Original Article

Agrochemical use in Farming Practices and Risk Factors for Kidney Disease among Dwellers of Rural Farming Communities in South-West Nigeria

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ABSTRACT

Background: The outlook of chronic kidney disease (CKD) in low-and-medium-income-countries is poor. Modern farming practices in Nigeria are becoming increasingly associated with the use of herbicides and pesticides. **Aim:** The study aimed to evaluate agrochemical use in farming practices and risk factors for kidney disease among dwellers of rural farming communities in South-West Nigeria. **Methods:** This was a cross-sectional survey of adult dwellers of an agrarian rural farming community in South-West Nigeria. Participants provided information on demographics, lifestyles, knowledge, and awareness of risk factors for kidney disease, and the use of agrochemicals in farming practice. Anthropometric measurements and blood pressure values were obtained while blood and spot urine were collected for random blood glucose, serum creatinine, urinalysis, and albumin-creatinine ratio. **Results:** A total of 572 rural dwellers were enrolled in the study, with a mean age of 49.9 ± 17.5 years while 39.3% were male and 88.9% engaged in active farming. The prevalence of traditional risk factors for kidney disease was hypertension (24.3%), Diabetes mellitus (2.8%), cigarette smoking (7.5%), alcohol intake (20.8%) and herbal consumption (57.1%). The use of pesticides/herbicides was reported in 69.9%, while 25.3% did not use protective gear during its use. Proteinuria, hematuria, and reduced eGFR were observed in 29.8%, 6.1%, and 33.9% of participants, respectively. **Conclusion:** This study showed a high prevalence of herbicides and pesticide use and traditional risk factors for kidney disease, in addition to the high prevalence of markers of kidney damage among the dwellers of rural farming settlements in South-West Nigeria.

KEYWORDS: *Awareness, kidney disease, Nigeria, pesticide and herbicide use, risk factors*

INTRODUCTION

Kidney disease is a major non-communicable disease whose worldwide burdens have assumed epidemic proportions.[1] It is a major cause of morbidity and mortality, in addition to its rising prevalence and exorbitant cost of treatment.[1,2] The outlook in low-and-medium-income countries is particularly poor, as well as among individuals of African ancestry

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who are at higher risk of kidney disease and have increased severity.[3] Inadequate resources, limited access to renal replacement therapy, and the absence of a well-coordinated primary healthcare system have worsened the burdens of kidney disease in sub-Saharan Africa.[4,5]

In Nigeria, chronic kidney disease (CKD) accounts for 8-10% of all medical admissions,[6,7] while recent community screenings have estimated the prevalence of CKD among the Nigerian population to be between 19-27%.[8,9] In Nigeria, most patients with the diagnosis of end-stage kidney disease rarely live beyond 6 months after diagnosis.[10,11] Therefore, a strong case for preventive nephrology has been made, where adequate population-based or target screenings and treatment will be embarked upon. This has the benefit of reducing the burden of kidney disease at the population level. Experiences from the Kidney Disease Early Evaluation Study (KEEP) in the United States and the Kidney Early Evaluation Programme in the United Kingdom have shown the success of targeted and population-based screening for kidney disease and its risk factors.[12,13]

Clinical nephropathies commonly encountered among patients with CKD in sub-Saharan Africa are chronic glomerulonephritis (CGN), hypertensive nephropathy, and diabetic nephropathy.[6,14] However, there is another commonly observed clinical nephropathy whose etiology is unknown after evaluation. This group accounts for 15 – 20% of patients with CKD seen in our clinical practice.[6,14]

Several hypotheses are being propagated on the possible causes of kidney disease among individuals with CKD of unknown etiology such as exposure to petrochemicals, heavy metals from ongoing constructions in the cities, and farming practices (use of herbicides and pesticides) among poor rural communities.[15,16] Preliminary reports from Costa Rica, Nicaragua, India, and Sri Lanka have demonstrated that these farming practices may be associated with CKD. Among the practices identified as risk is the use of agrochemicals, particularly those that contain organophosphates such as herbicides and pesticides, whose accumulation may cause acute or chronic manifestations of herbicides and pesticide exposure.[17]

In Nigeria, modern farming practices are becoming increasingly associated with the use of herbicides and pesticides to control weeds and pests.[18] The study aimed to evaluate agrochemical use in farming practices and risk factors for kidney disease among dwellers of rural farming communities in South-West Nigeria.

Materials and Methods

Study design

This was a cross-sectional descriptive study of dwellers of nine rural farming communities in Ogo-Oluwa local government, along the Iwo-Ogbomoso axis of Oyo State, South-West Nigeria. Included in the study were individuals whose occupation was farming and others who were not farmers but lived in the communities.

The minimum sample size was calculated using the sample size formula for a cross-sectional study[19]

$$n = \frac{Z_{1-\alpha/2}{}^2 \, P(1-P)}{d^2}$$

$Z_{1-\alpha/2}$ = Standard normal variate (at 5% type 1 error ($P < 0.05$) it is 1.96). P is taken to be 46.2% as the prevalence of pesticides/herbicides use among farmers as reported by Isah *et al*.[20] and d = Absolute error or precision error of 5% and at type 1 error of 5%.

$$n = \frac{1.96^2 \times 0.462\,(1-0.462)}{0.05^2}$$

n = 382 and with an attrition of 30%, the minimum sample size was estimated to be 497.

The participants must have been living in the selected communities for at least 6 months and aged 18 years and above. Excluded from the study were individuals with age less than 18 years, nonresident, and those with a history of malignancies.

Community engagement

Before the commencement of the study, our research team made at least two visits to each selected farming community to explain the purpose, benefits, and processes that the research would entail. The community leaders met during the visits, while the community heads helped the research team to identify contact persons within their communities. The contact persons assisted in reaching out to the members of the farming communities, informing them ahead of the days and times our research team will be visiting for the conduct of the study. At the beginning of every recruitment exercise, the research and the processes involved were further explained to the participants individually and collectively. Written informed consent was obtained from all participants.

Data collection

A study questionnaire was administered to every participant using a standard case report form, and information obtained included sociodemographic details, awareness of risk factors for kidney disease, use of herbicides and pesticides, and the safety measures

engaged in the use of agrochemicals, past medical history and medication history. The awareness of risk factors for CKD was assessed using a tool that comprises of a yes or no response for 10 items that are risk factors for CKD. The risk factors awareness tool was only applied to 233 of the participants. History suggestive of obstructive sleep apnea (excessive snoring, noisy breathing, and recurrent daytime somnolence) was obtained from the participants. Anthropometric measurements were obtained from the participants such as weight, height, waist, and hip circumferences. The body mass index (BMI) was calculated from the weight and height.

Laboratory assays

Ten milliliters of spot urine was obtained from all participants for a 10-point urinalysis and urinary albumin-creatinine ratio determination. Ten milliliters of venous blood was also collected from all participants for serum creatinine and hemoglobin concentration determination. Random plasma glucose was carried out using an Accu-Chek glucometer in all participants. The estimated Glomerular Filtration Rate (eGFR) was calculated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation.[21]

Data analysis

Data obtained were entered into Microsoft Excel and subsequently transferred to the Statistical Package for Social Science version 23 for analysis. Baseline descriptions of sociodemographic and clinical variables were reported as proportions for categorical variables and mean (standard deviation) for continuous variables. Statistical significance was set as P value < 0.05.

Definition of terms

Hypertension was defined as a previous diagnosis of hypertension by a medical doctor or the use of antihypertensive medications or the finding of elevated BP ≥140/90 mmHg[22] and diabetes mellitus (DM) was defined as a previous diagnosis of DM or the use of antidiabetic medications[23] while hyperglycemia was defined as random plasma glucose of greater than 11.1 mmol/L.[23]

Ethical consideration

This study adhered to the Declaration of Helsinki and ethical approvals were obtained from the Joint University of Ibadan and University College Hospital, Ibadan Institutional Review Board, and that of Ladoke Akintola University of Technology Teaching Hospital, Ogbomoso Ethics Committee with the approval numbers UI/EC/19/0065 and LTH/OGB/EC/2017/163, respectively. All participants gave verbal and written informed consent. Consecutively consenting adults were recruited for the study.

Return of clinical and laboratory results

The results of physical examinations and laboratory tests were returned to the participants in each of the participating communities, and those with hypertension, DM, and markers of kidney damage were counseled on lifestyle modifications and advised to register with a clinic/hospital of their choice for follow-up.

Results

A total of 572 rural dwellers were enrolled in the study with a mean age of 49.9 ± 17.5 years while males accounted for 225 (39.3%). Among the participants, 488 (85.3%) were actively engaging in farming, 455 (79.5%) were married while 232 (40.6%) had no formal education, Table 1. The mean BMI, MUC, DBP and SBP were 27 ± 8.9 kg/m^2, 26.7 ± 5.5 cm, 84.0 ± 13.6 mmHg and 138 ± 26.8 mmHg, respectively, while the mean serum creatinine, urea, random plasma glucose and eGFR were 97.2 ± 44.2 µmol/L, 124.1 ± 46.5 mmol/L, 8.4 ± 3.1 mmol/L and 77.0 ± 32 ml/min/1.73 m^2, respectively, Table 1.

Awareness of risk factors for kidney disease among participants was assessed. Only 202 out of the 233 participants had data on awareness of risk factors for CKD, which gives a response rate of 86.7%. Forty-six (22.8%) participants reported they were aware of hypertension as a risk factor for kidney disease, while 46 (22.8%), 36 (18.7%), 45 (23.4%), 40 (20.8%) and 23 (12.0%) were reported for DM, Human Immunodeficiency Virus (HIV) infection, herbal consumption, analgesic and diarrhea disease among the participants, respectively, Table 2.

The prevalence of traditional risk factors for kidney disease was hypertension 141 (24.1%), DM 83 (14.5%), cigarette smoking 43 (7.5%), alcohol intake 119 (20.8%), herbal consumption 331 (57.1%), analgesic

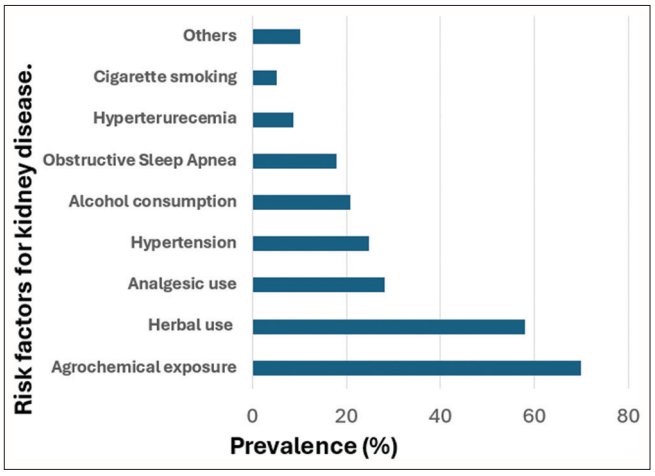

Figure 1: Prevalence of risk factors for chronic kidney disease among participants

Table 1: Baseline characteristics of participants

Variables	Mean±SD/frequency/ percentage *n*=572
Mean Age (years)	49.7±17.5
Age groups	
<39 years	166 (29.0%)
40-59 years	194 (33.9%)
>60 years	212 (37.1%)
Gender	
Female	347 (60.7%)
Male	225 (39.3%)
Occupation	
Farming	488 (85.3%)
Non-farming occupation	21 (3.7%)
Marital status	
Married	455 (79.5%)
Single	54 (9.4%)
Others	63 (11.0%)
Educational level	
No formal education	232 (40.6%)
Primary	182 (31.8%)
Secondary	108 (18.9%)
Tertiary	50 (8.7.%)
Farm settlement	
Alaroje	26 (4.5%)
Idi - Araba	56 (9.8%)
Ilu – Ode	72 (12.6%)
Iwata	22 (3.8%)
Lagbedu Orile	121 (21.2%)
Odo – Ifo	53. (9.3%)
Ologorun	21 (3.7%)
Opete	29 (5.1%)
Otamokun	172 (30.1%)
Mean BMI (kg/m^2)	27±8.9
Mean MUC (cm)	26.7±5.5
Mean DBP (mmHg)	84.0±13.6
Mean SBP (mmHg)	138±26.8
Mean waist circumference (cm)	82.1±12.3
Mean hip circumference (cm)	90.4±23.6
Mean waist-to-hip ratio	0.72
Mean urea (mMol/L)	124.1±46.5
Mean serum creatinine (µmol/L l)	97.2±44.2
Mean eGFR (ml/min/1.73 m^2)	77.0±32.29
Mean packed cell volume (%)	37.7±5.0
Mean random plasma glucose (mMol/L)	8.4±3.1

BMI – Body Mass Index, DBP- Diastolic Blood Pressure, eGFR – estimated Glomerular Filtration Rate, MUC – Mid Upper Arm Circumference, SBP – Systolic Blood Pressure, SD – Standard Deviation

use 111 (19.4%). Also, 147 (26.3%) usually added salt to meals, and 102 (18.2%) had symptoms of obstructive sleep apnea, Figure 1.

Table 2: Awareness of risk factors for chronic kidney disease among participants

Awareness of risk factor for chronic kidney disease	Frequency (%)
Hypertension (*n*=202)	
Yes	46 (22.8%)
No	156 (77.2%)
Diabetes mellitus (*n*=202)	
Yes	46 (22.8%)
No	156 (77.2%)
HIV infection (*n*=192)	
Yes	36 (18.7%)
No	156 (81.3%)
HBV infection (*n*=192)	
Yes	27 (14.1%)
No	165 (85.9%)
Other infection (*n*=192)	
Yes	29 (15.1%)
No	163 (84.9%)
Herbal consumption (*n*=192)	
Yes	33 (17.2%)
No	159 (82.8$%)
Analgesic use (*n*=192)	
Yes	45 (23.4%)
No	147 (76.6%)
Use of bleaching cream/soap (*n*=192)	
Yes	40 (20.8%)
No	152 (79.2%)
Exposure to heavy metals (*n*=192)	
Yes	26 (14.5%)
No	166 (85.5%)
Inherited kidney disease (*n*=192)	
Yes	35 (18.2%)
No	157 (81.8%)

HBV – Hepatitis B Virus, HIV – Human Immunodeficiency Virus

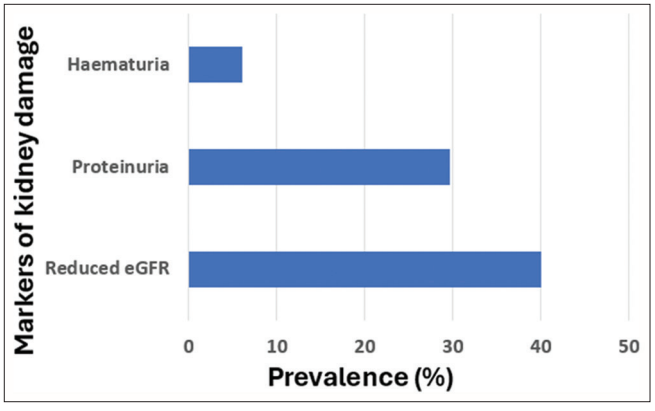

Figure 2: Markers of kidney disease among participants

The use of pesticides/herbicides was reported in 400 (69.9%) while 268 (25.3%) did not use protective

devices during its use. Markers of kidney damage vis-à-vis proteinuria, hematuria, and reduced eGFR were observed in 170 (29.8%), 35 (6.1%), and 194 (33.9%) participants, respectively, Figure 2. Glycosuria was observed in 23 (4.0%) participants.

Discussion

This study examined the awareness and risk factors for CKD among dwellers of nine rural farming settlements in Oyo State, South-West Nigeria. Majority (85.3%) of the dwellers of the rural farming settlements engaged in active farming. The demography of the study participants was that of a typical rural farming community in Nigeria, consisting of young, active, largely uneducated individuals beyond secondary school level, and mostly married individuals.[24,25] Over 70% of Nigerians live in the rural community and the major occupation among them is subsistence farming.[25] The level of education has a direct impact on health seeking behaviors of patients.[26-28] Omeire *et al*.[29] reported that most dwellers of rural farming communities in Nigeria lacked access to infrastructural facilities, and accessibility to healthcare is poor, and most would have to travel long distances to access healthcare. These consequently lead to late presentation, increased disease severity, and poor outcomes.[30,31] Furthermore, the level of education of the study population may also influence the farming practices that most of them engaged in, more so that some of the farming practices have been associated with poor health status.[32,33] The indiscriminate use of herbicides and pesticides without employing the use of protective gadgets has been associated with various health problems that include respiratory diseases, anemia, peripheral neuropathy, and recently chronic kidney disease of unknown etiology (CKDu) have been linked to these type of farming practices.[32-37]

The awareness of most risk factors for kidney disease was low among the study population. This finding is similar to the reports from previous similar studies.[35,36] The low level of awareness of risk factors for kidney disease may have been further compounded by the lack of exposure to both the electronic and print media because most of these rural farming settlements lack electricity supply. In addition, the low level of education among the participants might have also contributed substantially to the low level of awareness, as previous studies have shown an association between level of education and awareness of risk factors for diseases.[38,39] Although, the farmers have various occupational associations to which they belong, they rarely discuss health-related issues at their meetings. Most participants of this study were not aware that exposure to organophosphates poses health risks to them in any way.

The prevalence of common risk factors for CKD was high among the farm settlement population. The prevalence of hypertension in this study was 24.1%, which is comparable to that observed from other rural communities in the country.[40,41] Hypertension has been identified as a common risk factor for CKD in Nigeria, and the fact that most people with hypertension were unaware of it underscores the impact of hypertension on the end organs and the occurrence of various complications, including CKD.[42,43] The prevalence of DM was 2.8% and was lower compared to the reported prevalence in urban Nigerian cities.[44,45] The low prevalence of DM may be due to the fact that the farming population is active and engaged in less intake of processed foods unlike the urban population where most live sedentary lifestyle and patronize fast food joints. Analgesic consumption was reported in 28.1% of the participants; most of the analgesics consumed were non-steroidal anti-inflammatory drugs, and chronic use is associated with the development of analgesic nephropathy. Some combined the use of analgesics with alcohol and herbal concoctions. The prevalence of alcohol use (20.8%) and herbal ingestion (57.1%) were high in the study population. The prevalence of alcohol consumption observed in this study is similar to the 23.7% reported by Lasebikan *et al*.[46]

We observed a high prevalence of non-traditional risk factors for CKD among the farming population. About 70% of the participants reported exposure to organophosphates such as herbicides and pesticides. The exposure is worsened by the non-adherence to the use of protective wear. Association between organophosphate exposure and CKD has been reported, particularly with the entity called CKDu.[17,47-49] The prevalence of markers of kidney damage was high among the participants, including proteinuria (29.7%), hematuria (6.1%), and reduced eGFR (33.9%). The findings are similar to the report from similar studies among farmers using organophosphates for crop production in El Salvador and Sri Lanka.[48,49] The high prevalence of markers of kidney damage may be related to the low level of awareness of risk factors for kidney disease and the high prevalence of both traditional and non-traditional risk factors for kidney disease among the study population. These findings have brought to the fore the need for deliberate efforts to increase awareness of kidney disease and its risk factors among farming communities, which can be achieved through health education and advocacy. The use of community leaders and farmers' associations as the link to the communities will provide efficient opportunity to reach out to many members of the farm settlements. It is also imperative that governments at all levels work together to provide at least a well-equipped

primary health center/clinic per farm settlement and improve the existing infrastructural facilities such as electricity and good road network.

This study has some limitations. Some of the study participants were diagnosed as having hypertension based on a single reading of elevated blood pressure and without a previous history of hypertension. Similarly, proteinuria and hematuria were defined with single-spot urine testing. The use of a single reading or finding in defining these variables may have led to an overestimation of their prevalence. In addition, only 233 of the 572 were assessed for awareness of risk factors for CKD, although the response rate was high (86.7%) among those assessed. Furthermore, the study's strength lies in the large population size and well-selected rural farming communities and participants.

Conclusion

This study has demonstrated low level of awareness of risk factors for kidney disease among dwellers of rural farming settlements in Nigeria. This low level of awareness of risk factors for CKD was in spite of the high prevalence of both traditional and non-traditional risk factors for kidney disease and of the markers of kidney damage among members of the farming communities.

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Conflicts of interest

There are no conflicts of interest.

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