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Acknowledgements

All contributors who do not meet the criteria for authorship as defined above should be listed in the acknowledgements section.

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Alam M (2002): Knowledge, Attitude and Practices among Health Workers on needle stick injuries. Annals of Saudi Med. 22: 5 – 6.

Braunwald E, Fauci AS, Kasper DL (2001). Principles of Internal Medicine. 15th ed. New York: Mc. Graw Hill. Pp. 588 – 591.

Nagao Y, Kawaguchi T, Yanalu K, Ide I, Haradu M, Kumashin R, Sata M (2005). Causal relationship between Hepatitis C core and the development of type 2 diabetes in Hepatitis C virus hyperendemic area: a pilot study. Int. J. Mol. Med. 16: 109-114.

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Original Articles

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Original Article

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Relationship between family dynamics and glycemic control among adults with type 2 diabetes mellitus presenting at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria

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ABSTRACT

Background: The incidence of diabetes mellitus, especially type 2, is rapidly growing in the world, and the family dynamics is believed to play major roles in the adequacy of glycemic management in diabetic patients. **Aim**: This study aimed to determine the relationship between family dynamics and glycemic control among patients with type 2 diabetes mellitus in Sokoto, Nigeria. **Materials and Methods:** A cross-sectional study was conducted among 271 adults with type 2 diabetes mellitus (selected by systematic sampling technique) attending the Family Medicine Department clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Blood samples were collected and analyzed for glycosylated hemoglobin in addition to questionnaire administration. Data were analyzed using IBM SPSS version 20 statistical computer software package. **Results**: The ages of the participants ranged from 26 to 80 years with a median age of 50.00 years, and majority of them (55.4%) were males. Most of the participants were married (81.5%), and majority of them (61.7%) were in a polygamous family setting. Majority of participants had balanced families as they scored high marks in the cohesion, communication, flexibility, and satisfaction scales, but low marks in the enmeshed, chaotic and disengaged scales. Only a few, 23 (8.5%) of the 271 participants had good glycemic control, and it was associated ($p < 0.05$) with high scores on balanced cohesion and family communication scales, and low score on disengagement scale. **Conclusion**: Although, majority of the participants in this study had balanced families, only a few of them had good glycemic control, and it was associated with high scores on balanced cohesion and family communication scales, and low score on disengagement scale. Care providers should routinely assess the family dynamics of diabetic patients and also involve their family members in the management of their disease conditions.

Keywords: Family dynamics, glycemic control, type 2 diabetes mellitus, patients

INTRODUCTION

Chronic diseases are now the major causes of death and disability globally; it has been estimated that they account for 70% of deaths worldwide but disproportionately affect low- and middle-income countries where they account for about two-thirds of the disease burden (WHO, 2011; World Bank, 2011). Regrettably, these countries bear the dual burden brought about by infectious and chronic diseases. Diabetes mellitus (DM) is undoubtedly for them a public health concern epidemiologically and economically as it is associated with reduced life expectancy, significant morbidity (due to specific diabetes related micro-vascular complications such as retinopathy, nephropathy, and neuropathy), and increased risk of macro-vascular complications such as ischemic heart disease, stroke and peripheral vascular disease; and the development of these complications impacts substantially on both the productivity and quality of life of diabetic patients (WHO, 2011; World Bank, 2011). In addition, DM accounts for 3.8 million deaths worldwide per year, a number similar in magnitude to the mortality attributed to HIV/AIDS (Bahremand et al., 2015). Studies suggest that these deaths can be prevented, especially in economically productive individuals

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between the ages of 35 and 64 years of age (Haddadi and Besharat, 2010; Nozaki et al., 2009). The incidence of diabetes, especially type 2, is rapidly growing in the world, in 1985, an estimated 30 million people suffered with this chronic disease, which, by the end of 2006, had increased to 230 million, representing 6% of the world population; of this number, 80% is found in the developing world (Haddadi and Besharat, 2010; DiMatteo, 2004).

Diabetes mellitus was previously thought to be rare in rural Africa, but over the past decades it has emerged as an important non-communicable disease in sub-Saharan Africa (ADA, 2010). Approximately, 7.1 million Africans were said to be suffering from diabetes at the end of 2000, and this figure is expected to rise to 18.6 million by 2030 (Pereira et al., 2008). Similar to the situation in many sub-Saharan African countries, the prevalence of DM continues to rise in Nigeria, and it was estimated to have risen from 2.2% in 1997 to 8.5% in 2008 [Ogbera and Ekpebegh, 2014; WHO, 2011]. A cause for concern is the generally poor glycemic control reported in studies conducted among patients with type 2 DM in the country [Unadike et al., 2010; John et al., 2005]. Glycemic control refers to the typical levels of blood sugar in a person with diabetes mellitus. Since blood sugar levels fluctuate throughout the day and glucose levels are imperfect indicators of these changes, the percentage of hemoglobin which is glycosylated [i.e., glycosylated hemoglobin (HbA1C)] which reflects the average glucose levels over the preceding 2-3 months is used as a proxy measure of long-term glycemic control.

Family dynamics is the forces at work within the family that produce particular behavior and symptom (Garcia-Hudobro et al., 2012). Family dynamics describes how one individual perceives another family member's attitude about his role in the family unit, the effect that perception has on the way those two family members relate to each other and consequences for other family members based on that interaction in other words functionality of the family. Family dynamics is objectively measured by the level of functioning of the family and it comprises many psychosocial factors that are protective against the adverse effects of chronic diseases on the family (George, 2016; Batty and Fain, 2016). These include adaptability and flexibility of the dynamics of the family to stressful situations, as well as connectedness, communication, cohesion and satisfaction among the members of the family. Flexibility as a measure of family functioning varies from rigid, structured, and flexible to chaotic. Cohesion varies from disengaged, separated, connected to enmesh. A balanced family may be flexible-connected, flexibly-separated, structurally-separated or structurally-connected. An unbalanced family combines the extremes of these measures in chaotically-disengaged, chaotically-enmeshed, rigidly-disengaged and rigidly-enmeshed (He et al., 2014).

Diabetes management can be quite complex, requiring lifelong commitment and drastic changes to the patient's lifestyle so involving family members as a part of diabetes management plays a major role (Rosland et al., 2010; Armour et al., 2005). Psychosocial variables which included family functioning was said to help in better control of glycemic level than oral hypoglycemic agents alone in management of type 2 diabetes (Openshaw, 2011). Social support from family provides patients with practical help and can buffer the stresses of living with illness. It was found that practical and emotional support received from both family and friends had a positive influence on global measures of disease management in patients with diabetes (Olson and Gorall, 2003). In fact, a meta-analytic review of 122 empirical studies found that adherence was 27% higher when patients had practical support available to them (Winek, 2010). Additionally, research by Pereira et al. (2008) indicates strong associations between positive family dimensions (e.g., cohesion and familial guidance) and better glycemic control among diabetic patients (Mbanya and Gill, 2004).

With regard to family cohesion, in which families are described as warm, accepting, and close, the odds of adherence were three times higher when compared with non-cohesive families (Winek, 2010). Good level of cohesion, flexibility and communication help in better resilience in family, and thus take care of stress in the family (Jones et al., 2008). However, despite the high burden of DM in Nigeria [Ogbera and Ekpebegh, 2014; WHO, 2011], and the documented positive effects of family dynamics on glycemic management worldwide, there is a dearth of literature on the relationship between family dynamics and glycemic control in Nigeria, and it has never been examined in Sokoto, Nigeria. This study was conducted to determine the relationship between family dynamics and glycemic control among adults with type 2 diabetes mellitus presenting at UDUTH, Sokoto, Nigeria.

MATERIALS AND METHODS

Study Design, Population and Area

A cross-sectional study was conducted among adults with type 2 diabetes mellitus attending the Family Medicine Department clinics of Usmanu Danfodiyo

University Teaching Hospital, Sokoto, Nigeria, from January to April 2014. The hospital is a tertiary health institution which serves as a referral center for the health facilities in Sokoto State and the surrounding Kebbi, Zamfara, Katsina and Niger States. All adult patients (i.e., ≥ 18 years old) who have been diagnosed with type 2 diabetes mellitus for ≥ 1 year (and had no gross renal, ophthalmic, cardiovascular or psychiatric complications) and consented to participate were considered eligible for enrollment into the study, while those who were too ill to participate were excluded.

Sample Size Estimation and Sampling Technique

The sample size was statistically estimated at 271 and the eligible participants were selected by systematic sampling technique using the patients' attendance register to constitute the sampling frame. About 150 patients are seen at the clinics each day of which about 10% are diabetics; one of five patients that had been diabetic for ≥ 1 year was recruited as they present consecutively at the clinics over a period of 4 months until the estimated sample size of 271 was obtained.

Data Collection and Analysis

A semi-structured interviewer-administered questionnaire was used to obtain information on the participants' socio-demographic characteristics, while the Family Adaptability and Cohesion Evaluation Scale IV (FACES IV) questionnaire (Olson, 2011) was used to obtain information on the participants' family dynamics. The FACES IV questionnaire measures the dimensions of family cohesion and family flexibility using six scales. There are two balanced scales that assess balanced family cohesion and balanced family flexibility, and they are similar to FACES II. It also contains four unbalanced scales that assess the high and low extremes of cohesion (i.e., disengaged and enmeshment) and flexibility (i.e., rigid and chaotic). Blood samples were collected from the cubital or radial vein with an 18G needle and syringe into an ethylenediaminetetraacetic acid (EDTA) container and taken to the laboratory for analysis within 6 hours of collection. Analysis for glycosylated hemoglobin (HbA1C) was done using an automated spectrophotometer analyzer, and the results were entered into a data sheet. The glucose circulating in the blood enters the red blood cells resulting in formation of HbA1C which reflects the average blood glucose level over the preceding 2-3 months and it is widely used as the standard biomarker for the adequacy of glycemic management. The data on the participants' family dynamics were entered into FACES IV Excel program (Olson, 2010). The Excel program took each item response and summed them for each of the six FACE IV scales, thereby creating a total raw score. The total raw score was converted into percentage score using the percentile conversion chart. Patients that scored high marks in the flexibility, cohesion, communication and satisfaction scales were considered as having balanced families, while patients that scored high in the unbalanced scales, the rigidity, enmeshed, chaotic and separateness scales were considered as having unbalanced families. The data on the socio-demographic variables and HbA1C levels were analyzed using the IBM SPSS version 20 computer statistical software package. Quantitative variables were summarized using descriptive statistics, while qualitative variables were summarized using frequencies and percentages. The Chi-square test was used to assess for relationships between the respective family dynamics scales and the HbA1C levels which were categorized into good glycemic control (HbA1C = 6-7%) and poor glycemic control (HbA1C = 8-19%) (ADA, 2010). All levels of statistical significance were set at $p < 0.05$.

Ethical Consideration

Ethical approval was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, and informed written consent was also obtained from the study participants before data collection.

RESULTS

Socio-demographic characteristics of participants

All the 271 questionnaires administered were adequately completed and found suitable for analysis, giving a response rate of 100%. The ages of the participants ranged from 26 to 80 years with a median age of 50.00 years, and majority of them (55.4%) were males. Most of the participants were married (81.5%) and practiced Islam as religion (82.6%). Only about half of the participants (50.9%) had formal education, and majority of them (61.7%) were in a polygamous family setting (Table 1).

Participants' family dynamics and glycemic control status; and their relationship

Majority of participants had very connected (75.0%) and flexible (53.9%) families; the family communication level was just moderate in a larger proportion of participants (41.7%), and close to two-thirds (58.7%) had high or very high family satisfaction levels. Majority of participants had very low level of family disengagement (74.9%), and low or very low enmeshed family levels (73.0%). About half of participants (52.0%) had high or very high rigid family levels, but most of them (84.9%) had very low chaotic family level (Table 2). The participants'

glycated haemoglobin (HbA1C) values ranged from 6 to 19.0% with mean, median and modal levels of 9.67, 9.20, and 8.0% respectively. Only a few, 23 (8.5%) of the 271 participants had good glycemic control (Figure 1). Good glycemic control was associated ($p < 0.05$) with high scores on balanced cohesion and family communication scales, and low scores on disengagement scales (Table 3).

Table 1: Socio-demographic characteristics of Participants

Variables	Frequency (%)
Sex (n = 271)	
Male	150 (55.4)
Female	121 (44.6)
Marital status (n = 271)	
Single	3 (1.1)
Married	221 (81.5)
Divorced	8 (3.0)
Widowed	39 (14.4)
Religion (n = 270)	
Islam	223 (82.6)
Christianity	47 (17.4)
Education level (n = 269)	
None	31 (11.5)
Quranic only	101 (37.6)
Primary	48 (17.8)
Secondary	38 (14.1)
Tertiary	51 (19.0)
Family setting (n = 269)	
Monogamous	103 (38.3)
Polygamous	166 (61.7)

DISCUSSION

This study assessed the relationship between family dynamics and glucose control among adult type 2 diabetes mellitus patients presenting at Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Majority (55.4%) of the participants in this study were males, this finding is in contrast to the finding in studied conducted in Ido-Ekiti, Nigeria (Fatusi et al., 2016), and Lafia, Nigeria (Ndubuka et al., 2016), in which majority of participants were females. This could be because due to the culture in northern Nigeria in which women are required to obtain permission from their husbands before going outside their homes. Also, in contrast to the finding in the study conducted in Ido-Ekiti, Nigeria, majority of the participants in this study (83.0%) were Muslims, this is because Sokoto, Nigeria is predominantly a Muslim community, and this also explains why majority of participants (61.0%) were in polygamous family setting since polygamy is allowed in Islam.

Table 2: Participants' family dynamics

Family dynamics	Frequency (%), n = 271
Balanced cohesion level	
Somewhat connected	5 (1.8)
Connected	61 (22.5)
Very connected	205 (75.0)
Balanced flexibility level	
Somewhat flexible	5 (1.8)
Flexible	146 (53.9)
Very flexible	120 (44.3)
Family communication level	
Very high	23 (8.5)
High	51 (18.8)
Moderate	113 (41.7)
Low	53 (19.6)
Very low	31 (11.4)
Family satisfaction level	
Very high	74 (27.3)
High	85 (31.4)
Moderate	48 (17.7)
Low	38 (14.0)
Very low	26 (9.6)
Disengaged level	
Very high	1 (0.4)
High	12 (4.4)
Moderate	15 (5.5)
Low	40 (14.8)
Very low	203 (74.9)
Enmeshed level	
Very high	2 (0.7)
High	10 (3.7)
Moderate	76 (28.0)
Low	122 (45.0)
Very low	61 (22.5)
Rigid level	
Very high	49 (18.1)
High	92 (33.9)
Moderate	78 (28.8)
Low	35 (12.9)
Very low	17 (6.3)
Chaotic level	
High	1 (0.4)
Moderate	8 (3.0)
Low	32 (11.8)
Very low	230 (84.9)

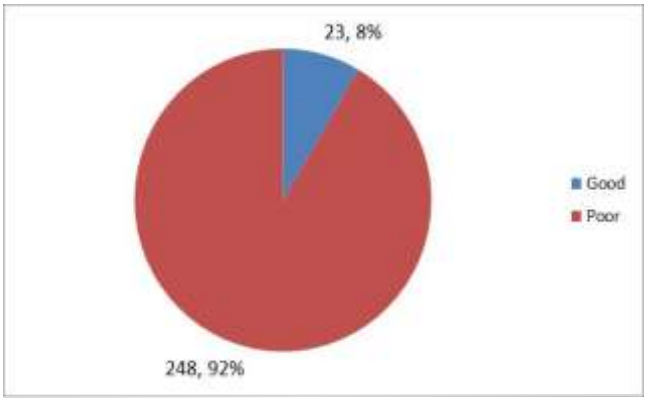

Figure 1: Participants' glycemic control status

Table 3: Distribution of glycemic control by participants' family dynamics

Family dynamics	Glycemic control status (n = 271)			Test of significance
	Good (HbA1C = 6-7%) Frequency (%)	Poor (HbA1C = 8-19%) Frequency (%)	Total Frequency (%)	
Balanced cohesion level				
Somewhat connected	2 (8.7)	2 (0.8)	4 (1.5)	Feχ^2= 6.023, p = 0.048*
Connected	5 (21.7)	57 (23.0)	62 (22.9)	
Very connected	16 (69.6)	189 (76.2)	205 (75.6)	
Balanced flexibility level				
Flexible	12 (52.2)	136 (54.8)	148 (54.6)	χ^2= 0.060, p = 0.806
Very flexible	11 (47.8)	112 (45.2)	123 (45.4)	
Family communication level				
Very high	2 (8.7)	21 (8.5)	23 (8.5)	χ^2= 1.662, p = 0.038*
High	6 (26.1)	42 (16.9)	48 (17.7)	
Moderate	8 (34.8)	106 (42.7)	114 (42.1)	
Low	5 (21.7)	50 (20.2)	55 (20.3)	
Very low	2 (8.7)	29 (11.7)	31 (11.4)	
Family satisfaction level				
Very high	10 (43.5)	65 (26.2)	75 (27.7)	Feχ^2= 4.650, p = 0.310
High	4 (17.4)	81 (32.7)	85 (41.4)	
Moderate	5 (21.7)	41 (16.5)	46 (17.0)	
Low	3 (13.0)	35 (14.1)	38 (14.0)	
Very low	1 (4.3)	26 (10.5)	27 (10.0)	
Disengaged level				
Very high	2 (8.7)	1 (0.4)	3 (1.1)	Feχ^2= 9.168, p = 0.037*
High	0 (0)	11 (4.4)	11 (4.1)	
Moderate	0 (0)	16 (6.5)	16 (5.9)	
Low	2 (8.7)	38 (15.3)	40 (14.8)	
Very low	19 (82.6)	182 (73.4)	201 (74.2)	
Enmeshed level				
Very high	0 (0)	2 (0.8)	2 (0.7)	χ^2= 2.012, p = 0.716
High	0 (0)	10 (4.0)	10 (3.7)	
Moderate	9 (39.1)	66 (26.6)	75 (27.7)	
Low	9 (39.1)	111 (44.8)	120 (44.3)	
Very low	5 (21.7)	59 (23.8)	64 (23.6)	
Rigid level				
Very high	8 (34.8)	44 (17.7)	52 (19.2)	Feχ^2= 3.491, p = 0.454
High	7 (30.4)	82 (33.1)	89 (32.8)	
Moderate	5 (21.7)	73 (29.4)	78 (28.8)	
Low	2 (8.7)	33 (13.3)	35 (12.9)	
Very low	1 (4.3)	16 (6.5)	17 (6.3)	
Chaotic level				
High	0 (0)	1 (0.4)	1 (0.4)	Feχ^2= 5.563, p = 0.148
Moderate	0 (0)	8 (3.2)	8 (3.0)	
Low	8 (34.8)	39 (15.7)	47 (17.3)	
Very low	15 (65.2)	200 (80.6)	215 (79.3)	

*Statistically significant; Fe: Fisher's Exact Test

Family functioning is one of the important aspects of family environment which may affect the physical, social and emotional health of individuals. In fact, what happens within a family and how the family functions are the crucial factors in creating flexibility and mitigating current and future risks associated with unfortunate events and unsuitable conditions (Ghamari and Khoshnam, 2011). In this study, the families of the participants were very connected (75%) and flexible (98%); this finding indicates high levels of closeness and support in their families. This is similar to the finding in a study by Fatusi et al. (2016) who also found that about half of the respondents in their study had good family support (53.2%), even though a much higher level was obtained in this study. This could be because the Nigeria traditional culture is close-knitted, but at the same time flexible enough to allow an individual to do what he/she wants, but with supervision since there is closeness in the family. Family communication level was moderate in a larger proportion (41.7%) of the participants in this study, and with low proportions of participants reporting extreme levels of very high (8.7%) and very low (11.4%) communication. This finding is keeping with the traditional Nigerian culture where communication is not well encouraged; and it is

similar to the finding in a study conducted among adolescents with type 1 diabetes mellitus in Pakistan (Najmi et al., 2013) where the level of communication among family members was found to be low. Communication among family members is said to improve the functioning of a family, and it is believed that if communication is improved among diabetic patients and their families, their glycemic control will concomitantly improve (Barnes and Olson, 1986).

Close to two-thirds (58.7%) of the participants in this study had high or very high family satisfaction levels, this could be related to the high proportion of participants (75.0%) with very connected families, as having a close knitted family most likely gave them satisfaction. This finding is in agreement with the finding in a study in New York (Trief et al., 1998) that reported that patients with high family cohesion were satisfied with adaptation to their disease conditions. It is not surprising that majority of participants in this study (74.9%) had very low level of family disengagement (74.9%), and low or very low enmeshed family levels (67.5%) considering the high proportion of participants with connected and very connected families (97.5%), and those with flexible or very flexible families (98.2%) among them.

The high and very high rigid family levels in majority of the participants (52.0%) in this study could be due to the fact that the traditional African society is a disciplinarian society in which although the families are closely knitted, there are rules guiding the conduct of the individual family members, and there are strict penalties for offenders; this probably accounts for the finding of most of the participants in this study (84.9%) having very low chaotic family level.

The 9.67% mean glycosylated haemoglobin (HbA1c) level obtained among the participants in this study with only a few of them (8.5%) having good glycemic control is disturbing in view of the microvascular and macrovascular complications that are associated with poor glycemic control, and the negative impacts of these complications on their health status, quality of life and productivity (WHO, 2011; World Bank, 2011). While a study by Ndubuka et al. (2016) similarly reported poor glycemic control with a mean HbA1C level of 11.2% in a study conducted in Lafia, Nigeria, on the contrary, Fatusi et al. (2016) found a much better glycemic control with a mean Hb1AC of 7.07% (and with only 22.4% of participants having Hb1AC level above 7.0%) in a study conducted in Ido-Ekiti, Nigeria, and good glycemic control was associated with family closeness and support. The poor glycemic control among the participants in this study could be due to poor drug compliance or inability to afford the drugs, and it brings to the fore the importance of family support in facilitating compliance to treatment among patients with chronic disease conditions.

The association between good glycemic control and high balanced cohesion and family communication levels, and also low disengagement levels in this study is in consonance with the findings in previous studies (Openshaw, 2011; Pereira et al., 2008; Mbanya and Gill, 2004), as it is believed that a closely knitted family that communicates well help in achieving good glycemic control. In addition, it is believed that high performance regarding family functioning can help to develop the individual members' resilience, and enable them to enjoy better health (Openshaw, 2011; Winek, 2010; Jones et al., 2008; Olson and Gorall, 2003). It is therefore necessary for care providers to routinely assess the family dynamics of diabetic patients, and also involve their family members in the management of their disease conditions, as it would enable their family members to better understand the health and social problems they are having, and to also provide them with the necessary support timely and consistently.

CONCLUSION

Although, majority of the participants in this study had balanced families, only a few of them had good glycemic control, and it was associated with high scores on balanced cohesion and family communication scales, and low score on disengagement scale. Care providers should routinely assess the family dynamics of diabetic patients and also involve their family members in the management of their disease conditions.

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Conflict of interest

None declared.

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Electronic quality authentication-linked antimalarial drug survey in Sokoto metropolis, Nigeria

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ABSTRACT

Chemotherapy remains a key malaria control strategy but the emergence of resistance to antimalarial drugs by the malaria parasite poses a threat to sustained positive impact of this strategy. Circulation and use of fake/substandard antimalarial drugs are major contributory factors to the development of malaria resistance to chemotherapeutic agents. This antimalarial drug survey was carried out by covert visits to randomly selected commercial drug outlets in Sokoto metropolis, Nigeria, by the research team. The scope of the survey included determining the variety of registered antimalarial drug brands available at the commercial drug outlets in the study area and finding out which of these brands have the National Agency for Food and Drug Administration and Control (NAFDAC) registration numbers with or without the 12-digit (NAFDAC) PIN numbers for electronic drug quality authentication. A total of two thousand and two units of antimalarial drugs distributed across 78 brand names were sampled in this study. All the drugs sampled carried valid expiry dates and registration numbers but only 17 brands (21.79%) had the NAFDAC PIN numbers (and all of them were confirmed to be authentic). None of the syrup or suspension samples had the 12-digit PIN numbers. Sixty-one (78.21%) of the sampled brands spread across various formulations lacked the NAFDAC PIN numbers and their genuineness or sources could not be authenticated at the points of purchase.

Keywords: Antimalarial drug survey, electronic quality authentication

INTRODUCTION

Malaria is a public health front liner in Nigeria with virtually all of her population at risk of the infection and accounting for about two-thirds of all hospital visits. It is estimated that Nigeria loses about 132 billion naira to malaria annually in terms of cost of malaria prevention, treatment and lost man-hours (Carrington, 2001; Jimoh *et al.*, 2007). To combat the malaria menace, prompt malaria diagnosis and effective chemotherapy using Artemisinin – based antimalarial drug combinations was adopted in year 2005 as a key strategy in the National Malaria Control Programs (Eastman and Fidoc, 2009). However, the gains of this anti-malaria policy could be reversed by the emergence of malaria parasite's resistance to antimalarial chemotherapeutic agents (Breman, 2012). Use of fake and/or substandard anti-malarial drugs has been shown to contribute substantially to the development of malaria parasite's resistance to drugs (Tipke *et al.*, 2008; Newton *et al.*, 2010). Drug counterfeiting (antimalarial agents inclusive) is a global phenomenon (El-Duah and Ofori-Kwankye, 2012). In Nigeria, the counterfeit prevalence for all drugs was reported to be about 40% in 2001. Between then and now NAFDAC, the nation's anti- drug counterfeit agency, has stepped up its regulatory activities including the introduction of Mobile Authentication Service and Truscan device. Consequently, the high counterfeit prevalence reported in 2001 for all drugs in general, and the antimalarial drugs in particular, was said to have dropped significantly within a period of about ten years (WHO, 2011; Kelesidis and Falagas, 2015).

In Sokoto metropolis, as in most other Nigerian cities, anti-malarial medicines are sold on the counter to consumers often without prescription. But there is paucity of reports on the survey and quality assessment of anti-malarial medicines available in Sokoto using the NAFDAC-introduced mobile authentication service. This study was conducted to determine the variety of

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antimalarial drug brands being sold to end users at the various retail outlets in Sokoto metropolis, Nigeria, and to confirm their authenticity by mobile authentication service. For the purpose of this study, an antimalarial drug brand or brand name was defined as any patented antimalarial medicine produced and marketed by a legally licensed pharmaceutical company. Herbal preparations and supplements were not captured by this definition and in this survey.

MATERIALS AND METHODS

Study Area and Population

Sokoto metropolis is the capital of Sokoto State, Nigeria, and the seat of the Caliphate. It is located in the Northwestern part of the country, and lies between latitude 13° 3' 490N and longitude 5° 14' 890E. It is at an altitude of 272 m above the sea level, and is in the dry Sahel belt, surrounded by the sandy savannah, and is dotted with isolated hills. It has an annual average temperature of 28.3°C (82.9 °F), and has a warm and dry weather with day-time temperatures generally around 40 °C (104.0 °F) during the months of February to October. The rainy season usually extends from June to October, while the dry season is usually dominated by the cold harmathan wind, particularly between late October and February (Tsoho, 2007). According to the 2006 National population census, Sokoto metropolis has a population of 427, 760 consisting predominantly of Muslims with a minority Christian population. The major indigenous tribes are Hausa and Fulani, but there are also other tribes such as the Zabarmawa, Nupes, Yorubas, Ibos, Edos, and Ebiras. The indigenous residents are majorly subsistence farmers, while those from other tribes are involved in trading/commerce and civil service. Pharmaceutical retail outlets are found in almost all parts of the city with at least a patent medicine store within a 5 minutes' walk from most households.

Data Collection and Analysis

Several randomly selected commercial medicine outlets in Sokoto metropolis were paid covert visits by the research team (in order not to reveal the purpose of the survey) in the months of July and August 2014. Unit samples of antimalarial drug brands were randomly selected and inspected for relevant data such as the manufacturing company, brand names, presence or lack of NAFDAC product registration numbers. Other data obtained were batch numbers, year of manufacture and expiry, formulation forms, whether single or combination therapy, and presence or lack of NAFDAC 12-digit mobile authentication PIN numbers. The drug packs were scratched and the PIN numbers were texted to any of NAFDAC codes 38353 and 1393 via cell phones. Instantaneous electronic responses from these codes indicating whether the drug samples were fake or authentic/original, were recorded. Where and when there was need for further clarification in the course of the study, the alternative NAFDAC GSM number 08039012929 was used. Between August 2015 and May 2018 physical visits were made by our research team to the Sokoto, Ibadan and Abuja NAFDAC offices to seek clarifications/further information on some of our findings regarding some samples of the antimalarial agents that were encountered during the survey, and the number of portals/codes approved by NAFDAC for this mobile authentication service. Data were analyzed as descriptive statistics and summarized as frequencies and percentages.

RESULTS

Electronic drug authentication profile of antimalarial drugs

Pharmaceutical retail outlets were fairly evenly distributed in all the residential areas of the metropolis with a commercial medicine store within 5 minutes' walk of most households. Forty-six retail outlets were visited for this study. In all, a total of 2002 units of anti-malarial drugs were examined in the survey. All the anti-malarial medicines had valid expiry dates as well as NAFDAC product registration numbers but only 202 (10.09%) of the 2002 units carried the 12-digit (NAFDAC) PIN numbers for mobile authentication. The 2002 antimalarial drug samples belonged to 78 different brand names. While only 202 anti-malarial samples belonging to 17 brand names had PIN numbers for mobile authentication service, the remaining 1800 samples belonging to 61 different brands did not possess PIN numbers. Further details of the brands surveyed are as shown in Tables 1-4.

The fourteen brand names with PIN numbers in tablet formulations were: Co-arinate (Artesunate-Pyramethamine-Sulfametoxypyrazine) FDC Adult dose, Amalar (Sulphadoxine-Pyramethamine) tablets, Codisin Plus (Dihydroartemisinin-Piperaquine Phosphate) tablets, Famter ds (Artemether 80mg/Lumefanthrine 480mg) tablets, Tamether Fort (Artemether 80mg-Lumefanthrine 480mg) tablet, Laridox (Suphadoxine-Pyramethamine) tablets, Gvither-Plus (Artemether-Lumefanthrine) Dispersible Tablet, Coatal Forte Artemether 80-Lumefanthrine 480) ACT tablet, ACT Pro AL Forte (Artemether 80mg-Lumefanthrine 480mg)

tablets, Camosunate (Amodiaquine-Artesunate) tablet adult dose, Lonart DS (Artemether 80mg/Lumefantrine 480mg) tablets, Camosunate (Amodiaquine 150mg-Artesunate 50mg) tablets, Camosunate (Amodiaquine 75mg-Artesunate 25mg) tablets, Artequin (Artesunate 600mg-Mefloquine 750mg) tablets and Amatem Forte (Artemether 160mg-Lumefanthrine 960mg) tablets. Of these tablet formulations, Camosunate (Amodiaquine 150mg-Artesunate 50mg) tablets, Camoquine (Amodiaquine 75mg-Artesunate 25mg) tablet and Gvither-Plus (Artemether 20mg-Lumefanthrine 120mg) dispersible powder were in pediatric dosage forms. All of these 17 antimalarial formulations having mobile authentication PIN numbers were electronically confirmed to be original or of authentic sources. Twelve of the fourteen brands of antimalarial tablet formulations were combination therapies while only two (Laridox and Amalar; both of which are Sulphadoxine-Pyramethamine synergies) were monotherapies. Two of the antimalarial brands with PIN numbers for mobile authentication were injections: α-β arteether (E- MAL) and Beether α-β-Arteether. All the units of α-β arteether (E- MAL) and Beether α-β-Arteether injections inspected were electronically confirmed to be original or of authentic quality. None of the antimalarial syrup or suspension samples had PIN numbers for mobile authentication

Table 1: Brand distribution of antimalarial drugs in Sokoto metropolis, Nigeria

Brand formulation	With PIN numbers			Without PIN numbers		
	Combina1tion therapies	Monotherapies	Total	Combination therapies	Monotherapies	Total
Tablets	12	2	14	22	12	34
Syrups	0	0	0	9	8	17
Powders	1	0	1	2	0	2
Injections	0	2	2	0	8	8
Total	**13**	**4**	**17**	**33**	**28**	**61**

Table 2: Percentages of antimalarial brand formulation with or without PIN numbers

Brand formulation	Brand formulations with PIN numbers		Brand formulations without PIN numbers	
	Frequency	Percentage	Frequency	Percentage
Tablets (n = 48)	14	29.17	34	70.83
Syrups (n = 17)	0	0	17	100
Powders (n = 3)	1	33.33	2	66.67
Injections (n = 10)	2	20.00	8	80.00
Total (n = 78)	**17**	**21.79**	**61**	**78.21**

Table 3: Percentages of combination antimalarial brands with or without PIN numbers

Brand formulation	Combination brands with PIN numbers		Combination brands without PIN numbers	
	Frequency	Percentage	Frequency	Percentage
Tablets (n = 34)	12	35.29	22	64.71
Syrups (n = 9)	0	0	9	100
Powders (n = 3)	1	33.33	2	66.67
Injections (n = 0)	0	0	0	0
Total (n = 46)	**13**	**41.30**	**33**	**71.74**

Table 4: Percentages of monotherapy antimalarial brands with or without PIN numbers

Brand formulation	Monotherapy brands with PIN numbers		Monotherapy brands without PIN numbers	
	Frequency	Percentage	Frequency	Percentage
Tablets (n = 14)	2	14.29	12	85.71
Syrups (n = 8)	0	0	8	100
Powders (n = 0)	0	0	0	0
Injections (n = 10)	2	20.00	8	80.00
Total (n = 32)	**4**	**12.50**	**28**	**87.50**

DISCUSSION

The seventy-eight different commercial brands of antimalarials encountered in the survey provided a variety of malaria chemotherapeutic agents (which comprised tablet, suspension, powdery and injectable formulations) that are available to the consumers in Sokoto metropolis. However, these consumers would not be able to determine the genuineness of a greater proportion of these drugs by electronic authentication as only 17 (21.79%) of the 78 commercial antimalarial brands inspected had the 12-digit PIN numbers for electronic drug quality authentication. This could put the Sokoto populace at risk of exposure to counterfeit/substandard antimalarial treatments with the attendant dire consequences. Not the least of these consequences are economic burden on patients, their families, the health system, and manufacturers of good quality drugs, as well as loss of confidence in the health care system (Johnbull and Ume, 2013). Other undesirable consequences of intake of poor-quality antimalarial drugs that could result from this situation whereby medicines of uncertain quality are left to circulate freely include increased morbidity and mortality, development of drug resistance and treatment failures (Akinyandemu, 2013). This risk becomes highly probable judging from the reported high prevalence of drug counterfeiting in Nigeria (Chika *et al.*, 2011; Buowari, 2012), especially in fringe states and remote communities (including Sokoto, Nigeria) where surveillance and other drug regulatory activities may not be as effective as in areas near the central seat of government (Newton et al., 2006). Also, previous similar drug surveys had reported high levels of counterfeit anti-infective medicines in Nigerian pharmaceutical outlets (Shakoor *et al.*, 1997; Taylor *et al.*, 2001).

It is important to note that all the 17 anti-malarial brands that had the PIN numbers for mobile quality authentication were confirmed to be original. It is also instructive to note that only 4 (23.53%) of the 17 antimalarial brands with mobile PIN numbers were monotherapies as compared to 28 (45.90%) of the 61 brands without the NAFDAC PIN numbers. While the monotherapeutic brands with the NAFDAC PIN numbers consisted of only Sulphadoxine-Pyramethamine prophylactic drug, the list of monotherapeutic brands without the PIN number was awash with different anti-malarial mono-therapeutic drugs including banned antimalarial mono-therapeutic drugs such as chloroquine and halofantrine. The finding of higher proportions of unapproved antimalarial brands being on the list of antimalarial brands without the NAFDAC PIN numbers in this study is a pointer to the fact that the mobile authentication scheme can, and should be, a veritable tool in the fight against drug counterfeiting by government and regulatory agencies by ensuring that antimalarial drug manufacturers are mandatorily enrolled into the scheme (WHO, 2011; Akinyuli, 2007). This position is supported by the discovery that all the 17 brands that had the PIN numbers in this study were returned as original on testing; it is therefore arguable that if all the 78 brands were made to possess the PIN numbers, the chances that all of them would be of original and of authentic sources are high.

It presupposes that if malaria drug manufacturers are made to key into the mobile drug quality authentication scheme by NAFDAC, Chloroquine and other unsafe antimalarial mono-therapeutic agents that are not desirable to be in circulation would be effectively screened out at the point of enlisting into the program. It is obvious from this survey that the continued sale/use of Chloroquine (Ughuro *et al.*, 2009) and other single-agent antimalarial chemotherapeutic drugs in the study area several years after their ban for malaria treatment highlights not only the risk to which consumers are exposed, but perhaps also the paucity of

drug regulatory activities and policy enforcement in the metropolis. Continued use of mono-therapeutic agents for the treatment of malaria clinical cases has severally been implicated in the development of malaria parasite's resistance to malaria chemotherapeutic agents (Mutabingwa, 2005; Dodoo *et al.*, 2009). Antimalarial mono-therapeutic drugs are still rampant in the market today due to factors bothering on their supply and demand. Factors on the supply end of the chain have been outlined to include reduced unit cost of producing these mono-therapeutic agents and hence increased profits for desperate drug manufacturers, and also weak drug supply regulation, in addition to poor drug supply monitoring and supervision. On the demand end of the antimalarial drug distribution chain is the continued attraction of these mono-therapeutic agents to consumers because they are far cheaper than the Artemisinin-based combination malaria therapeutic agents (Arrow *et al.*, 2004). One of the findings of this survey was the observation that on the average, most antimalarial monotherapies cost about 200 naira while most antimalarial Artemisinin-based combination therapies cost from 450 – 1,200 naira. More so most consumers can not differentiate between the packages of Artemisinin-based monotherapies and combination therapies, and so they ignorantly go for the more affordable drugs with the belief that both classes of drugs are equally effective.

This study also found that none of the several units of the 17 antimalarial brands in syrups or suspension forms inspected had mobile identification (PIN) numbers. This finding implies that none of the syrup antimalarial medications as at the time of the survey could have their quality electronically authenticated. This scenario could expose the pediatric end users to risk of adulteration because it has been known that pediatric formulations are by their physical nature prone to adulteration, and the pediatric tissues/organs are more sensitive to the adulterants/toxic substances contained in these poor-quality drugs. This is the reason behind the strict global requirements for extra pre-cautionary measures in the formulation of pediatric dosage forms; but in Nigeria, widespread counterfeiting of syrups such as Chloroquine and Sulphadoxine-Pyramethamine has been previously reported (Taylor *et al.*, 2001; Aina *et al.*, 2007; Bonati, 2009). The finding of only two of ten brands of antimalarial injections encountered in this study possessing the PIN numbers may indicate not only poor compliance of manufacturers to this anti-drug counterfeit policy but also weak enforcement by relevant regulatory agencies. Antimalarial injections are employed to treat severe and acute malaria attacks for prompt reduction in the anticipated high malaria parasitemia in such scenarios. Now, if the authenticity/genuineness of the greater number of these drugs could not be confirmed before use, it is obvious that the therapeutic efficacy of treatment with such drugs cannot be guaranteed. These foregoing postulations could have played out in previous reported incidence of circulation/use of counterfeit antimalarial injections (Taylor *et al.*, 2001; Cockburn *et al.*, 2007).

CONCLUSION

Although optimal utilization of the NAFDAC-linked electronic drug authentication scheme has been reported to be beneficial in the fight against drug counterfeiting, this study has shown that several antimalarial commercial brands across all formulations available to consumers in Sokoto metropolis, Nigeria, as at the time of this survey were yet to enroll into the scheme. All stakeholders should gear efforts towards the enrollment of antimalarial, and indeed, all drugs in all parts of the country into the scheme.

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Knowledge of sickle cell disease; attitude and practice regarding premarital genotype counseling and testing among the lecturers of Usmanu Danfodiyo University, Sokoto, Nigeria

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ABSTRACT

Background: Sickle cell disease (SCD) is one of the commonest monogenetic diseases in Nigeria. Knowledge of the disease and uptake of premarital haemoglobin genotyping has substantial influence on the choice of spouse and control of the disease. **Aim:** This study aimed to assess the knowledge of sickle cell disease; attitude and practice regarding premarital genotype counseling and testing among the lecturers of Usmanu Danfodiyo University, Sokoto, Nigeria. **Materials and Methods:** This was a descriptive cross-sectional study among 269 permanent lecturers (selected by multi-stage sampling technique) of Usmanu Danfodiyo University, Sokoto, Nigeria. A pre-designed, pretested self-administered questionnaire was used to obtain data on the research variables. Data were analyzed using the IBM SPSS version 23 statistical computer software package. **Results**: Almost all, 267 (99.3%) of the 269 respondents were aware of sickle cell disease, and most of them (89.2%) had good knowledge of the disease. Majority of respondents knew what premarital hemoglobin genotype testing is (62.5%), when it should be done (100%), and its benefits, including preventing having a child with sickle cell disease (69.1%). Only a fifth and below of respondents showed negative attitude towards the test. Although, majority of respondents (70.3%) were willing to do the test, less than half of them (47.6%) did the test before getting married. **Conclusion:** Despite good knowledge of sickle cell disease and positive attitude to premarital haemoglobin counseling and testing, uptake of the test was low among the lecturers of Usmanu Danfodiyo University, Sokoto, Nigeria. The management of the university should organize periodic haemoglobin genotype screening programs for the members of the university community.

Keywords: Knowledge, attitude, sickle cell disease, premarital screening

INTRODUCTION

Sickle cell disease (SCD) is a genetic disorder caused by an abnormality in the synthesis of the β-globin chain of the hemoglobin molecule. This abnormality results from the substitution of a polar amino acid, glutamic acid, with a non-polar amino acid, valine, in the 6th position of chromosome eleven. Under low oxygen tension, this single point mutation causes red blood cells to assume the shape of a "sickle" and leads to complications including tissue infarction, anemia, priapism, splenomegaly and reduced dietary intake (Stuart and Nagel, 2004; Serjeant 2001; Nagel and Platt, 2001). About 5% of the world's population carries the gene responsible for haemoglobinopathies and each year about 300,000 infants are born with major haemoglobin disorders including more than 200,000 cases of sickle cell anemia in Africa (WHO, 2006). About 25% of Africans are carriers of the abnormal hemoglobin gene, and Nigeria has the highest population of people with sickle cell disease, and has been estimated to have at least 150,000 newborns born with SCD annually (DeBaun and Galadanci, 2019; WHO, 2019). Choosing a partner is sometimes very challenging as it is necessary to balance the purpose of marriage including companionship, support and procreation with the enormous responsibilities associated with it in terms of time and financial commitments, and the situation of things could become terribly bad in the event of having a child or children with a chronic medical condition like sickle cell disease (Boadu and Addoah, 2018; Brake, 2016). Also, evidence from literature has shown that

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more than half of married couples enter into marriage unaware of their haemoglobin genotypes, and this is believed to account for the reported 2% annual births of children with SCD in most developing countries (Boadu and Addoah, 2018). Reports from the parents of affected children showed that they had entered into marriage without prior knowledge of their sickling status, and without knowing the symptoms of the disease in the newborn (CDC, 2019). While the current advances in diagnoses and the frequent campaigns through the mass media and by healthcare professionals are expected to increase people's knowledge about premarital counseling and sickle cell disease screening with a view to reduce the prevalence of high risk marriages, sickle cell disease is still very common in our society in spite of these efforts (Jiya et al., 2017; Amede, 2015; Akodu et al, 2013).

In addition, non-adherence to premarital sickle cell screening can lead to the birth of a child with the disorder, separation and divorce among parents, frequently going in and out of the hospital, and increased infant mortality and morbidity; and if intending couples are favorably disposed to doing premarital screening, it will help in the detection of carriers of sickle cell trait and prevent the birth of affected children. It is therefore worrisome that even though premarital sickle cell screening programs has a high potential to reduce the incidence of SCD in the population by preventing marriages among high risk couples, many people do not adhere to it (Udunbun, 2008; Acharya, 2009; Moronkola and Fadairo, 2006-2007). The school is an agent of change, and lecturers cannot promote prevention of sickle cell disease among their students (who are still young, predominantly not married, and most likely to benefit from such an intervention) if they lack knowledge of it, or have negative attitude towards it, or do not practice it. This study was conducted to assess the knowledge of sickle cell disease; attitude and practice regarding premarital genotype counseling and testing among the lecturers of Usmanu Danfodiyo University Sokoto, Nigeria.

MATERIALS AND METHODS

Study Design, Population and Area

This was a descriptive cross-sectional study among the lecturers of Usmanu Danfodiyo University, Sokoto, North-Western Nigeria. All the permanent lecturers who were present at the time of the survey and consented to participate were considered eligible for enrolment into the study, while visiting lecturers and those in the College of Health Sciences, Faculty of Veterinary Medicine, and Sciences were excluded.

Sample Size Estimation and Sampling Technique

The sample size was statistically estimated at 269 and the eligible participants were selected by multistage sampling technique. At the first stage, a list of all the faculties in the university was obtained and the selection of the faculties to be used for the study was done by simple random sampling using the balloting procedure. At the second stage, a list of the departments in the selected faculties was obtained and selection of the departments to be used for the study was done by simple random sampling technique using the balloting procedure. At the third stage, the study participants were selected in the selected departments by systematic sampling technique using the staff list in the respective departments to constitute the sampling frame. Proportionate allocation was done in the selection of participants from the respective departments based on their staff strength.

Data Collection and Analysis

A set of pretested semi-structured self-administered questionnaire was used to obtain information on the participants' socio-demographic characteristics, knowledge of sickle cell disease; and attitude and practice regarding premarital genotype counseling and testing. It was reviewed by senior researchers in the Department of Community Health, Usmanu Danfodiyo University, Sokoto, Nigeria, to ascertain content validity. The questionnaire was pretested on 25 lecturers working at Sokoto State University, Sokoto, Nigeria, and the necessary corrections were done based on the observations that were made during the pretesting. Data were analyzed using the IBM SPSS version 23 computer statistical software package. Respondents' knowledge of sickle cell disease was scored and graded on a 12-point scale. One point was awarded for a correct response, while a wrong response or a non-response received no points. Those that scored $\geq 50\%$ of the maximum score were graded as having good knowledge, while those that scored $< 50\%$ of the maximum score were graded as having poor knowledge. The categorical variables were summarized using frequencies and percentages.

Ethical Consideration

Ethical approval was obtained from the Ethics and Medical Education Committee of Usmanu Danfodiyo University, Sokoto, Nigeria. Permission to conduct the study was obtained from the management of the university, and informed written consent was obtained from the study participants prior to questionnaire administration.

RESULTS

Socio-demographic characteristics of respondents

All the 269 questionnaires administered were adequately completed and found suitable for analysis, giving a response rate of 100%. Larger proportions 103 (38.9%) and 79 (29.4%) of the 269 respondents were aged 45-64 and 35-44 years respectively. Most of the respondents were males (96.3%), married (88.8%), and practiced Islam as religion (87.7%). Close to half of respondents (44.2%) reported family history of sickle cell disease (Table 1).

Table 1: Socio-demographic characteristics of respondents

Variables	Frequency (%), n = 269
Age group (years)	
25-34	39 (14.5)
35-44	79 (29.4)
45-64	103 (38.3)
55-60	47 (17.8)
`Sex	
Male	259 (96.3)
Female	10 (3.7)
Marital status	
Single	27 (10.0)
Married	239 (88.8)
Separated	1 (0.4)
Widowed	2 (0.7)
Religion	
Islam	236 (87.7)
Christianity	33 (12.3)
Faculty	
Education	52 (19.3)
Sciences	70 (26.0)
FAIS	55 (20.4)
Agric. Sciences	29 (10.8)
Management Sciences	57 (21.2)
Law	6 (2.2)
Family history of sickle cell disease	
Yes	119 (44.2)
No	150 (55.8)

FAIS: Faculty of Arts and Islamic Studies

Knowledge of sickle cell disease among respondents

Almost all, 267 (99.3%) of the 269 respondents had heard of sickle cell disease, and the most common sources of information cited were schools (44.6%) and family members (40.5%). Most 248 (92.2%) of the 269 respondents had good knowledge of sickle cell disease. Most of them (88.1%) knew AA as normal hemoglobin (Hb) genotype, and that sickle cell disease can be inherited if both parents have SS or AS Hb genotype. Whereas, only 2 (0.7%) of the 269 respondents knew that SCD can be cured through bone marrow transplant, majority of them (53.2%) knew that it can be prevented through premarital genotype counseling and testing (Table 2).

Respondents' knowledge, attitude and practice regarding premarital sickle cell disease screening

While all the respondents (100%) knew that premarital sickle cell disease screening should be done during courtship or just before marriage, about two-thirds of them knew that the test is done to detect sickle cell disorder (62.5%), and doing the test helps to prevent having a child with sickle cell disease (69.1%). Only about a fifth and below showed negative attitudes to the test, such as believing that the test could bring conflicts between couples (20.4%), or increase the chances of not getting married (15.6%). Majority of respondents (70.3%) showed interest in doing the test., but less than half of them (46.5%) were willing to reveal the result of the test to their intending spouses. Whereas, majority of respondents (58.7%) had done hemoglobin genotype testing (58.7%) and reported being AA (58.9%), only about a third of respondents (33.1%) did sickle cell disease screening test before getting married (Table 3).

DISCUSSION

This study assessed the knowledge of sickle cell disease; attitude and practice regarding premarital genotype counseling and testing among the lecturers of Usmanu Danfodiyo University, Sokoto, Nigeria. Almost all the respondents (99.3%) were aware of sickle cell disease, and most of them (89.2%) had good knowledge of the disease.

This finding is in contrast to the finding in a study conducted among youth corps members in Benin City, Nigeria, in which only 17.8% of the respondents had good knowledge of SCD despite a high level (98.4%) of awareness (Adewoyin et al., 2015). In our study most of the respondents (95.5%) agreed that SCD is an inherited disease while about half (53.2%) knew that it can be prevented through screening before marriage. The good knowledge of SCD among the respondents may be due to their high levels of educational attainments as the minimum level of education of the respondents was university degree. This finding is similar to the finding in a study conducted among secondary school students in Jos, Nigeria in which 83.2% of respondents were aware of SCD, 80.0% knew that SCD is an inherited disorder, 83.0% knew that it affects the red blood cells, while only about half of respondents (54%) knew that the disease can only be diagnosed through blood test (Olarewaju et al., 2013).

Less than half (44.6%) of the respondents in this study obtained information about SCD at the schools, this is in contrast to the finding in a study among students of School of Nursing, Sokoto, Nigeria, in which most of the respondents (83.6%) obtained information about SCD at the schools (Isah et al., 2016). This could be due to the fact that whereas this study was conducted among

Table 2: Knowledge of sickle cell disease among respondents

Variables	Frequency (%), n = 269
Ever heard of sickle cell disease	
Yes	267 (99.3)
No	2 (0.7)
Source of information	
School	120 (44.6)
Friend	39 (14.5)
Media	68 (25.3)
Family	109 (40.5)
Transmission of sickle cell disease	
Knew AA as normal haemoglobin (Hb) genotype	237 (88.1)
Knew that SCD is caused by abnormal haemoglobin	112 (41.6)
Knew that SCD is an inherited disease	257 (95.5)
Knew that SCD can be inherited if both parents have SS or AS Hb genotypes	
Knew that SCD cannot be transmitted through blood transfusion	204 (75.8)
Knew that sickle cell disease can cause, or is associated with:	
High morbidity and mortality	101 (37.5)
Frequent illness / hospitalization	37 (13.8)
Huge financial burden	38 (14.1)
Marital discord	8 (3.0)
Knew that SCD can be diagnosed through laboratory test (Hb genotype)	248 (92.2%)
Knew that SCD can be prevented through:	
Premarital hemoglobin genotype counseling and testing	143 (53.2)
Marrying someone with AA genotype	47 (17.5)
Preventing marriage between two individuals with AS genotype	15 (5.6)
Knowledge grading	
Good	240 (89.2)
Poor	29 (10.8)

Table 3: Respondents' knowledge, attitude and practice regarding premarital sickle cell disease screening

Variables	Frequency (%), n = 269
Knowledge of premarital sickle cell disease screening	
Knew that it is a test done before marriage to rule out sickle cell disorder	168 (62.5)
Knew that it should be done during courtship or just before marriage	269 (100)
Knew that it helps to prevent having a child with sickle cell disease	186 (69.1)
Attitude towards premarital sickle cell disease screening	
Believed that doing it will expose their genetic make up to the public	29 (10.8)
Believed that it is against their cultural / religious belief	18 (6.7)
Believed that the test could bring conflicts between couples	55 (20.4)
Believed that the test could increase the chances of not getting married	42 (15.6)
Would like to do the test	180 (70.3)
Would reveal the result of the test to intending spouse	125 (46.5)
Would still prefer to marry the intending spouse irrespective of the test result	54 (20.1)
Practice of hemoglobin genotype testing	
Ever done hemoglobin genotype screening before	158 (58.7)
Hemoglobin genotype (n = 158):	
AA	93 (58.9)
AS	63 (39.9)
Has forgotten	2 (1.3)
Practice of premarital haemoglobin genotype counseling and testing	
Did the test before marriage	89 (33.1)

teachers from non-medical disciplines, the latter study was conducted among nursing students whose curriculum include epidemiology and control of endemic diseases including sickle cell disease. Less than a fifth of the respondents in this study showed negative attitude towards premarital sickle cell screening, this finding is in contrast to the finding in a study conducted on attitude of genetic screening among secondary school students in Jos, where about 38% of the students still had negative attitude towards premarital counseling and testing (Olanrewaju etal., 2013). This implies that there is hope that the uptake of premarital sickle cell screening can improve if they encourage both their students and relatives at home on the importance and the need to go for premarital screening as a means of reducing the incidence of the disease in the study area.

Majority (70.3%) of the respondents in this study were willing to do premarital SCD screening to know their haemoglobin genotype before marriage, this could be related to the high proportion of respondents (69.1%) that knew that undergoing the test helps to prevent having a child with sickle cell disease; and it is reassuring considering the fact that the more people are willing to go for the screening, the less the chance of transmitting the disease. This finding is similar to the finding in a study among students of a tertiary educational institution in South-Western Nigeria in which majority of respondents (73.4%) affirmed that genotype screening for intending couples will help prevent unnecessary worries about giving birth to a child with SCD, and were willing to confirm their haemoglobin genotype in a bid to take informed decision about marriage (Faremi et al., 2018).

Uptake of haemoglobin genotype testing was sub-optimal (58.7%), while uptake of premarital genotype counseling and testing was poor (10.4%) among the respondents in this study. These findings are disturbing in view of the high educational attainments of the respondents; and the high levels of awareness of the disease, its adverse health and social effects, and the effectiveness premarital haemoglobin genotype testing in preventing giving birth to a child with sickle cell disease among them. Of serious concern is the relatively high prevalence of HbAS genotype (39.9%) among the respondents that have ever done haemoglobin genotype testing in view of the poor uptake of genotype counseling and screening by them, as these findings imply wide gaps between knowledge and practice. Similar to the findings in this study, a study among pre-marital couples in Port Harcourt, Nigeria, reported that less than two-thirds of respondents (58.9%) had done premarital genotype testing, and about a fifth of them (21.9%) had HbAS genotype (Faremi et al., 2018). Also, a study among secondary school students in Jos, Nigeria, reported that only 59.0% of respondents knew their genotype, and of these, 11.1% had HbAS genotype. These findings underscore the need for the management of the tertiary institutions in Nigeria to promote uptake of premarital haemoglobin genotype counseling and testing among their staff and students by organizing periodic haemoglobin screening programs in their respective institutions in order to reduce the high burden of sickle cell disease in the country.

CONCLUSION

Despite good knowledge of sickle cell disease and positive attitude to premarital haemoglobin counseling and testing, uptake of the test was low among the lecturers of Usmanu Danfodiyo University, Sokoto, Nigeria. The management of the university should organize periodic haemoglobin genotype screening programs for the members of the university community.

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Conflict of interest

None declared.

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Perception and predictors of HIV status disclosure among people living with HIV/AIDS in Sokoto, Nigeria

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ABSTRACT

Background: Non-disclosure of HIV status particularly in the developing countries where large proportions of new HIV infections occur within HIV sero-discordant couples is a serious threat to HIV/AIDS prevention and control in these countries. **Aim**: This study was conducted to examine the perception and predictors of HIV status disclosure among people living with HIV/AIDS (PLWHA) in Sokoto, Nigeria. **Materials and Methods**: This was a cross-sectional study among 381 PLWHA (selected by systematic sampling technique) accessing treatment and care in the health facilities across the three levels of care in Sokoto metropolis, Nigeria. A semi-structured interviewer-administered questionnaire was used to collect data on the research variables. Data were analyzed using IBM SPSS version 22 statistical computer software package. **Results**: Less than half 138 (39.3%) of the 370 respondents that completed the questionnaire perceived it necessary to disclose their HIV status to somebody. Of these, the majority (52.1%) perceived the risks associated with disclosure to be more than the benefits, and considered fear of the consequences (59.4%) as the major barrier to the practice. A little above half of respondents (55.9%) disclosed their HIV positive status to someone. Of these, only about a third (36.7%) disclosed to their spouses or partners; and being counseled on status disclosure and receiving financial support from their spouses or partners were the predictors of HIV status disclosure among the respondents. **Conclusion**: The findings of this study underscore the need for HIV/AIDS care providers to give sufficient attention to counseling on disclosure in the care of PLWHA, while all stakeholders should intensify awareness campaigns on the need for their spouses or partners to give them the necessary financial and emotional support.

Keywords: HIV status disclosure, perception, predictors, PLWHA

INTRODUCTION

Although, the number of new HIV infections worldwide declined by about 35% from 3.4 million in 2001 to 2 million in 2014, the transmission of the disease remains disproportionately high in sub-Saharan Africa which houses about 70% of new HIV infections globally despite the rapid expansion of access to HIV voluntary counseling and testing (VCT) across the continent (UNAIDS, 2014; Masiye and Ssekubugu, 2008; WHO, 2007; UNAIDS, 2008). Recent surveys in several sub-Saharan African countries show decreasing condom use and/or an increase in the number of sexual partners (Masiye and Ssekubugu, 2008). Nigeria is among the countries with the highest burden of HIV worldwide, with an estimated 3,229,757 people living with HIV, 220,393 new HIV infections, and 210,031 AIDS related deaths in 2013 (Salami et al., 2011). Also, the main mode of HIV transmission among adults in Nigeria is through heterosexual intercourse, and about two-fifths (42%) of these infections occur among persons that are generally perceived as 'low-risk', because it involves a sub-population that are either cohabiting or married, and condom use among this group is usually low (Salami et al., 2011).

The high HIV transmission rates in the sub-Saharan African countries despite the rapid expansion of access to HIV voluntary counseling and testing (VCT) services across the continent shows that while it is important for

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individuals to know their HIV status, it is equally important for them to disclose the results to their sexual partners (WHO, 2007; UNAIDS, 2008).

The potential preventive health benefits of disclosure have been emphasized in health research and programs with a particular focus on HIV disclosure to sexual partners (Allen et al., 2007). Disclosure of HIV positive status gives any potential or current sexual partners the opportunity to adopt behaviors that protect them from HIV infection. Conversely, if HIV positive individuals do not share their HIV test results, sexual partners are instead forced to rely on subjective assessments of a spouse, partner or potential partner's HIV status, and these assessments are often unreliable (Anglewicz and Chintsanya, 2011). HIV status disclosure between spouses or sexual partners is particularly relevant for halting the spread of HIV/AIDS particularly in sub-Saharan Africa (SSA) because HIV discordant couples now represent the majority of HIV infected couples across the continent (De-Walque, 2007), and a large proportion of new HIV infections in this region occurs within discordant couples either in legal marriages or in long-term stable partnerships. Disclosure is also important for the health of HIV infected individuals, as it enables them to receive the necessary emotional and physical support from their families and friends, encourages their partners to be tested, facilitates access to anti-retroviral treatment, and motivates their sexual partners to seek testing, change behavior and ultimately decrease transmission of HIV (Antelman et al., 2001; Farquhar et al., 2001; Maman et al., 2003; King et al., 2008).

In addition, disclosure may facilitate other health behaviors that may improve the management of HIV, for example, women who disclose their status to partners may be more likely to participate in programs for the prevention of HIV transmission from mothers to their infants; and by adequately addressing the emotional, social and practical sequelae of their HIV positive status, they may be more willing to adopt and maintain behaviors such as cessation of breastfeeding or adherence to treatment regimens (Betancourt et al., 2010; Obermeyer et al., 2011). A cause for concern is the fact that despite the increase in campaigns and the number of people getting tested, research indicates that substantial proportions of individuals diagnosed with HIV do not reveal their serostatus to those around them, including their sexual partners, particularly in the developing countries where the average HIV status disclosure rate was estimated at 49% as compared to the developed countries where the average disclosure rate was 79% (WHO, 2004, Obermeyer et al., 2011; Olagbuji et al., 2011); and HIV status non-disclosure obviously constitutes a serious threat to HIV prevention and control especially in view of the evidence that large proportions of new HIV infections occur among HIV sero-discordant couples (Linda, 2013; Eyawo et al., 2010). Evidence from research has shown that HIV status disclosure is majorly influenced by the way it is perceived by those living with the infection, and with the main barrier to disclosure being fear of the consequences post disclosure, such as stigmatization, disgrace to family and self, rejection, abnormal reaction from their sexual partners, rejection, intimate partner violence, domestic violence and divorce, among others (Kumar et al., 2006; Eyawo et al., 2010; Adeyomo et al., 2011; Chandra et al., 2003).

Also, several studies have established associations between HIV status disclosure and some factors such as the discloser's experience (positive or negative reactions), motivations, personal and cultural beliefs, risk-benefit assessments, individual circumstances, previous experiences, perceived degree of control over private information, and knowledge of the HIV status of partner (Ebuenyi et al., 2014; Masupe et al., 2012; Tshisuyi, 2014). Understanding the perception and predictors of HIV status disclosure among people living with HIV/AIDS is important in identifying the barriers to the practice, and in developing appropriate strategies for promoting the practice among them. This study was conducted to examine the perception and predictors of HIV status disclosure among people living with HIV/AIDS in Sokoto, Nigeria.

MATERIALS AND METHODS

Study Design, Population and Area

A cross-sectional study was conducted among people living with HIV/AIDS accessing treatment and care in the health facilities across the three levels of care in Sokoto metropolis, Nigeria, from June to August 2016. There are 3 primary health care centers, one secondary and one tertiary health facilities providing comprehensive HIV/AIDS services for 11,256 registered clients in Sokoto metropolis, Nigeria. All HIV positive clients ≥ 18 years old who have been accessing treatment, care and support at any of the study centers for a period of at least 3 months prior to the study and consented to participate were considered eligible for enrollment into the study, while those with severe debilitating conditions were excluded.

Sample Size Estimation and Sampling Technique

The sample size was estimated at 362 using the statistical formula for calculating the sample size for descriptive studies (Ibrahim, 2009), a 61.5% prevalence of HIV status disclosure in a previous study (Adeyomo et al., 2011), and a precision level of 5%. It was then adjusted to 381 in anticipation of a 95% response rate. The eligible participants were selected by systematic sampling technique using the list of clients accessing services in each of the selected facilities to constitute the sampling frame. Proportionate allocation was done in determining the number of participants that were enrolled in the respective facilities.

Data Collection and Analysis

A semi-structured interviewer-administered questionnaire was used to obtain information on the respondents' socio-demographic characteristics, and the perception and predictors of HIV status disclosure among them. Ten resident doctors from the Department of Community Medicine, Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, assisted in data collection after being trained on the objectives of the study, use of the research instrument, and interpersonal communication skills. The questionnaire was pretested on people living with HIV/AIDS accessing treatment and care at General Hospital, Yabo, Nigeria. This was done to check the feasibility of the use of the instrument and to familiarize the research assistants with the instrument. Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 22.0 software. Quantitative variables were summarized using mean and standard deviation, while qualitative variables were summarized using frequency and percentage. Frequency distribution tables were constructed; and cross tabulations were done to examine the relationship between categorical variables. The chi-square test was used to determine the factors associated with HIV status disclosure, while logistic regression analysis was used to determine the predictors of HIV status disclosure. All levels of significance were set at $p < 0.05$.

Ethical Consideration

Institutional ethical clearance was obtained from the Research and Ethics Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Permission to conduct the study was obtained from the management of the facilities used as study centers, while informed written consent was also obtained from the participants after explaining to them the purpose of the study and assurance of confidentiality.

RESULTS

Socio-demographic characteristics of respondents

Three hundred and seventy out of the 380 questionnaires administered were adequately filled and found suitable for analysis, giving a response rate of 97.4%. The mean age of the respondents was 37.0 ± 11.0 years. Most 345 (93.2%) of the 370 respondents were aged 21 to 50 years, and majority of them were females (63.9%), married (64.1%), and were Muslims (80.4%). Larger proportions of respondents had only primary education (39.5%) and were artisans/petty traders (32.2%) as shown in Table 1.

Table 1: Socio-demographic characteristics of respondents

Variables	Frequency (%) n = 370
Age groups (years)	
18-20	20 (5.0)
21-30	105 (26.0)
31-40	125 (30.9)
41-50	115 (28.5)
≥51	39 (9.6)
Sex	
Male	146 (36.1)
Female	258 (63.9)
Marital status	
Single	40 (10.8)
Married	237 (64.1)
Divorced	27 (7.3)
Widowed	66 (17.8)
Religion	
Christianity	77 (19.1)
Islam	325 (80.4)
Traditional	2 (0.5)
Educational status	
No formal education	113 (31.0)
Primary	144 (39.5)
Secondary	35 (9.6)
Tertiary	73 (19.9)
Occupation	
Unemployed	92 (24.8)
Farmer	41 (11.0)
Artisan/Petty trader	119 (32.2)
Business	75 (20.2)
Civil servant	43 (11.8)

Respondents' perception on HIV status disclosure

Less than half 138 (39.3%) of the 370 respondents were of the opinion that it was necessary or important for them to disclose their HIV status to somebody. Among the 138 respondents who considered it necessary to disclose, as much as 126 (91.3%) specified the most important person to disclose to. Of these, larger proportion 46 (33.8%) were of the opinion that their parents were the most important persons to disclose to, while 32.4% and 23.5% would prefer to disclose to their

Table 2: Respondents' perception on HIV status disclosure

Variables	Frequency (%)
Perceived it necessary to disclose HIV status (n = 370)	
Yes	138 (39.3)
No	232 (62.7)
Persons that are most important to disclose HIV status to (n = 126)	
Spouse	32 (23.5)
Partner	44 (32.4)
Parent	46 (33.8)
Friend	3 (2.2)
Relative	7 (5.1)
Others	4 (2.9)
Perceived benefits of HIV status disclosure (n = 358)	
It encourages family support	122 (34.1)
It reduces self-burden and promote self-confidence	49 (13.7)
It promotes safer sex practices	103 (28.8)
It encourages partner's screening	58 (16.2)
Believed that it has benefits but could not specify	158 (44.1)
Did not know	15 (4.2)
Perception on benefits-risks of HIV status disclosure (n = 361)	
The benefit is greater than the risk	126 (34.9)
The risk is greater than the benefit	188 (52.1)
There is no difference	36 (10.0)
Did not know	11 (3.0)
Perceived fear as a cause of not disclosing HIV positive status (n= 262)	
Yes	215 (59.4)
No	147 (40.6)
*Reasons for fear (n = 215)	
Fear of job loss/denial of employment	42 (9.0)
Fear of discrimination and maltreatment from family members	108 (23.2)
Fear of loss of friends	118 (25.3)
Fear of partner becoming violent	20 (4.3)
Fear of people gossiping about them	115 (24.7)
Fear of being divorced or kicked out of home	21 (4.5)
Fear of children being abused or discriminated against	17 (3.6)
Fear of not getting care in the hospital	3 (0.6)
Others	12 (2.6)
Did not know	10 (2.1)
Opinion on making HIV status disclosure mandatory (n = 362)	
Yes	165 (45.6)
No	150 (41.4)
Indifferent	47 (13.0)

*Multiple responses allowed

partners and spouses respectively. Close to half 158 (44.1%) of the 358 respondents that indicated their perception on the benefits of HIV status disclosure believed that HIV status disclosure has benefits but could not specify any, while about a third believed that it encourages family support (34.1%), and promotes safer sex practices (28.8%). Majority, 188 (52.1%) of the 361 respondents that indicated their perception on the benefits versus risks of HIV status disclosure were of the opinion that the risks associated with HIV status disclosure are more than the benefits that would be derived from the disclosure.

Majority of respondents (59.4%) were of the opinion that fear could be responsible for non-disclosure; and fear of loss of friends (25.3%), fear of being gossiped about (24.7%) and fear of discrimination and maltreatment by family members (23.2%) were the most commonly cited reasons for non- disclosure. Of the 362 respondents that indicated their opinion on making HIV status disclosure mandatory, a larger proportion 165 (45.6%) were of the opinion that it should be made mandatory (Table 2).

Table 3: HIV status disclosure practices of respondents

Variables	Frequency (%)
Disclosure of HIV positive status (n = 370)	
Ever disclosed	207 (55.9)
Never disclosed	163 (44.1)
Person disclosed to (n = 207)	
Parent	83 (25.4)
Spouse	68 (20.8)
Partner	52 (15.9)
Biological child	70 (21.4)
Relative	29 (8.9)
Friend	24 (7.3)
Pastor	1 (0.3)
Immediate reactions and behaviors of spouses and partners to whom respondents disclosed their HIV status (n = 120)	
Shock and disbelief	25 (20.8)
Anger	9 (7.5)
Consoling	54 (45.0)
Not surprised	27 (22.5)
Others (sobbed, fainted, slapped)	5 (4.1)
Subsequent reactions and behaviors of spouses and partners to whom respondents disclosed their HIV status (n = 120)	
Supportive	84 (70.0)
Rejection	25 (20.8)
Indifferent	11 (9.2)

HIV status disclosure practices of respondents

A little above half 207 (55.9%) of the 370 respondents disclosed their HIV positive status to someone; of these, the persons most commonly disclosed to were parents (25.4%), biological children (21.4%), spouses (20.8%), and partners (15.9%). Among the 120 respondents that disclosed to their spouses or partners, a larger proportion 54 (45.0%) indicated that the immediate reaction of their spouses or partners was consoling, 27 (22.5%) indicated that their spouses/partners were not surprised, while 25 (20.8%) indicated that their spouses/partners expressed shock and disbelief. Majority of respondents 84 (70.0%) indicated that their spouses/partners' subsequent reaction was supportive, while only about a fifth of them (20.8%) experienced rejection (Table 3).

Factors associated with HIV status disclosure among respondents

HIV status disclosure was found to be associated with being counseled on disclosure, knowing the spouse/partner's HIV status, not being afraid of disclosure, receiving financial support from spouse or partner, believing that disclosure encourages family support, believing that disclosure has benefits, and believing that the benefit of disclosure is greater than the risk. The proportion of respondents that disclosed their HIV status was significantly higher ($p < 0.05$) among those that were counseled (65.1%) as compared to those that were not (46.4%); it was significantly higher among those that knew their spouses or partners' HIV status (61.6%) as compared to those that did not (47.5%); it was significantly higher among those that were not afraid of disclosure (64.6%) as compared to those that were afraid of disclosure (50.2%); and it was significantly higher among those that received financial support from their spouses or partners (61.6%) as compared to those that did not (44.8%). Also, the proportion of respondents that disclosed their HIV status was significantly higher ($p < 0.05$) among those that believed that disclosure encourages family support (63.1%) as compared to those that did not (52.1%); it was significantly higher among those that believed that disclosure has benefits (61.5%) as compared to those that did not (48.7%); and it was significantly higher among those that perceived the benefits of disclosure to be more than the risks (66.7%) as compared to those that perceived the risks to be more than the benefits (52.1%) as shown in Table 4.

Table 4: Factors associated with HIV status disclosure among respondents

Variables	HIV status disclosure		Test of significance
	Disclosed Frequency (%)	Not disclosed Frequency (%)	
Counseling on disclosure			
Counseled (n =189)	123 (65.1)*	66 (34.9)	χ^2= 12.995,
Not counseled (n = 181)	84 (46.4)	97 (53.6)	p = 0.001
Spouse/partner HIV status			
Positive (n = 138)	85 (61.6)*	53 (38.4)	χ^2= 4.657,
Negative (n = 99)	47 (47.5)	52 (52.5)	p = 0.031
Age group (years)			
≤ 40 (n = 258)	138 (53.5)	120 (46.5)	χ^2= 2.089,
> 40 (n = 112)	69 (61.6)	43 (38.4)	p = 0.148
Sex			
Male (n = 135)	68 (50.4)	67 (49.6)	χ^2= 2.681,
Female (n = 235)	139 (59.1)	96 (40.9)	p = 0.102
Religion			
Christianity (n = 71)	41 (57.7)	30 (42.3)	χ^2= 0.131,
Islam (n = 298)	165 (55.4)	133 (44.6)	p = 0.717
Educational status			
Uneducated (n = 168)	87 (51.8)	81 (48.2)	χ^2= 1.850,
Educated (n = 197)	116 (58.9)	81 (41.1)	p = 0.174
Occupational status			
Unemployed (n = 42)	27 (64.3)	15 (35.7)	χ^2= 1.337,
Employed (n = 328)	180 (54.9)	148 (45.1)	p = 0.248
Marital status			
Married (n = 237)	127 (53.6)	110 (46.4)	χ^2= 1.489,
Not married (n = 133)	80 (60.2)	53 (39.8)	p = 0.222
Fear of disclosure			
Yes (n = 215)	108 (50.2)	107 (49.8)	χ^2= 7.456,
No (n = 147)	95 (64.6)*	52 (35.4)	p = 0.024
No response (n = 8)	4 (50.0)	4 (50.0)	
Received financial support from spouse or partner			
Yes (n = 172)	106 (61.6)*	66 (38.4)	χ^2= 11.713,
No (n = 105)	47 (44.8)	58 (55.2)	p = 0.003
No response (n = 24)	8 (33.3)	16 (66.7)	
Believed that disclosure encourages family support			
Yes (n = 122)	77 (63.1)*	45 (36.9)	χ^2= 3.944,
No (n = 236)	123 (52.1)	113 (47.9)	p = 0.047
Believed that disclosure promotes safer sex practices			
Yes (n = 103)	55 (55.3)	46 (44.7)	χ^2= 0.016,
No (n = 255)	143 (56.1)	112 (43.9)	p = 0.899
Believed that disclosure encourages partner's screening			
Yes (n = 58)	37 (63.8)	21 (36.2)	χ^2= 1.764,
No (n = 300)	163 (54.3)	137 (45.7)	p = 0.184
Believed that disclosure has benefits (but could not specify)			
Yes (n = 200)	123 (61.5)*	77 (38.5)	χ^2= 5.834,
No (n = 158)	77 (48.7)	81 (53.1)	p = 0.016
Perceived benefit-risk of disclosure			
Benefit is greater than risk (n = 126)	84 (66.7)*	42 (33.3)	χ^2= 11.506, p = 0.009
Risk is greater than benefit (n = 188)	98 (52.1)	90 (47.9)	
No difference between benefit and risk (n = 36)	14 (38.9)	22 (61.1)	
Don't know (n = 11)	7 (63.6)	4 (36.4)	

*Statistically significant (p < 0.05)

Table 5: Predictors of HIV status disclosure among respondents

Variables	Odds Ratio (OR)	95% confidence interval		P value
		Lower limit	Upper limit	
Disclosure counseling	2.624	1.558	4.420	< 0.001
Knowledge of spouse or partner's HIV status	0.211	0.016	2.742	0.211
Fear of disclosure	0.313	0.035	2.794	0.313
Availability of financial support	4.843	1.708	13.726	0.002
Encourage family support	0.922	0.441	1.928	0.992
Unspecified benefits	0.785	0.400	1.541	0.785
Risk-benefit of disclosure	1.336	0.291	6.129	1.336

Constant: HIV status disclosure

Predictors of HIV status disclosure among respondents

In logistic regression analysis, the predictors of HIV status disclosure among the respondents were counseling on disclosure and availability of financial support. Respondents that were counseled on disclosure were almost 3 times more likely to disclose (OR = 2.624, 95% CI = 1.558-4.420, p < 0.001) as compared to those that were not, while respondents that received financial support from spouse or partner were more than 4 times more likely to disclose their status (OR = 4.843, 95% CI = 1.708-13.726, p = 0.002) as compared to those that did not (Table 5).

DISCUSSION

This study examined the perception and predictors of HIV status disclosure among people living with HIV/AIDS in Sokoto metropolis, Nigeria. Less than half (39.3%) of the respondents perceived it necessary to disclose their HIV status; and of these, only about a third and less would disclose to their spouses or partners. This could be due to the fact that less than half of respondents (44.1%) believed that disclosing HIV status has any benefit at all, while majority of them (52.1%) believed that the risk associated with status disclosure is greater than the benefit. This study found that the largely negative disposition to HIV status disclosure by the respondents in this study was due to the fear majority of them (59.4%) had for it as a result of the consequences, particularly, fear of loss of friends (25.3%), fear of people gossiping about them (24.7%), and fear of discrimination and maltreatment from family members (23.2%). It is therefore not surprising that less than two-thirds of respondents (55.9%) have ever disclosed their HIV status, and only about a third of the disclosures (36.7%) were specific to spouse or partner. The findings of this study are in consonance with the findings in studies conducted in several developing countries, and they in essence confirm the fact that the generally low HIV status disclosure in many developing countries is rooted in the prevalent fear of the adverse consequences of the practice in these countries.

However, the disclosure rates obtained in this study are higher than the disclosure rates reported in a study conducted in Ilorin, North-central Nigeria, where a disclosure rate of 39.5% was reported, and less than a fifth of respondents (18.6%) disclosed to their spouses (Salami et al., 2011). While the finding of 55.9% general disclosure in this study is similar to the 52.9% disclosure rate that was reported in a study involving HIV positive adolescents and young adults in Accra, Ghana (Kenu et al., 2014), it is much lower than the 89% disclosure rate that was obtained in a study conducted among women in a PMTCT programme in Jos, Nigeria (Sagay et al., 2006), and the 97.1% disclosure rate that was reported in a study conducted among HIV positive pregnant women attending a prevention of mother to child transmission (PMTCT) clinic in Nnewi, Southeastern Nigeria (Igwegbe and Ugboaja, 2010). The latter study also reported a much higher rate of disclosure to husbands (90%), but a lower disclosure rate to family members (11.4%) as compared to this study (Igwegbe and Ugboaja, 2010). The higher rates of disclosures to spouses or partners in the latter studies as compared to this study could be as a result of the structured nature of ANC and PMTCT programs.

In contrast to the relatively low HIV status disclosure to sexual partners (36.7%) among the respondents in this study, high disclosure rates were obtained in studies conducted several African countries including Mali (73%), Ghana (78.6%), Uganda (83.8%), and Cameroon (86.3%) (Cisse et al., 2016; Obiri-Yeboah et al., 2015; Batte et al., 2015; Loubiere et al., 2009); but while the disclosure rates were higher in the latter studies than this study, the reasons for non-disclosure in this study and the latter studies were principally fear of the consequences of disclosure. Similarly, studies conducted

across Nigeria and other places principally reported fear of the consequences of disclosure as the main barrier to the practice. A study conducted in Lagos, South western Nigeria, reported perceived fear as the most common reason (65%) for non-disclosure (Adeyomo et al., 2011). In a study conducted in Nnewi, South eastern Nigeria, the only issue found to be of concern as regard non-disclosure to husbands was perception of fear of divorce (Igwegbe and Ugboaja, 2010). Similarly, in a study conducted in Dar es Salaam, Tanzania, about half (52%) of those that did not disclose, reported perceived fear of their partners' reaction as the main reason for non-disclosure (Maman et al., 2003). A study conducted in Bobo-Dioulasso in Burkina Faso, also reported that women were reluctant to inform their partners of their HIV status for fear of being stigmatized by relatives and friends (Issiaka et al., 2001).

Although, counseling on disclosure, knowing spouse or partners' HIV status, lack of fear of disclosure, perceiving that disclosure encourages family support, perceiving that the benefit of disclosure is greater than its risk, and obtaining financial benefits from spouse or partner were the factors that were found to be associated with disclosure of HIV status among the respondents in the study, while the predictors of disclosure were counseling on disclosure and availability of financial support. These findings are in consonance with the findings in studies conducted in Nigeria and other places. Similar to the findings in this study, studies conducted in the Niger Delta region of Nigeria (Ebuenyi et al., 2014), and Botswana (Tshisuyi et al., 2014), found HIV status disclosure to be associated with knowing the partner's HIV status, while studies conducted in South India (Chandra et al., 2003), and Jamaica (Clarke et al., 2010), found HIV status disclosure to be associated with emotional and material support from family members. The findings of this study, in essence, highlights the pivotal role of counseling and family support in facilitating HIV status disclosure among people living with HIV/AIDS, and the need for HIV/AIDS care provider to give sufficient attention to counseling on disclosure in the care of PLWHA, while all stakeholders should intensify awareness campaigns on the need for their spouses or partners to give them the necessary financial and emotional support.

CONCLUSION

This study showed low levels of perception of the relevance and benefits of HIV status disclosure among PLWHA in Sokoto, Nigeria, with the most commonly perceived barrier being fear of the consequences of the practice. Also, HIV status disclosure was relatively low among the respondents with the predictors being counseling on disclosure and availability of financial support from spouse or partner. HIV/AIDS care providers should give sufficient attention to counseling on disclosure in the care of PLWHA, while all stakeholders should intensify awareness campaigns on the need for their spouses or partners to give them the necessary financial and emotional support.

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Conflict of interest

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Phytochemical, elemental and in-vitro anti-oxidant activity screening of crude methanol *Tapinanthus globiferus* leaf extract

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ABSTRACT

Tapinanthus species have been reported with safe toxicity profiles and efficacy in several categories of diseases. Their ethnobotanical/pharmacological activities are viewed to be related to their phytochemical and elemental constituents as well as their anti-oxidant activity. This study carried out phytochemical, elemental and in-vitro anti-oxidant activity screening on crude methanol *Tapinanthus globiferus* leaf extract. Flavonoids, terpenoids, phenols, alkaloids, saponins, tannin, cardiac glycosides and carbohydrates but not anthraquinones were found in the leaf extract. Cadmium, copper, iron, manganese, sodium, potassium, calcium but not lead and cobalt were present in the extract. The extract also demonstrated dose-dependent ferric ion reducing and α, α-diphenyl-β-picrylhydrazyl (DPPH) free radicals scavenging anti-oxidant activities that were inferior to those of the standard anti-oxidant (ascorbic acid). Some of the phytochemicals and the metal elements may be responsible for the anti-oxidant activity of this extract and for the reported ethnobotanical/pharmacological efficacies of *Tapinanthus globiferus* extracts.

Keywords: *Tapinanthus globiferus*, oxidative stress, ferric ion reducing, DPPH radical scavenging

INTRODUCTION

Phytochemical compounds such as phenols, steroids, saponins, carotenoids, tannins, alkaloids, flavonoids, etc., are non-nutrient macromolecular plant-derived bio-active secondary metabolites. These chemical substances have been reported to play preventive roles in several classes of diseases including diabetes mellitus, hypertension, cancers, nervous disorders, atherosclerosis, dementia and microbial infections (Altemimi *et al*., 2017; Adesina *et al*., 2013; Noumi and Eloumou, 2011). Ethnobotanical and scientific studies on *Tapinanthus globiferus* and related species from ten different host trees (excluding *Azadirachta indica*) have reported their efficacies in diverse disease spectra and their ubiquitous biological activities have been largely attributed to the presence of arrays of phytochemicals such as chlorogenic acid, caffeic acids, gallic acid, rutin and quarcetin in addition to the above-named compounds present in them (Abedo *et al*., 2013; Borokini and Omotayo, 2012).

Preliminary activity screening of crude methanol leaf extract of *Tapinanthus globiferus* growing on *Azadirachta indica* showed that the extract possessed significant anxiolytic activity (Umarudeen and Magaji, 2019) but its phytochemical composition is yet unknown. Studies have also shown that the key disease-modulatory effects of medicinal plants largely reflect the levels of anti-oxidant activity of their phytoconstituents (Herrera-Arellano *et al*., 2007) and that the differences in the anti-oxidant activities of medicinal plants also reflect their differential phytochemical compositions (Belobrajdic and Bird, 2013).

Exogenous anti-oxidant compounds from medicinal plants have been shown to be useful in ameliorating/counteracting the deleterious oxidizing effects of some of the products of cellular respiratory/metabolic activities in scenarios where the endogenous anti-oxidant activity is overwhelmed or defective (Grilo *et al*., 2014). Anti-oxidant activities have also been reported for extracts of *Tapinanthus bangwensis*, *Piliostigma thonningii*-grown *Tapinanthus globiferus*, *Ficus glumosa* grown-*Tapinanthus globiferus, Persea Americana*-grown *Tapinanthus globiferus and Acacia*-grown *Loranthus*

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acacia (Abubakar *et al.*, 2018; Emmanuel *et al.*, 2017; Molehin and Adefegha, 2015). But scientific reports on the anti-oxidant activities of *Tapinanthus globiferus* growing on *Azadirachta indica* are sparse in spite of its several reports of diverse ethno-botanical and ethno-pharmacological activities. Inorganic elemental metals have also been viewed to play an important modulatory or adjunctive role not only in the maintenance of brain health but also in the pathogenesis of affective and neurodegenerative diseases and their analysis and quantification has been shown to give insight to their pharmacological and toxicological properties (Piao *et al.*, 2017; Jellinger, 2013).

Essential minerals like Fe2+, Ca^{2+}, K^{+}, Na^{+}, Mg^{2+}, Zn^{2+} and PO_4^{2-} have been previously identified in extracts from citrus-grown *Tapinanthus globiferus*, *Tapinanthus sessilifolius* and *Tapinanthus preusi* but metal elements' analysis of leaf extracts of *Tapinanthus globiferus* growing on *Azadirachta indica* has not been reported (Jeremiah *et al.*, 2018; Tarfa *et al.*, 2018; Tarfa *et al.*, 2002). The aim of the present study, therefore, is to carry out a qualitative phytochemical, elemental and in-vitro anti-oxidant activity screening of the crude methanol leaf extract of *Tapinanthus globiferus* from *Azadirachta indica* tree.

MATERIALS AND METHODS

Collection, identification and extraction of plant materials

Tapinanthus globiferus leaves were collected from an *Azadirachta indica* (Neem) tree at Shuni road, Mabera, Sokoto, Sokoto State, Nigeria. Specimen vouchers were deposited and authenticated at the herbarium of the Botany Department, Faculty of Science, Usmanu Dan Fodiyo University, Sokoto, Nigeria, with the following identification numbers: *Tapinanthus globiferus* (UDUH/ANS/0135). Following collection, the plant materials were briefly washed with clean water in order to remove potential dirt contaminants. They were then air-dried under shade for several days till they attained constant weights. The materials were then ground to a fine powder using a mortar and an electric blender, and stored under room temperature till use. Seventy per cent (70%) crude methanol extract of *Tapinanthus globiferus* (CMTG) leaves was obtained by soaking 250 g of fine powder of the plant material in 1 L of methanol/distilled water (70/30) for 24 hours. The macerate was then filtered using Whatman's paper (150 mm) and evaporated in rotatory water bath at 45-50 degree Celsius. The drying process produced 31.45 g of dry greenish *Tapinanthus globiferus* leaf extract (12.58%).

Phytochemical screening and determination of the elemental constituents of crude methanol *Tapinanthus globiferous* leaf extract

Crude methanol *Tapinanthus globiferus* leaf extract was screened for its phytochemical constituents according to the standard methods described by Sofowora (1993). The elemental composition of CMTG leaf extract was determined by an atomic adsorption spectrophotometric procedure that was previously adopted by Zafar *et al.* (2010). Briefly, a small quantity (0.2 g) of dry powder of CMTG was dissolved in 10 ml of solution of nitric acid (NHO3) and hydrochloric acid (HCL) (1/3: V/V) and the resulting mixture was heated till almost dryness. The almost dry powder was put in a volumetric flask and distilled water was added up to the 100 ml mark. The extracted sample was then filtered with 150 mm Whatman's filter paper and the filtrate was collected and stored in a tightly stoppered labeled plastic bottle. The solution was then analyzed for the elements and the percentages of different elements in the sample were determined by flame atomic absorption spectrophotometer model 6800 Shimadsu, Japan.

Determination of anti-oxidant activity of crude methanol Tapinanthus globiferous leaf extract

The anti-oxidant activity of the crude methanol *Tapinanthus globiferus* leaf extract was evaluated by two different in-*vitro* procedures, i.e. determination of the reducing power of CMTG extract against Fe3+ and determination of the DPPH radical scavenging activity of the extract viz-a-viz a standard anti-oxidant agent. Determination of the reducing power of the crude methanol *Tapinanthus globiferus* leaf extract against Fe3+ was done in accordance with the method of Oyaizu (1986). Briefly, CMTG or vitamin C (0, 1, 2, 3, 4 or 5 mg/kg) was dissolved in 1 ml of distilled water and was mixed with 2.5 ml of 0.2M phosphate buffer (pH 6.6) and 2.5 ml of 1% potassium ferricyanide [KFe (CN) e]. The mixture was then incubated at 50 °C for 20 minutes. Then, 2.5 ml of 10% trichloroacetic acid was added to this mixture before centrifuging it at 3000 rpm for 10 minutes. Finally, 2.5 ml of the upper layer of each sample was mixed with an equal volume of distilled water and 0.5 ml of 1 % Fe3+ and the absorbance was determined at 700 mm. Evaluation of the α, α-diphenyl-β-picrylhydrazyl (DPPH) radical scavenging activity of crude methanol *Tapinanthus globiferus* leaf extract was carried out according to the method of Liyana-Pathiranan and Shahidi (2005). Briefly, 1 ml of a stock solution of 0.135 nM DPPH was mixed with an equal volume of CMTG or vitamin C (25, 50, 125, 250 or 500 µg/ml). The resulting reaction mixture was thoroughly mixed with a vortex mixer and allowed to stay in the

dark at room temperature for 30 minutes. Finally, the absorbance of each sample was measured spectrophotometrically at a wavelength of 517 nm. The ferric ion reducing/DPPH scavenging power of each sample was calculated as follows:

DPPH radical scavenging activity = [(Abs control – Abs sample)/Abs control] X 100.

Where: Abs control = Absorbance of Fe^{3+} ion/DPPH free radical and methanol; and Abs sample = absorbance of Fe^{3+}/DPPH free radical and CMTG or vitamin C (standard). All data were expressed as means of triplicate values.

RESULTS

Phytochemical constituents and elemental metals detected in crude methanol *T. globiferus* leaf extract

The phytochemical constituents detected in crude methanol T. globiferus leaf extract are shown in Table 1. Cadmium, calcium, sodium, magnesium, copper, iron, zinc and manganese were the elemental metals detected, but lead and cobalt were not detected (Table 2).

Table 1: Phytochemicals detected in crude methanol *T. globiferus* leaf extract

Constituents	Inference
Tannin	+
Saponin	+
Terpenoids	+
Cardiac glycosides	+
Alkaloids	+
Flavonoids	+
Anthraquinone	-
Carbohydrates	+
Phenols	+

+ present; - not detected

Table 2: Elemental metals and their concentration in crude methanol *T. globiferus* leaf extract

Element	Concentration (mg/l)
Cadmium	0.0037
Calcium	0.5699
Sodium	1.8285
Magnesium	0.7292
Cobalt	0.0000
Copper	0.0108
Lead	0.0000
Iron	1.3869
Zinc	0.0807
Potassium	0.0000
Manganese	0.2252

Anti-oxidant activities of crude methanol *T. globiferus* leaf extract

The Fe3+ reducing activity of both the crude methanol *T. globiferus* leaf extract and vitamin C were dose-dependent. The ferric ion reducing potential of the crude methanol *T. globiferus* leaf extract was lower than that of vitamin C. However, the IC50 of the extract (3.0 mg/kg) was lower than that of vitamin C of 3.6 mg/kg (Figure 1). Both the crude methanol *T. globiferus* leaf extract and vitamin C dose-dependently increased the percentage inhibition of DPPH free radicals. However, the extract's scavenging activity against DPPH free radicals with an IC50 of 180µg/ml was significantly lower than that of the standard drug (vitamin C) with an IC50 of 20 µg/ml (Figure 2).

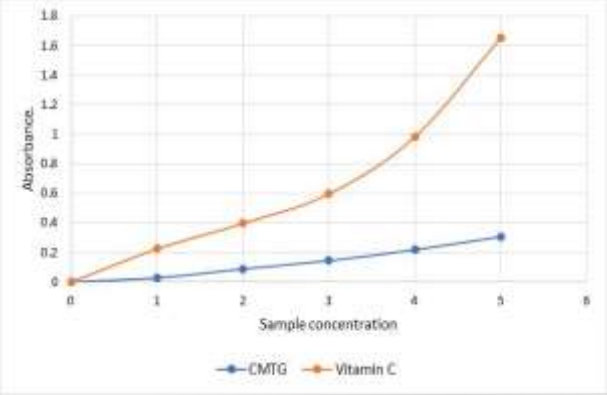

Figure 1: Ferric ion reducing power of crude methanol *T. globiferus* leaf extract

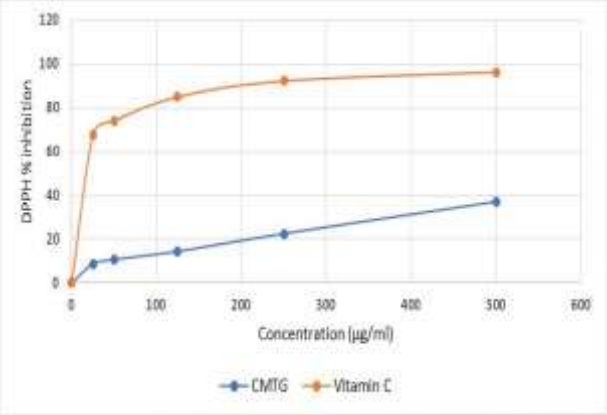

Figure 2: DPPH radical scavenging activity of crude methanol *T. globiferus* leaf extract

DISCUSSION

The detection of bio-active macromolecules such as phenols, flavonoids, tannin, saponin, terpenoids, cardiac glycosides, alkaloids and carbohydrates in the crude methanol *Tapinanthus globiferus* leaf extract is an indication that the extract is rich in phytochemicals. Phytochemical compounds are secondary metabolites that have been shown to play a vital role in chronic disease prevention (Molehin and Adefegha, 2015). The rich phytochemical profile of the extract being investigated in this study implies that *Tapinanthus globiferus* leaf extracts have the potential to be effective in disease prevention across a broad spectrum, thus justifying the traditional use of this plant for diverse therapeutic indications (Adesina *et al.*, 2013). Additionally, the presence of these compounds and the absence of anthraquinones in the methanol *Tapinanthus globiferus* leaf extract in this study are in agreement with the qualitative phytochemical findings in previous studies on the methanol extracts of *Tapinanthus globiferus* from different host trees (Abedo *et al.*, 2013; Jeremiah *et al.*, 2018), and of *Tapinanthus dodoneifolius* growing on locust beans tree (Ndamitso *et al.*, 2013). Terpenes (Wang and Heinbockel, 2018), saponins (Gujar and Kasture, 2005), flavonoids (Zhang *et al.*, 2012), alkaloids (Flausino *et al.*, 2007) and carbohydrates extracted from plants have been shown to exhibit significant anxiolytic activities in animal studies. These bio-active compounds present in the crude methanol extracts of the *Tapinanthus globiferus* leaf extract in the present and previous studies must have been responsible for their reported anxiolytic and other biologic activities (Umarudeen and Magaji, 2019; Jeremiah *et al.*, 2018; Adesina et al., 2013; Ndamitso *et al.*, 2013; Noumi and Eloumou, 2011).

The elemental analysis revealed the presence of magnesium and zinc among other elements in the extract of this study. This finding may explain in part, the multiple efficacies of various *Tapinanthus globiferus* leaf extracts that were reported in previous studies (Umarudeen and Magaji, 2019; Szklany *et al.*, 2016; Adesina *et al.*, 2013). Emerging evidence indicates that magnesium and zinc have not only been shown to play important roles in cellular metabolism, neurotransmission and neuromuscular conduction, but are also thought to have a critical adjunctive role in the anxiolytic mechanism (s) of some known and putative agents (Singewald *et al.*, 2014). Magnesium has been shown to be vital for optimal nerve transmission and neuromuscular conduction, for increasing brain GABA levels and neural plasticity, for reducing brain cellular inflammation and stress hormone level, and for detoxifying the brain cells by binding and removing heavy metals (Kirkland *et al.*, 2018). Magnesium's neuroprotective activity has been shown to be connected to its interaction with the N-methyl-D-aspartate (NMDA) receptor where it plays a gating role on calcium ion influx into neuronal receptors, thereby limiting neuronal excitatory signals (Stroebel *et al.*, 2018). Zinc is an essential nutritional trace element that has been shown to play a critical role in neurogenesis, cognition and affective disorders deriving from its demonstrated roles in several important protein-linked cellular biochemical processes such as DNA replication and transcription, enzyme catalysis and cell signaling (Molina-Navarro and Garcia-Verdugo, 2016). Studies have further indicated that the putative role of zinc in anxiolytic mechanism may be related to its reported modulatory attenuation on the excitatory glutamatergic neurotransmission by allosterically interacting with the NMDA glutamate receptor (Mlyiec *et al.*, 2017).

The elemental analysis of the methanol *Tapinanthus globiferus* leaf extract also shows that the extract is devoid of detectable levels of toxic metals such as lead and cobalt. This may partly explain the relative safety profiles reported for extracts from *Tapinanthus globiferus* (Shehu *et al.*, 2017; Abdullahi *et al.*, 2016). This study has also demonstrated a dose-dependent in-vitro anti-oxidant activity of the methanol *Tapinanthus globiferus* leaf extract in the ferric ion reducing and DPPH free radicals scavenging assays. This finding is in consonance with the finding-of significant anti-oxidant activities of extracts of *T. globiferus f*rom different host trees (Jeremiah *et al.*, 2018; Adekunle *et al.*, 2012; Ogunbolude *et al.*, 2014).

Anti-oxidant activity has been shown to be partly responsible for the disease-preventing property of many medicinal plants such as *Tapinanthus* species against degenerative diseases such as cancers, atherosclerosis, Parkinson's disease and Alzheimer's disease (Zhang *et al.*, 2015). The anti-oxidant property of these plants is believed to derive from their innate ability to synthesise natural secondary metabolites and other exogenous anti-oxidants (some of which have been confirmed to be present in the methanol *Tapinanthus globiferus* leaf extract in this study) (Kasote *et al.*, 2015). The essential elements zinc and magnesium have been shown to exhibit significant anti-oxidant activity and to be effective in countering cellular oxidative stress by enhancing endogenous anti-oxidant defence mechanisms (Salmonowiccz et al., 2014; Valco et al., 2005). The presence of these metal elements may contribute to the observed anti-oxidant activity of the extract *Tapinanthus globiferus* in this study.

CONCLUSION

This study has shown that crude methanol leaf extract of *Azadirachta indica*-grown *T. globiferus* possesses rich phytochemical and elemental compositions and dose-dependent in-vitro anti-oxidant activity. Some of the phytochemicals and metal elements may be responsible for the anti-oxidant activity of the leaf extract. These findings may be a justification for the traditional uses of extracts of *Tapinanthus globiferus* in the management of diseases.

Source of support

Nil.

Conflict of interest

None declared.

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Evaluation of the hypoglycemic and hypolipidemic effects of aqueous *Eleusine coracana* seed extract

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ABSTRACT

Patients with diabetes mellitus almost always have secondary hyperlipidemia which requires tight control of the blood glucose level with drugs. *Eleusine coracana* (EC) is widely used in northwestern Nigeria for the treatment of diabetes by traditional healers who consider it to be effective and safe. This study evaluated the hypoglycemic and hypolipidemic effects of *Eleusine coracana* seed extract in alloxan-induced hyperglycemic Wistar rats. All the doses of EC prevented a sustained increase in the blood glucose level after glucose loading. The antihyperglycemic effect was dose dependent and reached a maximum level at 120 and 180 minutes, and there was a significant reduction in blood glucose level in all the treated groups as compared to the normal control and metformin diabetic control groups. There were steady reductions in the levels of serum triglycerides (TG's) and high density lipoprotein (HDL) in a dose dependent pattern in the treated group as compared to the metformin diabetic control group. EC extract also reduced serum triglycerides (TG's) and high density lipoprotein (HDL) in all the doses tested. This study has shown that aqueous *Eleusin coracana* seed extract remarkably reduced serum blood glucose level in both normal and alloxan-induced diabetic rats at the studies doses. Furthermore, the extract showed a significant hypolipidemic effect with decreases in serum total cholesterol and low density lipoprotein levels. These findings showed that EC seed extract has therapeutic potential in combating the multi factorial disorders which are a part of the major complications of diabetes, and further studies should be conducted to determine the mechanism of the action of its hypoglycemic and hypolipidemic effects.

Keywords: *Eleusine coracana*, hypoglycemic and hypolipidemic effects

INTRODUCTION

Diabetes mellitus has become a serious public health problem worldwide, and its prevalence is rising faster than earlier estimated. Whereas, the prevalence of diabetes mellitus was estimated to rise from 4.0% in 1995 to 5.4% in 2025 (while the number of adults with the disease was estimated to rise from 135 million to 300 million over the same period of time), its prevalence was found to have risen to 8.5% in 2014 (WHO, 2018; King et al., 1998). The disturbing aspect is the fact that the prevalence of the disease is rising more rapidly in middle- and low-income countries where a 170% numerical increase in the number of people affected (from 84 million in 1994 to 225 million in 2025) is expected to occur as compared to a 42% increase in developed countries (from 51 million in 1994 to 72 million in 2025) (King et al., 1998). In addition, whereas majority of people with diabetes in the developing countries are ≥ 65 years, the majority of people with diabetes in the developing countries are in the age range 45-64 years (King *et al.*, 1998). Diabetes is a chronic disease that requires long term attention and treatment to limit the development of its devastating complications and to manage them when they occur (Peter, 2002). Diabetes is a major cause of blindness, kidney failure, heart attack, stroke and lower limb amputation; and it was estimated to be the seventh leading cause of death in 2016, with an estimated 1.6 million deaths directly caused by the disease, and with almost half of deaths occurring before the age of 70 years (WHO, 2018).

According to the International Diabetes Federation (IDF) the impact of diabetes mellitus on health care spending will be enormous, with an estimated direct health care expenditure on diabetes worldwide of between 213-396 billion dollars for the year 2025; and in some countries, particularly in sub-Saharan Africa, it may

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reach as much as 50- 90% of their total health care budget (IDF, 2003 and Wild *et al.*, 2004). In patients with diabetes mellitus, the level of triglyceride and cholesterols in plasma are frequently elevated (i.e., hyperlipidemia). The abnormal high concentration of serum lipids in diabetic patients is believed to be mainly due to an increase in the mobilization of free fatty acids from the peripheral fat depots (Bopanna *et al.*, 1997). These secondary hyperlipidemias are always associated with absence or marked insufficiency of insulin. In addition, the low density lipoprotein (LDL), and high density lipoprotein (HDL) levels are also elevated in diabetes mellitus (Mary and John, 2007). Patients with diabetes mellitus almost always have secondary hyperlipidemia which requires tight control of the blood glucose level with drugs (Umesh and Micheal, 2007).

Also, achieving good glycemic control and preventing or delaying the onset of complications requires regular physical exercise, and maintaining a normal body weight in addition to drug treatment and regulated/restricted diets which are often difficult for patients to adhere to (WHO, 2018). Worse of all, the treatment is for a lifetime, the drugs are scarce and relatively expensive, and patients with diabetes are known to be especially at high risk for experiencing drug therapy problems (DTPs) as they are subject to receive multiple drug therapies for their diabetes co-morbidities (Huri and Ling, 2013; Cipolle *et al.*, 2013). The common DTPs among patients with chronic medical conditions include unnecessary drug therapy, need for additional drug therapy, ineffective drug therapy, dosage too low, dosage too high, adverse drug reaction, and non-adherence (Cipolle *et al.*, 2012).

In many developing countries including Nigeria, use of medicinal plants for treatment of diverse diseases is popular as they are cheap, readily available and are believed to be effective and safe. Hypoglycemic and/or hypolipidemic properties have been demonstrated in several plant species including *Vernonia amygdalina* (Erato *et al.*, 2005; Okolie *et al.*, 2008), *Aloe vera* (Okyar *et al.*, 2001), *Allium sativum* (Garlic) (Eidi *et al.*, 2006), *Eugenia jambolina* (Pepato *et al.*, 2005), *Terminata chebula* (Sabu and Kuftan, 2002), and *Eleucine coracana* (Okoyomoh *et al.*, 2013). *Eleucine coracana* is extensively cultivated and consumed in the tropics and sub-tropics. It is very common in Africa (especially Senegal, Niger and Nigeria), and Asia, where it is called different names including finger millet, African millet, Ragi (India), Tamba (Hausa-Nigeria), Dendi (Leeni-Niger), Kpana (Birom-Nigeria), Changari (Fulani-Nigeria), Sarga (Kaniri-Nigeria), Oka tamba (Ibo-Nigeria), and Oka gbegi (Yoruba-Nigeria) (Burkill, 1985). In Sokoto State, Nigeria (the study area), similar to the situation across the country, the majority of the populace reside in the rural areas where access to healthcare services is poor, as the health facilities are majorly located in the urban areas; and even where the services are available they are too poor to buy the expensive anti-diabetic drugs. They inevitably rely on traditional preparations and mostly present late at the health facilities when complications have set in. *Eleusine coracana* is widely used in northwestern Nigeria for the treatment of diabetes by traditional healers who consider it to be effective and safe. To the best of our knowledge, this folkloric claim has not been validated scientifically in Sokoto, Nigeria. This study was conducted to evaluate the hypoglycemic and hypolipidemic effects of aqueous *Eleusine coracana* seed extract.

MATERIALS AND METHODS

Collection, identification and preparation of plant seeds' extract

Eleusine coracana (finger millet) seeds were purchased at the Kara market, Sokoto, Nigeria. The seed was identified by taxonomists at the Botany Department, Faculty of Science, Usmanu Danfodiyo University, Sokoto, Nigeria, and the specimen voucher was deposited at the Botany Department's herbarium (the plant and seeds are shown in Figures 1 and 2 respectively). The plant seeds were air dried to constant weight at room temperature in the Pharmacology & Therapeutics Department's laboratory, Usmanu Danfodiyo University, Sokoto, Nigeria. The dried material was then pulverized into dry powder using crushing machine. About 500 grams of the powder was obtained during the extraction using 2 liters of distilled water in Soxhlet apparatus, and the percentage yield was calculated from the extracted residue (w/w). The extracted residue was kept in the refrigerator at 4 degree Celsius. The extract was reconstituted in distilled water at an appropriate concentration for each use whenever desired.

Animal, drug, chemical and equipment

A total of 150 Wistar rats of both sexes weighing 100-350g were used in this study. They were obtained from the National Institute for Trypanosomiasis Research's animal house, Vom, near Jos. They were housed in separate cages, and kept in a room maintained at 12 hours light/dark cycle and temperature of 28-34 degree Celsius. The animals were allowed free access to water and food (growers mash) from Vital Feed Nigeria Limited, Jos, Nigeria, before the beginning of the

experiment. The animals were kept in this condition for two weeks before the commencement of the experiment (acclimatization). Only food was withheld from the rats the night preceding the experiment (to make them fast). A dispensable form of Metformin (Guamet 500), with Batch number 370094, manufactured by Medreich Limited, Avalahalli, Bangalore, India; Alloxan from Avighkar Laboratory Technology and Chemicals, India, with Lot No-230500D; and Glucose meter (Accu-chek active) from Roche Group Limited, Germany were used for the study.

Induction of diabetes mellitus in rats

Diabetes was induced in the rats by a single intra-peritoneal injection of freshly prepared alloxan monohydrate (150mg/kg) dissolved in normal saline, after overnight fasting for 12 hours (Al Shamony *et al.*, 1994; Federiuk, 2004). Blood samples were collected after 72 hours to determine the glucose level. Those with a blood glucose level >140mg/dl were considered to be diabetic and selected for the study.

Determination of the effect of *Eleusine coracana* on oral glucose loading

The experimental procedures were performed to mimic type 2 diabetes mellitus of human. Hyperglycemia was induced by 10g/kg oral glucose loading (Cunha, *et al.*, 2008). Blood samples were obtained by tail tipping (making an incision on the tail for blood to sip out) and the glucose level was determined using Accu-chek active glucose meter. Twenty rats (fasted overnight) were divided into 5 groups of four rats each. Group 1 received 5ml/kg distilled water only; Group 2 received 100mg/kg of extract; Group 3 received 200mg/kg of extract; Group 4 received 400mg/kg of extract; while Group 5 received 100mg/kg of metformin. The rats in the respective groups were given the treatments 30 minutes prior to the glucose loading and blood samples were taken for glucose level measurement immediately before the glucose loading (0 minute), and then subsequently at 30, 60, 90, 120, and 180 minutes.

Determination of the effect of 28 days dosing of *Eleusine coracana* on glucose and lipid status of alloxan induced diabetic rats

The rats were divided into six groups of six each. Group 1 served as normal control and received 5ml/kg distilled water through feeding tube by gavages, while groups 2-6 were the diabetic groups (following induction with Alloxan). The serum glucose level was assessed by measuring the blood glucose level by tail tipping (Frode and Medeiros, 2008). Group 2 rats received 100mg/kg of extract dissolved in distilled water; Group 3 rats received 200mg/kg of extract dissolved in distilled water; Group 4 rats received 400mg/kg of extract dissolved in distilled water; Group 5 rats served as positive diabetic control and received metformin 100mg/kg dissolved in distilled water; while Group 6 rats served as negative diabetic control which received 5ml/kg of distilled water only. All the animals received the specified doses daily for 28 days. At day 29, all the animals were sacrificed by ether inhalation after the blood sample has been taken for blood glucose and lipids analysis by cardiac puncture.

Data analysis

Data analysis was carried out using Graph-pad statistical software package. Statistical comparisons between the controls and treatments were performed by analysis of variance (ANOVA), followed by Tukey-Kramer. Data were presented as mean ± standard error of mean (SEM). All levels of statistical significance were set at $p < 0.05$.

Figure 1: *Eleusine coracana* (Finger millet) plant

Figure 2: *Eleusine coracana* (Finger millet) seeds

RESULTS

Effect of Eleusine coracana (EC) on mean blood glucose level following oral glucose loading

A single oral dosing of EC on hyperglycemic induced rats by oral glucose loading showed a peak value of serum glucose level for all the groups at 30 minutes. This hyperglycemia was maintained until 60 minutes and later returned to its initial value at 90-120 minutes. All the doses of EC prevented an increase in blood glucose level after glucose loading, and also showed significant reduction ($P<0.05$) in glucose level. The antihyperglycemic effect was dose dependent and reached a maximum level at 120 and 180 minutes (Table 1).

Effect of *Eleusine coracana* (EC) extract on the body weight, serum lipid profile, and blood glucose levels of Wistar rats after 28 days treatment

Administration of aqueous extract of EC on the animals after 28 days showed no significant difference ($p > 0.05$) in the body weight of the treated and control groups (Table 2). There were significant differences ($P<0.05$) in the serum levels of total cholesterol (TC) and low density lipoprotein (LDL) in the treated group as compared to normal control and metformin diabetic control groups. There were marked reductions in serum total cholesterol at a dose of 400mg/kg, and serum low density lipoprotein (LDL) at a dose of 100mg/kg. There were steady reductions in the levels of serum triglycerides (TG's) and high density lipoprotein (HDL) in a dose dependent pattern in the treated group as compared to the metformin diabetic control group. EC extract also reduced the serum triglycerides (TG's) and high density lipoprotein (HDL) levels in all the doses tested (Table 3). Oral administration of EC extract showed no significant difference in ($P>0.05$) serum glucose level between tested group and normal control, but there was significant reduction in blood glucose level in all the treated groups as compared to normal control and metformin diabetic control groups (Table 3).

Table 1: Mean blood glucose levels following oral glucose loading

Group	Serum glucose concentration (mg/dL)					
	0min	30min	60min	90min	120min	180min
Control	125.5 ± 7.9	177.2 ± 1.3	131.0 ± 13.3	110.7 ± 17.6	99.25 ± 12.7	90.8 ± 10.2
E/100mg/kg	101.5 ± 15.2	155.0 ± 8.1	129.2 ± 6.7	98.0 ± 8.4	115.5 ± 11.0	99.5 ± 9.2
E/200mg/kg	105.2 ± 12.3	194.7 ± 31.7	164.0 ± 22.1	113.2 ± 15.9	92.5 ± 10.5	94.5 ± 9.6
E/400mg/kg	184.7 ± 18.7	158.7 ± 3.5	145.5 ± 4.9	136.7 ± 2.3	147.6 ± 5.3	134.0 ± 9.6
M/100mg/kg	123.2 ± 12.7	175.7 ± 9.5	128.0 ± 7.5	115.7 ± 14.2	89.8 ± 13.1	88.2 ± 19.2
P value	0.0051	0.3980	0.2529	0.3671	0.0117	0.1023

E: Extract; M: Metformin; mg: milligram; kg: kilogram; dL: deciliter

Table 2: Effect of *Eleusine coracana* on the body weight of Wistar rats after 28 days Treatment

Group	Mi weight (g) ±SEM	Mf weight (g) ±SEM	Mc weight (g) ±SEM
N/Control	209.5 ± 22.0	209.4 ± 22.6	4.8 ± 1.9
E/100mg/kg	259.0 ± 29.2	268.1 ± 35.4	3.2 ± 1.8
E/200mg/kg	224.5 ± 22.5	227.1 ± 21.9	4.3 ± 1.7
E/400mg/kg	210.4 ± 13.7	212.6 ± 13.7	2.4 ± 0.9
M/100mg/kg	296.8 ± 21.2	297.9 ± 21.2	1.4 ± 0.4
DC/5ml/kg	208.1 ± 16.8	199.9 ± 23.6	2.5 ± 1.2
P value	0.3350	0.3890	0.5004

N: Normal; E: Extract; M: Metformin; DC: Diabetic control; Mi: Initial Mean weight; Mf: Final mean weight; Mc: Change in mean weight; g: gram; SEM: Standard error of mean

Table 3: Effect of *Eleusine coracana* on the serum lipid profile and blood glucose level of Wistar rats after 28 days treatment

Group	Serum lipid profile (mg/dL) ±SEM				Blood glucose level (mg/dL) ±SEM		
	TG's	TC	HDL	LDL	Mi blood sugar	Mf blood sugar	Mc blood sugar
N/Control	56.0 ± 7.8	69.0 ± 6.5	19.8 ± 1.4	37.2 ± 9.1	23.0 ± 7.4	111.2 ± 7.2	92.6 ± 4.4
E/100mg/kg	76.6 ± 11.2	60.8 ± 2.3	26.7 ± 5.6	19.0 ± 8.9	91.8 ± 39.6	253.8 ± 69.2	181.4 ± 57.0
E/200mg/kg	69.8 ± 6.8	71.0 ± 4.9	21.2 ± 1.7	35.8 ± 6.8	44.6 ± 45.9	223.3 ± 45.3	178.7 ± 52.5
E/400mg/kg	57.2 ± 6.3	53.6 ± 3.9	19.8 ± 1.8	*22.4 ± 5.3	80.7 ± 21.1	299.2 ± 59.9	218.5 ± 49.5
M/100mg/kg	81.8 ± 17.2	76.7 ± 5.8	25.2 ± 1.5	35.0 ± 5.4	44.3 ± 22.1	219.6 ± 72.4	175.3 ± 52.5
DC/5ml/kg	77.7 ± 3.1	106.0 ± 7.3	29.7 ± 6.0	61.5 ± 6.0	16.8 ± 16.3	307.1 ± 56.4	290.5 ± 74.6
P value	0.4215	*0.0010	0.4515	*0.0078	0.1623	0.1998	0.1639

N: Normal; E: Extract; M: Metformin; DC: Diabetic control; TG's: Triglycerides; TC: Total cholesterol; HDL: High density lipoproteins; LDL: Low density lipoproteins; Mi: Initial mean blood glucose level; Mf: Final mean blood glucose level; Mc: Change in mean blood glucose level; mg: milligram; kg: kilogram; dL: deciliter; SEM: Standard error of mean; *p < 0.05

DISCUSSION

This study evaluated the hypoglycemic and hypolipidemic effects of aqueous *Eleusine coracana* seed extract in alloxan-induced hyperglycemic Wistar rats. All the doses of EC prevented a sustained increase in the blood glucose level after glucose loading. The finding of significant reductions ($P < 0.05$) in blood glucose levels in all the treated groups as compared to normal control and metformin diabetic control groups in this study indicates that aqueous EC seed extract has hypoglycemic property. Similarly, the finding of significant differences ($P < 0.05$) in the serum levels of total cholesterol (TC) and low density lipoprotein (LDL) in the treated group as compared to normal control and metformin diabetic control groups in this study confirms the hypolipidemic property of EC seed extract. The hypoglycemic and hypolipidaemic properties exhibited by aqueous *Eleusine coracana* seed extract in this study is in concordance with the findings in other studies that also reported antihypoglycemic and hyperlipidemic effects of *Eleusin coracana* in alloxan- or stroptozocin-induced hyperglycemic Wistar rats (Yaro *et al.*, 2018; Shobana *et al.*, 2010; Ananthan *et al.*, 2004). The hypoglycemic effect of EC may be due to the presence of flavonoids, tannins, alkaloids, saponins, and cardiac glycosides in it, as the hypoglycemic activity of these chemical constituents have been reported in a previous study (Ahmed *et al.,* 2000). This study found no significant difference ($P>0.05$) in the body weight of the treated rats as compared to the control group after 28 days of oral administration of EC extract. This may be due to the absence of steroid among the chemical constituents of the extract (Johnson *et al.*, 1988).

The abnormal high concentration of serum lipid in diabetes is believed to be mainly due to an increase in the mobilization of fatty acids from peripheral depots, since insulin inhibits the hormone sensitive lipase. The marked hyperlipidemia that characterized diabetic state may therefore be regarded as a consequence of uninhibited actions of lipolytic hormones on the fat depots (Al Shamony *et al.*, 1994). It has also been demonstrated that insulin deficiency in diabetes mellitus causes a variety of derangement in metabolic and regulatory processes, which in turn leads to accumulation of lipids such as total cholesterol and triglycerides in diabetic patients (Goldberg, 1981). Alterations in serum lipid profiles are well known in diabetes, and these increase the risk of cardiovascular diseases in them (Mary and John, 2007). A reduction in

serum lipids, particularly total cholesterol (TC), low density lipoprotein (LDL), and triglycerides (TG's) level is considered to be beneficial in the long-term outcome of diabetes management. The hypolipidemic and hypoglycemic properties of aqueous EC seed extract observed in this study showed that it has therapeutic potential in combating the multi factorial disorders which are a part of the major complications of diabetes, and further studies should be conducted to determine the mechanism of the action of its hypoglycemic and hypolipidemic effects.

CONCLUSION

This study has shown that aqueous *Eleusin coracana* seed extract remarkably reduced serum blood glucose level in both normal and alloxan-induced diabetic rats at the studies doses. Furthermore, the extract showed a significant hypolipidemic effect with decreases in serum total cholesterol and low density lipoprotein levels. These findings showed that EC seed extract has therapeutic potential in combating the multi factorial disorders which are a part of the major complications of diabetes, and further studies should be conducted to determine the mechanism of the action of its hypoglycemic and hypolipidemic effects.

Source of support

Nil.

Conflict of interest

None declared.

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Effect of home visits on lifestyle modification, drug adherence and control of hypertension

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ABSTRACT

Background: Hypertension remains the leading risk factor for cardiovascular morbidity and mortality globally. Unhealthy lifestyle and non-adherence to medication are believed to constitute serious obstacles to achieving blood pressure control among hypertensive patients. **Aim**: This study aimed to determine the effect of home visits on lifestyle modification, drug adherence and blood pressure control among patients with uncontrolled hypertension in Sokoto, Nigeria. **Materials and Methods**: A randomized control trial was conducted among 139 patients with uncontrolled hypertension (selected by systematic sampling technique) attending the General Outpatient Clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. A semi-structured questionnaire and data sheet were used to obtain information on the research variables. In addition to the routine hospital care for hypertension, the intervention group also had 3 home visits over a period of 3 months. Data were analyzed using the IBM SPSS version 22 statistical computer software package. **Results**: The participants in both groups were predominantly females and married. Although significant reductions in the proportion of participants that practiced unhealthy lifestyle, and significant increases in the proportion of participants that were adherent to medications, and those with controlled blood pressure, were recorded in both groups, the differences observed were by far higher in the intervention group as compared to the control group. **Conclusion**: This study showed that home visits are effective in facilitating healthy lifestyle modification, high medication adherence and blood pressure control among patients with uncontrolled hypertension in Sokoto, Nigeria. Management of healthcare institutions should make home visits a core component of the standard care of patients with hypertension.

Keywords: Home visits, lifestyle modification, drug adherence, blood pressure control

INTRODUCTION

Hypertension remains a major global health challenge that has been identified as the leading risk factor for cardiovascular morbidity and mortality, as well as all-cause mortality (Ndou et al., 2013). It affects approximately 1 billion people worldwide (i.e., 4.5% of the current global disease burden), with 340 million of these in economically developed and 340 million in economically developing countries; and it causes 7.1 million preventable premature deaths globally (Ogah et al., 2012; Ibrahim and Smith, 2010). High blood pressure (hypertension) is one of the most common chronic medical conditions in the developed world and it is rapidly becoming a major problem in the developing countries (Kearney et al., 2004). Until recently, hypertension was mainly associated with more affluent regions of the world. Estimates now show that in some settings in Africa, more than 40% of adults have hypertension (Awotidebe et al., 2014).

The prevalence of hypertension in Nigeria was estimated at 12.4 to 34.8%, and it was higher in urban than rural areas (Okwuonu et al., 2014). Non-adherence to medication is well established as an important contributor to poorly controlled blood pressure among hypertensive patients. However, despite the convenience of once daily dosing schedules of anti-hypertensive drugs, the relative lack of adverse effects and many interventions that were developed to improve medicine taking, adherence to anti-hypertensive drugs remain sub-optimal, thus resulting in persisting rates of uncontrolled blood pressure among hypertensive patients (Iloh et al., 2013; Cutrona et al., 2003). The blood pressure control rate is generally low across various settings in Nigeria including Kano (31%) (Sani et al., 2008), Umuahia (32.9%) (Iloh et al., 2013), and Abeokuta (31.4%) (Ayodele et al., 2004). One of the most important factors affecting the efficacy of blood

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pressure control in Nigeria is the lack of patient adherence to prescribed anti-hypertensive drugs and therapeutic lifestyle modification (Iloh et al., 2014); and generally low drug adherence levels were reported in studies conducted across Nigeria including Ado-Ekiti (44.7%) (Raimi, 2017), and Kano (54.2%) (Kabir et al., 2004).

Although, several studies have been conducted to determine the best way to promote medication adherence and lifestyle changes in hypertensive patients, only a few have addressed the effect of home visits on lifestyle modification and drug adherence in the management of hypertension. Reports from studies that employed home visits intervention generally showed improvement in blood pressure control and medication adherence. A study in South Africa by Ndou et al. (2013) utilized nurse supervised indigenous health workers who were trained and certified in blood pressure management, monitoring, education and counseling. It compared outcomes of patients receiving home visits and usual care with a control group receiving usual care alone. There was a significant decrease in the mean systolic and diastolic blood pressure after the intervention, and a significant increase in the proportion of those with controlled blood pressure.

A study conducted in Oklahoma, United States (Planas et al., 2009) reported that monthly home visits by community pharmacists to 52 patients with hypertension (which employed counseling on medication adherence and lifestyle modification) caused a significant improvement in medication adherence from 67.9% at baseline to 87.5% after six months of intervention. In an intervention (that comprised counseling on drug adherence and frequent telephone reminders) among patients on treatment for hypertension in a teaching hospital in Coimbatore, India, the compliance level rose from 0% at baseline to 67.0% at 6 months, and with an average blood pressure of 141/90mmHg (Palanisamy and Sumathy, 2009).

Despite the high burden of hypertension in Nigeria, and the prevalent poor drug adherence and blood pressure control across the country, little is known about the effect of home visits on lifestyle modification, drug adherence and blood pressure control in Nigeria. This study was therefore conducted to determine the effect home visits on lifestyle modification, drug adherence, and blood pressure control among patients with uncontrolled hypertension in Sokoto, Nigeria.

MATERIALS AND METHODS

Study Design, Population and Area

A randomized control study was conducted among patients with uncontrolled hypertension attending the General Outpatient Clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, from June to October 2016. The hospital is a tertiary health institution which serves as a referral center for the health facilities in Sokoto State and the surrounding Kebbi, Zamfara, Katsina and Niger States. Adult patients (i.e., ≥ 18 years old) with uncontrolled hypertension (defined as having a blood pressure reading of ≥ 140/90mmHg for ≥ 1 month) (American Academy of Family Physicians, 2014) who live in Sokoto metropolis (to avoid difficulties in performing home visits) and consented to participate were considered eligible for enrollment into the study, while pregnant women and those with severe debilitating conditions were excluded.

Sample Size Estimation and Sampling Technique

The sample size was statistically estimated at 67 participants per group using the formula for comparing proportions in two groups (Ibrahim, 2009), and it was adjusted to 73 participants per group in anticipation of a 10% attrition rate. The eligible participants were selected by systematic sampling technique using the patients' attendance register to constitute the sampling frame. About 950 hypertensive patients are seen at the outpatient clinics per month. Of these, a total of 442 patents with uncontrolled hypertension were identified over a period of 4 weeks to constitute the sampling frame. One of 3 patients on the list was recruited into the study and randomized into the intervention group (which received both routine hospital care for hypertension and 3 home visits) and the control group (which received only routine hospital care for hypertension) using the MS Excel program.

Data Collection and Analysis

Both groups had four treatment contacts after recruitment (i.e., at the commencement of the study, and at the 4th, 8th and 12th weeks). The routine hospital care for hypertension comprised blood pressure measurement, treatment monitoring and assessment of ill health, education on drug adherence and counseling on lifestyle modification; while the home visits involved educating both the participants and their family members on drug adherence and lifestyle modification, and monitoring of the participants for drug adherence and lifestyle modification). The home visits were made about 2 weeks after the participants' clinic visits, or before their next clinic appointment.

A semi-structured interviewer-administered questionnaire was used to obtain information on the participants' socio-demographic characteristics, lifestyle modification and drug adherence. The questions on lifestyle modification were adapted from the Simple Lifestyle Indicator Questionnaire (SLIQ) (Godwin et al., 2008). It was developed in 2005 in Ontario, Canada, by two family physicians and a nutritionist to measure the individual components of lifestyle that affects cardiovascular diseases. It has twelve questions in five components; diet (3 questions), exercise (3 questions), alcohol consumption (3 questions), smoking (2 questions) and stress (1 question). For each component, a raw score and a category score were calculated. To provide equal weighting for each component, the overall SLIQ score was based on the five category score. Each component has a category score of 0, 1 or 2, so the overall SLIQ score can range from 0 to 10; and the higher the score, the healthier the lifestyle (with 0-2 as very unhealthy lifestyle; 3-5 as unhealthy lifestyle; 6-8 as healthy lifestyle; and 9-10 as very healthy lifestyle).

The questions on drug adherence were adapted from the modified Morinsky Medication Adherence Scale 8 (MMAS-8) (Morisky et al., 2008). It was developed by Dr. Morinsky D.E. and his colleagues in 2008 from an original four item Morinsky scale. It has 8 questions, and each question has a score of either 0 or 1 (with a minimum of 0 and a maximum of 8); and the higher the score, the lower the adherence (with 0 as high adherence; 1-2 as medium adherence; and 3-8 as low adherence). Blood pressure was measured using the Omron M2 sphygmomanometer (Omron Global, Japan) and stethoscope (Littman quality) with all tight clothing and other similar materials removed from the arm and in the sitting position. The first measurement was taken after the participant had rested for at least 10 minutes in a sitting position with the arm rested on a table such that the middle of the forearm is about the level of the heart. The second measurement was taken at the end of the interview; the mean of the 2 readings was entered into a data sheet and used in the analysis. Eight resident doctors assisted in data collection after pre-training on the study objectives, selection of participants, procedure for attending to patients, and use of survey instrument. Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 22.0 software. Frequency distribution tables were constructed; and cross tabulations were done to examine the relationship between categorical variables. The chi-square test was used to compare differences between proportions. All levels of significance were set at $p < 0.05$.

Ethical Consideration

Ethical approval was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria, and informed written consent was also obtained from the study participants before data collection.

RESULTS

Socio-demographic characteristics of participants

One hundred and thirty nine of the 146 participants that were recruited completed the study giving an attrition rate of 4.8%. Of these, 68 were in the experimental group, while 71 were in the control group. Majority of participants in both groups were females, married, practiced Islam as religion, and had at least primary education. There was no significant difference ($p > 0.05$) in the socio-demographic characteristics of the participants in both groups (Table 1).

Participants' lifestyle, drug adherence and blood pressure control status

Almost all the participants in both the intervention group (95.6%) and the control group (95.8%) practiced unhealthy lifestyle. Only a quarter of the participants in the intervention group (25.0%) and less than a quarter (23.9%) of those in the control group were adherent to their medications for hypertension. All the participants (100%) in both groups had uncontrolled blood pressure. There was no significant difference in the distribution of the participants in both groups by their lifestyle, drug adherence and blood pressure control status (Table 2).

Effect of home visits on lifestyle modification, drug adherence and control of hypertension among participants

Although significant reductions in the proportion of participants that practiced unhealthy lifestyle; and significant increases in the proportion of participants that were adherent to medications, and those with controlled blood pressure were recorded in both groups, the changes were more pronounced in the intervention group as compared to the control group. The proportion of participants that practiced unhealthy lifestyle reduced drastically in the intervention group from 95.5% at baseline to 20.6% at post intervention, while it only decreased marginally in the control group from 95.8% at the beginning of the study to 73.3% at the end of the study. The proportion of participants that were adherent to anti-hypertensive medication increased markedly in the intervention group from 25.0% at baseline to 76.5% at post intervention, while it only increased marginally in the control group from 23.9% at the beginning of the

study to 39.4% at the end of the study. The proportion of participants with controlled blood pressure increased substantially in the intervention group from 0% at baseline to 80.9% at post intervention, but the increase was much less in the control group from 0% at the beginning of the study to 46.5% at the end of the study (Table 3).

DISCUSSION

This study assessed the effect of home visits on lifestyle modification, drug adherence and blood pressure control among patients with uncontrolled hypertension in Sokoto, Nigeria. The predominance of females among both the intervention group and the control group participants in this study is similar to the findings in studies conducted in other cities in Nigeria including Kano (Sani et al., 2008) and Abia (Iloh et al., 2013) in which majority of participants were females.

Table 1: Socio-demographic characteristics of participants

Variables	Intervention Group (n = 68) Frequency (%)	Control Group (n = 71) Frequency (%)	Test of significance
Age group (years)			
35-39	7 (10.3)	4 (5.6)	χ^2= 2.366,
40-44	13 (19.1)	17 (24.0)	p = 0.669
45-49	14 (20.6)	16 (22.5)	
50-54	16 (23.5)	20 (28.2)	
≥55	18 (26.5)	14 (19.7)	
Sex			
Male	31 (45.6)	27 (38.0)	χ^2= 8.816,
Female	37 (54.4)	44 (62.0)	p = 0.366
Marital status			
Single	14 (20.6)	16 (22.5)	χ^2= 1.433,
Married	40 (58.8)	41 (57.8)	p = 0.838
Separated	3 (4.4)	2 (2.8)	
Divorced	7 (10.3)	5 (7.0)	
Widowed	4 (5.9)	7 (9.9)	
Religion			
Christianity	16 (23.5)	23 (32.4)	χ^2= 1.352,
Islam	52 (76.5)	48 (67.6)	p = 0.245
Educational status			
None	2 (3.0)	2 (2.8)	χ^2= 2.592,
Qur'anic school only	13 (19.1)	18 (25.4)	p = 0.628
Primary	27 (39.7)	20 (28.1)	
Secondary	13 (19.1)	18 (25.4)	
Tertiary	13 (19.1)	13 (18.3)	
Occupational status			
Unemployed	11 (16.2)	11 (15.5)	χ^2= 4.509,
Farmer	12 (17.6)	11 (15.5)	p = 0.341
Unskilled laborer	20 (29.4)	12 (16.9)	
Skilled laborer	22 (32.4)	31 (43.7)	
Professional	3 (4.4)	6 (8.4)	

Table 2: Participants' lifestyle, drug adherence and blood pressure control status

Variables	Intervention Group (n = 68) Frequency (%)	Control Group (n = 71) Frequency (%)	Test of significance
Lifestyle			
Healthy	3 (4.4)	3 (4.2)	χ^2= 0.1442,
Unhealthy	65 (95.6)	68 (95.8)	p = 0.931
Drug adherence status			
Adherent	17 (25.0)	17 (23.9)	χ^2= 0.021,
Non adherent	51 (75.0)	54 (76.1)	p = 0.885
Blood pressure control status			
Controlled	0 (0)	0 (0)	χ^2= 0.066,
Uncontrolled	68 (100)	71 (100)	p = 0.798

Table 3: Effect of home visit on lifestyle modification, drug adherence and control of hypertension among participants

Variables	Intervention Group		Control Group	
	Pre-intervention (n = 68) Frequency (%)	Post-intervention (n = 68) Frequency (%)	Beginning of study (n = 71) Frequency (%)	End of study (n = 71) Frequency (%)
Lifestyle				
Healthy	3 (4.4)	55 (79.4)	3 (4.2)	19 (26.7)
Unhealthy	65 (95.6)	14 (20.6)	68 (95.8)	52 (73.3)
	χ^2= 79.542, p = 0.000		χ^2= 13.770, p = 0.0002	
Drug adherence status				
Adherent	17 (25.0)	52 (76.5)	17 (23.9)	28 (39.4)
Non adherent	51 (75.0)	16 (23.5)	54 (76.1)	43 (60.6)
	χ^2= 36.037, p = 0.000		χ^2= 3.936, p = 0.047	
BP control status				
Controlled	0 (0)	55 (80.9)	0 (0)	33 (46.5)
Uncontrolled	68 (100)	13 (19.1)	71 (100)	38 (53.5)
	χ^2= 92.346, p = 0.000		χ^2= 42.991, p = 0.000	

Also, the finding of majority of the participants in both the intervention and control groups in this study being married is in agreement with the higher proportion of females that was reported in the latter studies, and this could be due to the cultural similarities in the study areas concerned.

Although, there was no significant difference in lifestyle between the participants in the intervention and control groups at baseline, it is disturbing that almost all the participants in both the intervention (95.6%) and control (95.8%) groups practiced unhealthy lifestyle considering the adverse effects of such practices on blood pressure control, disease progression and onset of complications. Evidence from studies has shown that lifestyle modifications (including dietary control, regular moderate exercise, weight reduction, cessation of smoking and stress management, among others) are cardinal points in achieving blood pressure control (Okwuonu et al., 2014; Mcdonald et al., 2009; Onwukwe and Omole, 2012). Whereas, the proportion of participants that practiced unhealthy lifestyle reduced drastically from 95.6 to 20.6% in the intervention group, far less reduction was observed in the control group (from 95.8 to 73.3%). These findings therefore provide additional evidence in support of the effectiveness of home visits intervention in causing lifestyle changes among patients with hypertension.

The low drug adherence levels among the participants in both the intervention (25.0%) and control (23.9%) groups in this study essentially mirror the low drug adherent levels that were reported in studies conducted in other cities across Nigeria including Ado-Ekiti (44.7%) (Raimi, 2017), and Kano (54.2%) (Kabir et al., 2004).

A very important finding in this study is the tremendous increase in adherence levels among the participants in the intervention group (from 25.0 to 76.5%) as compared to the marginal increase in adherence levels among the participants in the control group (from 23.9 to 39.4%). This finding is similar to the finding in a community based randomized trial that reported a high anti-hypertensive medication adherence level (77.0%) following a home visit intervention (Morisky et al, 2008), and it is reassuring as it highlights the importance of home visits in facilitating drug adherence among patients with hypertension.

Even though, all the participants (100%) in both groups had uncontrolled hypertension at baseline (being one of the eligibility criteria for recruitment into the study), the proportion of participants that achieved blood pressure control in the intervention group (80.9%) was almost twice that of the control group participants (46.5%). Similar to the finding in this study, a community based randomized control trial in Nigeria reported a high proportion of participants (66.0%) that achieved blood pressure control in the intervention group following the home visits intervention (Adebowale et al., 2013). Likewise, a study in Germany which involved delegated General Practitioner home visits to uncontrolled hypertensive patients showed a significant decrease in the mean systolic blood pressure after the intervention (van den Berg et al., 2013). Also, a study that utilized Community Health Workers (CHWs) who were trained to provide social support, deliver drugs and offer counseling to hypertensive patients reported a significant improvement in blood pressure control among the group visited at home as compared to the group that received routine care (Gaziano et al., 2014).

While the significant improvement in the proportion of the control group participants with healthy lifestyle, drug adherence, and blood pressure control is not surprising (as their routine care also involved counseling on the elements of the intervention), the substantially higher levels of improvement that were recorded in the intervention group as compared to the control group provide additional evidence in support of the submissions of other studies (Gaziano et al., 2014; Chiu and Wong, 2011; Theile et al., 2011) regarding the effectiveness of home visits in facilitating healthy lifestyle modification, high medication adherence, and ultimately blood pressure control. These findings therefore underscore the need for the management of healthcare institutions to make home visits a core component of the standard care of patients with hypertension.

CONCLUSION

This study showed that home visits are effective in facilitating healthy lifestyle modification, high medication adherence and blood pressure control among patients with uncontrolled hypertension in Sokoto, Nigeria. Management of healthcare institutions should make home visits a core component of the standard care of patients with hypertension.

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Conflict of interest

None declared.

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Prevalence, knowledge of hazards and practices regarding generator use among small-scale business operators in Sokoto, Nigeria

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ABSTRACT

Background: The perennial inadequate electricity supply in Nigeria has become a serious threat to the economic development of the country, and a major driving force behind the proliferation of fossil fuel generator as an alternative source of energy for both domestic and commercial purposes across the country. **Aim**: This study aimed to assess the prevalence, knowledge of hazards and practices regarding generator use among small-scale business operators in Sokoto, Nigeria. **Materials and Methods:** This was a cross-sectional study among 285 small-scale business operators selected by a multistage sampling technique. A structured self-administered questionnaire was used to collect data on the research variables. Data were analyzed using the IBM SPSS version 20 statistical computer software package. **Results**: The mean age of respondents was 28.59 ± 7.09 years; most of them were males (80.4%) and have worked for ≤ 10 years (91.9%). Majority, 212 (74.4%) of the 285 respondents use fossil fuel generator as an alternative source of energy to run their businesses. Despite high levels of good knowledge of the hazards of generator use (73.7%) and the methods of preventing exposure to them (94.7%), practices related to exposure to the hazards were very prevalent among the respondents. **Conclusion**: This study showed high prevalence of generator use and practices related to exposure to its hazards among small-scale business operators in Sokoto, Nigeria, despite good knowledge of the hazards and the methods of preventing exposure to them. The Nigerian government should provide adequate and regular electricity supply across the country.

Keywords: Prevalence, generator use, hazards, knowledge, practices, small-scale business operators

INTRODUCTION

The perennial inadequate electricity supply in Nigeria has become a serious threat to the economic development of the country, and a major driving force behind the proliferation of fossil fuel generator as an alternative source of energy for both domestic and commercial purposes across the country (Oyedepo, 2012; Iwayemi, 2008; Akande, 2008). Over the years, the proportion of households in Nigeria with access to electricity remains poor and only increased marginally from 56% in 2013 to 59% in 2018 (NPC and ICF International, 2014; NPC and ICF, 2019). It has been estimated that over 90% of businesses (particularly small-scale businesses) and over 30% of homes depend on generators for energy supply; and this constitutes a huge economic loss to the country because they are largely imported from other countries, and they are expensive to buy, maintain and fuel (Ikhuosho-Asikhia, 2014; Ibitoye and Adenikinju, 2007). In addition to its devastating effects on the economy, use of fossil fuel generators is known to be associated with serious environmental and health hazards including environmental pollution, noise, impaired hearing, sleeplessness, choking sensation, vibration, heat, and fire hazards; and all these in turn adversely affects the psychological and mental health of those concerned (Mbamali et al., 2012; Offiong, 2003).

While in operation, electric generators produce noise at high levels; a study conducted in Ibadan, Nigeria, reported high generator noise levels of between 91.2 and 100.5 dB(A) (Yesufu and Ana, 2012), and high noise levels (beyond the World Health Organization's limit of 70 to 75dB) have been found to be associated with adverse health and social effects including high blood pressure, abnormal fetal development, extreme emotions and behavior, hearing impairments, sleep disturbance, and friction among neighbors (Smith et al., 2004; Osuntogun and Koku, 2007; Minja et al., 2003). Electric generators also release toxic gases including carbon monoxide into the atmosphere which cause indoor air poisoning particularly when used in enclosed spaces

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inside or close to business premises, thus increasing the risk of carbon monoxide poisoning (Dimari et al., 2007; Rao, 2007). Evidence from literature has confirmed that carbon monoxide poisoning is the most common type of fatal air poisoning in many countries (Omaye, 2002). It was also estimated that indoor air pollution from fossil fuel combustion claimed more than 1.6 million lives and left over 38.5 million disabled worldwide in the year 2000 (Smith et al., 2004).

Outdoor air pollution from incomplete combustion and other emissions from fuel use is also an important health risk globally. The Global Energy Assessment (GEA) estimates that it was responsible for some 2.7 million premature deaths in 2005, with the dominant sources of outdoor air pollution being combustion of fossil fuels in industry and transportation (Smith, 2020). In 2019, the World Health Organization (WHO) considered air pollution as the greatest environmental risk to health as it kills about 7 million people prematurely every year from diseases such as cancer, stroke, heart and lung diseases (WHO, 2020). In addition, the primary cause of air pollution (i.e., burning fossil fuels such as in generators) is also a major contributor to climate change, which impacts people's health in different ways. Between 2030 and 2050, climate change is expected to cause 250,000 additional deaths per year, from malnutrition, malaria, diarrhea and heat stress (WHO, 2020).

The Sustainable Development Goals Report 2019 (United Nations, 2019) revealed that ambient air pollution from traffic, industry, power generation, waste burning and residential fuel combustion, combined with household air pollution, poses a major threat to both human health and efforts to curb climate change; and more than 90 percent of air pollution related deaths occur in low- and middle- income countries, mainly in Asia and Africa. Surprisingly, despite the myriads of health and environmental hazards that are associated with the use of generators, and the prevalent use of generators among small-scale business in Nigeria, there is a dearth of literature on their knowledge and practices regarding these hazards. This study was conducted to assess the prevalence, knowledge of hazards and practices regarding generator use among small-scale business operators in Sokoto, Nigeria.

MATERIALS AND METHODS

Study Design, Population and Area

This was a cross-sectional study among small-scale business operators in Sokoto metropolis, Sokoto State, Nigeria, in November and December 2014. Sokoto metropolis is both the capital and center of economic activities in the state. It comprises 4 Local Government Areas (of the 23 in the state) with a combined population of 809,387 based on the 2006 census, and covers an area of 60.33 square kilometers (NPC, 2006). The Hausas and Fulanis are the most predominant ethnic groups in the state, they are mainly farmers, while the non-natives belong to Igbo, Yoruba and Igala ethnic groups among others, and are mainly involved in small-scale businesses. Employees and operators of small-scale business establishments that were aged 18 years and above, and have worked for at least 6 months in the respective business establishments and consented to participate were considered eligible for this study.

Sample Size Estimation and Sampling Technique

The sample size was statistically estimated at 285, and the eligible participants were selected by a multistage sampling technique. At the first stage, Sokoto metropolis was divided into 12 business districts and 7 of them were selected by simple random sampling using the ballot option. At the second stage, the selection of business establishments in each of the selected districts was done by systematic sampling technique using the list of business establishments in the respective districts to constitute the sampling frame. One of every 3 business establishments was selected in the selected districts at the end of which 48 business establishments were selected. At the third stage, the selection of participants in the selected business establishments was done by systematic sampling technique using the staff list in the respective business establishments to constitute the sampling frame. One of every 5 eligible participants was selected in the selected business establishments at the end of which 285 participants were selected.

Data Collection and Analysis

A set of pretested, structured, interviewer-administered questionnaire was used to obtain information on the participants' socio-demographic characteristics; and the prevalence, knowledge of hazards and practices regarding generator use among them. The questionnaire was pretested on 20 employees and operators of small-scale business establishments in one of the business districts that were not selected for the study. Five resident doctors assisted in questionnaire administration after being trained on the conduct of survey research, the objectives of the study, and questionnaire administration. Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 20 statistical computer software package. Quantitative variables were summarized using mean and standard deviations, while qualitative variables were summarized

using frequencies and percentages. Respondents' knowledge of the hazards of generator use was scored and graded on a 7-point scale. One point was awarded for a correct response, while a wrong response or a non-response received no points. This gives a minimum score of '0' and a maximum score of '7' points. Those that scored ≥ 4 of 7 points were considered as having 'good' knowledge, while those that scored < 4 of 7 points were graded as having 'poor' knowledge. Knowledge of the methods of preventing exposure to the hazards of generator use was scored and graded on a 10-point scale. One point was awarded for a correct response, while a wrong response or a non-response received no points. This gives a minimum score of '0' and a maximum score of '10' points. Those that scored ≥ 6 of 10 points were considered as having 'good' knowledge, while those that scored < 6 of 10 points were graded as having 'poor' knowledge.

Ethical Consideration

Institutional ethical clearance was obtained from the Ethical Committee of Usmanu Danfodiyo University Teaching Hospital, Sokoto, Nigeria. Permission to administer the questionnaires was obtained from the management of the respective business establishments that were selected for the study. Informed consent was also obtained from the participants before questionnaire administration.

RESULTS

Distribution of respondents by age, sex and status in business

All the 285 questionnaires administered were adequately completed and found suitable for analysis giving a response rate of 100%. The ages of the respondents ranged from 18 to 65 years (mean = 28.59 ± 7.09), and majority 177 (62.1%) of the 285 respondents were aged < 30 years. Most of the respondents were males (80.4%) and have worked for ≤ 10 years (91.9%). A slight majority of respondents (50.2%) were employees (Table 1).

Prevalence of generator use among respondents

Majority, 212 (74.4%) of the 285 respondents use fossil fuel electricity generator as an alternative source of energy to run their businesses (Figure 1).

Respondents' knowledge of the hazards of generator use

Majority, 210 (73.7%) of the 285 respondents had good knowledge of the hazards of generator use with the hazards most commonly known to them being fire accident (87.4%), social problems like annoyance and communication problems (80.7%), and exposure to poisonous gases (77.2%). About a third and less of respondents knew the other hazards of generator use (Table 2).

Table 1: Socio-demographic characteristics of respondents

Variables	Frequency (%) n = 285
Age group (years)	
<30	177 (62.1)
30-49	103 (36.1)
≥50	5 (1.8)
Sex	
Male	229 (80.4)
Female	56 (19.6)
Length of stay in business (years)	
≤10	262 (91.9)
>10	23 (8.1)
Status in the business	
Owns the shop/factory	142 (49.8)
Employed to work in the shop or factory	143 (50.2)

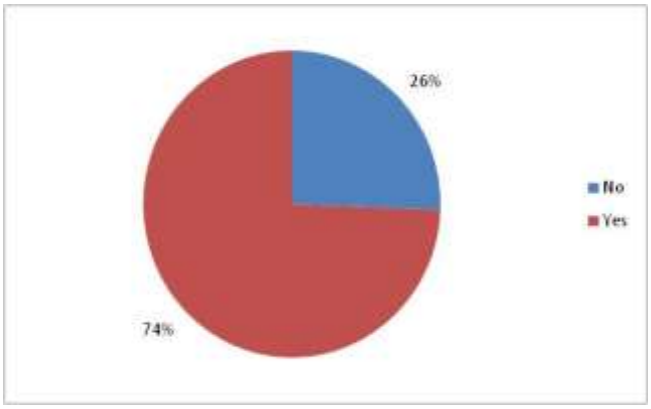

Figure 1: Prevalence of generator among respondents

Respondents' knowledge of the methods of preventing exposure to the hazards of generator use

Most, 270 (94.7%) of the 285 respondents had good knowledge of the methods of preventing exposure to the hazards of generator use with the methods most commonly known to them being avoiding storing fuel inside the shop or near flames (95.4%), operating generator outdoor and far from windows and vents (95.1%), and turning off the generator and allowing it to cool before refueling (92.6%). Most of the respondents also knew the other methods of preventing exposures to the hazards of generator use (Table 3).

Respondents' practices regarding exposure to the hazards of generator use

Majority of respondents had engaged in practices related to exposure to the hazards of generator use such as operating a generator inside or in front of the shop near windows or doors (76.1%), using an old and noisy generator close to the shop or factory (67.0%), and storing fuel inside the shop or near flames (56.1%). The other practices related to exposure to the hazards of generator use ever committed by the respondents are shown in Table 4.

Table 2: Respondents' knowledge of the hazards of generator use

Variables	Frequency (%) n = 285
Knew the following as hazards of generator use:	
Exposure to poisonous gases	220 (77.2)
Social problems like annoyance and communication problems	230 (80.7)
Adverse health effects such as noise induced hearing loss and sleep disturbance	194 (68.1)
Electric shock and electrocution	191 (67.0)
Fire accident	249 (87.4)
Back-feeding into the national grid	140 (49.1)
Damage to equipment and machines	193 (67.7)
Knowledge grading	
Good	210 (73.7)
Poor	75 (26.3)

Table 3: Respondents' knowledge of the methods of preventing exposure to the hazards of generator use

Variables	Frequency (%) n = 285
Knew the following as methods of preventing exposure to the hazards of generator use:	
Operate generator outdoor and far from windows and vents	271 (95.1)
Use sound muffler and enclose generator to reduce noise	257 (90.2)
Operate generator under an open canopy-like structure and dry surface to prevent contact with water	254 (89.1)
Dry hands before touching the generator while in operation	256 (89.8)
Connect appliances correctly using appropriate extension cords	253 (88.8)
Protect electric cord from getting crushed or pinched if it passes through a window or doorway	261 (91.6)
Avoid running electric cords under rug or carpet	262 (91.9)
Avoid storing fuel inside the shop or near flames	272 (95.4)
Turn off the generator and let it cool before refueling	264 (92.6)
Use an appropriate device to prevent back-feeding into the national grid	256 (89.8)
Knowledge grading	
Good	270 (94.7)
Poor	15 (5.3)

Table 4: Respondents' practices regarding exposure to the hazards of generator use

Generator use practices	Frequency (%) n = 285
Operate generator inside or in front of the shop near windows or doors	217 (76.1)
Use an old and noisy generator close to the shop/factory	191 (67.0)
Operate the generator on a wet surface or where water can reach it	146 (51.2)
Touch the generator while in operation with wet hands	152 (53.3)
Use any available electric extension cord irrespective of the load capacity or length	153 (53.7)
Use an electric cord to connect appliances without checking to ensure absence of cuts or tears	160 (56.1)
Run electric cords under rug or carpet	105 (36.8)
Store fuel inside shop or near flames	160 (56.1)
Refuel the generator while it is in operation	121 (42.5)

DISCUSSION

This study assessed the prevalence, knowledge of hazards and practices regarding generator use among small-scale business operators in Sokoto, Nigeria. The high prevalence of use of fossil fuel electricity generators (74.4%) among the respondents in this study is in consonance with findings in studies conducted in other cities in Nigeria including Kaduna (89.9%) (Mbamali et al., 2012), Anyigba (73.2%) (Akande and Owoyemi, 2008), and some cities in South-Southern Nigeria (80.1%) (Ibhadode et al., 2016); and these essentially reflect the grossly inadequate electricity supply across the country.

Although, the high proportion of respondents with good knowledge of the hazards of generators use in this study (73.7%) is in contrast to the low proportion of respondents with good knowledge of generator use hazards in a study conducted in selected areas of Ibadan, Nigeria (44.5% and 53.3%) (Yesufu et al., 2013), awareness of the respective hazards of generator use was similarly high in the studies conducted in other cities across Nigeria (Akande and Owoyemi, 2008; Mbamali et al., 2012; Ibhadode et al., 2016). These findings are reassuring in view of the fact that those concerned are more likely to prevent exposing themselves to these hazards since they are aware of them.

A very disturbing finding in this study is the prevalent engagement in practices related to exposure to the hazards of generator use among the respondents despite the fact that most of them (94.7%) had good knowledge of the methods of preventing exposing themselves to the hazards. Worse of all, the most common hazardous practices among the respondents such as operating generators inside or in front of their shop near windows or doors (76.1%) and using old and noisy generators close to their shops or factories (67.0%) appear to be inevitable in view of the prevalent poverty and unhealthy housing conditions across Nigeria. These findings bring to the fore the enormities of the harsh and dangerous conditions in which small-business operators are inextricably entangled in Nigeria, by having to operate in a country with inadequate and irregular power supply, as only 59% of the population have access to electricity (NPC and ICF, 2019); and having to provide alternative sources of energy supply to run their businesses where they could neither afford new generators that produce less noise and smoke, nor rent conducive premises with sufficient space to operate their generators safely, as about 40% of the population live below the country's poverty line (National Bureau of Statistics, 2020).

It is therefore not surprising that studies conducted across Nigeria reported high prevalence of adverse health and social hazards of use of fossil fuel generators among small-scale business operators. A study among traders by Ighoroje et al. (2004) reported high ambient noise levels (>90dB) in their workplaces, and noise-induced hearing impairment was present in 100% of the workers exposed for a period of 14 years, and by 4-8years, 100% of sawmill workers had developed hearing impairment. An institutional based study among staff, students and business operators by Olamijulo et al. (2016) reported that the mean indoor and outdoor noise levels in all the sampling locations exceeded the World Health Organization (WHO) guideline limits of 35dB and 55dB respectively. Also, about 24.0% of respondents reported experiencing difficulty in hearing clearly when at work, while the major complaints reported by them were tinnitus (34.0%), sleeplessness (68.0%), tiredness (60.0%), ear pains (68.0%), headache (40.0%) and annoyance (28.0%).

A study among commercial workers in Agbowo and Ajibode areas of Ibadan, Nigeria by Yesufu and Ana (2012) reported high prevalence of indoor generator placement (Agbowo, 60.0%; Ajibode, 19.0%), high mean generator sound levels [Agbowo, 100.5 ± 7.5dB(A); Ajibode, 91.2 ± 4.86dB(A)], and high prevalence of non-audictory health effects including headache, tiredness, sleeplessness, irritability, lack of concentration, annoyance and poor social interaction. The high prevalence of generator use and exposure to its hazards despite good knowledge of the hazards and the methods of preventing exposure to them among the respondents in this study underscore the need for the Nigerian government to provide adequate and regular electricity supply across the country.

CONCLUSION

This study showed high prevalence of generator use and practices related to exposure to its hazards among small-scale business operators in Sokoto, Nigeria, despite good knowledge of the hazards and the methods of preventing exposure to them. The Nigerian government should provide adequate and regular electricity supply across the country.

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Nil.

Conflict of interest
None declared.

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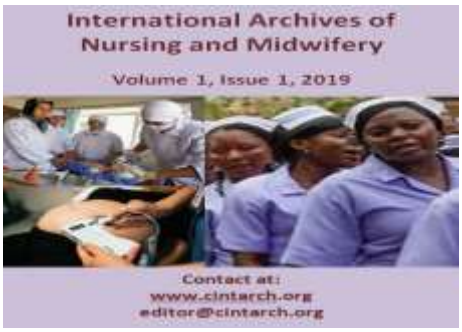

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