JIRESH-Biotech

Journal of Innovation and Research in Health Sciences & Biotechnology: Open Access

Volume 1, Issue 4, June 2016 http://jiresh-biotech.edmgr.com

Original Article

An Assessment of the Modulatory effect of Zinc on Humoral Immune Parameters in Welders and Cement Block Moulders in Ogbomosho, Nigeria

Nurudeen A. Adeniyi, Isiaq O. Omotosho, Abdulfatahi A. Onifade, John I. Anetor

Toxicology and Micronutrients Metabolism Unit, Chemical Pathology Department, College of Medicine, University of Ibadan, Nigeria

Corresponding Author: John Anetor E-mail: johnanetor@gmail.com Cell: +2348062308002

J. innov. res. health sci. biotechnol. 2016; 1(4): 186 – 194 doi: 10.18644/jiresh-biotech.0000022

ABSTRACT

Welding and cement block moulding (CBMs) are increasing in the developing countries due to increase in small scale industries resulting in excessive exposure to lead (Pb) and cadmium (Cd). Welding is associated with simultaneous release of zinc (Zn) fumes unlike cement block moulding. Unlike Cd and Pb, zinc enhances immune response while Pb and Cd are immunosuppressants. The possible modulation by Zn of the immunosuppressive effect of Pb and Cd is unexplored. Thirty welders, thirty CBMs and thirty unexposed participants were studied. Cadmium, Pb and Zn were determined using atomic absorption spectrophotometry technique. Immunoglobulins, IgA, IgG and IgM were assayed using ELISA. Total lymphocyte count (TLC) and monocyte (TMC) were determined using standard haematological methods. Lead and Cd were significantly higher in welders and CBMs than in controls. Cadmium was significantly higher in welders than in CBMs unlike Pb. Remarkably, Zn was significantly higher in welders than in CBMs. Interestingly, IgG and IgM in welders were significantly higher than in CBMs; IgG being approximately two fold in welders. Monocytes were significantly higher in CBMs than in welders. These data suggest antagonism of Pb and Cd to Zn by the lower levels of zinc in the exposed groups and the humoral immunomodulatory effect of zinc, by the higher levels of immunoglobulins in welders with higher zinc levels

Key words: *Cadmium, Lead, Zinc, Immunomodulation, Welders, Cement block moulders.*

RÉSUMÉ

Les activités du soudage de métaux ainsi que celles du moulage en ciment pour la fabrication des blocs de construction se multiplient dans les pays en développement suite à une augmentation du nombre des petites et moyennes entreprises. Ces activités aboutissent à une libération exagérée du plomb (Pb) et du cadmium (Cd). En plus, le soudage est associé à une libération simultanée des vapeurs du Zinc (Zn) contrairement au moulage en ciment. Zinc améliore la réponse immunitaire des individus pendant que les Pb et Cd sont des immunosuppresseurs. La modulation possible par Zn de l'effet immunosuppresseur du Pb et du Cd est inexplorée. Trente soudeurs, trente fabricants du moulage en ciment et trente participants non exposés (témoins) ont été étudiés. Les taux de Cd, Pb et Zn ont été mesurés à l'aide de la technique de spectrophotométrie d'absorption atomique. Immunoglobulines : IgA, IgG et IgM ont été analysées en utilisant ELISA. Le nombre total des lymphocytes et celui des monocytes ont été déterminés à l'aide de méthodes hématologiques standard. Plomb et Cd ont été significativement plus élevés chez les soudeurs et les fabricants du moulage en ciment que chez les témoins. Cadmium était significativement plus élevé chez les soudeurs que chez les fabricants du moulage en ciment contrairement à Pb. Remarquablement, Zn était significativement plus élevé chez les soudeurs que chez les fabricants du moulage en ciment. Faits intéressants, IgG et IgM chez les soudeurs étaient significativement plus élevées chez les fabricants du moulage en ciment ; IgG étant qu'environ deux fois chez les soudeurs. Les taux de monocytes étaient significativement plus élevés chez les fabricants du moulage en ciment que chez les soudeurs. Ces résultats suggèrent l'antagonisme du Pb et du Cd au Zn avec des niveaux inférieurs du Zn dans les groupes exposés ainsi que les effets immunomodulateurs du Zn observés à travers des taux très élevés d'immunoglobulines chez les soudeurs ayant des concentrations importantes du Zn.

Mots clés : *Cadmium, Plomb, Zinc, Immunomodulation, Soudeurs,* fabricants du moulage en ciment.

Submitted 27/11/2015, accepted 22/05/2016 http://jiresh-biotech.edmgr.com

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

INTRODUCTION

In an attempt to raise the standard of living and improve their economies, developing countries are emphasizing both small and medium scale enterprises (SME) (1) on the understanding that SMEs play a substantial role in employment generation and national development (1). Welding and cement block moulding are among the most prevalent of these small-scale industrial activities but associated with excessive occupational exposure to toxic substances such as Pb, Cd and many others, which occur due to lack of proper workplace control measures.

The upsurge observed in welding and cement block moulding activities in these countries may be related in part to the relatively low level of education required in these occupational activities. A country like Nigeria is a good case in point to assess the potential human health effects posed by these two occupations where there may be exposure to toxic metals with one also associated with high degree of exposure to an essential metal such as is seen in welding where there is simultaneous exposure to both toxic metals and the essential metal, zinc (Zn) which has substantial effect on immune function.

Welding involves joining metals at very high temperature using electrodes which improve the joining process, leading to release of fumes rich in both toxic metals and zinc (2). The fume consists of very small particles, including ultrafine matter (2). Exposure to welding fumes is affected by several factors, including the welding process itself, work place characteristics, and use of protective measures (3).

Welding fume generated during the welding process contain at least 13 metals, including manganese (Mn), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), zinc (Zn), antimony (Sb), and vanadium (V) (4). Of these metals, lead, cobalt, chromium (IV) and Cadmium have been found to have critical adverse effect on the immune system (5, 6, 7).

Several researchers have shown that inhalation of cement dust containing a number of toxicants perturb both haematological and immunological parameters (8, 9). Ogunbileje et al. (10) demonstrated that metals such as lead, mercury, cadmium, chromium, nickel, copper, zinc, calcium, iron, manganese and chromium (VI) are present in cement dust.

Although certain properties differentiate between welding fumes and cement dust (aerodynamic size), there is the likelihood that both may have common effects and mechanism of toxicity on humoral immune system due to relative similarity in their immunotoxic metal composition (4, 11). Studies by Steel and Sanderson (1966) and Noweir (1988), show that metal composition of welding fumes and cement dust are relatively similar with higher zinc content in welding fumes than in cement dust (12, 13).

Growing studies on metals have revealed numerous essential bio-metal functions and presence of excess biologically active metals can disrupt the normal physiological processes in the body. Chemical elements such as Zn are essential for life while Cd and Pb have no known beneficial effects in animals and humans. Cadmium, the common component of welding fumes and cement dust is confirmed to be carcinogenic, and exhibit toxic effects on many body systems, including the immune, nervous, endocrine, renal, musculoskeletal, and cardiovascular systems (14). In vivo studies have shown that Pb is an immunotoxicant, depressing humoral immunity (15,16), increasing host susceptibility to bacterial (17,18) and viral infections (19).

While lead and cadmium impair immune system (5, 6, 7), Zn at physiological dose plays a vital role in enhancing immune system. It is known that zinc affects multiple aspects of the immune system, from the barrier of the skin to gene regulation within lymphocytes (20). Zinc is crucial for normal development and function of cells involved in nonspecific immunity such as neutrophils and natural killer cells (20). Zinc also affects the development of acquired immunity by affecting certain functions of T lymphocytes such as activation, Th1 cytokine production, and B lymphocyte development (20). Similarly, B lymphocyte development and antibody production, particularly immunoglobulin G, depend on physiological role of Zn (21). The activities of macrophage, a pivotal cell in many immunologic functions, such as intracellular killing, cytokine production and phagocytosis require Zn (21). Inhalation of Zn fumes during welding of galvanized metals is analogous to Zn supplementation above the recommended daily allowance in welders, while in block moulding there is little or no Zn or lower Zn exposure due to its very low concentration in cement dust. The implications of this supplementation and its consequent effect on humoral immunity based on the physiological role of Zn have not been well explored.

In this study, we investigated the humoral immune response to welding fume laden with Pb and Cd but also rich in Zn and cement dust exposure which is also rich in Pb and Cd with relative paucity of the immune response enhancing prime micronutrient Zn. The immunological response was assessed by examining the levels of immunoglobulins (IgG, IgA and IgM), total lymphocyte count, and total monocyte count between the exposed groups and the control group. Data were further stratified by zinc status to determine whether zinc modified the immunological parameters. This was conducted by comparing the immunological index in welder with those of cement block moulders with lower Zn level.

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

Previous study by Boshnakova et al. has shown that welding fume exposure significantly reduce IgG levels (22). Hanovcova et al. reported similar findings of alterations in certain parameters of humoral immunity which include decrease in IgG and IgA levels (23). In contrast, Tuschl et al. observed no effect on immunoglobulin levels in a study involving 30 welders who worked in a plant where levels of welding fumes typically exceeded Austrian Working Limits of 5mg/m3 (24). We hypothesized that Zn status may significantly modify immune function in welders with higher Zn levels.

MATERIALS AND METHODS

Selection of Subjects:

A total of ninety (90) participants were selected for the study consisting of sixty males both exposed groups (18-40 years): 30 welders and 30 cement block moulders (CBM) who have been occupationally exposed a for minimum of five years, were recruited and thirty (30) age and sex matched apparently healthy civil servants who were neither welders nor moulders of cement block served as control (18-42years). The participants were selected for the study after a detailed interview using a structured questionnaire with details about personal data and health, residence, surrounding environment, smoking habits, length of time in occupational and daily hour of exposure, age, body mass index (BMI) as well as activity of serum alanine aminotransferase to exclude liver pathology and serum creatinine level to exclude renal disease. These formed part of the eligibility or inclusion and exclusion criteria. As far as it could be ascertained no subject selected for control was occupationally or by hobby exposed to the metals of interest.

Prospective control subjects residing in polluted industrial areas where there could be possibility of increase passive exposure were also excluded from the study. Importantly also, vestigial passive exposure may be similar to both control and test group which cancels out. The socio-economic status of participant was essentially between low and medium; most were uneducated and control subjects were also largely selected to match the study subjects.

Only subjects who were not smokers and who have no history or signs and symptoms suggestive of haematological, infectious, liver and kidney disease were eligible and recruited into the study. However, participants with symptoms that are common clinical manifestation among workers involved in dusty occupations such as coughing and sneezing were recruited into either of the exposed groups. This was established by a careful history and complete physical examination.

Sample Collection & Laboratory Studies:

Blood sample (10ml) was drawn from the cubital vein of each participant. An aliquot of 3ml of blood sample was dispensed into lithium-heparin bottle for whole blood analyses of lead and cadmium. Another aliquot of 3ml of blood was dispensed into bottle containing EDTA for total lymphocyte and monocyte count, while 4 ml of blood were dispensed into plain tubes to yield serum for determination of total protein, albumin, immunoglobulins (IgG, IgM, IgA) as well as zinc level.

Lead, cadmium, and zinc were determined using flame Atomic Absorption Spectrophotometer (FAAS) (205 Buck Scientific, Germany). Blood lead and cadmium were determined by the method of Bannon et al. (25) and Lauwerys et al. (26) respectively, while plasma zinc was determined by the method of Smith et al. (27). Total protein (Tp) and albumin (Alb) were determined with standard biuret and bromocresol green methods (BCG) respectively while total globulin level was computed from the values of total protein and albumin. Total lymphocyte and monocyte counts were determined using Auto Haematology Analyzer (HA6700 Model, Hawksley and Son Ltd, London). Serum immunoglobulin levels of IgM, IgG and IgA were determined by ELISA technique using kits from

Statistical Analysis:

Statistical analysis was performed using SPSS version 21. The results were reported as mean ± standard deviation. Shapiro–Wilk's and Komolgorov Smirnov tests were used to verify normality. Since most data were not normally distributed, non-parametric equivalent of their parametric test were used and the data concerned were ranked before the analysis. Either an analysis of variance or Kruskal–Wallis ANOVA test was used for multiple comparisons of data. Comparisons between the exposed groups, either of the exposed group and control group were conducted using the Student's t-test for parametric data and the Mann-Whitney test for non-parametric data. A value of $p<0.05$ was considered to be statistically significance.

Ethical Considerations:

The University of Ibadan/University College Hospital (UI/UCH) Joint Ethics Review Committee (UI/EC/05/01) approved this study. Additionally, written informed consent (approved by the UI/UCH Ethics Committee) was obtained from each subject.

RESULTS

The age range of 90 study participants was 18-40 years and they were all males. Average work history was 5 years for welders and cement block moulders. Daily hour of occupational exposure to fumes and cement dust and indicators of nutritional status such as body mass index

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

(BMI), total protein, albumin and globulin were similar among the studied population (**Table 1**). **Table 2** summarizes the central elements in the study population. Cadmium as well as Pb levels were significantly higher in welders and cement block moulders than in control subjects, while zinc concentrations were significantly lower in both exposed groups than in control. The blood levels of Pb did not differ significantly between the two exposed groups. Cadmium level was significantly higher in welders than in CBMs. Remarkably the level of zinc was observed to be significantly higher in welders than in CBMs ($p < 0.001$) (**Table 2**). Total lymphocyte count was similar in both exposed groups (**Table 3**) but significantly higher in both exposed groups than in the control group (**Tables 4&5**). Total monocyte count was significantly higher in CBMs than in welder and control groups (**Tables 3&5**). Interestingly, the levels of the immunoglobulins (IgG, IgM and IgA) were observed to be higher in welders than in CBMs and the control group. IgG and IgM were significantly higher in welders than in CBMs while only IgA and IgM were significantly higher in welders compared to control group ($p < 0.05$) in each case (**Table 3**). The IgG level was significantly higher in the control group compared to CBMs ($p < 0.05$). Remarkably, IgG level in welders demonstrated approximately 2-fold increase compared with that of cement block moulders. Serum IgA levels appeared to be higher in welders than in CBMs however, this difference did not reach statistically significant difference.

Table 1: Occupational exposure and nutritional indices of studied population

Parameters	Welder Mean ±SD, Mean Rank	CBMs Mean± SD, Mean Rank	Control Mean± SD, Mean Rank	P-value
Occupational exposure (Hours/day)	9.0 ± 2.4	9.1 ± 2.6	-	0.918
BMI (kg/m^2)	25.0 ± 3.7	23.8 ± 2.4	25. 6± 3.0	0.065
Protein (g/l)	85.0 ± 4.0, 51.7	83.0± 3.0, 45.6	82.0± 2.0, 39.2	0.179
Albumin (g/l)	44.0± 6.0, 48.3	44.0± 5.0, 44.7	44.0± 4.0, 43.5	0.754
Globulin (g/l)	41.0 ± 2.0, 50.5	39.0 ± 1.0, 46.5	38.0± 2.0, 39.5	0.259

P< 0.05 is statistically significant.

Table: 2 Lead, cadmium, zinc levels and immunological parameters in the study population and control

Parameters	Welders Mean ±SD, Mean Rank	CBMs Mean± SD, Mean Rank	Control Mean± SD, Mean Rank	P-value	Expected normal value
Monocyte (10^3/µl)	0.2 ±0.1, 25.1	0.5 ± 0.2, 64.5	0.3 ± 0.2, 47.0	0.001	0.1-1.0
Lymphocyte (10^3/µl)	2.5±0.6	2.6± 0.8	2.2 ± 0.5	0.003	1.0-5.0
IgA(mg/dl)	440.0 ±120, 58.9	380.0 ± 190, 35.6	360.0± 80, 42.0	0.002	81-211
IgG (mg/dl)	1530.0±560,59.6	810.0 ±350, 27.8	1290.0±590,49.1	0.001	688-1251
IgM(mg/dl)	160.0 ±30.0	130.0 ±30.0	140.0 ±30.0	0.001	65-132
Zinc (µg/dl)	76.6 ± 8.3, 45.0	65.6 ± 10.1, 23.6	93.7 ± 16.3, 67.9	0.001	
Cadmium (µg/dl)	0.1 ± 0.0, 68.1	0.01 ± 0.0, 52.2	0.002 ± 0.0, 16.3	0.001	
Lead(µg/dl)	5.0 ± 2.1, 60.0	4.4 ± 2.3, 51.1	2.3 ± 1.0, 25.4	0.001	

P< 0.003; 0.002 & 0.001 statistically significant
CBMs = Cement block moulders

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

Table 3: Lead, cadmium, zinc levels and immunological parameters in the two exposed groups

Parameters	Welders Mean± SD, Mean Rank		CBMs Mean± SD, Mean Rank		P-value	Expected normal value
Monocyte (10^3/µl)	0.2 ±0.1,	18.2	0.5 ± 0.2,	42.8	0.001	0.1-1.0
Lymphocyte (10^3/µl)	2.5±0.6		2.6± 0.8		0.651	1.0-5.0
IgA(mg/dl)	440.0 ±120,	37.5	380.0 ± 190,	23.5	0.002	81-211
IgG (mg/dl)	1530.0±560,	41.1	810.0 ±350,	19.9	0.001	688-1251
IgM(mg/dl)	160.0 ±30.0		130.0 ±30.0		0.001	65-132
Zinc (µg/dl)	76.6 ± 8.3,	39.6	65.6 ± 10.1,	21.4	0.001	
Cadmium (µg/dl)	0.1 ± 0.0,	38.3	0.01 ± 0.0,	22.7	0.001	
Lead(µg/dl)	5.0 ± 2.1,	33.8	4.4 ± 2.3,	27.2	0.135	

P< 0.002 & 0.001 is statistically significant.

Table 4: Lead cadmium, zinc levels and immunological parameters in welders and control group

Parameters	Welders Mean± SD, Mean Rank		Control Mean± SD, Mean Rank		P-value	Expected normal value
Monocyte (10^3/µl)	0.2 ±0.1,	22.3	0.3 ± 0.2,	38.7	0.001	0.1-1.0
Lymphocyte (10^3/µl)	2.5±0.6		2.2 ± 0.5		0.018	1.0-5.0
IgA(mg/dl)	440.0 ±120,	36.9	360.0± 80,	24.1	0.004	81-211
IgG (mg/dl)	1530.0±560,	34.0	1290.0±590,	27.0	0.116	688-1251
IgM(mg/dl)	160.0 ±30.0		140.0 ±30.0		0.006	65-132
Zinc (µg/dl)	76.6 ± 8.3,	21.0	93.7 ± 16.3,	40.1	0.001	
Cadmium (µg/dl)	0.1 ± 0.0,	45.3	0.002±0.0,	15.8	0.001	
Lead(µg/dl)	5.0 ± 2.1,	41.7	2.3 ± 1.0,	19.4	0.001	

P< 0.02; 0.004; 0.006 & 0.001 statistically significant

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

Table 5: Lead, cadmium, zinc levels and immunological parameters between CBMs and control group

Parameters	CBMs Mean± SD,	Mean Rank	Control Mean± SD,	Mean Rank	P-value	Expected normal value
Monocyte ($10^3/\mu l$)	0.5 ± 0.2,	37.2	0.3 ± 0.2,	23.8	0.003	0.1-1.0
Lymphocyte ($10^3/\mu l$)	2.6± 0.8		2.2 ± 0.5		0.018	1.0-5.0
IgA(mg/dl)	380.0 ± 190,	27.6	360.0± 80,	33.4	0.197	81-211
IgG (mg/dl)	810.0 ±350,	23.3	1290.0±590,	37.7	0.001	688-1251
IgM(mg/dl)	130.0 ±30.0		140.0 ±30.0		0.121	65-132
Zinc (µg/dl)	65.6 ± 10.1,	17.7	93.7±16.3,	43.3	0.001	
Cadmium (µg/dl)	0.01 ± 0.0,	45.0	0.002±0.0,	16.0	0.001	
Lead(µg/dl)	4.4 ± 2.3,	39.5	2.3 ± 1.0,	21.6	0.001	

P< 0.018; 0.003 & 0.001 statistically significant
CBMs = Cement block moulders

DISCUSSION

Globally, workplace hazards are recognized to be deleterious to the health of workers and the attendant public health concern has considerable medical and social impact. Welding and cement block moulding are common vocations and mostly embraced by those in the medium socioeconomic class in the developing countries. The rise in number of practitioners of these vocations coupled with the very few control measures has brought with it the possibility of excessive exposure to toxicants associated with different degrees of severity. In this present study, occupational exposure to toxicants, mainly cadmium and lead, present in welding fumes and cement dust in welders and cement block moulders, was evident by the significantly higher blood Pb and Cd levels than in the occupationally unexposed or control group. This appears also alluded by the significantly higher zinc level in the control than the occupational groups. An adverse effect of this exposure is that it may at least in part have contributed to the observed depression of immunological response indices in one of the occupationally exposed groups.

The significantly lower zinc level, an essential and prime micronutrient, in the exposed groups compare to control group is of central importance in this study. Given the key roles zinc plays in a number of biological processes including genomic activities embracing synthesis of indices of immune function. The non-significant change in the nutritional indices such as body mass index, total protein and albumin in the exposed groups compare to
metabolic antagonism between the toxic metals, lead and cadmium. The synergistic inhibiting effect of Cd and Pb induced metallothionein synthesis may be operant (28). This might have also played a role in the observed significantly reduced zinc level in the exposed groups. Aside from exposure to the metallothionein inducer, Cd is a well-known metabolic antagonist of Zn (29). Thus the observed lower level of zinc in the exposed groups could also in part be attributed to the higher Cd level. Our result is consistent with the reports of Dioka et al. (30) and Ayatollahi (31) who observed decrease in serum Zn level in artisans who were occupationally exposed to low Pb level. Other investigators, Mehdi et al. (32) and Chiba et al. (33) have reported non-significant differences in the Zn levels between Pb occupationally exposed groups and control group. The explanation for these discrepancies is not clear, but may involve a combination of nutritional status duration of occupational exposure and the constituents of the metals involved. Li et al. (34) have demonstrated that long - term low level exposure to the welding fume increases serum concentrations of manganese, iron lead, while it decreases serum zinc level among the career welders.

The significantly increased Zn level in welders compared to CBMs may be due to the higher Zn in welding some of

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

which contain galvanized Fe. Several studies have shown that welders are exposed to high level of Zn in welding fumes. Steel and Sanderson (12) investigated the toxic fumes produced from various types of coated welding electrodes and found Zn concentration produced by burning such electrodes to range from 1.07 to 2.76. The elevated Zn level in the welders compared to the cement block moulders is analogous to supplementation with Zn to welders. Noweir (13) showed that cement dust contains 12.25µg zinc/g of cement concentration, a concentration that is lower than the level of zinc reported by Steel and Sanderson (12) in welding fume. This may corroborate the higher level of zinc observed in welder compared to CBMs being largely due to that inhaled during welding process.

Importantly, the observed higher levels of immunoglobulins in welders compared to CBMs may be ascribed to the significant increase in zinc level in welders. Supporting a modulatory role of zinc in humoral immune response. Although previous reports in occupationally exposed individuals to welding fumes have been equivocal, Borska et al. (35) reported decreased levels of serum IgG, IgA, and IgM in welders with blood Pb level greater than the recommended WHO safe limit (WHO recognized toxic level, 10µg/dl). The low levels of Pb (5µg/dl) in our study may explain why there was no immunosuppression in both exposed groups.
The observed higher levels of IgM and IgG in welders is of great biological significance. It appears to support a role of Zn in immune response and that this principle could be applied to modulate the immunotoxic effects of exposure to toxic metals, which may be, dose dependent.

While IgM is associated with primary immune response, IgG plays an important role in secondary immune response. Therefore, the increased IgG and IgM may be indicative of immune enhancement induced by higher Zn level in welders compared to CBMs. One implication of this observation is that there is increased IgG in turn due to raised Zn level in the welders' group. The report of Ayatollahi (31) demonstrated lower IgG levels but IgA and IgM were unchanged in car battery workers with low Pb and low zinc exposure. This appears consistent, as there was no Zn supplementation to boost humoral immune response. Cement block moulders in this study also had their IgG levels significantly lower compare to control and welder group while IgA and IgM were not significantly different from control group. The report of Ayatollahi (31) and our findings in CBMs appear to suggest that workers engage in occupations that expose them to Pb and low Zn may have low level of IgG, probably implying to supplement the workers with zinc. It also appears to underscore that zinc has profound effect on IgG synthesis than on other immunoglobulin classes. Thus, the immunostimmulatory effect of Zn on IgG synthesis was demonstrated in welder with higher Zn level compare to CBMs.

The significantly higher humoral immune parameters, IgA and IgM in welders compared to the control group despite lower but optimum Zn level in welders. This may suggest a role for stoichiometric relationship between the toxic and essential metals, implying that the Zn intake during the welding process, not only modified the immunoglobulin levels but competed and overturned the immunoinhibitory effect of toxic metals on humoral immune response.
The elevated lymphocyte count in welders in our study is similar to the report of Hanovcova et al. (23) who observed increased lymphocyte counts in welders compared to unexposed populations. This may play a role in the argument on immune response enunciated above. Some investigators such as Shenker et al. (36); Gaworski and Sharma (37); McCabe and Lawrence (38) have reported the possible immunostimulatory effect of low blood Pb level on lymphocyte proliferation. Many of these reports did not consider the possible role of zinc. The main message of this study gaps not withstanding is that zinc has a modulatory effect on immune function particularly in humoral immune system. This as might be expected arises from the diversity of the function of Zn with a wide range of effects including protein synthesis of which the humoral immune system is dependent (39).

CONCLUSION

Although previous reports in oc

The data from this study suggest that exposure to welding fumes and cement dust perturbed humoral immune system but modulated by the higher Zn level in the welders. The higher Zn level in the welders and the corresponding higher lymphocyte and immunoglobulin levels in the same group appear to argue strongly for a modulatory role for Zn in immune response in these workers. This appears supported by the findings in the CBMs with low Zn levels exhibiting significantly decreased IgG level compared to the welders. One implication of these data is that the immunosuppressive roles of toxic metals such as Pb and cadmium may be modulated by increase zinc intake. An indirect support for this appears to be demonstrated by the antagonism of Pb and Cd to Zn by the lower levels of zinc in the exposed groups than in controls and associated indices of immune response and may explain why there could be varied susceptibility to illness in occupationally exposed individuals. The data imply that cement block workers may benefit from zinc supplementation.

It appears to support a role Zn in i

Recommendations

Every measure should be taken to reduce exposure to metal fumes; metal fume exposure, particularly in the rapidly developing nations is inevitable but can be modulated by nutritional means. Owing to the observed positive modulating effect of Zn in this study, increased intake of this micronutrient may serve as host resistance to the deleterious effect of Pb and Cd (present in these

The significantly higher humoral i

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

metal fumes) on the immune system. Zinc therefore may be considered a factor in public health that deserves greater recognition and the need for a separate advised dietary intake (ADI) in polluted communities.

Conflict of Interest

Authors declare that they have no competing interest.

REFERENCES

1. Akingunola, R. O. Small and medium scale enterprises and economic growth in Nigeria: An assessment of financing options. Pakistan Journal of Business and Economic Review 2011; 2: (1).

2. Berlinger B, Benker N, Weinbruch S, et al. Physicochemical characterisation of different welding aerosols. Anal Bioanal Chem 2011; 399: 1773-80.

3. Newhouse ML, Oakes D and Woolley AJ. Mortality of welders and other craftsmen at ashipyard in England. Br. J. Ind. Med.1985; 42: 400-410.

4. OSHA 1995. Welding Fumes (Total Particulate). Chemical Sampling Information. http://www.osha-slc.gov/dts/chemicalsampling/data/CH 276100.html.

5. Jaremin B. Immunological humoral immune responsiveness in men occupationally exposed to lead. Bull Inst. Marit. Trop. Med. Gdynia1990; (4): 27-36.

6. McCabe MJ and Lawrence DA. The heavy metal lead exhibits B cellstimulatory factor activity by enhancing B cell Ia expression and differentiation. J Immunol 1990; 145:671-677.

7. Lewis TA, Munson AE, McCoy KL. Gallium arsenide selectively suppresses antigen processing by splenic macrophages for CD4+ T cell activation. The Journal of Pharmacology and experimental therapeutics 1996; (278): 1244-1251.

8. Ogunbileje JO, Akinosun OM, Akinduti PA, Nwobi LA and Ejilude OA. Serum levels of some trace metals and leucocyte differential counts in Nigeria cement factory workers: Possible toxicity implications. Florida Int. J 2010; 2: 55-58.

9. Mandal MA and Suva P. Haematological changes among construction workers exposed to cement dust in West Bengal, India Prog. Health Sci,2014; Vol 4, No1.

10. Ogunbileje JO, Sadagoparamanujam VM, Anetor JI, Farombi EO, Akinosun OM,Okorodudu AO. Lead, mercury, cadmium, chromium, nickel, copper, zinc, calcium, iron, manganese and chromium (VI) levels in Nigeria and United States of America cement dust Chemosphere 2013; 90 (11):2743-2749.

11. Cohen MD, Yang Z, Zelikoff JT. Immunotoxicity of particulate lead: in vitro exposure alters pulmonary macrophage, tumor necrosis factor production and activity. J Toxicol. Environ. Health 1994; 42: 377-92.

12. Steel J and Sanderson JT. Toxic constituents of welding fumes. Ann. Occup. Hyg. 1966 9 (3): 103-111.

13. Noweir MH, el-Gazzar RM, Noweir KH. Trace metals in cement and in airborne cement dust. J Egypt Public Health Assoc. 1988; 63:(3-4)151–67.

14. Sears M E, Kerr K J, and Riina I. Arsenic, cadmium, lead, and mercury in sweat: A Systematic Review. Bray Journal of environmental and public health 2012.

15. Koller LD and Kovacic S. Decreased antibody formation in mice exposed to lead. Nature (London) 1974; 250:148-149.

16. Luster MI, Faith RE and Kimmel CA. Depression of humoral immunity in rats following chronic developmental lead exposure. J Environ Pathol Toxicol 1978; 1:397-402.

17. Hemphil FE, Kaeberle ML and Buck WB. Lead suppression of mouse resistance to Salmonella typhimurium. Science (Wash DC) 1971; 172:1031-1032.

18. Lawrence DA. Heavy metal modulation of lymphocyte activities: II. Lead, an in vitro mediator of B-cell activation. Int J Immunopharmac 1981; 3:153-161.

19. Gainer JH. Lead aggravates viral diseases and represses antiviral activity. Environ Health Perspect 1974; 7:113-119.

20. Fraker PJ, King LE, Laakko T, et al. The dynamic link between the integrity of the immune system and zinc status. Journal of Nutrition 2000; (130): 1399 – 1406.

21. Prasad AS. Zinc deficiency has been known of for 40 years but ignored by global health organisations. British Medical Journal 2003; 326 (7386): 409–10.

22. Boshnakova E, Divanyan S, Zlatarov I, Marovsky SV, Kisyova K, Zanev D, Karev G, and Marinova TZ. Immunological Screening of Welders. J. Hyg. Epidemiol. Microbiol. Immunol. 1989; 33:379-382.

23. Hanovcova I, Chylkova V. Terjal T, et al. Long term monitoring of the immune reactivity of stainless steel welders. Central Europe Journal of Public Health 1998; (6): 51–56.

24. Tuschl H, Weber E, and Kovac R. Investigations on Immune Parameters in Welders. J. Appl. Toxicol 1997; 17:377-383.

25. Bannon DI, Murashchik C, Zapf CR, Farfel MR, Chisolm JJ Jr. 1994 Graphite furnace atomic absorption spectroscopic measurement of blood lead in matrix matched standards. Clinical Chemistry 40: 1730-34.

26. Lauwerys R, Roels H, Regniers M, Buchet JP, Bernard A, Goret A. Significance of cadmium concentration in blood and in urine in workers exposed to cadmium. Environ. Res. 1979; 20:375-91.

27. Smith JC Jr, Butrimovitz GP and Purdy WC. 1979. Direct measurement of zinc in plasma by atomic absorption spectroscopy. Clinical Chemistry Volume (25): 1487–1491.

28. Lin Wang, Dawei Chen, Heng Wang, Zongping Liu. Effects of Lead and/or Cadmium on the Expression of Metallothionein in the Kidney of Rats bilogical trace element research 2009; Volume 129, Issue 1, pp 190-199.

29. Bizoskal M M. Food and chemical toxicology 2001; 38(10): 968-980.

30. Dioka CE, Orisakwe OE, Adeniyi FA, Meludu SC. Liver and renal function tests in artisans occupationally exposed to lead in mechanic village in Nnewi, Nigeria. Int J Environ Res Public Health 2004; 1:21–25

31. Ayatollahi M. Study of the impact of blood lead level on humoral immunity in humans.Toxicology and Industrial Health 2002; 18: 39-44.

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**

32. Mehdi JK, al-Imarah FJ, al-Suhail AA. Levels of some trace metals and related enzymes in workers at storage-battery factories in Iraq. East Medit. Health J. 2000; 6:76–82.

33. Chiba M, Shinohara A, Matsushita K, Watanabe H, Inaba Y. Indices of lead exposure in blood and urine of lead-exposed workers and concentrations of major and trace elements and activities of SOD, GSH-Px and catalase in their blood. Tohoku J Exp. Med 1996; 178:49–62.

34. Guojun Jane Li, Long-Lian Zhang, Ling Lu, Ping Wu,Wei Zheng. Occupational Exposure to Welding Fume among Welders: Alterations of Manganese, Iron, Zinc, Copper, and Lead in body fluids and the oxidative stress status. JOEM 2004; 46,(3).

35. Borská L, Fiala Z, Ctirad A, Krejsek J, and Tejral J. Health risk of occupational exposure in welding processes II. Immunological effects. Acta Medica (Hradec Kralove) 2003; 46:31–35.

36. Shenker BJ, Matarazzo WJ, Hirsch RL and Gray I. Trace metal modification of immunocompetence: I. Effect of trace metals in the culture on in vitro transformation of B lymphocytes. Cell Immunol 1977; 34:19-24.

37. Gaworski CL and Sharma RP. The effects of heavy metals on H-thymidine uptake in lymphocytes. Toxicol Appl Pharmacol 1978; 46:305-313.

38. Mccabe MJ and Lawrence DA. Lead, a major environmental pollutant, is immunomodulatory by its differential effect on CD4+ T cell subsets. Toxicol. Appl. Pharmacol. 1991; (111): 13-23.

39. Ayling, RM. Clinical biochemistry of nutrition. In: Marshall, WJ, Lapsley M, Day AP, and Ayling RM. Clinical Biochemistry: Metabolic and Clinical Aspects. Churchill Livingstone (Elsivier), Edinburgh, pp.199.

40. Oyeyinka GO, Salimonu LS, Williams AI, Johnson AO, Ladipo OA, Osunkoya BO. Range of normal serum immunoglobulin (IgG, IgA and IgM) values in Nigerians. Afr J Med Med Sci. 1984 Sep-Dec; 13(3-4):169-76.

Citation: Adeniyi NA, Omotosho IO, Onifade AA, Anetor JI (2016) *An assessment of the modulatory effect of zinc on humoral immune parameters in welders and cement block moulders in Ogbomosho, Nigeria. J. innov. res.. health sci. biotechnol.* 1(4): 186-194. **doi: 10.18644/jiresh-biotech.0000022**