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Full Length Research Paper

Preliminary report on hepatic and cardiovascular risk assessment of automobile mechanics in Nigeria

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Automechanics are among the job professionals in proximity to diesel and gasoline exhaust whose components are known to be toxic. This raises serious public health concern. This study is a population-based-cross-sectional survey, set up to investigate the risk of cardiovascular and hepatic injury incurred by people engaged in work as mechanics. For information on the year of experience, socio demography, nutrition and lifestyle, structured questionnaires were administered. Ninety-one out of 186 mechanics drawn from 671 mechanic workshops along with 91 control subjects were analyzed. Venous blood was taken for determination of concentrations of lipids, transaminases and alkaline phosphatase activity. The body mass index, coronary and artherogenic risk index and blood pressure were also determined. Student's t-test for unpaired samples was used to analyze all data. As such, P-values of <0.05 were accepted as significant. The mechanics' total cholesterol, LDL-cholesterol and HDL-cholesterol, were not different from that of the control subjects. The triglyceride level, artherogenic and coronary risk index of the mechanics was higher than that of the control subjects. However, the enzymes' activity was not different for the mechanics and the control subjects, and the blood pressure of the mechanics was also not different from that of the control subjects. Our result does not suggest a greater risk of hepatic and cardiovascular diseases in the mechanics, but the observed increase in artherogenic and coronary risk index is, however, of interest.

Key words: Occupational risk, mechanics, lipid profile, cardiovascular disease, liver dysfunction, benzene.

INTRODUCTION

Occupational safety and health is a cross-disciplinary area concerned with protecting the safety, health and welfare of people engaged in work or employment (Udonwa et al., 2009). It aims at the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention of health problems caused by the working conditions amongst workers of departures; the protection of workers in their employment from risks resulting from adverse factors to health; and the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities. The international labour organization (ILO) estimates that, globally, about 2.2 million people die every year from occupational injury and illness. Of this total, about 350,000 deaths are due to fatal occupational injuries (Decent work, 2005). This figure indicates an enormous toll of suffering for workers and their families, employers and society. As such, estimates of global non-fatal injuries and illnesses are particularly difficult to construct. In the 2005 report, the ILO utilizes a variety of

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national reports to generate estimates, and stated that the global workforce of 2.8 billion persons suffers some 270 million serious non-fatal injuries and 160 million work- related diseases. Pointing out that fatal accidents are just the tip of the iceberg, ILO used an accident pyramid to illustrate that 500 to 2,000 less serious injuries take place for each fatality depending on the type of job. Occupational risk factors that have been reported to contribute to global illness and injury include: back pain, hearing loss, chronic obstructive pulmonary disease (COPD), asthma, trachea, bronchus lung cancer, injuries and leukemia (Dockery and Pope, 1994).

Good health is indicative of good business, however many work places present higher than normal risk to health due to environment and handling of certain materials. Occupational risks workers in factories, massing sites and motor garages have been an object of research in the last decade (Samuel, 2004; Chinweze, 2004; NIOHS, 1988; Garshick et al., 1987). One of the reasons is the increased usage of petrochemicals in these sites/ work places. No alternative to petrol (premium motor spirit {PMS}) has been introduced into the Nigerian automobile industry; therefore, millions of automobiles on Nigerian roads run on PMS or diesel fuel. PMS contains volatile organic compound (VOC) such as benzene which is limited by regulation to 6 to 8% of the content of PMS in Nigeria (Rowat, 1998) and between 1 (v/v) and 5% in the USA and Europe (Menkes and Fawcett, 1997; Brief et al., 1980; Owen and Coley, 1995).

Motor mechanics analyze service and repair motorized vehicles, ranging in size from small engines to lightweight vehicles. Automobile re-fueling and repairs reasonably expose Nigerian mechanics to volatile organic compounds such as benzene, whereas nitrobenzene is largely used in the manufacture of aniline and for the production of lubricating oils used in automobiles and machineries among other uses. Another popular practice among the mechanics is the sucking of PMS by mouth and this also constitute an important source of exposure to PMS components. Furthermore, mechanics are regularly exposed to dust and other air pollutants which have all been reported to be associated with cardiovascular diseases (Boritz et al., 2008). Chronic exposure to benzene has been reported to result in cardiac abnormalities and heart attack among some other diseases (Hunter, 2002). Following inhalation, benzene vapour is rapidly absorbed into the blood and distributed throughout the body (Hunter, 2002; Travis et al., 1990). Diesel and gasoline fuel and the products of their combustion represent one of the most common toxins to which people living in both urban and rural areas of the world are exposed. Exposures to diesel exhaust vary widely in intensity and duration. Among people most likely to be in proximity to diesel and gasoline exhaust on the job, and thus suffer from occupational exposure, include automobile engine repair and maintenance garage workers. The liver is the principal organ of xenobiotics' metabolism and hence it is very important to monitor its function in individuals such as mechanics who are regularly exposed to agents that may be considered as toxic. This raises serious public health concern. These classes of workers are seldom subjected to pre-employment medical examination or provided with regular medical check-ups to detect potential serious risks that the exposure may have.

This present study is thus set up to investigate the possible cardiovascular and hepatotoxic risk being faced by the automobile mechanics in Nigeria who by the nature of their occupation are constantly exposed to diesel and gasoline engine exhaust and also uses PMS regularly in the cause of performance of their job. The study was a population-based-cross-sectional study in which levels of some biochemical and physiological parameters which are indices of cardiovascular risk and enzyme activities (indices of hepatotoxic risk) were estimated for some individuals who were automobile mechanics.

Sampling procedure and sample size

The sample size for the study was 186 subjects. A sampling frame was drawn comprising 162, 188 and 221 automobile workshops in Sagamu, Ijebu-Ode and Abeokuta, Nigeria, respectively. Every 6th workshop in each of these cities was selected from this frame to make a total of 91 workshops. One workshop mechanic was chosen per workshop by simple balloting, provided that the mechanic satisfies the criteria specified in the questionnaire. A total of 91 subjects were also selected from the general population (not targeted occupational group) using the same criteria as with the automechanics. These 91 individuals represented this study's control subjects. Informed consent was obtained for in-depth interview of the mechanics and control subjects, and collection of venous blood was done for the analysis. The questionnaire consists of a structured section requesting information on socio-demographic, medical history and lifestyle characteristics of the artisans. The subjects selected were male between the ages of 20 to 50. They were non smokers with no hereditary diseases. The artisans selected were also known to have been in the workplace for a period not less than 5 years. The study was conducted in accordance with the declaration of the Helsinki and with the approval of the ethics committee, College of Health Sciences, Olabisi Onabanjo University, Ago-Iwoye, Nigeria.

Measurement of blood pressure and covariates

The blood pressure was measured by well-trained physicians three times in a seated position using a mercury column sphygmomanometer with an appropriately sized cuff according to standard protocol. The initial blood pressure was obtained after, at least, five minutes of rest. Systolic blood pressure was measured first to obtain approximate systolic blood pressure levels. However, systolic (SBP) and diastolic (DBP) blood pressures were the average of the second and third measurements recorded, at least, 1 minute apart.

Blood collection

After an overnight fast for 12 to 14 h, ten milliliters of blood were collected, by standard vene-puncture method from each of the 182

Table 1. Drug use pattern among the respondents.

Drug	Auto mechanics			Control		
	Regular (%)	Occasional (%)	Not at all (%)	Regular (%)	Occasional (%)	Not at all (%)
Tobacco	24 (12.90)	10 (5.38)	152 (81.72)	08 (4.30)	12 (6.45)	166 (89.24)
Alcohol	28 (15.05)	30 (16.13)	128 (68.81)	25 (13.44)	50 (26.88)	111 (59.68)
Recreational drug	21 (11.29)	21 (11.29)	144 (77.42)	27 (14.52)	58 (31.18)	101 (54.30)
Prescription drug	57 (30.65)	129 (69.35)	Nil	08 (4.30)	90 (48.39)	88 (47.31)
Non prescription drug	46 (24.73)	80 (43.01)	60 (32.26)	02 (1.08)	111 (59.68)	73 (39.24)
Alternative medicine	75 (40.32)	101 (54.30)	10 (5.38)	47 (25.26)	88 (47.31)	51 (27.42)

Table 2. History of disease among the respondents.

Category	Auto mechanics		Control	
	Yes (%)	No (%)	Yes (%)	No (%)
Family disease	17 (9.14)	169 (90.86)	64 (34.41)	122 (65.59)
Any major illness (for example, diabetes, hypertension, etc.)	45 (24.19)	141 (75.81)	77 (41.40)	109 (58.62)
Any previous surgery	18 (9.68)	168 (90.32)	33 (17.74)	153 (82.26)
Any ongoing illness	12 (6.45)	174 (93.55)	45 (24.19)	141 (75.81)

subjects using a disposable pyrogen free plastic syringe (Beckton-Dickson, Dublin), and kept in a clean and dry sterile bottle. The blood was then allowed to clot and the serum separated. The samples were transported to the Laboratory, Chemical Pathology Department, College of Health Sciences, Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu, Nigeria within one hour of collection, using field ice boxes for maintaining a temperature of between 18 and 24°C. Samples were analyzed within one hour of collection. Those that could not be analysed were stored in a refrigerator at 2 to 4°C, but not kept beyond 24 h.

Biochemical analysis

Serum cholesterol was determined by the method of Lieberman (Lieberman, 1958), whereas the colorimetric end point method of Sigma (Sigma, 1991) was used in the determination of triglyceride. HDL- cholesterol was determined by the precipitation, enzymatic and colorimetric method of Sigma (Sigma, 1991), while serum LDL-cholesterol was calculated by differences using Friedwald formula. Atherogenic index was calculated using the formula of Abott et al. (1988), whereas coronary risk index was obtained by the method of Alladi and Khada (1989). Technique for assay of plasma ALT and AST was based on the original method of Reitman and Frankel as described by Varley et al. (1988). However, alkaline phosphatase activity was estimated by measuring the 4-nitrophenol liberated from 4-nitrophenyl phosphate at 400 nm (Wright et al., 1972).

Validation of biochemical analysis

For validation of the aforementioned assay, all the parameters were repeatedly analyzed in the serum of healthy subjects. As such, reproducible assay, characterized by standard error of mean (SEM) and obtained in repeated determinations (n = 5), were noted.

Statistics

All discrete values, expressed as the mean ± SEM were analyzed using the two- tailed independent Student's t-test for unpaired samples after assuring the homogeneity for variance. As such, P-values of <0.05 were accepted as significant.

RESULTS

Cardiovascular disease risk factor

The result of the medical history and life style characteristics of the respondents are shown in Tables 1 and 2. The respondents selected for the study were those identified through the questionnaire as non smokers. They were also non alcoholic drinkers and have no family history of diseases nor were they currently having an on going disease.

The analyzed age range, systolic and diastolic blood pressure of the subjects was shown in Table 3, and the table indicates that 62 (68.06%) mechanics and 66 (73.53%) control subjects had their age range between 20 and 39 years old. Eighty two (90.04%) mechanics and 85 (91.53%) control subjects had their age range between 20 and 49 years old. The median age for the mechanics was determined to be 32 years, while the median age for the control population was 31 years. Out of the 91 mechanics analyzed, 24 (26.37%) have worked as mechanics for 15 to 19 years (Table 4). Extending the work experience between 10 and 29 years, there were 65

Table 3. Age distribution of subjects analyzed.

Age range	Auto mechanics			Control		
	(%)	Blood pressure		(%)	Blood pressure	
		Systolic	Diastolic		Systolic	Diastolic
20-29	34 (37.30)	100.5±6.3	72.5±5.4	40 (43.96)	101.2±2.7	70.8±5.2
30-39	28 (30.76)	103.2±3.4	75.6±4.6	26 (28.57)	108.8±6.8	68.4±6.6
40-49	20 (21.98)	110.8±6.2	79.8±5.7	19 (20.88)	105.8±7.4	66.8±6.3
>50	9 (9.89)	109.6±7.22	80.9±6.7	6 (6.59)	110.5±6.6	68.5±5.6
Total	91 (100)			91 (100)		

Table 4. Distribution of job experience by the automobile mechanics.

Year	Frequency	Percentage
5 - 9	12	13.19
10 - 14	19	20.88
15 - 19	24	26.37
20 - 24	10	10.99
25 - 29	12	13.19
30 - 34	8	8.79
35 - 39	6	6.59
Total	91	100

(70.24%) mechanics. However, the average year of experience for the auto mechanics was 19 years. When the systolic and diastolic blood pressures were compared, no significant difference was observed between the blood pressure of the mechanics and the control subjects among the different age groups. In all the age groups analyzed, the systolic and diastolic blood pressures of the mechanics were not different from that of the control population.

Result of the serum lipid concentration, body mass index, coronary risk index and artherogenic risk index is shown in Table 5. The result indicates that serum total cholesterol, HDL-cholesterol and LDL-cholesterol level of the mechanics did not vary significantly from that of the control subjects. Moreover, no significant variation was also observed between the body mass index of the mechanics and the control subjects. The serum triglyceride level, artherogenic risk index and the coronary risk index of the mechanics were however observed to be significantly higher than that of the control subjects, and as such, all the values obtained for these parameters were within the reference range values.

Liver enzymes

Table 6 is the result of the serum alanine amino transferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP) activity. The result indicates that the activities of these enzymes did not vary significantly between the control subjects and the auto mechanics.

DISCUSSION

Among several other goals, occupational health seeks to promote and maintain the highest degree of physical, mental and social well being of workers in all occupation. The median age of 32 years obtained for the auto mechanics is not different from the 31 years obtained for the control populations. Furthermore, about 90% of the auto mechanics and 93% of the control subjects were of the same age range (20 to 49), hence the differences in some of the cardiovascular risk factors observed in this study could not be attributed to the difference in age range. The lifestyle and medical history of the automechanics were also similar to those of the control subjects, indicating that these factors may not also be responsible for the differences observed in their cardiovascular risk factors.

Air pollution exposure has been associated with significant changes in many cardiovascular indexes (Boritz et al., 2008; Seaton et al., 1995). At the same time, the progression of atherosclerosis accelerates as a result of a more prolonged (chronic) exposure to increased concentration of particulate air pollutants (Boritz et al., 2008). A literature survey has provided some support for the hypothesis of possible association between occupational exposure to dust and increased risk of ischemic heart disease (Sjogren, 1997, 1998a, 1995), for example, coal miners showed manifestations of pneumoconiosis. There were increased levels of fibrinogen in the blood of the coal miners with pneumoconiosis, and as such, fibrinogen is a risk factor for ischemic heart disease. A hypothesis has been put forward that long-term inhalation of particles retained in the lung induces an inflammation which is accompanied by an increase of plasma fibrinogen, leading to elevated risk for blood clotting and ischaemic heart disease (Sjogren, 1998b).

More so, the literature has shown that there is a positive correlation between the risk of developing ischemic heart disease and raising plasma cholesterol and LDL-cholesterol concentrations and a negative one with raising plasma HDL- cholesterol. Lowering plasma total

Table 5. Serum lipids concentration, body mass index (BMI), coronary risk index (CI) and atherogenic risk index (AI) of automobile mechanics.

Group	Cholesterol (mg/dl)	Triglycerides (mg/dl)	HDL-c (mg/dl)	LDL-c (mg/dl)	BMI	AI	CI
Auto mechanics	138.87 ± 5.64	98.11 ± 9.69[a]	41.60 ± 1.10	88.33 ± 10.11	23.74 ± 0.55	5.35 ± 0.13[a]	2.38 ± 0.17[a]
Control	149.83 ± 10.68	68.00 ± 6.19[b]	44.33 ± 1.42	80.13 ± 4.86	23.61 ± 0.52	3.11 ± 0.12[b]	1.81 ± 0.11[b]

Values are expressed as mean ± SEM of 91 determinations; Values in the same column with similar superscript are not significantly different from each other; HDL, high density lipoprotein; LDL, low density lipoprotein.

Table 6. Liver enzyme activities of artisans in mechanic sites.

Group	AST activity (U/L)	ALT activity (U/L)	ALP activity (U/L)
Auto mechanics	40.60±6.42	19.30±3.62	25.50±6.60
Control	31.11±9.77	15.53±4.50	26.18±5.60

Values are expressed as mean ±SEM of 91 determinations; Values in the same column with similar superscript are not significantly different from each other; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

cholesterol and LDL- cholesterol concentrations reduces the risk of cardiovascular disease (Olugbenga et al., 2006; Adler and Holub, 1997). Report by the National Cholesterol Education (NCEP, 2001) indicated that an individual is considered not at risk with the upper limit of triglyceride (at 150 mg/dl, with the total cholesterol value less or equal to 200mg/dl), LDL-cholesterol (less than 158 mg/dl) and HDL- cholesterol (60 mg/dl). The report from our study thus indicates that the lipid profile of all the mechanics analyzed were within the normal reference range and comparable with that of the control values. The present study therefore did not suggest an increased risk of ischaemic heart disease in automobile mechanics who are occupationally more exposed to diesel and gasoline exhaust. It must however be noted that the triglyceride level of the automechanics was observed to be significantly higher than that of the control subjects. As such, this could indicate an increased hepatic secretion and a decreased clearance of triglyceride in the automechanics (Xve et al., 2001).

Our findings also suggest that, though no general variations were seen in the lipid profile of the mechanics from that of the control subjects (except the triglyceride level), the atherogenic risk index and the coronary risk index were observed to be higher in the mechanics. Atherogenic index of 3.4 and 4.0 had been reported for men at very low risk and low risk respectively, while men with atherogenic index of 5.0 and 9.5 are classified at an average risk and moderate risk, respectively (Hotz and Lauwerys, 1997). The result from this study indicates that where the control subjects were at very low risk, the mechanics studied were at average risk of atherosclerosis. The observed increase of atherogenic index in mechanics, opined by the study, may be largely contributed by chronic exposure to exhaust from gasoline and diesel and to other pollutants in the workshop environment. This may have caused an abnormal ratio of triglyceride (TG) /HDL-cholesterol which indicates a risk for the development of coronary risks (Prasad et al., 2009). Occlusion of a coronary artery by lipid deposit has been reported to cause several local oxygen starvations and ultimately the degeneration of a localized portion of the heart muscle (Hotz and Lauwerys, 1997). This result may not suggest that the mechanics studied were at a higher risk of developing coronary disorders such as hypertension, more importantly, since no variation in the systolic and diastolic blood pressure was observed.

Automobile mechanics does routine maintenance and repair of vehicles and are commonly exposed to petroleum motor spirit (PMS) by sucking it with their mouth through a tube in an attempt to siphon the fuel from a vehicle tank. In addition to this, they also often wash vehicle parts with PMS without any gloves. In the process, the mechanics inhale the fuel fume. Thus, refueling and repair of automobiles significantly expose this group to benzene and this could possibly account for the significant increase in atherogenic risk index (AI) and coronary risk index (CI) observed in this study. The median work experience of 19 years observed for the automechanics in this study indicates that the mechanics had a long job experience and this may contribute significantly to their prolonged exposure to PMS. Previous report indicates that the practice of sucking PMS by mouth by mechanics was an important source for exposure (Menkes and Fawcett, 1994; Birtcher, 2000). Although the primary route of exposure to benzene, which is a volatile chemical organic compound, is by inhalation of PMS fume, PMS comes in contact with airways and lungs and through the skin when the study subjects either wash their hands and/or vehicle parts or took in some quantity of PMS. When compared, our result suggest that the body mass index of all the artisan studied

were comparable with the control populations and also indicates that the body mass index for all the populations were within the normal reference value. As such, an optimal body mass index (a measure of fatness or thinness) of 18.5 to 25.0 has been reported (Salau et al., 2003).

Serum alanine aminotransferase (EC, 2.5.1.2) is a very important enzyme in clinical diagnostic enzymology, and as such, it catalyses the reversible reaction between amino acid, alanine and ketoacid, α-ketoglutararate, leading to the formation of pyruvate and glutamate (White et al., 1978). Abnormal values of serum ALT have been observed for different disease conditions, but most especially in hepatic diseases (Plummer, 1978). The finding from this study indicates that occupational exposure of the mechanics did not significantly alter the activity of the enzyme. Results from this study indicate that the enzyme activity of all the populations were within the normal range.

Serum aspartate amino transaminase (AST) is an enzyme located in the liver, the kidney's myocardium and muscles. It is an enzyme that acts as a catalyst in amino acid metabolism, and its high level indicates hepatitis, mononucleosis, carcinoid syndrome, some infections, muscular dystrophy and liver dysfunction (Akaqnji et al., 1993). The enzyme activity observed for both the mechanics and the control subjects were not significantly different from each other and were within the normal range. Our result thus suggests that the mechanics are not at greater risk of developing liver dysfunction.

Alkaline phosphatase, a 'marker enzyme' for the plasma membrane and endoplasmic reticulum (Wright and Leathwood, 1972), is often employed to assess the integrity of these tissues (Sandstron et al., 1998). The activity observed for this enzyme in the mechanics was not different from that of the control subjects and also lies within the normal reference range. We thus opined, based on the result from this study, that mechanics are not at greater risk of disruption of their plasma membrane and endoplasmic reticulum, hence they may not suffer liver dysfunction as a consequence of the nature of their occupation.

Conclusion

This study suggests that though automobile mechanics in Nigeria are more exposed to PMS fumes, diesel and gasoline exhaust and other environmental pollutants, they may not necessarily have increased tendency of developing cardiovascular and liver dysfunction diseases compared to their counterparts who are not occupationally exposed. The increases in triglyceride level, coronary and artherogenic risk index observed in this study may however be important enough to create awareness among this group of people and also ensure that protective devices are used by them in the cause of performance of their job.

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