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Regression Formulae for Predicting Hematologic and Liver Functions from Years of Exposure to Cement Dust in Cement Factory Workers in Sokoto, Nigeria

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ABSTRACT

Recent studies suggest that occupational exposure to cement dust may have deleterious effects on the lungs and on haematologic and liver functions. The present study was designed to investigate further the relationship between haematologic and liver functions on one hand and years of exposure to cement dust on the other. Haematologic parameters and alkaline phosphatase (ALP) levels measured previously in 23 cement factory workers were correlated with years of exposure to cement dust. Haemoglobin (Hb) concentration and packed cell volume (PCV) correlated negatively with years of service [r= -0.345 (P<0.0001) and -0.154 (P<0.0001) respectively]. The equations defining these relationships are: Hb concentration = 13.394 - 0.119 x years of service and PCV = 41.065–0.154 x years of service. On the other hand platelet and white blood cell (WBC) counts in these workers correlated positively with years of service [r = 0.342 (P <0.001) and r = 0.130 (P<0.0001) respectively]. The equations defining these relationships are: platelet count = 205.681 +7.041 x years of service and WBC count = 7.64 + 0.078 x years of service. ALP concentration correlated negatively with years of service [r= -0.144, (P< 0.0001)]. The regression equation defining this relationship is: ALP concentration = 33.68 – 0.075 x years of service. These suggest that there was an adverse effect on the haematological parameters and ALP concentration as years of exposure to cement dust increased. The obtained equations may be useful in predicting haematological parameters and ALP concentrations from years of exposure to cement dust.
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Key words: - *Regression formulae, haematological parameters, liver enzyme*

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INTRODUCTION

The major pollution problem in cement factories is cement dust emission into the environment from various points of the production process such as the crusher, rotary kiln, cranes, mills, storage silos and packing sections (ILO, 1999). This has resulted in the exposure of factory workers to cement dust leading to the impairment of respiratory function and a prevalence of respiratory symptoms amongst workers (Alakija et al., 1990; Noor et al., 2000; Al-Neaimi, Gomes and Lloyd, 2001; Laraqui et al., 2001; Meo et al., 2002; Mwaiselage, Moen and Bratveit, 2006). The severity of the impairment of respiratory function has been shown to depend on years of exposure (Alakija et al., 1990). However there are reports that contradict this notion (Vestbo and Rasmussen, 1990; Yang et al., 1993; Fell et al., 2003). These reports suggest that cement dust exposure may neither increase the morbidity of respiratory diseases (Vestbo and Rasmussen, 1990; Fell et al., 2003) nor be associated with the prevalence of respiratory symptoms among workers (Yang et al., 1993; Fell et al., 2003). Whatever the findings, most studies have concentrated on lung function probably because of the obvious tendency to inhale abundant cement dust in the work environment. Fewer studies have examined the effect on other systems such as the skin and eyes (Ezenwa, 1996) and respiratory muscles (Meo et al., 2002). Indeed occupational exposure to cement dust not only depressed lung function but also reduced intercostals muscle performance as evidenced by surface electromyography studies (Meo et al., 2002)

Recently, Jude et al., (2002) reported haematologic and genetic damages in workers occupationally exposed to cement dust in India. The deleterious effect on the haematologic system was confirmed by Merenu (2003) in workers at the Sokoto cement factory. She also observed a fall in the liver enzymes that was significant only for alkaline phosphatase. The study of Merenu (2003) suggests that cement dust exposure may have toxic effects on haematologic and liver functions. In the present study we have examined the relationship between the haematologic parameters and alkaline phosphate levels measured by her and the years of exposure of the workers to cement dust. We have also derived formulae defining these relationships in an effort to predict these parameters from years of exposure. It is envisaged that these formulae may be useful in predicting these parameters from years of exposure among the workers in this factory. This may make frequent performance of haematological parameters and liver function tests as a way monitoring the health of these workers unnecessary.

MATERIALS AND METHODS

The relationships between haematologic parameters and alkaline phophatase levels on one hand and years of exposure to cement dust on the other were studied. The haematologic parameters used were Haemoglobin (Hb) concentration, packed cell volume (PCV), platelet and WBC (White blood cell) counts. Of the liver function parameters only alkaline phophatase (ALP) concentration differed significantly in the cement factory workers compared to control (Merenu, 2003) and so this was selected. These data were obtained previously (Merenu, 2003) from workers in the cement factory of Northern Nigeria Sokoto. The study population comprised of those working in the cranes, packing, crusher and mill sections of the factory. The workers in these sections were selected because of their high level of exposure (Alakija et al., 1990; Mwaiselage et al., 2005).

Twenty three eligible subjects working in these sections were randomly enrolled into the study. Their mean (±SEM) period of exposure to cement dust was 9.6 ± 1.5 years. Only subjects who were non smokers and who had no history or signs suggestive of respiratory, haematologic, bone or liver diseases were eligible and selected.

Data collection was effected by way of an interviewer-administered structured questionnaire, to determine years of exposure as deduced from date of employment, site or position at workplace, use of safety gadgets such as dust masks and earplugs e.t.c. Information on general health, history of past disease(s) and habits such as smoking and alcohol consumption were obtained.
Haematological parameters and alkaline phosphatase concentrations were estimated in the

subjects as described previously (Merenu, 2003).

Seven ml of venous blood was obtained from each worker. Two ml was anticoagulated with NaEDTA and used to measure the haematological parameters using the quantitative buffy coat (QBC) machine. QBC capillary tubes were used to draw blood from the bottles, mixed by rubbing and spun at 2000 rpm for five minutes. They were then placed in the previously calibrated QBC II machine (Becton Dickinson, Franklin Lakes, NJ, USA) for analyses. The remaining 5ml was allowed to clot and the serum extracted. The serum was used to estimate ALP concentration by means of the RANDOX (RANDOX laboratories, Crumlin, Antrim, UK) test kits.

The relationship between each of these parameters and years of exposure to cement dust was subjected to correlation analyses and a regression formula defining the relationship was derived using the statistics computer software statview.

RESULTS

The relationships between the haematological parameters and the years of service in the cement factory workers are presented in figures 1 to 4. Hb concentration (figure 1) and PCV (figure 2) correlated negatively with years of service [r= -0.345 (P<0.0001) and -0.154 (P<0.0001) respectively].

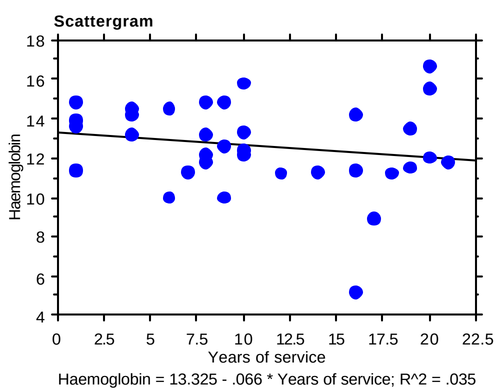

Figure 1.
Scatter gram showing the relationship between haemoglobin concentration and years of exposure. The regression equation (given by the straight line) defining the relationship is: Hb concentration = 13.394 - 0.119 x years of service [r= -0.345 (P<0.0001)].

Regression Summary
PCV vs. years of service

Count	23
Num. Missing	0
R	.154
R Squared	.024
Adjusted R Squared	•
RMS Residual	7.017

ANOVA Table
PCV vs. years of service

	DF	Sum of Squares	Mean Square	F-Value	P-Value
Regression	1	24.955	24.955	.507	.4844
Residual	21	1034.095	49.243		
Total	22	1059.050			

Regression Coefficients
PCV vs. years of service

	Coefficient	Std. Error	Std. Coeff.	t-Value	P-Value
Intercept	41.065	2.764	41.065	14.856	<.0001
years of service	-.154	.217	-.154	-.712	.4844

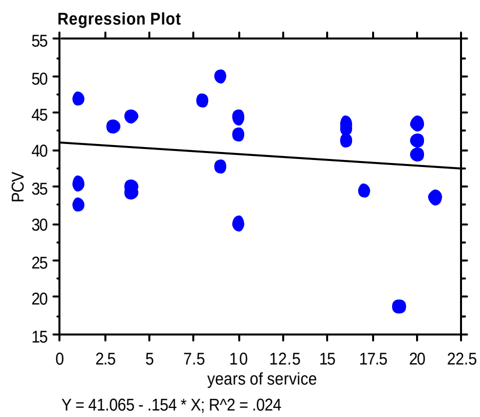

Figure 2.
Scatter gram showing the relationship between PCV and years of exposure. The regression equation (given by the straight line) defining the relationship is: PCV = 41.065–0.154 x years of service [r=-0.154 (P<0.0001)].

The equations defining these relationships are: Hb concentration = 13.394 - 0.119 x years of service and PCV = 41.065–0.154 x years of service. On the other hand platelet and WBC counts in these workers correlated positively with years of service[r = 0.342 (P <0.001) and r = 0.130 (P<0.0001) respectively]. The equations defining these relationships are: platelet count = 205.681 +7.041 x years of service and WBC = 7.64 + 0.078 x years of service respectively.

The relationship between ALP concentration and years of service is shown in figure 5. ALP concentration correlated negatively with years of service [r= -0.144, (P< 0.0001)]. The regression equation defining this relationship is: ALP concentration = 33.68 – 0.075 x years of service.

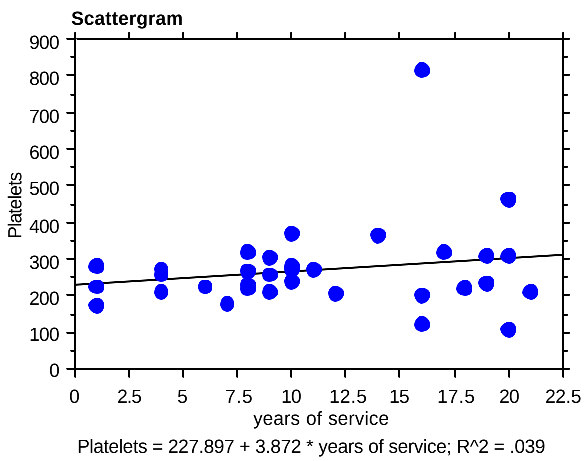

Figure 3.
Scatter gram showing the relationship between platelet count and years of exposure. The regression equation (given by the straight line) defining the relationship is: platelet count = 205.681 +7.041 x years of service [r = 0.342 (P <0.001)].

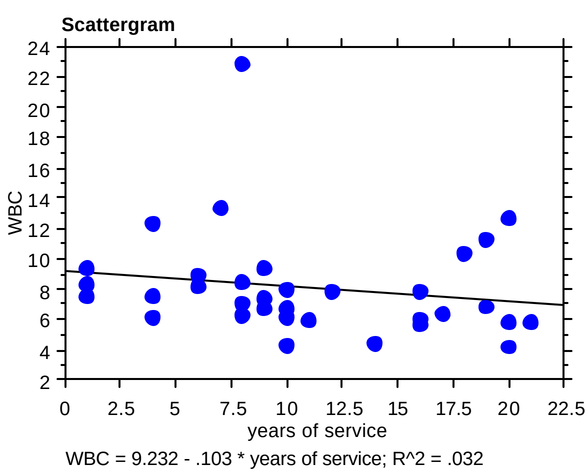

Figure 4.
Scatter gram showing the relationship between WBC count and years of exposure. The regression equation (given by the straight line) defining the relationship is: WBC count = 7.64 + 0.078 x years of service[r = 0.130 (P<0.0001)]

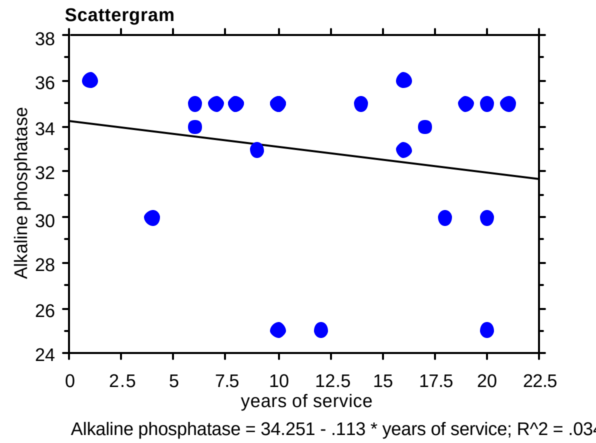

Figure 5.
Scatter gram showing the relationship between Alkaline phosphatase (ALP) concentration and years of exposure. The regression equation (given by the straight line) defining the relationship is: ALP concentration = 33.68 – 0.075 x years of service [r= -0.144, (P< 0.0001)].

DISCUSSION

In this study the relationships between haematological parameters and alkaline phosphatase concentration on one hand and years of exposure to cement dust on the other were subjected to regression analyses. Our aim was to derive regression equations, which might be useful in predicting them from the years of exposure. The obtained equations may be useful in predicting haematological parameters and alkaline phophatase concentrations from years of service (years of exposure to cement dust). Thus it may not be necessary to perform these measurements every time in order to assess the effect of cement dust on the health of factory workers. Once the year(s) of exposure is known, it could be substituted in the appropriate equation and the each haematological parameter or alkaline phosphate concentration predicted. However these formulae should be used with caution for the following reasons. First the population sample (n=23) was relatively small. A bigger sample size may increase the predictive power of these formulae. Secondly only those who were heavily exposed as judged by the section in which they worked (i.e. the cranes, packing, crusher and mill sections) were studied. Thus these equations may be applicable only to workers in these sections. It may be interesting to expand this study to include those working in sections with lower exposure to cement dust. Generally prediction equations may be applicable only to the population from which they were derived. Their predictive ability may be flawed when applied to other populations. For instance applying prediction equations derived among Caucasians to predict lung function in Africans has frequently produced inaccurate results (Onadeko et al., 1984; Jaja, 1989) and so have equations derived from within Nigeria when applied to populations outside that from which they were derived. It may be interesting to extend this work to other cement factories in Nigeria and derive an equation to predict haematological and serum liver function tests from years of service among their exposed workers.

The scattergrams and the equations obtained suggest a negative relationship between PCV, Hb and alkaline phosphatase concentrations on one hand and years of exposure on the other. This suggests that as years of occupational exposure to cement dust increased these parameters decreased. Also the scattergrams and equations obtained suggest a positive correlation between WBC and platelet counts on one hand and years of exposure on the other implying that these parameters increased as the years of exposure increased. These findings suggest that there was an adverse effect on these parameters as years of exposure to cement dust increased. It is interesting that Jude et al. (2002) reported abnormal blood cell counts implying haematological damage in subjects occupationally exposed to cement dust in India. In addition they reported that cement dust exposure was genotoxic as evidenced by chromosomal aberrations, decreased mitotic index and increased frequency of sister chromatid exchanges seen among their volunteers. These findings, those of those of Merenu (2003) and the present findings suggest that cement dust exposure may be more toxic than presently imagined.

In this study, responses from the questionnaires and interview of the workers indicated that protective measures were provided and that they were used. Thus the observed deleterious effect of cement dust exposure may be due to the ineffectiveness of the protective gears. However non compliance of the workers in the use of protective gears cannot be ruled out in spite of contrary questionnaire and interview responses. Consequently we recommend that the cement factory management embark on health education of workers, acquire effective protective gadgets and enforce their usage.

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