Effect of Metals on Smoker Immune System and their Correlation with Viral Infections

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Original Research

Abstract:
This study was standardized to investigate the effects of trace metals in smokers' blood samples and find metals' correlation with virulent diseases. An auxiliary finding was used to detect the inflated amount of metal absorption, which was determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The large metal level does not generate immunity in the smoker’s body. Human samples display fickle computation of concentrations of these metals. The Mean±SD of As, B, Pb Sr, and Zn in smoker’s samples were (6.1±2.9 ppb), (285.9±118.1 ppb), (60.7±28.5 ppb), (28.6±9.8 ppb), and (420.5±100.4 ppb) reciprocally. The As, B, Pb, Sr, and Zn concentrations in all the smokers’ blood samples were over the acceptable limit, with all the P-value= (≥0.05) all the samples have displayed no correlation in smokers against viral inflammation. This examination can be used as a support and quotation for further investigations. These findings declare that the number of metals in the body for long periods contributes to toxicity and promotes viral infections.

Keywords: Cytokines; Immunology; Metals; Smokers; Viral Infections

Introduction

Immunity is the capacity of multicellular organisms to prevent adverse microorganisms from penetrating them in the body. Immunity is associated with both specific and nonspecific items. Some other incidents of immune activity observe the promote epidemicity combative [1]. Innate immunity, also called native protection, is tolerated by the integrity of pathogens, that is, its genomic fundamentals without a supplementary impetus or an introductory ailment. ‘Passive immunity’ is acquired over the displacement of immunoglobulin or stimulates [2]. Over an array of impressions called immune feedback, the immunity of our body structure kills viruses as well as
stuff that infects human anatomy and motivates infection [3]. Anatomical and physiological barriers provide protection, which is supplemented by innate immunity. The innate immune system relies on a small number of invariant receptors to identify invasive pathogens, but it makes up for this by focusing on conserved microbial components that are shared by many different pathogen types. The innate immune system is known for its speed: minutes after being exposed to a pathogen, it begins to produce a protective inflammatory response. Further, the ensuing adaptive immune response is mostly activated by innate immunity [4, 5].

The virus has lethal textures of small size and expansive composition that may multiply in the human body, fern, and bacterium [6]. All viral cells contain a genomic structure that may be DNA/RNA or protein. Viruses boost efficiency with other chemical actions from the host cell [7]. The host must detect the invader and its components, such as uncapped viral RNA [8], as well as cellular stress, metabolic changes, and cellular damage brought on by infection, before the immune response to a virus or other microbe may be launched. Germline-encoded pattern recognition receptors (PRRs) [4, 8] are principally responsible for this early response to infection. There are five different kinds of PRRs. These include the nucleotide oligomerization and binding domain-like receptors (NLRs), the Pyrin-HIN domain (PYHIN) receptors [4, 9, 10], the Toll-like receptors (TLRs) localized to the cell surface or within endosomes, the intracellular retinoic acid-inducible gene-I-like receptors (RLRs), and the C-type lectin receptors. Each of these receptor types contains several members, and each member of a receptor-type recognizes a different pathogen-associated product or damage-associated chemical pattern, such as reactive oxygen species, adenosine triphosphate, or apoptotic/necrotic cells [11, 12].

Smoking is an activity that is observed where a substance is burned and the ensuing smoke breathed in to be enjoyed and absorbed into the blood [13]. Even a minute amount of tar cigarettes and without smoking tobacco was shown to extend the danger of heart disease as compared to non-smokers [14]. In vivo, chronic smokers are related to the enlarged levels of many inflammatory markers together with serum globulin, IL-6, and alpha TNF in each male and female smoker [15]. Containing 4000 known chemical components, the roll of tobacco is incredibly toxic and hepatotoxic for an individual’s health [16]. Around 2 billion people use tobacco products globally, primarily in the form of cigarettes, and at least 4 million people die from tobacco-related diseases each year [17]. The sharp increase in diseases linked to tobacco use or cigarette smoke, such as cardiovascular disease, chronic obstructive pulmonary disease (COPD), Crohn’s disease, and various cancers [18], suggests that smoking may have a negative influence on the development of human diseases [19]. The World Health Organization (WHO) presently estimates that there are 1.1 billion smokers in the world [20]. It is calculable that the ubiquity of smoking is 36% in men’s and 9% in women’s, and around 1200 kids begin smoking every day [21].

The ordinary components of the planet also consist of non-essential metals such as Pb, As, Cd, and Zn, etc. A few of the metals are fundamental aspects; however, when they endure in a huge amount, they become lethal [22]. The toxicity of heavy metals develops when the concentration level of the metal is very low or very high. Due to the aggregation of heavy metals, many fractions health problems developed [23].

A few metals are called essential metals, but they are also toxic if their amount is increased. Heavy metals are important for human beings on a controlled level. Heavy metals, for example lead, cadmium, and arsenic, are extensively present in the environment [24]. A significant public health issue is heavy metal contamination [25, 26]. Toxic heavy metals include metals including lead (Pb), cadmium (Cd), arsenic (As), and mercury (Hg), which can seriously impair human health even at low doses [27]. Even though some metals, such as nickel (Ni) and manganese (Mn), are regarded as essential or trace elements to perform significant physiological functions [28, 29], they can harm a person’s body if their concentration crosses a predetermined threshold [30, 31]. Metals that attach with the MHC/peptide complicated inside the TCR receptors can produce neoantigens that are identified as foreign, for that reason blurring the distinction between hypersensitivity and autoimmunity [32]. Stimulation of T cells is essential for hypersensitivity induced by metals. The revival of T cells’ desire to engage with TCRs with MHC complexes asserted on the surface of dendritic cells. Metal ions and other tiny fragments attach with MHC proteins in a variety of ways to grant this signal. Some metals act as haptons with the aid of interacting with residues of amino acids on major histocompatible peptides. T cells recognize metals through this mechanism [33]. Due to its intricate structure, the immune system is vulnerable to a wide range of assaults, including physical and chemical agents from the environment, medications, and biologics. Any type of dysregulation may cause immunological derangements with harmful implications for health since the immune system is a highly regulated network of cells and soluble mediators [34]. Because pollutants build up in the body and may have an impact on the immune system, environmental pollution poses a severe threat to human health [35]. Early (Immuno) toxicological investigations and experimental rodent studies initially identified the immunomodulatory potential of environmental chemicals, often known as xenobiotics, as a result of immune-mediated lung illnesses connected to occupational exposure. Certain heavy metals, well-documented for their impact on the immune system, are associated with immune-mediated illnesses as environmental contaminants. Among these, cadmium (Cd) stands out as one of the most hazardous [36-38]. Analyzing small quantities of heavy metals in a sample pattern can be accomplished for regulatory approval and quality management purposes. We identify the heavy metalloids in actual samples, and we can additionally decide to examine the contaminants in smokers. These
metals can be measured to components per billion levels by using our laboratory equipment. In chemical laboratories, metals can be explored through a number of strategies. Most regularly, examining techniques of metal identification rely on different techniques, such as Atomic Absorption Spectrophotometer (AAS), Inductively Coupled Plasma- Optical Emission Spectrophotometer (ICP-OES), and Inductively Coupled Plasma- Mass Spectrophotometer determination of such low quantity demands highly touchy methods [39]. Few investigative strategies have been used for trace analysis of metals. We used the ICP-OES method to detect metals found in our samples [40].

**Material and Methods**

A cross-sectional record was determined, in which 20 subjects were included in this finding. In this discussion, all symptomatic checks were carried out in the Chemistry department of Government College University Lahore. A survey pattern was set for subjects alongside their age. After obtaining permission, a complete 3ml of blood was drawn from selected subjects. The sample used to be aseptically accumulated from a medial cubital vein in a red-capped vial. After centrifugation, serum was separated, and in serum, nitric acid dropped for storage of metals.

**Chemicals**

The chemicals used had complete control over pureness and quality. Analytical grade chemicals are used in this study. The chemicals’ concentration HNO₃, H₂SO₄, H₂O₂, and double distilled water were received from the chemical store of the Chemistry department of Government College University Lahore.

**Conventional Wet Acid**

The Digestion Procedure Wet acid digestion method was used in this research work. With the help of an acid (or mixture of acids) a sample is dissolved. Therefore, it is called acid digestion. Open vessels are used to conduct such dissolving procedures with the help of a hot plate. The successive method was followed for sample qualification. In 100 mL of beaker total, 2 g of sample was taken. Samples were digested by adding a 10 mL conc. of Nitric acid (HNO₃) to each sample separately, and heating on a hotplate at 70 °C for 30 min until orange fumes disappeared. Then 10 mL of conc. sulfuric acid (H₂SO₄) was added to each sample and the temperature increased to 150 °C (the sample was heated for 1 h). The temperature was increased to 300 °C after 1 h, and at this temperature, the dissolution of samples was accomplished for about 30 minutes until white fumes disappeared. Then 2 mL of hydrogen peroxide (H₂O₂) was added to each sample and heated at 180° C for 30 min, until the remaining volume of the sample was 20 mL. Then we powered off the hot plate and cooled the samples at room temperature. 20 mL samples were then filtered at the end by using filter paper.

**Preparation of Standard Solution**

The stock solution of arsenic was prepared with a concentration of 1000 mg/L. From the stock solution, the working solutions of 2, 4, 6, 8, and 10 ppm were made by using the following eq. 1. After that, a calibration curve showing the linear response of the ICP-OES signal versus the concentration of standards was drawn.

\[ C_1V_1 = C_2V_2 \]  

\[ C_1 = \text{Concentration of stock standard (1000 mg/L), } V_1 = \text{Volume of stock standard to be used (unknown), } C_2 = \text{Desired concentration of working standard (mg/L), } V_2 = \text{Total volume of working standard (mL)} \]

**ICP-OES**

This method has high efficiency, many component examinations, and high potency. The origination is lead into argon plasma. Plasma is the 4th element of the universe, next to the solid, aqueous, and gaseous states. In the ICP-OES the plasma is provoked at the end of a quart’s torch by a frosty introducing coil, through which an immense density changes current flow (Figure 1).

**Statistical Analysis**

The statistical finding, mean ± standard deviation, and correlation test were done using SPSS software 21.

Figure 1. A calibration curve showing the linear response of the ICP-OES signal versus the concentration of standards prepared...
Results

Demographic Characteristics

The total subjects was 20, which are included in this examination. 5 samples were excluded due to age issues. 15 smokers’ samples were also included in this study.

Determination of Elements by ICP-OES and Wavelength Used for Metal Detection

The estimation and evaluation of heavy metals in smoker samples were carried out using an analytical technique ICP-OES, and different wavelengths were used for the analysis of different metals (Table 1).

Table 1: Wavelength used for the analysis of metals in Samples

<table>
<thead>
<tr>
<th>Element</th>
<th>Wavelength</th>
<th>Unit</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>As</td>
<td>189.042</td>
<td>ppb</td>
<td>Analyte</td>
</tr>
<tr>
<td>B</td>
<td>249.773</td>
<td>ppb</td>
<td>Analyte</td>
</tr>
<tr>
<td>Pb</td>
<td>220.353</td>
<td>ppb</td>
<td>Analyte</td>
</tr>
<tr>
<td>Sr</td>
<td>407.771</td>
<td>ppb</td>
<td>Analyte</td>
</tr>
<tr>
<td>Zn</td>
<td>213.856</td>
<td>ppb</td>
<td>Analyte</td>
</tr>
</tbody>
</table>

Results of Smokers

We used ICP-OES to estimate the heavy metals in the blood of smokers and coded them as S 1-S 15, respectively. The research shows the estimated results for the level of concentrations of metals in all samples. These are discussed below in Table 2.

Table 2: Concentration (ppb) of (As, B, Pb, Sr, and Zn) in blood samples of smokers

<table>
<thead>
<tr>
<th>Sample Code</th>
<th>As</th>
<th>B</th>
<th>Pb</th>
<th>Sr</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>6.33</td>
<td>340.4</td>
<td>78.33</td>
<td>25.20</td>
<td>434.20</td>
</tr>
<tr>
<td>S2</td>
<td>2.7</td>
<td>312.7</td>
<td>45.7</td>
<td>12.80</td>
<td>321.70</td>
</tr>
<tr>
<td>S3</td>
<td>8.8</td>
<td>220.6</td>
<td>98.23</td>
<td>34.7</td>
<td>5438</td>
</tr>
<tr>
<td>S4</td>
<td>9.12</td>
<td>432.54</td>
<td>25</td>
<td>35.78</td>
<td>487.34</td>
</tr>
<tr>
<td>S5</td>
<td>3.7</td>
<td>123.7</td>
<td>56.23</td>
<td>34.81</td>
<td>316</td>
</tr>
<tr>
<td>S6</td>
<td>3.32</td>
<td>154.21</td>
<td>34.30</td>
<td>14.26</td>
<td>316.40</td>
</tr>
<tr>
<td>S7</td>
<td>5.7</td>
<td>230.5</td>
<td>44</td>
<td>34.8</td>
<td>424</td>
</tr>
<tr>
<td>S8</td>
<td>5</td>
<td>325.8</td>
<td>35</td>
<td>27</td>
<td>234.8</td>
</tr>
<tr>
<td>S9</td>
<td>3.21</td>
<td>431.42</td>
<td>65.12</td>
<td>21.8</td>
<td>366</td>
</tr>
<tr>
<td>S10</td>
<td>7.7</td>
<td>276.9</td>
<td>32.43</td>
<td>18.8</td>
<td>432.43</td>
</tr>
<tr>
<td>S11</td>
<td>3.9</td>
<td>345.9</td>
<td>24</td>
<td>23.7</td>
<td>287.34</td>
</tr>
<tr>
<td>S12</td>
<td>4.8</td>
<td>322.8</td>
<td>23.8</td>
<td>12.8</td>
<td>345.12</td>
</tr>
<tr>
<td>S13</td>
<td>2.8</td>
<td>234.6</td>
<td>35</td>
<td>31.34</td>
<td>298.45</td>
</tr>
<tr>
<td>S14</td>
<td>7.84</td>
<td>145.9</td>
<td>46</td>
<td>26.12</td>
<td>345.81</td>
</tr>
<tr>
<td>S15</td>
<td>4.76±1</td>
<td>456.73</td>
<td>76.56</td>
<td>42.65</td>
<td>234.34</td>
</tr>
<tr>
<td>Mean±SE</td>
<td>5.3±0.55</td>
<td>290±27.2</td>
<td>25±6.0</td>
<td>26.4±2.4</td>
<td>7.0±34</td>
</tr>
</tbody>
</table>

Correlation of Metals with Immunity

To detect the effects of metals (As, B, Pb, Sr, and Zn) on the ability of the host cells to increase viral infections, the viral masses in metals define toxic effects after different kinds of viral contamination were determined. The induction of an immune response to a viral microbe was examined upon metal exposure to assess the effects of metals on immunity.

Comparison of Metals with Immunity Against Viral Infection in Smokers

On a subset of samples (n=15) a correlation analysis was done. Results indicate there is no significant association between metals (As, B, Pb, Sr, and Zn) and immunity (P value= ≥0.05) as given in Table 3.

Table 3: Comparison of metals with immunity against viral infection in smokers

<table>
<thead>
<tr>
<th>Parameters</th>
<th>P-value</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>As ppb</td>
<td>0.228</td>
<td>5.3±2.2</td>
</tr>
<tr>
<td>B ppb</td>
<td>0.893</td>
<td>290.3±11.3</td>
</tr>
<tr>
<td>Pb ppb</td>
<td>0.120</td>
<td>47.4±22.5</td>
</tr>
<tr>
<td>Sr ppb</td>
<td>0.228</td>
<td>26.4±9.2</td>
</tr>
<tr>
<td>Zn ppb</td>
<td>0.698</td>
<td>36.2±89.09</td>
</tr>
</tbody>
</table>

Determination of Elements by ICP-OES and Wavelength Used for Metal Detection

The estimation and evaluation of heavy metals in smokers and RT-PCR patients’ negative samples was carried out using an analytical technique ICP-OES. Different wavelengths were used for the analysis of different metals.

Discussion

This study aimed to find out the affiliation between alloys and immunity towards viral samples in smokers. This is findings-categorical, that the outcomes of metals viewed as unprotected and not essential aspects of the innate immune response and host increase the chances of viral infection and toxicity. Various analyses were used to detect the correlation between immunity with viral infection, due to the presence of metals in the body. Metals, such as cadmium, lead, arsenic, and nickel, are found in cigarette smoke. These metals can accumulate in the body over time, primarily affecting the respiratory system due to inhalation. They can trigger inflammation and oxidative stress, as well as disrupt immune function.

For instance, cadmium has been shown to impair immune responses by affecting the function of immune cells and reducing antibody production. Smoking is a well-known risk factor for various diseases, including...
Effect of Metals on Smoker…

respiratory infections. The chemicals in tobacco smoke can impair the immune system, making smokers more susceptible to infections and hindering the body’s ability to fight off pathogens. Smoking can reduce the effectiveness of immune cells, compromise the respiratory tract’s defenses, and impair the clearance of mucus and foreign particles. Metals in cigarette smoke can synergistically interact with the detrimental effects of smoking on the immune system. These metals can further contribute to oxidative stress, inflammation, and immune dysfunction, compounding the negative impact of smoking on the immune response. The presence of metals may intensify the damage caused by smoking, making the immune system even more compromised.

Many studies show that there are negative effects to smoking, both on the immune system and many body organs [41-43]. Our results also showed there is no correlation between the low amounts of arsenic exposure in the smoker in different ways. The most important findings have been that boron consumption is inversely related to lung cancer, although low boron consumption combined with no HRT use is associated with increased odds for this disease in women, and our results show low-level boron produces immunity in smokers P value=0.228 [44]. Another study explains the immunological outcomes of low-level occupational exposure to lead, investigates the phenotypic guidelines and practical purity of peripheral blood lymphocytes in a group of firearms advisors, and contrasts the records to those bought from some unexposed controls. Their results indicate that among humans with delicately extended blood lead levels (>25 μg/dL), hazardous results on the host’s immune features [45, 46], and our results also indicate a small amount of lead and strontium in the body for a long time can produce toxicity in smokers and enhance the chances of diseases. P-value= (0.120) and (0.228). Zn is a cofactor in greater than 300 enzymes, altering several organ functions and having a secondary effect on the immune system. A weakened immune system resulting from smoking and metal exposure can increase susceptibility to viral infections. Viruses, including respiratory viruses like influenza and respiratory syncytial virus (RSV), can cause more severe illnesses in smokers due to their impaired immune responses. Viral infections may also exacerbate the negative effects of metals and smoking on the immune system, creating a vicious cycle of immune dysfunction, compounding the negative impact of smoking on the immune system. These metals can synergistically interact with the detrimental effects of smoking on the immune system. The presence of metals may intensify the damage caused by smoking, making the immune system even more compromised.

Conclusions

In summary, metals in cigarette smoke can worsen the adverse effects of smoking on the immune system, making individuals more susceptible to viral infections. Efforts to reduce smoking and minimize exposure to metals are essential to enhance immune function and protect individuals from the detrimental consequences of both smoking and viral infections. We confirm the accumulation of trace metals (As, B, Pb, Sr, Zn) in distinctive human samples that have been collected from Government College University Lahore. The amount of arsenic, boron, lead, strontium, and zinc in all blood samples of smokers is high, following WHO (World Health Organization) set limits, and all of these alloys have proven no correlation with immunity against virulent diseases. So, it can be concluded that trace metals accumulate in the body for a long duration, causing toxicity and making the immune system weak.

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Conflict of Interest

The authors declare no conflict of interest.

References and Notes


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