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Original Research Article

# Assessment of cardiac function in farmers occupationally exposed to pesticides in gboko local government area, benue state

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ABSTRACT

**Background of Study:** Any compound or combination of substances meant to prevent, eradicate, repel, or mitigate any pest is known as a pesticide. Despite the benefits of using pesticides for pests, weeds, and disease control, there have been concerns about adverse effects of these compounds on the human health. This cross-sectional study was designed to assess the cardiac function of farmers occupationally exposed to pesticides, in Gboko Local Government Area, Benue State, Nigeria.
**Materials and Methods**: One hundred and ten (110) participants comprising 70 farmers and 40 controls were recruited for the study using a multi-stage random sampling technique. They were aged between 20-60 years and were age-matched. Five (5) ml of fasting blood samples were collected from each participant for the determination of Apolipoprotein A1 (ApoA1), Apolipoprotein B-100 (ApoB100) and Troponin I level using standard laboratory methods. Also, the body mass index (BMI), systolic blood pressure (SBP) and diastolic blood pressure (DBP) of the participants were also determined.
**Results:** The results showed significantly lower mean BMI (23.02±3.94 Vs 24.94±3.12; p= 0.031) and serum ApoA1 (150.73±13.52 Vs 167.27±15.65; p=0.024) while the mean SBP (140.49±19.34 Vs 119.75±10.30; p=0.000), DBP (82.86±12.16 Vs 77.53±7.76; p=0.014) and mean serum Troponin-I (3.11±5.46 Vs 1.38±0.15; p=0.049) levels were significantly higher in the farmers compared to control respectively. However, there was no significant difference in the mean serum ApoB-100 level in the farmers when compared to the control group (p=0.104).
**Conclusion**: Nonetheless, in both the test and control groups, these results fell within the typical reference ranges. Further longitudinal research is required to gain a deeper understanding of the effects of pesticide exposure on cardiac function in farmers.



## 1. Introduction

Due to weeds, diseases, and pests that appear before harvest season, food, fiber, and other commodities are continuously lost in the agricultural sector.[1] Over the past

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few years, there has been a rise in the use of pesticides in emerging nations, which recently accounted for close to 20% of global pesticide spending,[2] Since pesticides are known to have negative biological effects on target organisms, there have been worries about potential negative consequences on human health despite the benefits of using them to manage pests, weeds, and diseases.[3] Among the most significant occupational hazards faced by farmers in developing nations is pesticide exposure.[4] Furthermore, poor pesticide handling techniques, a negligent attitude, and a lack of information pose a significant health danger to farmers. The agricultural sector provides the majority of food, raw materials, and foreign exchange to Nigeria, where 70% of the population primarily depends on it for existence.[5] A key management method for farmers has been the use of pesticides due to the nation's aim to improve agricultural productivity and the rise of various insect species that wreak havoc on and destroy agricultural items in fields and storage.[6]

A pesticide is "any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest," according to the US Environmental Protection Agency. The word "pesticide" actually refers to any material used to manage pests, not just insecticides. Among the popular pesticide categories based on their use are herbicides, insecticides, rodenticides, and fungicides.[7] The percentage of insecticides used for weed and pest management that actually reach the intended pests is less than 1%. Pesticides are lost in considerable quantities due to run-off, photodegradation, off-target deposition, and spray drift. These processes can have negative impacts on humans as well as certain species, communities, and ecosystems.[8] The fact that many chemicals at low concentrations may not have immediate, observable impacts on organisms but instead cause long-term harm such genetic diseases and physiological changes that shorten life expectancy is another important consideration.[9]

Exposure to pesticides occurs primarily through inhalation and dermal contact.[10–13] Organochlorines, organophosphates, and carbamates were among the many useful pesticides. Polychlorinated biphenyls (PCBs) and organochlorine pesticides are widely found in the environment, according to data from several pesticide evaluations.[14,15] Pesticide use is on the rise, mostly in agriculture and public health. This is linked to higher risks of pesticide exposure in humans and a number of diseases, including as cancer, diabetes, obesity, autism, and neurodegenerative diseases (NMD).[16,17]

High pesticide exposure results in metabolic disorders such hyperlipidemia and, eventually, cardiovascular disease (CVD), as well as oxidative cellular damage and stress.[18] For example, those who work in factories that produce chlorophenol and herbicides have greater prevalence rates of coronary heart disease, diabetes, and circulatory system disorders.[19] Several experimental investigations have demonstrated the toxicity of pesticides and their detrimental impact on CVD.[20,21]

The consequences of agro pesticides on the health of farmers who apply them are yet unknown, despite the fact that they are used more frequently and extensively in the Gboko Local Government Area. Therefore, in Gboko Local Government Area, Benue State, the current study was conducted to look at the effects of pesticide exposure on the cardiac function of farmers who are occupationally exposed to pesticides.

## 2. Materials and Methods

### 2.1. Type of study and study population

The purpose of this cross-sectional study was to evaluate the cardiac function of farmers in Gboko L.G.A., Benue State, who were occupationally exposed to pesticides. A total of 110 subjects—70 exposed individuals and 40 non-exposed individuals (control)—were recruited for the study using a multi-stage random sampling technique; the controls were not exposed to pesticides at work, but they did live in the same area as the farmers. Questionnaires were used to gather data on sociodemographic characteristics, medical histories, and the frequency and duration of pesticide use. For the purpose of evaluating the biochemical parameters (apoA-I, apoB-100, and Troponin I levels), a blood sample was taken from the same farmers who completed the questionnaire.

### 2.2. Sample size and sample size calculation

The study employed a multi-stage random selection procedure to choose study participants. Six of the seventeen wards in the Gboko Local Government Area—one ward from each of the six districts—were chosen at random for the first stage. In the second phase, a total of twelve villages were chosen at random from each of the six districts. A total of 120 randomly chosen villagers were given questionnaires; however, 110 willing subjects, 40 of whom were non-exposed (controls) and 70 of whom were exposed farmers, had their blood samples taken for the analysis of apoA-I, apoB-100 and Troponin I levels.[22]

### 2.3. Ethical clearance

Ethical clearance was obtained from the Ministry of Health and Human Services, Makurdi, Benue State (MOH/STA/204/VOL.1/169).

### 2.4. Data collection

Questionnaires were administered to get information on socio-demographic and anthropometric measurements.

### 2.5. Inclusion criteria

Apparently healthy large scale farmers exposed to pesticides between the ages of 18-60 years.

### 2.6. Exclusion criteria

People who were not between the ages of 18 and 60.

Those having a history of diabetes, cardiovascular illness, or liver disease.

### 2.7. Sample collection

Through venipuncture, five milliliters (5 milliliters) of fasting whole blood was obtained from the subjects. The sample was put into a plain container, allowed to coagulate, then retracted and centrifuged for five minutes at 5000 rpm. Following separation, the serum was used to measure the levels of Apo B-100, Apo A-1, and Troponin-I.

### 2.8. Methods

### 2.9. Estimation of Troponin –I

Troponin-I was assayed using the Enzyme Linked Immunosorbent Assay method.[23]

### 2.10. Assay procedure

Before proceeding with the assay, all reagents, serum, reference calibrators and controls were brought to room temperature (20-27ºC). Microplate wells were formatted accordingly for calibrator, control and participants samples to be assayed.25$\mu$l of the appropriate calibrator, control and participants samples were dispensed into the assigned wells.100 $\mu$l of the troponin-I enzyme reagent were then dispensed into each well using multichannel pipette.It was then swirled to mix for about 20-30 seconds and covered with a plastic wrap.It was incubated for 15 minutes at room temperature (20-27ºC). Afterwards, the contents of the microplate were discarded by decantation.350 $\mu$l of wash buffer were added into each well and decanted afterwards.The processes were repeated for five times.100 $\mu$l of working substrate solution were then dispensed into each well using multichannel pipette and incubated for 15 minutes at room temperature.50 $\mu$l of stop solution were then dispensed into each well using multichannel pipette and mixed gently for 15-20 seconds.Absorbance in each well was read at 450nm wavelength using a microplate reader. The test and control samples concentrations were extrapolated from the standard curve.

*Estimation of Apolipoprotein A-I level* (Biobase Biodustry Shandong co., Ltd, China).

Serum apolipoprotein A-I levels were assayed using immunoturbidimetric method.

### 2.11. Assay procedure

All reagents, standard and samples were brought to room temperature before use. Two microliters (2 $\mu$l) of standard or samples were dispensed into the appropriate wells in the microtiter plate and 250 $\mu$l of ApoA-I buffer was added to each well. The plate was then incubated for 5 minutes at 37 °C and absorbance (A1) was determined at 340 nm using ELISA microplate reader (Model: Biobase-EL 10A made in China). Subsequently, 50 $\mu$l of ApoA-I antibody reagent was dispensed into each well and incubated for an additional 5 minutes at 37 °C and the absorbance (A2) of the test and standard samples was measured at 340 nm.

### 2.12. Calculation

Concentration of ApoA-I (mg/dl) = Absorbance of test (A2-A1) X concentration of standard

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Absorbance of standard (S2-S1)

*Estimation of Apolipoprotein B-100 level* (Biobase Biodustry Shandong co., Ltd, China).[24]

Serum apolipoprotein B100 levels were assayed using immunoturbidimetric method.[25]

### 2.13. Assay procedure

All reagents, standard and samples were brought to room temperature before use. Two microliters (2 $\mu$l) of standard or samples were dispensed into the appropriate wells in the microtiter plate and 250 $\mu$l of ApoB-100 buffer was added to each well. The plate was then incubated for 5 minutes at 37 °C and absorbance (A1) was determined at 340 nm using ELISA microplate reader (Model: Biobase-EL 10A made in China). Subsequently, 50 $\mu$l of ApoB-100 antibody reagent was dispensed into each well and incubated for an additional 5 minutes at 37 °C and the absorbance (A2) of the test and standard samples was measured at 340 nm.

### 2.14. Calculation

Concentration of ApoB-100 (mg/dl) = Absorbance of test (A2-A1) X concentration of standard

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Absorbance of standard (S2-S1)

### 2.15. Statistical analysis

Version 23.0 of the Statistical Package for Social Sciences was used to analyze the data. Data obtained was analyzed using the independent and dependent student's t-test and Pearson correlation. At p<0.05, the results were considered significant.

**Table 1:** Anthropometric indices, blood pressure and pulse rate in the subjects studied

| Parameter | Farmers (n=70) | Control (n=40) | t-value | P Value |
|---|---|---|---|---|
| Age (years) | 42.76±12.88 | 39.15±13.34 | 1.395 | 0.166 |
| Ht (m) | 1.91±188.57 | 1.67±7.60 | 1.761 | 0.436 |
| Wt (Kg) | 65.66±7.86 | 69.13±6.90 | 2.003 | 0.048* |
| BMI (Kg/m$^2$) | 23.02±3.94 | 24.94±3.12 | 2.183 | 0.031* |
| SBP (mmHg) | 140.49±19.34 | 119.75±10.30 | 6.282 | 0.000* |
| DBP (mmHg) | 82.86±12.16 | 77.53±7.76 | 2.497 | 0.014* |
| Pulse (beats/minute) | 81.95±14.49 | 80.45±10.94 | 0.571 | 0.569 |

*Statistically significant at p<0.05

## 3. Results

According to Table 1, there was no significant difference in the farmers' mean age (years) and mean height (meters) compared to the control participant (p>0.05).

The mean weight (kg) and Body mass index (kg/m$^2$) was significantly lower in the farmers than in the control group (p<0.05) respectively. However, the farmers had a significantly higher mean systolic and diastolic blood pressure (mmHg) compared to the control group (p<0.05) respectively.

**Table 2:** The biochemical parameters in the subjects studied (mean ± SD).

| Parameter | Farmers (n=70) | Control (n=40) | t-value | p-value |
|---|---|---|---|---|
| ApoA1 (g/l) | 150.73±13.52 | 167.27±15.65 | 2.304 | 0.024* |
| ApoB-100 (g/l) | 126.48±25.70 | 117.53±30.52 | 1.639 | 0.104 |
| Trpn-I(ng/ml) | 3.11±5.46 | 1.38±0.15 | 1.989 | 0.049* |

*Statistically significant at p<0.05

Table 2 indicates that there was no significant difference (p>0.05) in the mean serum ApoB-100 level when compared between the farmers and the control group. However, the mean serum ApoA-I level (150.73±13.52 Vs 167.27±15.65; p= 0.024) was significantly lower in the farmers than in the control group. On the other hand, the mean Troponin-I (ng/ml) level was significantly higher in the farmers than in control participants (3.11±5.46 Vs 1.38±0.15; p = 0.049).

## 4. Discussion

Pesticides have been reported to contain some toxic substances, especially organophosphates and carbamates, glyphosate.[22] The main ways that pesticides are exposed to humans are by ingestion, inhalation, and skin contact. The circulatory system then distributes this exposure to different organs.[12,13] Pesticides are widely used chemicals that are employed, especially in agriculture, to get rid of a wide range of unwanted living things.

This study examined the health impacts of pesticide exposure at work among farmers in Gboko Local Government Area, Benue State, with a particular emphasis on the effects of pesticides on cardiac function. The finding of this study showed a significant decrease in the BMI of farmers when compared to the control group though the result is still within the normal range of BMI. This may indicate a good health status. This finding agrees with the research work of Devi[26] on the Health Risk Perceptions, Awareness and Handling Behavior of Pesticides by Farm Workers in Kerala, India that a majority of the respondents (72.02%) were of satisfactory health status by the BMI values but this is contrast with LaVerda et al.[27] that found a positive association between exposure to triazine herbicides, particularly atrazine, and BMI. Also in a cohort study, by Lee et al.[28], which found that dichlorodiphenyldichloroethylene (p,p'-DDE), and polychlorinated biphenyl (PCBs) were associated with higher BMI. This study revealed that the mean systolic and diastolic blood pressure of the farmers showed significant increase compared to the control. Approximately 46% of farmers were identified as hypertensive, which is greater than the 34% prevalence of hypertension in Indonesia's general population in 2018, according to a study by Prihartono et al.[29] According to other research, pesticide exposure contributes to the development of high blood pressure and atherosclerosis. This could result from oxidative stress and hyperlipidemia brought on by liver damage caused by pesticides.[30] Research indicates that pesticide exposure may change the levels of thyroid hormone[31] and may be a significant risk factor for elevated TSH levels, which raise blood pressure at the systolic and diastolic levels.

The neurotransmitter acetylcholine may be impacted by exposure to organophosphates, a common pesticide used extensively in agriculture. This is because exposure to organophosphates can impede the function of the enzyme cholinesterase, increasing the amount of acetylcholine in the body. Increased levels of acetylcholine at neuromuscular junctions impact cardiac, visceral, and skeletal muscle activity, which may change blood pressure.[19]

The result obtained from the current study also indicated a significant decrease in the mean serum Apo-A1 level of the farmers, when compared to the control group. This result is in agreement with the report of Pothu et al.,[32] that HDL cholesterol levels were decreased in those exposed to pesticides when compared to controls but it is in contrast with Saheed et al.,[33] whose study indicated an increase in serum HDL-C level in response to exposure to chemicals. This is in line with a study that discovered that different pesticide exposure scenarios, such as total exposure, months of exposure, and the usage of certain pesticides, were linked to lower apolipoprotein A1 concentrations and higher apo B/apo A1 ratios in females.[34] According to some reports, pyrethroids increase phospholipids, triglycerides, and very low-density lipoprotein cholesterol (VLDLC) but have no effect on HDL,[35] which may be a sign of disordered lipid metabolism. The primary protein component of high density lipoprotein (HDL), apolipoprotein A-I (ApoA-I), is well known for controlling cholesterol transport and preventing cardiovascular disease (CVD). ApoA-I may also influence immunological and inflammatory responses.[36] Even though the test group's level was greater than the control group's, the current investigation did not find a statistically significant difference between the mean serum ApoB-100 levels in the two groups. Although our results were not statistically significant, this is consistent with a study that revealed participants in the highest quartile of 2,4-D had greater levels of total and low density lipoprotein (LDL) cholesterol than those in the lowest quartile.[37] However, Kongtip et al., (2018)[38] reported significantly higher mean serum LDL cholesterol and total cholesterol levels in conventional farmers than in organic farmers in Thailand which is in contrast with the current finding. The primary apolipoprotein found in LDL particles is ApoB-100, a 550 kDa glycoprotein produced in the liver that functions as the binding domain for the LDL receptor.[39] ApoB is as good as non-HDL cholesterol in forecasting future risk of coronary artery disease (CAD), and it may even be better than non-HDL cholesterol in predicting cardiovascular events, according to evidence,[40] According to research conducted in 2019 by Ference et al., each low-density lipoprotein (LDL) particle contains a single ApoB molecule, and over 90% of all ApoB is found in LDL; naturally, a small amount of ApoB is also carried on other atherogenic particles, such as intermediate-density lipoproteins and very-low density lipoproteins; therefore, plasma ApoB generally indicates the number of LDL particles.[41]

In the current investigation, farmers' serum troponin I was significantly increased than that of the control group. This is consistent with the findings of Abdel Wahab et al.[42] who observed a non-significant difference between the mild and moderate groups but a significantly higher serum troponin in the severe group among phosphide-intoxicated individuals compared to those in the mild and moderate groups. Following unintentional exposure to phosphine gas, Akhtar et al.[43] discovered elevated serum troponin I levels, a sign of serious myocardial injury that may result in circulatory collapse and death. After acute aluminum phosphate (ALP) toxicity, Kalawat et al.[43] found that troponin I was raised in 26% of the patients under investigation. They linked this to cardiac injury by echocardiography rather than alterations in electrocardiograms (ECGs). The results of Mostafalou et al.[44] and Hakimoğlu et al.[45] contradict our findings, stating that while elevated levels of certain cardiac enzymes, such as CK-MB or troponin T (Tn T), may validate cardiotoxicity and suggest death, their absence does not rule out cardiotoxicity following acute phosphides exposure.

## 5. Conclusion

Our research highlighted the possibility that occupational exposure to pesticides could change biochemical markers, indicating cardiotoxicity in farmers who blended and sprayed pesticides. These characteristics could be helpful in monitoring the early detrimental impacts of pesticides on the health of farmers.

## 6. Recommendation

To reduce pesticide exposure and avoid negative health consequences in Gboko farmers, a comprehensive intervention promoting the effective use of personal protective equipment (PPE), especially chemical respirators, and educating people about the possible risks of occupational pesticide exposure should be taken into consideration. Furthermore, the government needs to acknowledge and give priority to pesticide-related issues in order to create strategies and policies that work and to maintain stringent measures aimed at fortifying the inadequate laws and regulations, which will eventually result in a real decrease in these issues.

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## 8. Conflict of Interest

The authors declare no conflict of interest in the conduct and publication of this work.

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