Commentary
Volume 12:11, 2022

Journal of Environmental & Analytical Toxicology

ISSN: 2161-0525 Open Access

Exposure to Metals in the Environment, Blood Oxidative Stress Markers and Prostate Cancer

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Introduction

As, Cd, Cr, Hg, Ni and Pb exposure may play a role in prostate cancer, according to our research. There were two cohorts established the cohorts from Croatia, which had 62 cases and 30 controls and Serbia, which had 41 cases and 61 controls. Samples of serum and blood were taken. The levels of various oxidative stress parameters, prostate-specific antigen (PSA) and the investigated metalloids were measured in the samples that were collected. Blood Hg, SOD and GPx levels were significantly higher in prostate cancer patients than in controls and serum SH levels were significantly lower in prostate cancer patients than in controls in both Croatian and Serbian cohorts. Metalloids induced oxidative stress imbalance may play a role, as correlation analyses showed a significant relationship between measured metalloids concentrations and certain oxidative stress parameters. In addition, when the model was adjusted for the effects of the remaining parameters, there was no significant association found between the serum PSA and the measured parameters. However, there was a significant inverse relationship found between the blood Pb and the serum PSA in prostate cancer patients.

Description

The study as a whole reveals that the measured metalloids significantly contributed to the imbalance in the oxidant/antioxidant system. Despite being somewhat contradictory, the current study's findings suggest that the investigated metalloids may play a role in prostate cancer, particularly Hg, as a relationship was found for both cohorts, followed by changes in oxidative stress status that were found to be correlated with Hg levels. However, further research with larger cohorts is needed to explain and verify the findings. There will be over 1.4 million new cases of prostate cancer and 375,000 deaths by 2020, making it one of the most common cancers affecting men worldwide. Its frequency and death rates shift especially among various populaces. In 2020, prostate cancer accounted for 17.6% of all newly diagnosed cancers in men in Croatia, while it was the third most common cancer in men in Serbia, accounting for 12.3% of all newly diagnosed cancers in men. In 2020, Croatia's estimated age-standardized mortality rate was also higher than Serbia's, at 14.7 *vs* 12.0. Prostate cancer is more common in men over the age of 65, where the risk goes up with age. It is generally acknowledged that its development is linked to multiple risk factors. However, its pathogenesis and etiology are still poorly understood. It has been hypothesized that exposure to various external risk factors may be the cause of these variations because incidence and mortality rates vary significantly by residential geographic location across various populations, in addition to differences in race, ethnicity, screening practices, health care and cancer registration. Prostate cancer typically progresses very slowly and can frequently be successfully treated, particularly when diagnosed early. After a positive digital rectal examination or elevated prostate-specific antigen (PSA), histopathological confirmation of prostate biopsy cores is used to make a diagnosis of prostate cancer. The PSA is mostly excreted from the normal epithelium of prostate tissue and as the prostate gland gets bigger, its level gets slightly higher with age. However, PSA levels can also be influenced by lifestyle and metalloid exposure, among other things [1].

Soil, water and air all contain metalloid, which are ubiquitous in the human environment. Food that has been tainted and both active and passive inhalation of tobacco smoke are the primary sources of non-occupational human exposure. As a result, they build up in the body over many years or even decades. According to the ATSDR 2019 Substance Priority List, the three chemicals with the greatest impact on human health are arsenic (As), lead (Pb) and mercury (Hg). As, cadmium (Cd), phosphorus (Pb) and mercury (Hg) are four of the ten chemicals that the World Health Organization (WHO) has identified as being of major concern to public health. They may have negative health effects even at low doses, especially under environmental exposure conditions of long-term exposure. On some male reproductive system parameters, environmental exposure to these metalloids had negative effects. As, Cd, chromium (Cr) (VI), nickel (Ni) and some of their compounds are categorized as human carcinogens (group 1) by the International Agency for Research on Cancer (IARC), while inorganic Pb and Pb compounds are categorized as a probable human carcinogen (group 2A).Additionally, a number of these metalloids are known to be endocrine disruptor chemicals (EDCs) [2] .

These EDCs affect the expression of genes involved in the growth and secretory function of the prostate gland and contribute to prostate carcinogenesis. Only a handful of studies investigated their contribution to the elevated PSA levels in presumably healthy men, despite the fact that the scant epidemiological data that are currently available point to the possibility that a number of distinct metalloids play a role in the increased risk of prostate cancer. The modification of tumour suppressor gene expression, the activation of redox-sensitive transcription factors and the signalling pathways of proteins involved in cell growth, apoptosis, cell cycle regulation, DNA repair and differentiation have all been linked to the carcinogenic effects of metalloids. Oxidative stress has been shown to play a significant role in the activation of inflammatory mediators and other cellular processes involved in the initiation and progression of cancer, despite the fact that the precise mechanisms of metal-induced toxicity and carcinogenicity are not well understood. The biological systems capacity to repair oxidative damage to proteins, lipids and DNA may be reduced as a result of an imbalance between the production of reactive oxygen species (ROS) and antioxidant defense molecules [3].

This could contribute to the pathogenesis and progression of age-related diseases like prostate cancer. Oxidative DNA base lesions, 8-hydroxyadenine (8-oxoA) and 8-hydroxyguanine (8-oxoG) were more common in malignant and aging benign prostatic tissues. Compared to control subjects, prostate cancer patients displayed significantly higher expression levels of prostate tissue, higher levels of 8-hydroxyguanosine (8-OHdG) in the urine and leucocytes and lower levels of reduced plasma glutathione and glutathione S-transferase. Although certain factors have been shown to play a significant role in the pathogenesis of various cancers, their interrelationships and effects on the levels of tumour markers in prostate cancer patients have not yet been investigated. As, Cd, Cr, Hg and Pb, as well as Ni in the blood and serum of prostate cancer patients and control men in Serbia and Croatia, are presented as biomarkers of exposure in this study. The study's objective was to

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Date of submission: 01 November, 2022, Manuscript No. jeat-22-82074; **Editor assigned:** 02 November, 2022, PreQC No. P-82074; **Reviewed:** 08 November, 2022, QC No. Q-82074; **Revised:** 15 November, 2022, Manuscript No. R-82074; **Published:** 22 November, 2022, DOI: 10.37421/2161-0525.2022.12.686

evaluate the influence of environmental exposure to these elements on serum PSA and oxidative stress parameters on prostate cancer: Prostate cancer patients levels of total sulfhydryl (SH) group, total oxidative stress (TOS), total antioxidant status (TAS), the activity of superoxide dismutase (SOD) and glutathione peroxidase (GPx), advanced oxidation protein products (AOPP) and total oxidative stress (TAS) [4].

An association between blood metalloids concentration and the parameters of oxidative stress and antioxidant defense was found in the current study when measured parameters of prostate cancer patients and controls were compared. Metalloids and the cohort group that was studied varied in the obtained results, which were somewhat contradictory. This is due to the diversity of the study groups and a metalloids imbalance that is exacerbated by prostate cancer itself. The differences in natural sources and levels of environmental and industrial exposure to the investigated metalloids in Croatia and Serbia may also account for these findings. Coal mining and mineral processing, in addition to fumes from coal power plants, may have contributed to the Serbian cohort's exposure to Cd and Hg because, for instance, both coal and copper ore in Serbia contain significant amounts of Cd and Hg naturally occurring in those materials. In some Croatian regions, the spatial distribution of metalloids in the surface part of the soil revealed higher concentrations of naturally occurring As, Cd and Ni, which contributed to the daily intake of these metalloids from food [5].

Conclusion

Even after age-matched the groups, the results for the levels of mercury were consistent in both cohorts, indicating that cases had significantly higher levels of mercury than controls. The disturbances in oxidative stress status, which were found to be correlated with Hg levels, can partially explain the presumed role that Hg plays in prostate cancer. However, there was no evidence of this connection between PSA levels and Hg levels. The obtained results need to be explained and confirmed by additional studies with larger cohorts.

Acknowledgement

None.

Conflict of interest

None.

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How to cite this article: Marzenna, Joao. "Exposure to Metals in the Environment, Blood Oxidative Stress Markers and Prostate Cancer." J Environ Anal Toxicol 12 (2022): 686.