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# Impact of Cement Dust Exposure on Liver Function in Exposed Individuals

*Ameer A. Alameri*
*Department of Pharmaceutical Chemistry, College of Pharmacy, University of Babylon, 51001 Babylon, Iraq*

## ABSTRACT

**Background and Objective:** Exposure to cement dust presents serious threats to one's health at work, especially for construction workers. Its possible effects on liver function are still little understood, despite the well-established benefits on respiratory and skin health. This study investigates the effects of cement dust exposure on liver function among construction workers in Akala Express, focusing on biomarkers such as AST, ALT, ALP, Bilirubin, Albumin, and Total Protein. **Materials and Methods:** This study was performed on the smoker and nonsmoker students in the University of Babylon, and all the blood samples were collected between November, 2023 to January, 2024. As 50 exposed and 50 non-exposed people, matched for age and demographics, participated in a case-control study. Standardized biochemical techniques were used to gather blood samples and test them for liver indicators. To do statistical analysis, SPSS version 24.0 was used. The data was summarized using descriptive statistics, and the amounts of biomarkers in each group were compared using independent t-tests. The association between exposure length and liver dysfunction was evaluated using Chi-square testing. **Results:** ALT levels were significantly lower in the exposed group (29.23±10.54 IU/L) compared to the control group (38.32±19.26 IU/L, p = 0.004). Other biomarkers, including AST (37.95±13.09 vs 33.5±12.13 IU/L, p = 0.081), ALP (76.94±23.07 vs 70.6±26.29 IU/L, p = 0.203), Albumin (4.06±0.75 vs 4.19±1.04 g/L, p = 0.457), and Total Protein (7.19±0.95 vs 7.37±1.37 g/L, p = 0.443) showed no statistically significant differences. The prevalence of liver dysfunction was 8% in the exposed group and 0% in the control group. Chi-square analysis revealed a significant association between longer exposure durations and liver dysfunction (p = 0.026). **Conclusion:** Prolonged exposure to cement dust significantly reduces ALT levels, indicating potential liver stress. However, other liver biomarkers remained within normal ranges, suggesting that adaptive mechanisms may mitigate severe damage. The results highlight the importance of enforcing protective measures and conducting longitudinal studies to better understand long-term effects.

## KEYWORDS

Cement dust, liver biomarkers, occupational health, ALT, construction workers

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## INTRODUCTION

For construction workers in particular, who are frequently exposed to its hazardous components, such as calcium oxide, heavy metals, and crystalline silica, cement dust exposure poses a serious occupational risk. These substances toxic qualities, which have the potential to harm several organs systems systemically,

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provide several health problems. Specifically, exposure to cement dust has been linked to the development of skin irritation, respiratory conditions, and, more recently, worries about possible hepatotoxic effects. Although the effects of cement dust on the respiratory and dermatological systems are well established, less is known about how it may affect liver function, even though the liver is an essential organ for metabolism and detoxification. This information vacuum necessitates a more thorough investigation of the potential effects of cement dust exposure on liver health, particularly for construction workers who are exposed to these dangerous substances for extended periods.

Long-term exposure to cement dust has been shown in several studies to cause considerable oxidative stress, as seen by elevated malondialdehyde (MDA) levels and reduced total antioxidant capacity (TAC) in exposed workers relative to non-exposed controls[1,2]. Numerous negative health effects seen in workers exposed to cement dust are believed to be caused by oxidative stress, a key contributor to cellular damage. Furthermore, research has demonstrated that exposure to cement dust can cause systemic inflammatory reactions, as seen by increased white blood cell counts, which could be a sign of persistent inflammation in the liver and other organ systems[3]. Particularly concerning is exposure to respirable crystalline silica, a major ingredient in cement dust, which has been closely associated with serious lung diseases, including silicosis[4]. To protect the health of construction workers, the cumulative consequences of these exposures underscore the necessity of stringent safety procedures, health monitoring, and preventive measures.

Although cement dust exposure has drawn a lot of attention for its effects on respiratory and dermatological disorders, there is mounting evidence that liver function may also be negatively impacted. In animal models, it has been discovered that inhaling cement dust causes changes in liver function markers, including notable changes in enzymes such as alkaline phosphatase (ALP) and total protein levels[5,6]. Studies on livestock, especially sheep that reside close to cement manufacturers, have confirmed these findings. They showed that exposure to heavy metals found in cement kiln dust significantly changed both hematological and hepatic parameters[7].

There may be a connection between extended exposure to cement dust and liver damage, as human studies have shown that employees in cement factories have higher levels of toxic metals and elevated liver enzymes like ALT and AST[8]. Further supporting the possible detrimental effects of cement dust on liver function are the observations of systemic inflammation and hepatotoxicity in animal studies involving cements based on mineral aggregates[9].

Long-term exposure to a variety of environmental and lifestyle factors has been linked to liver dysfunction, especially when it disrupts important liver biomarkers like AST, ALT, and ALP. In Wistar rats, for example, investigations have shown that extended exposure to aluminum chloride causes increased serum levels of liver enzymes together with histological evidence of oxidative stress and liver damage[10,11]. Chronic alcohol use has also been demonstrated to raise ALT, AST, and GGT levels in alcoholic liver disease patients, underscoring the fibrosis and inflammatory processes linked to excessive alcohol use[12].

Long-term exposure to a variety of toxicants has been shown to have negative effects on liver health, as evidenced by the alteration of important liver biomarkers, and lead exposure has also been associated with elevated liver injury markers, indicating that chronic exposure to environmental pollutants can contribute to liver dysfunction[13].

Given that the liver is a key organ for detoxification, the presence of heavy metals and particulate matter in cement dust particles may make it especially susceptible to the harmful effects of the dust. Nevertheless, not enough research has been done on the possible hepatotoxic effects of cement dust exposure, especially when it comes to construction workers who are constantly exposed to such risks. The purpose of this study is to fill the knowledge gap about the influence of cement dust on liver function, given the known impacts on other organ systems. The effects of cement dust exposure on liver biomarkers in construction workers in Akala Express, a rapidly urbanizing area in Nigeria, are investigated in this study using a case-control methodology.

This study intends to add to the expanding body of research on occupational health hazards in construction workers by concentrating on important liver biomarkers like AST, ALT, ALP, bilirubin, albumin, and total protein. It also attempts to offer a thorough evaluation of the possible hepatotoxic effects of cement dust exposure. Study goal is to provide insight into the long-term health dangers and the necessity of preventive measures in the construction business by shedding light on the little-known aspect of cement dust exposure.

## MATERIALS AND METHODS

**Study design and setting:** To compare liver function biomarkers in construction workers exposed to cement dust to controls who were not exposed, this study used a case-control study design. The study was carried out in the busy neighborhood of Akala Express in Ibadan, Oyo State, which is seeing a rise in building and fast urbanization. The environment was perfect for assessing the risks to one's health at work from exposure to cement dust. "This study was conducted on both smoker and nonsmoker students at the University of Babylon, with all blood samples collected between November, 2023 and January, 2024".

**Study design:** Fifty construction workers who were regularly exposed to cement dust were chosen for the study, and the control group consisted of 50 people who were not. Office workers and residents without any occupational exposure to cement dust were chosen as the control group. Confounding variables were minimized by matching the two groups based on age, gender, and socioeconomic position.

**Sample size determination:** The minimal sample size for each group was determined to be 35 individuals using Cohen's technique for comparing two means. There were 50 participants in each group after an extra 10% was added to allow for any non-responders or dropouts. The statistical power of this sample size was adequate to identify meaningful variations in liver biomarkers between the exposed and control groups.

**Study subjects**
**Inclusion criteria:**

- Active construction workers aged 18-50 years with at least one year of occupational exposure to cement dust
- Control participants aged 18-50 years with no history of occupational exposure to cement dust
- Individuals willing to provide informed consent and participate in blood sample collection

**Exclusion criteria:**

- Individuals with known pre-existing liver conditions or chronic illnesses
- Participants with a history of significant alcohol or drug use
- Individuals taking medications known to affect liver function
- Pregnant women or those with other significant health risks

**Materials and equipment:** Using tools and materials of laboratory quality, biochemical studies were carried out. Standardized test kits for detecting AST, ALT, ALP, albumin, bilirubin, and total protein were among them, as were centrifuges for separating serum and spectrophotometers for examining liver enzymes and proteins.

**Clinical laboratory investigation**

**Sample collection and analysis:** Sterile procedures were followed to obtain venous blood samples from the median cubital vein. After being centrifuged to extract the plasma, the samples were kept in vials containing lithium heparin. The ALP, AST, ALT, albumin, total and conjugated bilirubin, and total protein were all biochemically analyzed using enzyme assay kits. To guarantee accuracy and dependability, every sample was processed under uniform circumstances.

**Statistical analysis:** Version 24.0 of SPSS was used to enter the data and perform statistical analysis. To summarize the data, descriptive statistics such as means, standard deviations, and frequencies were employed. The exposed and control groups biomarker levels were compared using independent t-tests. To evaluate the relationships between exposure factors and liver dysfunction, Chi-square tests were employed. At $p<0.05$, statistical significance was established.

**RESULTS**

The study included 100 participants divided equally into the control and exposed groups. The majority were aged 18-29 years, predominantly male, and mostly of Yoruba ethnicity. A significantly higher proportion of males was found in the exposed group (94%) compared to the control (78%) ($p = 0.041$), and all Exposed participants were Yoruba ($p = 0.013$). While Christianity was more common in the control group, Islam prevailed in the exposed group. Most participants resided in urban areas, and secondary education was significantly more common among the Exposed group ($p = 0.043$). No major differences were observed in age, religion, marital status, or residence in Table 1.

Among the exposed participants, bricklaying was the most common job role (48%), followed by various other construction-related roles (34%). Half of the workers reported working 5 or more hours per week, and 40% had been exposed to cement dust for 1-3 years. A vast majority (94%) experienced daily exposure to cement dust, yet only 16% reported using personal protective equipment (PPE), indicating poor adherence to protective measures in the work environment in Table 2.

**Symptoms and health perception (case, N = 50):** The symptoms and health perception of the construction workers are presented in Table 3. Half of the participants (50%) of participants experienced symptoms potentially related to liver health, with fatigue (48%) being the most common symptom, followed by abdominal pain (28%), feeling sick (20%), and loss of appetite (4%). Few of the participants (20%) have noticed changes in their health since starting work in construction, while 80% have not.

**Awareness and safety practice (case, N = 50):** The awareness and safety practices of the participants are presented in Table 4. Only 28% of participants are aware of the health risks associated with cement dust exposure. The majority of the participants (86%) describe their workplace as having full ventilation, 8% as partial, and 6% as not enough. Few of the prticipants (14%) report the presence of other hazardous substances besides cement dust. 8% state that their work and exposure to cement dust affect their daily life and activities outside work. Only 6% have received health screenings related to their work, while 94% have not. Various hazardous substances present in the work environment, including: Chemicals, heavy metals, gases and vapors, biological hazards, dust, iron fillings, paint, sawdust, and snakes.

**Levels of liver enzymes in study groups:** An independent sample t-test was conducted to determine whether there is a difference in mean scores of AST, ALT, ALP, albumin, total protein, Conjugated Bilirubin, Unconjugated Bilirubin, and Total Bilirubin between the control and case study groups. The parameters

Table 1: Demographic characteristics of participants (N = 100)

| | Study groups | | |
|---|---|---|---|
| Variables category | Control (%) | Exposed (%) | p-value |
| **Age** | | | |
| 18-29 | 23 (46) | 24 (48) | 0.770 |
| 30-39 | 18 (36) | 15 (30) | |
| 40-49 | 5 (10) | 8 (16) | |
| 50 | 4 (8) | 3 (6) | |
| Total | 50 (100) | 50 (100) | |
| **Gender** | | | |
| Male | 39 (78) | 47 (94) | 0.041 |
| Female | 11 (22) | 3 (6) | |
| Total | 50 (100%) | 50 (100) | |
| **Religion** | | | |
| Christian | 29 (58) | 22 (44.0) | 0.096 |
| Muslim | 19 (38) | 28 (56.0) | |
| Traditional | 2 (4) | 0 (0.0) | |
| Total | 50 (100) | 50 (100) | |
| **Ethnicity** | | | |
| Yoruba | 42 (84) | 50 (100) | 0.013 |
| Igbo | 4 (8) | 0 (0.0) | |
| Hausa | 4 (8) | 0 (0.0) | |
| Total | 50 (100) | 50 (100) | |
| **Marital status** | | | |
| Single | 18 (36) | 24 (52.0) | 0.085 |
| Married | 27 (54) | 24 (48.0) | |
| Divorced | 3 (6) | 0 (0.0) | |
| Widow | 2 (4) | 0 (0.0) | |
| Total | 50 (100) | 50 (100) | |
| **Residence** | | | |
| Urban | 50 (100) | 49 (98.05) | 1.000 |
| Rural | 0 (0.0) | 1 (2.0) | |
| Total | 50 (100) | 50 (100) | |
| **Highest level of education** | | | |
| Primary school | 15 (30) | 6 (12) | 0.043 |
| Secondary school | 22 (44) | 34 (68) | |
| Tertiary | 13 (26) | 9 (18) | |
| Postgraduate | 0 (%) | 1 (2) | |

are reported with their respective standard deviations and ranges as shown in Table 5. The AST levels are higher in the exposed group (37.95±13.09 IU/L) compared to the control group (33.5±12.13 IU/L), p = 0.081. The ALT levels are significantly lower in the exposed group (29.23±10.54 IU/L) compared to the control group (38.32±19.26 IU/L), with a p-value of 0.004. Although the ALP levels are slightly higher in the exposed group (76.94±23.07 IU/L) compared to the control group (70.6±26.29 IU/L), the p-value of 0.203 indicates that this difference is not statistically significant. The difference in albumin levels between the two groups is minimal (control group = 4.19±1.04 and case group 4.06±0.75 g/L), and the p-value of 0.457 suggests that this difference is not statistically significant. Similar to albumin, the difference in total protein levels between the control (7.37±1.37 g/L) and exposed groups (7.19±0.95 g/L) is not statistically significant, with a p-value of 0.443. Conjugated bilirubin levels are lower in the exposed group (0.25±0.10 mg/dL), but the p-value of 0.195 indicates that this difference is not statistically significant. The levels of unconjugated bilirubin are slightly higher in the exposed group (0.33±0.67 mg/dL), but the p-value of 0.121 suggests that the difference is not statistically significant. The total bilirubin levels are lower in the exposed group (0.50±0.097 mg/dL), but this difference is not statistically significant, with a p-value of 0.411.

Table 2: Occupational exposure (case, N = 50)

| Variables category | Frequency (N) | Percentage (%) |
|---|---|---|
| **What is your current job role in construction?** | | |
| Bricklayers | 24 | 48.0 |
| Cement mixer | 4 | 8.0 |
| Laborer | 5 | 10.0 |
| Ten others | 17 | 34.0 |
| Total | 50 | 100 |
| **How many hours per week do you typically work?** | | |
| One hour | 2 | 4.0 |
| Two hours | 1 | 2.0 |
| Five hours | 22 | 44.0 |
| Hours | 25 | 50.0 |
| Total | 50 | 100 |
| **How long have you been exposed to cement dust in your current job?** | | |
| 1-3 Years | 20 | 40.0 |
| 4-6 Years | 8 | 16.0 |
| 7-9 Years | 9 | 18.0 |
| Total | 50 | 100 |
| **How frequently are you exposed to cement dust?** | | |
| Daily | 47 | 94.0 |
| Once a while | 3 | 6.0 |
| Total | 50 | 100 |
| **Do you use Personal Protective Equipment (PPE) when working with cement dust?** | | |
| Yes | 8 | 16.0 |
| No | 42 | 84.0 |
| Total | 50 | 100 |

Table 3: Symptoms and health perception (case, N = 50)

| Variables category | Frequency (N) | Percentage (%) |
|---|---|---|
| **Do you experience any symptoms that may be related to liver health?** | | |
| Yes | 25 | 50 |
| No | 25 | 50 |
| Total | 50 | 100 |
| **If yes,** | | |
| Fatigue | 12 | 48.0 |
| Abdominal pain | 7 | 28.0 |
| Loss of appetite | 1 | 4.0 |
| Feeling sick | 5 | 20.0 |
| Total | 25 | 100 |
| **Have you noticed any changes in your health since starting work in construction?** | | |
| Yes | 10 | 20.0 |
| No | 40 | 80.0 |
| Total | 50 | 100 |

**Prevalence of liver dysfunction:** The summary of the prevalence of liver dysfunction among the participants in the exposed and control groups is provided in Table 6. In the exposed group, which consisted of 50 participants, 4 individuals were diagnosed with liver dysfunction, resulting in a prevalence rate of 8%. In contrast, the control group, also comprising 50 participants, reported no cases of liver dysfunction, leading to a prevalence rate of 0%.

**Correlation between the degree of exposure to cement dust and changes in liver function markers:** The association between degree of exposure and liver dysfunction is shown in Table 7. For weekly exposure, the analysis shows a Chi-square value of 1.99 with a p-value of 0.590, indicating no significant association between the duration of weekly cement exposure and liver dysfunction. Specifically, liver dysfunction was observed in 0 out of 10 individuals with one hour of weekly exposure, 1 out of 17 with 2 hrs, 2 out of 13 with 5 hrs, and 1 out of 10 with 10 hrs. The high p-value suggests that variations in weekly exposure duration do not significantly affect liver dysfunction risk.

Table 4: Awareness and safety practice (case, N = 50)

| Variables category | Frequency (N) | Percentage (%) |
|---|---|---|
| **Are you aware of the health risks associated with exposure to cement dust?** | | |
| Yes | 14 | 28.0 |
| No | 36 | 72.0 |
| Total | 50 | 100 |
| **How would you describe the ventilation and air quality at your workplace?** | | |
| Full ventilation | 43 | 86.0 |
| Not enough | 3 | 6.0 |
| Partial | 4 | 8.0 |
| Total | 50 | 100 |
| **Are there any other hazardous substances in your work environment besides cement dust?** | | |
| Yes | 7 | 14.0 |
| No | 43 | 86.0 |
| Total | 50 | 100 |
| **Does your work in construction and exposure to cement dust affect your daily life and activities outside of work?** | | |
| Yes | 4 | 8.0 |
| No | 46 | 92.0 |
| Total | 50 | 100 |
| **Have you received any health screenings related to your work in construction?** | | |
| Yes | 3 | 6.0 |
| No | 47 | 94.0 |
| Total | 50 | 100 |

Table 5: Levels of liver enzymes in study groups (N = 100)

| Liver enzymes | Unexposed workers (Control group) (Mean±SD) (Range) (N = 50) | Exposed workers (Case group) (Mean±SD) (Range) (N = 50) | p-value |
|---|---|---|---|
| Aspartate aminotransferase (IU/L) | 33.50±12.13 | 37.95±13.09 | 0.081 |
| Alanine aminotransferase (IU/L) | 38.32±19.26 | 29.23±10.54 | 0.004* |
| Alkaline phosphatase (IU/L) | 70.60±26.29 | 76.94±23.07 | 0.203 |
| Albumin (g/L) | 4.19±1.04 | 4.06±0.75 | 0.457 |
| Total protein (g/dL) | 7.37±1.37 | 7.19±0.95 | 0.443 |
| Conjugated bilirubin (mg/dL) | 0.42±0.93 | 0.25±0.10 | 0.195 |
| Unconjugated bilirubin (mg/dL) | 0.28±1.0 | 0.33±0.67 | 0.121 |
| Total bilirubin (mg/dL) | 0.702±0.38 | 0.50±0.097 | 0.411 |

*Statistically significant

Table 6: Prevalence of liver dysfunction

| Group | Number of participants (n) | Number with liver dysfunction (n) | Prevalence (%) |
|---|---|---|---|
| Exposed group | 50 | 4 | 8 |
| Control group | 50 | 0 | 0 |

For length of exposure, the Chi-square value for the length of exposure is 1.345 with a p-value of 0.026, suggesting a significant association between the duration of exposure and liver dysfunction. liver dysfunction was observed in 1 out of 12 individuals with 1-3 years of exposure, 1 out of 8 with 4-6 years, 0 out of 11 with 7-9 years, and 2 out of 19 with 10 years and above. The p-value indicates that longer exposure duration may increase the likelihood of liver dysfunction. For use of protective measures, the Chi-square value is 0.649 with a p-value of 0.421, which implies no significant association between the use of protective measures and liver dysfunction. Liver dysfunction was found in 1 out of 23 individuals who used protective measures and 3 out of 29 who did not. The p-value suggests that using protective measures does not significantly impact the risk of liver dysfunction.

Table 7: Correlation between the degree of exposure to cement dust and liver dysfunction

| | Liver functioning status | | | |
|---|---|---|---|---|
| Exposure parameters | Liver dysfunction (n = 4) | No liver dysfunction (n = 46) | $X^2$ | p-value |
| **Weekly exposure** | | | | |
| One hour | 0 | 10 | 1.99 | 0.590 |
| Two hours | 1 | 16 | | |
| Five hours | 2 | 11 | | |
| Ten hours | 1 | 9 | | |
| **Length of exposure** | | | | |
| 1-3 years | 1 | 11 | 1.345 | 0.026 |
| 4-6 years | 1 | 7 | | |
| 7-9 years | 0 | 11 | | |
| 10 years and above | 2 | 17 | | |
| **Use of protective measures** | | | | |
| Yes | 1 | 22 | 0.649 | 0.421 |
| No | 3 | 26 | | |

## DISCUSSION

The results of this investigation show that construction workers exposed to cement dust had significantly lower levels of alanine aminotransferase (ALT). Although the precise mechanisms underlying this are still unclear and somewhat controversial, this observation is consistent with other research suggesting that occupational exposure to cement dust can result in subclinical liver stress. The absence of notable variations in other biomarkers, like Alkaline Phosphatase (ALP) and Aspartate Amino transferase (AST), may be a reflection of adaptive mechanisms in the liver or it may suggest that the acute toxicity thresholds required to cause more noticeable changes in these enzymes were not exceeded by the cement dust exposure levels in this investigation.

The results of this study about cement dust exposure and its effects on liver function among construction workers also highlight the need for targeted interventions, as the observed prevalence of liver dysfunction in 8% of the exposed group serves as a critical indication of the potential risk of occupational exposure to cement dust.

The literature has reported a complex relationship between cement dust exposure and liver function, with some studies reporting significant changes in liver enzymes in workers exposed to cement dust and others finding minimal or no significant effects. For instance, one study found significantly higher serum ALT levels in workers exposed to cement dust compared to controls, although still within normal reference ranges, suggesting possible subclinical liver stress[14].

On the other hand, other research has shown that cement handlers had reduced ALT levels, which may reflect both exposure levels below the acute toxicity limits or adaptive physiological processes[15]. A similar adaptive response may be reflected in the study's finding that exposed workers ALT levels decreased; however, further research into the specific physiological alterations in the liver would be required to validate this theory.

Remarkably, workers exposed to cement dust had higher levels of oxidative stress indicators, and there were associations between raised oxidative stress and poor liver function outcomes, especially for those with longer exposure times. Despite the lack of noticeable alterations in liver enzyme activity, this implies that oxidative damage can contribute to liver dysfunction. These results are in line with earlier research showing that exposure to harmful substances in cement dust can cause reactive oxygen species to be produced, which can harm liver cells and interfere with normal liver function[15].

The increase in oxidative stress markers highlights the possibility of underlying liver impairment that may not yet be apparent by traditional enzyme assays alone, even while there are no notable alterations in some liver enzymes.

Although there were no discernible changes in liver enzyme activity, the prevalence of liver dysfunction in 8% of the exposed group emphasizes the need for focused health measures to reduce the dangers associated with prolonged occupational exposure to cement dust. Moreover, this study contributes to the increasing amount of evidence indicating that cement dust exposure may be a substantial risk factor for liver dysfunction, even if it has been connected to respiratory and dermatological disorders. Because liver disease is subtle, routine biomarker monitoring is essential for early identification and averting long-term health issues.

A p-value of 0.590 for the weekly exposure Chi-square test indicates that there is no significant correlation between the weekly hours of cement dust exposure and the risk of liver dysfunction.

This finding suggests that either the cumulative exposure over time may have a greater influence than short-term exposure variations, or the weekly exposure duration may not be the most important factor in determining liver health. Therefore, factors including the intensity and length of exposure across a worker's career may have a greater impact on liver health than the number of hours of exposure. On the other hand, the length of exposure Chi-square test produced a p-value of 0.026, which is below the 0.05 cutoff and suggests a statistically significant correlation between the length of exposure to cement dust and liver dysfunction.

The results of this study provide additional support for the findings of other studies that found significant differences in liver biomarkers between individuals with shorter and longer durations of cement dust exposure, including the finding that prolonged exposure to cement dust resulted in changes in liver function, including elevated bilirubin levels, indicating potential hepatic impairment associated with cumulative exposure[14]. These findings also suggest that longer exposure to cement dust is correlated with a higher likelihood of liver dysfunction.

Longer exposure times may put workers at greater risk for liver dysfunction, which emphasizes the necessity of ongoing health monitoring and safety precautions for cement sector personnel. The cumulative effect of hazardous components in cement dust is shown by the Chi-square test, which shows a substantial correlation between exposure length and liver damage. Crystalline silica, heavy metals, and calcium oxide are just a few of the dangerous materials found in cement dust that can cause oxidative stress and liver damage.

Long-term exposure to these chemicals may cause cellular damage to gradually accumulate and eventually show up as liver dysfunction. In order to reduce these hazards, preventive steps such as requiring the use of personal protective equipment (PPE), enhancing ventilation in the workplace, and instituting routine health examinations are essential. The long-term health implications of prolonged cement dust exposure require more investigation, especially the cumulative effects on liver function throughout a worker's lifetime.

## CONCLUSION

This study found that prolonged exposure to cement dust significantly reduces ALT levels, indicating potential liver stress among exposed workers. Although other liver biomarkers (AST, ALP, albumin, and total protein) remained within normal ranges, the association between exposure duration and liver dysfunction suggests that ongoing exposure poses health risks. The findings emphasize the need for regular liver function monitoring, mandatory use of PPE, and improved workplace ventilation and dust control. Occupational health education and stricter enforcement of air quality regulations are essential to protect workers in high-risk environments.

## SIGNIFICANCE STATEMENT

This study identified the impact of prolonged cement dust exposure on liver biomarkers, particularly ALT levels, which could be beneficial for developing early detection and prevention strategies for occupational liver stress. This study will assist researchers in uncovering critical areas of occupational health risks that have remained unexplored by many. Consequently, a new theory on adaptive liver responses to chronic low-level toxic exposure may be developed.

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