lymphocytes (10×10 ⁹ /L)	1.90 (1.06–3.50)	2.09 (1.42–3.96)	NS
Monocytes (10×10 ⁹ /L)	0.50 (0.24–0.97)	0.51 (0.23–1.03)	NS
Systemic inflammatory indices			
SIRI	0.71 (0.28–2.70)	0.79 (0.24–3.43)	NS
SII	368.84 (188.57–1449.10)	349.20 (168.79–994.83)	NS
LMR	4.39 (2.47–6.84)	4.07 (2.10–7.13)	NS
NLR	1.47 (0.89–4.54)	1.47 (0.93–3.73)	NS
dNLR	1.08 (0.66–2.97)	1.11 (0.70–2.52)	NS
PLR	129.68 (74.76–247.29)	118.91 (56.07–178.17)	NS

Data are presented as median (min-max). *Mann-Whitney U test.

CORRELATION BETWEEN LYMPHOCYTES AND OCCUPATIONAL EXPOSURE DURATION



Weak, but statistically significant negative correlation.

KEY FINDINGS AT A GLANCE



NLR, PLR, SII, and SIRI are widely used systemic inflammatory indices.



Low-dose occupational IR exposure did not significantly affect these indices.



Higher exposure dose and longer exposure duration were associated with lower lymphocyte levels.

CONCLUSION

Although inflammatory indices such as NLR, PLR, SII, and SIRI are widely used in clinical practice, their role in assessing the biological effects of occupational exposure to IR remains insufficiently explored. The relatively small sample size and low annual effective doses in our study may have limited the statistical power to detect subtle associations. Nevertheless, our findings contribute to filling this gap by systematically assessing these indices in the context of chronic occupational exposure to IR.

KEYWORDS

Healthcare Workers; Ionizing Radiation; Hematopoietic Cells; Systemic Inflammatory Indices

Even low doses matter. Monitoring biological responses in healthcare workers strengthens the foundation of radiation protection.

