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Analysis of Cardiovascular Risk Factors in Hypertensive Farmers and Non-Farmers in the Zou Region of Central Benin

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Abstract

The heavy use of chemicals, pesticides, cosmetics and plastic packaging coincides with a resurgence of cardiovascular disease, in particular hypertension, which is affecting younger and younger populations. The aim of this study was to analyze the cardiovascular risk factors in hypertensive farmers compared with hypertensive non farmers. This was a prospective case-control study that included 239 hypertensive farmers and non farmers aged 25 to 65 with blood pressure ≥ 140 mmHg and 90 mmHg. Hypertensive farmers (101) represented 42.25% of the population versus hypertensive non farmers (138) 57.74%. The median ages were 47 ± 11.3 years for farmers and 51.45 ± 9.77 years for non farmers. Biochemical analysisand screening for major cardiovascular disease risk factors such as metabolic syndrome were performed. Metabolic syndrome was defined according to the new definition of the International Diabetes Federation. Our results revealed higher blood glucose levels in farmers (47.77%) than in non farmers (27.20%) ($p = 0.0132$). Dyslipidemia was more frequent in non farmerswith high level of LDL cholesterol and total cholesterol. Farmers presented a high level of tryglycerides. The prevalence of obesity was higher in non farmers 51 (36.96%) than farmers 18 (17.82%). The prevalence of metabolic syndrome was 106 (44.35%) in our study population. There was not an important difference between farmers (39.60%) and non farmers (47.82%). However, the variation of metabolic syndrome according to age and sex showed a higher prevalence in young male farmers aged 25 to 45 whereas non farmers presented an increasing prevalence of metabolic syndrome according to age and the absence of metabolic syndrome between age 25 and 35. Our results showed that the cardiovascular risk appeared early in young farmers compared with non farmers suggesting a possible role of pesticides in the onset of this risk.

Keywords

Chemicals, Farmers, Metabolic Syndrome, Hypertension

1. Introduction

The demographic surge generated by the technological revolution and globalization in recent years throughout the world, and particularly in Africa, had a major impact on certain sectors of activity, with agriculture and industrial processing in the forefront [1]. To meet the population's ever-increasing need for food products and raw materials for industrial processing, the agricultural sector in African countries is turning to modernization, a sine qua non condition for moving towards large-scale production [2]. In Benin, in December 2010, with the aim of improving agricultural performance, ensuring food and nutritional security, and promoting economic development, the government adopted a strategic plan for agricultural revival [3], which is based, among other things, on improving access to agricultural inputs to facilitate effective control of pests, crop diseases and so on. Every year, large quantities of pesticides are regularly used to increase crop yields [4] [5]. However, the uncontrolled use and dubious origin of phytosanitary products have been denounced by several studies in Benin [6] [7] [8]. The same observations have been made in the rice-growing lowlands of the Dano commune in Burkina Faso [9]. According to [5], 85% of cotton growers use higher doses of insecticides than those recommended. For these authors, the low or virtually non-existent level of education of most growers is a factor conducive to the emergence of poor phytosanitary practices. However, the coincidence between the heavy use of pesticides, cosmetics and plastic packaging and the resurgence of cardiovascular disease, in this case hypertension, raises questions. In recent years, a growing number of scientific data has highlighted the important role played by chemical pollution in the emergence of metabolic diseases that can lead to hypertension and cardiovascular disease [10] [11] [12]. A number of research studies have already highlighted the harmful consequences of the use of pesticides, chemical molecules derived from plasticizers such as phthalates, dioxins and cosmetics on human health. These consequences include endocrine disruption, which can affect reproductive health and cause metabolic diseases, cancers, etc [13] [14] [15] [16] [17]. In Benin, there are few studies on the risk of exposure to pesticide residues on the health of agricultural producers. Thus, with the aim of assessing the possible effect of chemical pollutants on the etiological processes of hypertension and cardiovascular disease, we initiated this project, which proposes a comparative analysis of the main risk factors for cardiovascular disease in hypertensive agricultural patients who, in addition to exposure to chemical pollutants in the general population, are exposed to pesticides through occupational handling, and in hypertensive patients who are not agricultural workers in the Zou region in central Benin.

2. Materials and Methods

2.1. Study Population

This study took place from November 2021 to April 2022 and from November 2022 to January 2023. It was a prospective case control study which included hypertensive patients who were farmers or non-farmers and aged 25 years at least and 65 years at most. They have given their informed consent and their systolic and diastolic blood pressures at the time of recruitment were respectively ≥ 140 mmHg and 90 mmHg. We excluded hypertensive patients whose age was less than 25 years or more than 65 years at the time of recruitment. Non-farmer patients living near an agricultural production field, patients unable to give informed consent as well as all patients who were alcoholics, smokers or suffering from chronic illnesses (kidney failure, liver conditions) were also excluded.

Determination of sample size

According to Cochran formula and according to the adoption of a cost-bias compromise, the size of our study population is estimated at 213 patients with a risk level set at 6% [18].

Cochran's formula:

$$N = t^2 \times P \times (1 - P) / m^2$$

(N: The minimum sample size; t: The confidence level (95%); P: estimated prevalence (27.5%); m: the risk level set at 6%).

Blood sampling and data collection

Data collection and blood sampling were carried out in three peripheral health centers (the health center of Dan, the health center of Djidja and the health center of Godaix) and two reference centers (hospital of Zou and Collines (CHD/ZC); Zonal Hospital Djidja-Abomey-Agbangnizoun (DAA)). An interview with the patients was carried out and then the weight, the size and the blood pressure was taken in all patients who gave their informed consent. The blood pressure was taken using an OMRON M3 V3 brand automatic upper arm blood pressure monitor recommended by WHO. All informations were collected on survey sheets previously designed for this purpose. Finally, venous blood was collected from patients with blood pressure ≥ 140 mmHg and 90 mmHg.

2.2. Individual Variables

2.2.1. Socio-Demographic Variables

The socio-demographic data collected were age, sex, profession, risk behaviors linked to exposure to chemical pollutants such as: consumption of foods prepared or packaged with non-biodegradable plastic bags, use of insecticides for domestic use, professional use of pesticides.

2.2.2. Anthopometric Measures

Height and weight were measured in centimeters (cm) and kilograms (kg) respectively using a height chart and a digital scale in shoeless patients. Body mass index (BMI) in kg/m^2 was obtained by dividing weight by the square of height. Patients with a BMI ≥ 25 kg/m^2 and < 30 kg/m^2 were overweight and those with a BMI ≥ 30 kg/m^2 were considered obese. The average blood pressure (BP) measured in millimeters of mercury (mmHg) in both arms in a seated position after 10 to 15 minutes (min) of rest was taken. It was considered high when the systolic pressure (SBP) is ≥140 mmHg and the diastolic pressure (DBP) ≥ 90 mmHg [19].

2.3. Biochemical Parameters

2.3.1. Blood Glucose

Blood glucose was determined from plasma samples collected in fluoride tubes and centrifuged at 3500 rpm for 10 minutes. The Elitech diagnostic kit REF GPSL-5505 LOT: 22-0470 was used. Fasting blood glucose levels ≥ 1.10 g/L or ≥5.6 mmol/L are considered high.

2.3.2. Urea and Creatinine

Urea and creatinine levels were determined from serum samples of study population collected in dry tubes and centrifuged at 3500 rpm for 10 minutes. Elitech diagnostic kits REF URSL-5405 LOT: 22-0724 and REF CRCO-6600 LOT: 22-0821 were used. Uremia levels > 0.55 g/L or >7.5 mmol/L were considered elevated. Creatinine levels in women > 11 mg/L and >13.56 mg/L in men are considered abnormal.

2.3.3. Transaminases (ALAT, ASAT)

Serum Alanine Aminotransferase (ALAT) and Aspartate Aminotransferase (ASAT) transaminase assays were performed using CYPRESS DIAGNOSTICS brand kits REF HBEL020 LOT: GPT-00511A and REF HBEL010 LOT: GOT-00531A. Enzyme activity of (ALAT) > 40 IU/L and (ASAT) > 37 IU/L are considered abnormal.

2.3.4. Lipid Profile

Kinetic and calorimetric methods were used to screen for dyslipidemia in the study population. Elitech diagnostic kits REF CHDL-5090 LOT: 22-06-35, REF TGML-5515 LOT: 21-1068 and REF CHSL-5505 LOT: 21-0667 were used. Lipid profiles included total cholesterol (elevated if >2 g/L or >5.2 mmol/L); HDL-c (elevated if >0.4 g/L or >1 mmol/L in men and >0.5 g/L or >1.3 mmol/L in women); triglycerides (elevated if >1.5 g/L or >1.7 mmol/L); LDL-c (elevated if >1.6 g/L or >4.1 mmol/L). LDL cholesterol is calculated using the Friedewald formula [20].

2.4. Metabolic Syndrome (MS)

In addition to arterial hypertension, SM was decreed in the presence of at least two (02) of the following components: fasting hyperglycemia (≥1 g/L); hypertriglyceridemia (≥1.50 g/L); hypo HDL-cholesterol (<0.4 g/L (men); <0.50 g/L (women), waist circumference ≥ 94 cm in men and ≥80 in women or obese status for one (BMI ≥ 30 kg/m^2) in accordance with the new 2005 International Diabetes Federation definition (IDF, 2005) taken up by [21].

2.5. Statistical Analysis

Study data were processed using Microsoft Excel software for organization of raw data and tables. R studio software was used to test differences in the distribution of biochemical parameters between farmersand non farmers. Graf Pad Prism version 9.5 (733) was used for graphing. A probability value of less than 5% ($p < 0.05$) is considered statistically significant.

3. Results

A total of 239 cultivating and non-cultivating hypertensive patients were included in this study.

3.1. Sociodemographic Characteristics and Distribution of the Study Population

Aged between 25 and 65, the study population consisted of patients of both sexes. Female patients 121 (50.62%) were slightly higher than male patients 118 (49.37%). Farmers 101 represented (42.25%) of the population versus 138 or (57.74%) non farmers. The median ages were 47 ± 11.3 years for farmers and 51.45 ± 9.77 years for non farmers. 86.13% of farmers had received no education, compared with 39.85% of non farmers. Only 10.89% and 2.97% had attained primary and secondary education respectively. High levels of education (15.94%) were found among non farmers (**Table 1**).

Almost all of the patients included admitted to having the habit of consuming foods prepared or packaged hot with non-biodegradable plastic bags as well as the use of insecticides for household use (**Table 2**). Protective measures during the use of pesticides in the field, such as the wearing of masks, were observed by 12.87% of farmers and the wearing gloves by 3.96% of farmers.

3.2. Variation of Biochemical Parameters

Analysis of biochemical parameters revealed significant differences between farmers and non farmers.

Farmers presented high blood sugar (1.23 g/L ± 0.61) compared to non farmers (1.04 g/L ± 0.40). There was no difference in creatinine and urea levels in farmers and non farmers (**Table 3** and **Figure 1**). However farmers had significantly higher levels of transaminasses (ALT 32.2 g/L ± 20.7; AST 39.9 g/L ± 18.4) compared to non farmers (ALT 24.2 g/L ± 8.96; AST 29.1 g/L ± 12.7. Stratified according to gender, ASAT levels were significantly higher ($p < 0.05$) in both genders in farmers than in non farmers (**Table 3** and **Figure 2**).

Table 1. Educational level of study population.

	Education level				
	No education	Primary level	Secondary level	University level	Total (%)
Farmers	86.13	10.89	2.97	0	100
Non farmers	39.85	19.56	24.64	15.94	100

Table 2. Risk behaviors related to exposure to chemical pollutants in farmers and non farmers.

Patients	Variables	Frequency (%)
Farmers and non farmers	Recognition of the long-standing and/or recent use of foods prepared and/or packaged with non-biodegradable plastic bags	100
	Household insecticide use	99.16
Farmers	Wearing a mask	12.87
	Wearing gloves	3.96

Table 3. Variation in biochemical parameters between farmers and non farmers.

Parameters	Farmers (Avg ± SD)	Non farmers (Avg ± SD)	p-Value (ANOVA variance)
Blood glucose (g/L)	**1.23 ± 0.61**	**1.04 ± 0.40**	0.003
Uremia (g/L)	0.29 ± 0.27	0.33 ± 0.46	0.455
Creatininemia (mg/L)	11.5 ± 7.31	11.7 ± 5.89	0.818
ALAT (UI/L)	**32.2 ± 20.7**	**24.2 ± 8.96**	<0.006
AST (UI/L)	**39.9 ± 18.4**	**29.1 ± 12.7**	0.0001
Total cholesterol (g/L)	**1.61 ± 0.42**	**1.78 ± 0.48**	**0.006**
HDL-cholesterol (g/L)	0.46 ± 0.16	0.45 ± 0.23	0.807
LDL-cholesterol (g/L)	**0.93 ± 0.4**	**1.21 ± 0.47**	**<0.001**
Triglycerides (g/L)	**1.15 ± 0.55**	**0.91 ± 0.43**	<0.002

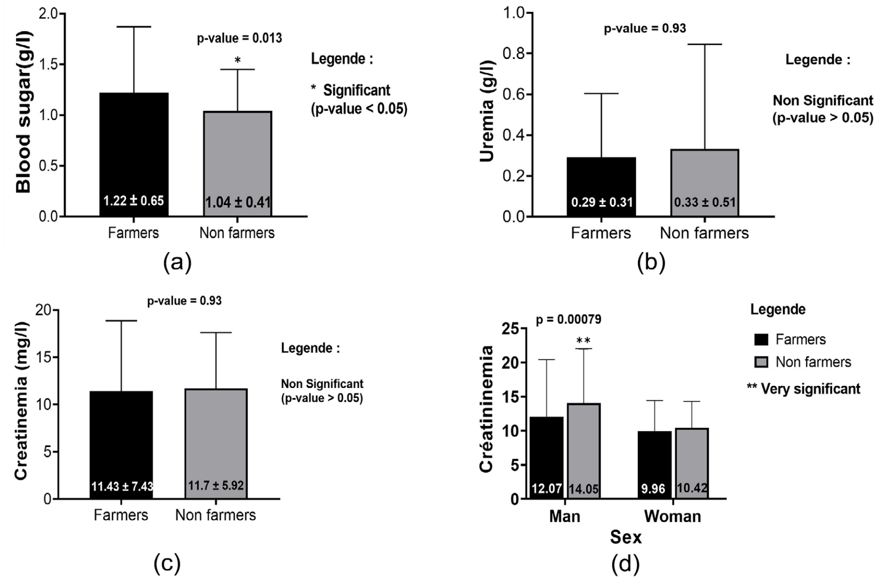

Figure 1. Variation in blood sugar, uremia and creatininemia in the study population. (a): Variation in blood glucose levels between farmers and non farmers: The mean blood glucose level for farmers was 1.22 g/l versus 1.04 g/l for non farmers. (b): Uremia showed a non significant variation (p = 0.93) with a mean of 0.29 g/l in farmer versus 0.33 g/l in non farmers. (c): Variation in creatinine levels showed a non significant variation between farmers and non farmers. (d): Stratified by gender, there was a significant difference in distribution (p = 0.00079) in non farmers men, with a mean of 14.05 mg/l versus 12.07 mg/l in farmers. *p < 0.01; **p < 0.001 by ANOVA variance.

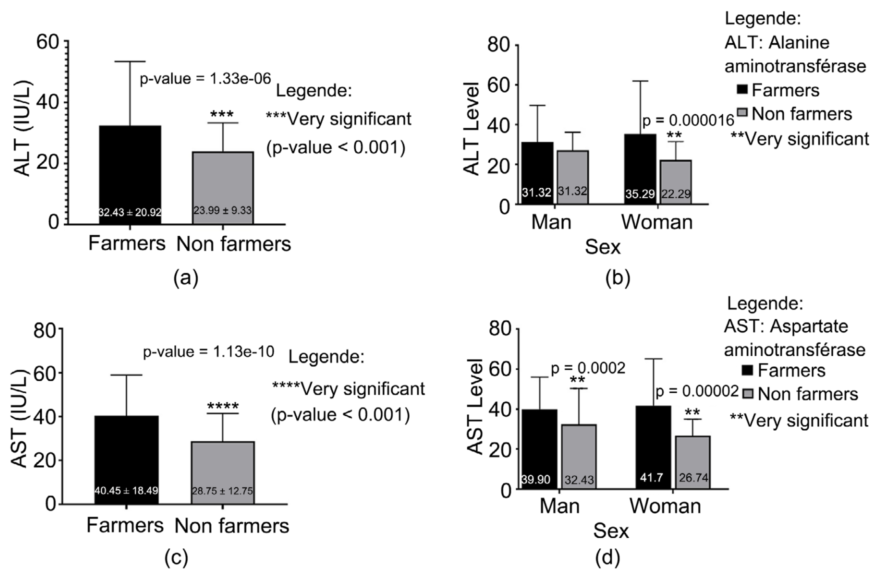

Figure 2. Variation in transaminases in the study population. (a): Variation in aminotransferase (ALAT) levels: farmers (32.43 IU/L) versus non farmers (23.99 IU/L). (b): Stratified according to gender, men farmers and non farmers (31.32 IU/L); women farmers (35.29 IU/L) and women non farmers (22.29 IU/L) (p = 0.000016). (c): Variation in Aspartate aminotransferase (ASAT) levels: farmers (40.45 IU/L) versus non farmers (28.75 IU/L). (d): Stratified by gender, men farmers (39.90 IU/L) (p = 0.0002); men non farmers (32.43 IU/L); women farmers (41.7 IU/L) (p = 0.00002); women non farmers (26.74 IU/L). *p < 0.001; **p < 0.00001 by ANOVA variance.

The mean of LDL cholesterol and total cholesterol levels were significantly higher in non farmers than in farmers (p-value < 0.001). The mean of triglycerides were significantly higher in farmers than in non farmers (Table 4 and Figure 3). Considering the prevalence of dyslipidemia in the population we observed that more hypertensive non farmer patients had hypercholesterolemia (29.62%) and hypo HDL-cholesterol (67%), than hypertensive farmer patients (16.32%) and (39.79%) respectively (Table 4)

Overweight and obesity were respectively found in 24.75% and 17.82% of farmers, compared with 36.49% and 37.22% of non farmers. Obesity was more frequent in non farmers than in farmers, with a cumulative percentage (overweight + obesity) of 73.71% (Table 5)

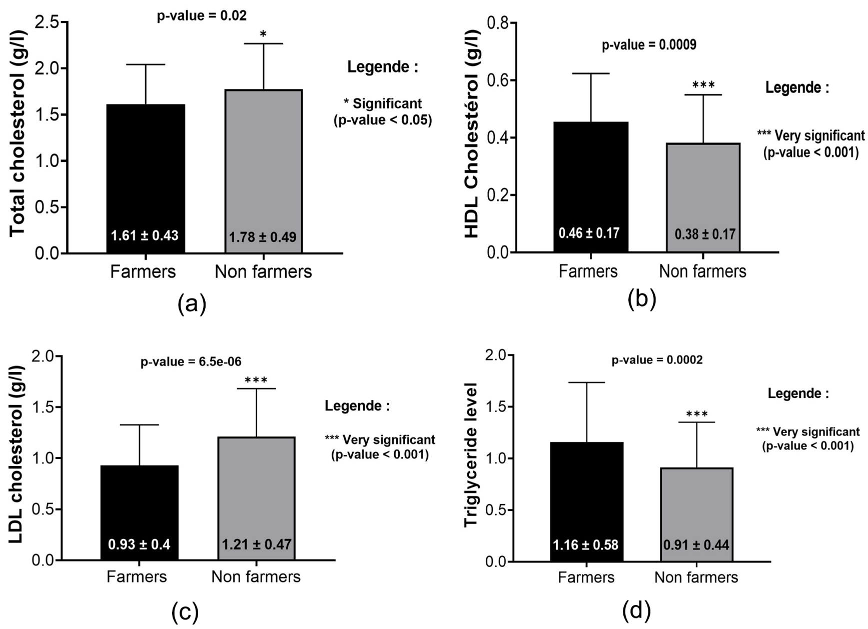

Figure 3. Variation in lipid parameters between farmers and non farmers. (a): Cholesterol levels showed a significant variation (p = 0.02) with a higher average in non farmers (1.78 g/L) compared to farmers (1.61 g/L); (b): HDL cholesterol showed a highly significant variation (p = 0.0009) with a higher average in farmers (0.46 g/L) compared to non farmers (0.38 g/L); (c): LDL cholesterol was more preponderant in non farmers (1.21 g/L) with a highly significant difference (p = 0.000) compared to farmers (0.93 g/L); (d): Triglycerides showed a highly significant difference (p = 0.0002) with a higher average in farmers (1.16 g/L) compared with non farmers (0.91 g/L). *p < 0.01; **p < 0.001 by ANOVA.

Table 4. Prevalence of dyslipidemia in the study population.

Parameters	Prevalence of dyslipidemia	
	Farmers	Non farmers
Hypercholesterolemia	16 (16.32%)	40 (29.62%)
Hypo HDL-cholesterol	39 (39.79%)	91 (67.40%)
High LDL-cholesterol	5 (5.10%)	26 (19.40%)
Hypertriglyceridemia	21 (21.64%)	14 (10.52%)

3.3. Variation in Metabolic Syndrome (MS)

According to the new 2005 International Diabetes Federation definition [22], metabolic syndrome was determined in 106 patients (44.35%) of our study population. Among farmers, 40 (39.60%) had metabolic syndrome, compared with 66 (47.82%) among non farmers. Stratified by sex and age, farmers showed a wide disparity in variation of metabolic syndrome with a higher prevalence in male aged between 25 and 45. In contrast, non farmers showed increasing prevalence of metabolic syndrome with age. Men aged between 25 and 35 did not present metabolic syndrome (Figure 4 and Figure 5).

Table 5. BMI distribution in farmers and non farmers.

Status	Farmers	Non farmers
Underweight	09 (8.91%)	0 (0%)
Normal weight	49 (48.51%)	36 (26.08%)
Overweight	25 (24.75%)	51 (36.96%)
Obesity	18 (17.82%)	51 (36.96%)

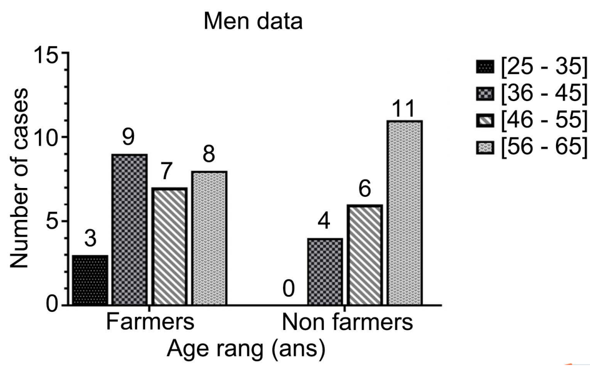

Figure 4. Age-dependent variation in metabolic syndrome in hypertensive farmer and non farmer men. Farmers: age [25 - 35] (3); age [36 - 45] (9); age [46 - 55] (7); age [56 - 65] (8); Non farmers: age [25 - 35] (0); age [36 - 45] (4); age [46 - 55] (6); age [56 - 65] (11).

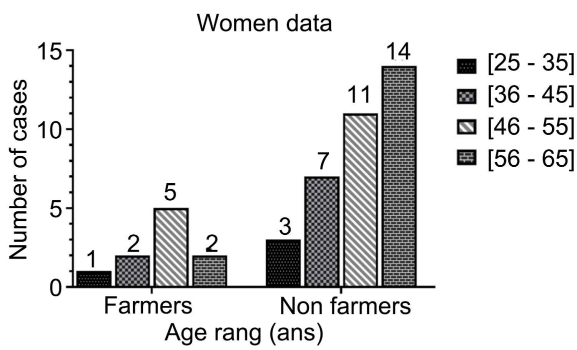

Figure 5. Age-related variations in metabolic syndrome in hypertensive farmer and non farmer women. Hypertensive farmer women: age [25 - 35] (1); age [36 - 45] (2); age [46 - 55] (5); age [56 - 65] (2); Hypertensive non farmer women: age [25 - 35] (3); age [36 - 45] (7); age [46 - 55] (11); age [56 - 65] (14).

4. Discussion

The aim of this study was to analyze the cardiovascular risk factors in hypertensive farmers compared with hypertensive non farmer patients, with a view to assess the effect of chemical pollutants on cardiovascular risk factors. Farmers, in addition to exposure to pesticides in the general population, are exposed to pesticides through occupational handling. Our objective was to evaluate the possible effect of chemical pollutants on biochemical parameters in hypertensive farmer patients. The median ages of our patients were 50.27 ± 9.98 years in women and 49.01 ± 11.28 years in men. Among farmers, the mean age was 47 ± 11.3 years, compared with 51.45 ± 9.77 years among non farmers. In a recent study conducted in 2022 in Nigeria on a hypertensive population [23], the mean age was 56.2 ± 13.6 years. Our results showed higher blood glucose levels in farmers (47.77%) than in non farmers (27.20%) ($p = 0.0132$), in accordance with work carried out on cotton farmers in the Borgou cotton basin in northern Benin [24]. These authors highlighted the high levels of exposure to organochlorine pesticide residues and the risk of diabetes, particularly type 2 diabetes. Similarly, a recent study of a rural population in Korea revealed an association between pesticide use and the prevalence of diabetes [25]. Based on the results of the National Health and Nutrition Survey conducted between 1999 and 2002, the authors [26] highlighted a strong relationship between serum concentrations of persistent organic pollutants and diabetes. Stratified by gender, blood glucose levels did not differ significantly between farmers and non farmers, suggesting that the possible effect of exposure to chemical pollutants on carbohydrate metabolism is equally valid in men and women. Our results revealed the presence of a higher prevalence of obese patients in non farmers than in farmers, and this is justified by the fact that farmersmay have a higher rate of physical activity than non farmers [27] [28] [29]. In our study, in addition to hypertension, hyperglycemia and hypertriglyceridemia represent the components of the metabolic syndrome in the farmers group. In contrast, dyslipidemias such as hyper-total-cholesterolemia, hyper-LDL-cholesterolemia and insistent obesity (36.96% VS 17.82%) (**Table 5**) were the contributing factors in the occurrence of metabolic syndrome in non farmers. Hyper-triglyceridemia, on the other hand, was more frequent in farmers than in non farmers. These results are in concordance with the authors of [30] who published observations on the risk of dyslipidemia in relation to the level of physical activity in Thai professionals and office workers. Metabolic syndrome (MS) was just as prevalent (39.60%) in farmers as in non farmers (47.82%). These values are much lower than those obtained respectively by the authors [31] [32] in adult hypertensive patients in health facilities in Parakou (Benin) and in a Spanish hypertensive population in whom metabolic syndrome was found in proportions of 69.6% and 61.7% respectively with the IDF criteria. However, our results are similar to those of authors [33] in Nigeria, who reported a prevalence of 42.9% using IDF criteria. A similar prevalence of 35.3% was found among type 2 diabetic patients in Dakar, Senegal [33]. On the other hand, CISSE F. *et al.* in Senegal [34] found lower prevalences (6.57%), with a predominance of women in a non-hypertensive population. In this study conducted on an adult Senegalese population, CISSE F. et al, however, found hypertension (86.2%) followed by obesity to be the main components of metabolic syndrome. High blood pressure is therefore a major factor in the appearance of cardiovascular disease. Our study reported not only the presence of a wide disparity in the variation of metabolic syndrome in male farmers apparently more exposed than non farmers, but also the presence of metabolic syndrome in young farmers aged between 25 and 45. However non farmers presented increasing prevalence of metabolic syndrome with age and absence of metabolic syndrome between 25 and 35. Our results confirm the works of [35] which had shown that advancing in age increases the risk of cardiovascular diseases. Considering the fact that young farmers are more exposed to chemical pollutants through their work we suggest that the appearance of metabolic syndrome at young age could have a link with pesticides. In addition, farmers had abnormal transaminase levels compared with non farmers, suggesting liver damage in farmers [36] [37]. Health problems linked to exposure to chemical pollutants could be due to poor practices in their use. In our study population, only 12% of farmers wore masks and 5% gloves when handling pesticides. These poor practices could be due to the slow level of education of farmers. In our study, 86.13% of farmers received no instruction, compared with 39.85% of non farmers; only 10.89% and 2.97% had attained primary education (low) and lower secondary education (medium) respectively. High levels of education were found among 15.94% of non farmers. These results are in line with the conclusions of the authors [9] in a study on the health risks associated with pesticide use in Burkina Faso.

5. Conclusion

The results of our study on the analysis of the main cardiovascular risk factors in hypertensive farmers and non farmer's patients of the Zou region in central Benin, showed that in the group of hypertensive farmer patients there were more diabetics, patients with liver dysfunction and young patients with metabolic syndrome. In the group of non farmers there were more obese with dyslipidemia and increasing metabolic syndrome according to age with absence of metabolic syndrome at young age. These results suggest that the presence of cardiovascular risk among young farmers could be due to exposure to pesticides while age-dependent cardiovascular risk among non farmers could be linked to aging, life style and diet.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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