Original Article

Fasting blood glucose profile of tuberculosis patients in Port Harcourt, Nigeria

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Abstract

Background: The inter-relationship between tuberculosis (TB) and diabetes mellitus (DM) continues to trigger global interest, especially due to increasing prevalence of TB, propelled largely by the HIV epidemic and almost on an equal scale by the increasing incidence of diabetes worldwide, especially in the developing countries.

Aim: The aim of this study is to determine the fasting blood glucose (FBG) profile of TB patients in Port Harcourt, Rivers State, Nigeria.

Methods: A facility based cross sectional study. A total of 225 adult patients on intensive phase treatment for TB at the two facilities were recruited into the study. Purposive sampling was used to recruit participants into the study in that all the consecutive patients newly diagnosed and attending the clinics during this period were recruited. A semi-structured questionnaire was administered to all participants for medical and socio-demographic data. FBG estimation was done for all the study participants after 8 h of overnight fast using a standardised glucometer. The World Health Organisation criteria were used to classify the study participants into normal, impaired fasting glucose (IFG) and frank DM. Data analysis was carried out using the Statistical Package for the Social Sciences Version. 18.

Results: About 5.3% of the participants already knew they were diabetic. The prevalence of newly diagnosed frank diabetes was 8.6%. We obtained prevalence of 15.5% for IFG among the study participants.

Conclusion: Our findings confirm a high prevalence of IFG and DM among TB patients in our locality.

Keywords: Fasting blood glucose, Port Harcourt, tuberculosis

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INTRODUCTION

In the early part of last century, the prevailing view, as noted by Root in 1934[1] was that patients with tuberculosis (TB) do not develop diabetes more often than the general population. Nichols,[2] however, changed this view. In 1957, they examined 178 TB patients and discovered 5% to have diabetes and a further 22% had an abnormal fasting plasma glucose test. These proportions were higher than the values for the general population.

The concerns over the relationship between TB and diabetes mellitus (DM) continue to trigger global interest, especially due to increasing prevalence of TB, propelled largely by the HIV epidemic and almost on an equal scale by the increasing incidence of diabetes worldwide. Restrepo and Dooley and Chaisson described the

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situation as a convergence of great epidemics.[3,4] Earliest studies concentrated on the more commonly known pre-disposition of patients with diabetes to TB.[5,6] Avicenna[7] in the 11th century was among the first to document the relationship between DM and TB. According to him, diabetes is frequently complicated by phthisis, especially TB. Following Avicenna's landmark report, several other studies have associated diabetes with TB.[8,9] Fewer studies have, however, explored the converse relationship whereby TB predisposes the individual to diabetes. Nichols, in 1957, and Zack *et al*., in 1973, pioneered this research. Depressed cellular immunity, micronutrient deficiency and alcoholism, among other culprits, were identified as major contributors to this relationship.[2,8-10]

In Africa, South African and Tanzanian researchers also made early contributions on the epidemiological association between TB and diabetes.

They observed that diabetes was four times more common in patients with TB compared to the total population. In their study, 4% of TB patients had diabetes compared to 0.9% in the general population.[11,12]

In 2013, Koo hypothesised that as much as 10%–30% of people living with active TB were likely to develop DM.[13]

In Nigeria, a prominent multi-centre implementation study investigated this relationship and recorded a 9.4% prevalence rate of DM among TB patients. In this particular Nigerian study, about 5.5% were newly diagnosed giving 59% yield of DM that was attributable to screening.[14]

Several pathways have been identified to explain this relationship. One reasoning process is that stress resulting from active TB disease which is often debilitating is capable of stimulating the stress hormones epinephrine, glucagon, growth hormone and cortisol, which act in synergy to distort glucose metabolism in these patients.[15]

The other equally notable pathway is such that Mycobacterium TB triggers chronic pancreatitis in some patients, causing damage to the Islet cells and resulting in abnormal glucose metabolism. In addition, isoniazid and rifampicin, the two most important drugs for drug-susceptible TB have been reported to exhibit hyperglycaemic effects and a tendency to effect the requirement of increased drug dosages. The maximum effect due to the drugs is usually noticed about 1 week after commencement and disappears 2 weeks after discontinuing the drugs, a phenomenon referred to as 'transient hyperglycaemia'.[16,17]

Worthy of note is the report that the transient hyperglycaemia may also occur in the setting of other infections such as pneumonia.[18]

The preferred method for plasma glucose screening has been a subject of debate. The World Health Organisation (WHO)-IUATLD collaborative framework suggests that the type of screening and diagnostic tests for DM in TB patients should be adapted to the context of local health systems and the availability of resources.[19] Several different methods and techniques have been suggested.

They include measurement of fasting blood glucose (FBG), random blood glucose, 2 h post-prandial glucose, urine glucose, glycated haemoglobin and oral glucose tolerance test. In a study in West African Guinea, just ticking out a checklist of symptoms of DM led to the diagnosis in all of the DM cases.[20,21]

In most directly observed treatment short-course (DOTS), centres in Nigeria part of the standard operating procedure (SOP) is to screen all presumptive TB cases for HIV, but no such SOP to screen for DM which, as has been noted is growing in prevalence in Nigeria. In the light of the increasing prevalence of TB and diabetes, especially in the developing countries, this study aimed to carry out a preliminary study to screen TB patients on treatment in our centres to determine their FBG profile. This is in view to raising awareness on the relationship between TB and DM, early identification of any derangements, classify appropriately and commence prompt intervention.

METHODS

Study location

The University of Port Harcourt Teaching Hospital is one of the tertiary hospitals located at the South-South zone of Nigeria. It is the largest public health institution in this zone. It started its operations in 1980 and currently has capacity of almost 1000 beds. Every year, over two hundred thousand patients visit the facility from the catchment states for various forms of medical care.

Model Primary Health Centre, Rumuigbo in Port Harcourt is one of the 386 primary health centres in the state and one of the 12 in Port Harcourt City. It is a foremost public primary health facility that serves as the coordinating centre for all activities pertaining to TB in the state.

Study population

The study population comprised all diagnosed adult TB patients 18 years of age and above receiving outpatient treatment at the DOTS clinic of University of Port

Harcourt Teaching Hospital and the Model Primary Health Centre Rumuigbo, both in Port Harcourt, Rivers State, Nigeria, during the study period.

Sampling technique

Purposive sampling technique was adopted for the study. A total of 239 participants who were in their intensive phase of treatment for pulmonary TB were recruited from the DOTS clinics of the two health institutions. Patients on the intensive phase of treatment were chosen because they report more frequently to the clinics for their daily drug ingestion or weekly refills for those unable to come to the clinic daily.

Adult patients diagnosed with pulmonary TB and placed on treatment in the out-patient clinics were included in the study. Patients on treatment for extrapulmonary TB and patients on admission in the wards were excluded from the study.

Relevant medical and socio-demographic information was obtained using semi-structured interviewer administered questionnaire from 1st May to 30th September, 2017. Four-trained research assistants were involved in the data collection process. FBG was measured using a validated Fine Test Glucometer (Fine Test Auto-Coding™ Premium Glucometer Model: IGM-17B), after an overnight fast of at least 8 h. Peripheral blood sample was obtained through a finger puncture before participants took their first meal of the day. Recruitment into the study was done during the previous visits to the clinic when the study was explained to the participants and individual ethical clearance applied.

The glucometer is a point-of-care instrument in common use by patients for self-care in our locality. It is also widely used by healthcare workers for blood glucose estimation, especially for urgent and emergency assessments. It is easy to use, affordable and reliable. Validity was ensured by measuring a participant's FBG using the glucometer and the colorimetric method and comparing the two values.

Participants were considered to have DM if FBG is ≥7.0 mmol/L or reported by patients as using insulin or oral hypoglycaemic medication. Participants who were diagnosed DM for the first time during this survey were called newly-diagnosed DM; participants who had a history of DM were called previously-diagnosed DM. Normal fasting glucose was defined as FBG <6.1 mmol/L. Impaired fasting glucose (IFG) is defined as FBG ≥6.1 mmol/L but <7.0 mmol/L according to the WHO criteria.[22]

Patients who were found to have IFG or frank diabetes were counselled and referred to the diabetes clinic for further evaluation and management.

Data analysis

Data analysis was carried out using the Statistical Package for Social Sciences version 18.0, SPSS Inc., Chicago, Illinois, USA: Continuous variables were summarised with means. Summary statistics were generated and presented using tables and illustrated with a pie chart.

Ethical clearance and consent

Ethical clearance was obtained from the School of Graduate Studies University of Port Harcourt, University of Port Harcourt Teaching Hospital and Rivers State Ministry of Health. Informed consent was obtained from every participant after purpose and procedure of the study were explained. Confidentiality of participants assured before collection of data and postdata collection.

RESULTS

Socio-demographic characteristics of the respondents

The socio-demographic characteristics of the respondents as presented in Table 1 show that. A total of 239 participants were recruited into the study comprising 112 (46.9%)/a response rate of 94.1% (103 [45.8%] males and 122 [54.2%] females). The mean age was 33.9 ± 8.9 years (female) and 37.20 ± 7.60 years (male). More than half of the respondents were married 134 (59.6%), 44 (19.6%) were single, 8 (3.6%) were divorced, 14 (6.2%) were separated, whereas 25 (11.1%) widowed. Regarding educational status, the majority of the participants 102 (45.3%) had a secondary level of education, 23 (10.2%) no formal education, 69 (30.7%) had primary education, whereas 31 (13.8%) had tertiary education.

Fasting blood glucose profile of respondents

Of the total 225 participants that completed the study, 159 participants (70.70%) had values in the normal range, 35 (15.5%) had IFG, 19 (8.6%) were newly diagnosed patients with diabetes in this study following their high blood glucose value equal or above 7.0 mmol/L, while 12 (5.3%) were self-reported old cases of DM [Figure 1].

Fasting blood glucose profile of respondents by sex

Table 2 shows the fasting blood glucose profile of respondents by sex. The results of this study reveal that of the total number of 159 study participants that had normal FBG, 54.1% (n = 86) were female (mean FBG 5.18 ± 0.42 mmol/L) and 45.9% (n = 73) were male (mean FBG 5.16 ± 0.49 mmol/L).

Table 1: Sociodemographic characteristics of respondents

Variable	Frequency *n* (%)
Sex	
Male	103 (45.8)
Female	122 (54.2)
Age range	
Female	
18-27	34 (21.4)
28-37	47 (29.6)
38-47	19 (11.9)
>47	22 (13.8)
Mean	33.9±8.90
Male	
18-27	14 (8.8)
28-37	31 (19.5)
38-47	49 (30.8)
>47	9 (5.7)
Mean	37.2±7.60
Marital status	
Single	44 (19.6)
Married	134 (59.6)
Divorced	8 (3.6)
Separated	14 (6.2)
Widow	25 (11.1)
Educational status	
No formal education	23 (10.2)
Primary	69 (30.7)
Secondary	102 (45.3)
Tertiary	31 (13.8)

Table 2: Fasting blood glucose profile of tuberculosis patients by sex

Variables	Frequency n (%)	Mean±SD fasting blood glucose
Normal		
Female	86 (54.10)	5.18±0.42
Male	73 (45.90)	5.16±0.49
IFG		
Female	21 (60.00)	6.61±0.24
Male	14 (40.00)	6.52±0.25
Newly diagnosed DM		
Female	8 (57.90)	10.71±1.70
Male	11 (42.10)	93.71±1.90
Previously diagnosed DM		
Female	7 (58.30)	11.22±2.04
Male	5 (41.70)	11.20±2.70

DM: Diabetes mellitus, IFG: Impaired fasting glucose, SD: Standard deviation

Our results further showed that of the 15.5% (n = 35) participants with impaired FBG, 21 (60.0%) of them were female (mean FBG 6.61 ± 0.24 mmol/L) and 40.0% (n = 14) were male (mean FBG 6.52 ± 0.25 mmol/L).

Of the 19 (8.6%) newly diagnosed patients with diabetes, 8 (42.10%) were female (mean FBG 10.71 ± 1.70 mmol/L), while 11 (57.90%) were male (mean FBG 9.93 ± 1.90 mmol/L).

Of the 12 (5.3%) participants that were previously diagnosed patients with diabetes, 7 (58.33%) were female and 5 (41.67%) were male.

DISCUSSION

As happened not too long ago, the world was taken unawares by the HIV epidemic of the 1980s and 90s. The initial response by the health and political communities to that challenge was slow and uncoordinated. What resulted was spread of the virus with alarming and increasing speed, especially in sub-Saharan Africa. Now, with the growing inter-relationship of the great epidemics of diabetes, TB and HIV/AIDS, the global community must not make the same mistake. Now is the time to foster global partnerships to galvanise and coordinate public health actions and policies aimed at containing this emerging epidemic.[3,4,23] Some studies have been carried out in Nigeria describing the relationship between DM and TB[14,24,25] but in Rivers State, there is a dearth of information on glucose metabolism of TB patients, hence the need to carry out this preliminary study in this locality to determine the profile of glucose tolerance of patients with TB.

In this study, the majority of the participants (70.7%) had normal FBG. This finding is in line with a similar study by Sivatana *et al.* in India,[26] where 75.9% of their study participants also had normal FBG levels. In this study, more than half of those with normal FPG were females (54.08%) presenting with a mean value of 5.18 ± 0.42 mmol/L.

In this study, the prevalence of IFG was 15.5% among the study participants. This result corresponds to a study in Tanzania which recorded 16.2% although a much earlier report also from Tanzania obtained a higher prevalence of 25.7%. The lower prevalence obtained more recently from Tanzania could be due to increased awareness of this important relationship and possible public health action. An Ethiopian study obtained a higher prevalence of 29.6%. One study from South Africa recorded 18.1% as IFG prevalence. The variation in the prevalence of IFG levels among TB patients corresponds with similar variation in IFG among non-TB patients globally.[11,27-29]

Although studies have shown IFG to normalise at the end of TB chemotherapy, the high percentage recorded in this study is still a matter of concern as it is a pointer to a likely increase in the burden of DM in the near future. The US National Institutes of Health has warned that what obtains is not total reversal as 1%–5% of IFG or more cases go on to become overt DM.[30] This result underscores the need for continuous surveillance on those with IFG with the aim of limiting progression to frank DM.

Of the IFG group (n = 35), 60.0% of them were female presenting with a mean FBG value of 6.61 ± 0.24 mmol/L,

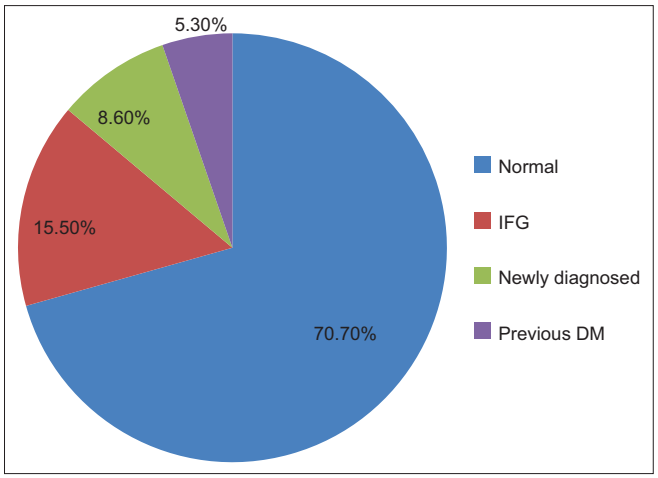

Figure 1: Fasting blood glucose profile of respondents. DM: Diabetes mellitus, IFG: Impaired fasting glucose

whereas males were 40.0% with a mean FBG value of 6.52 ± 0.25 mmol/L.

The study also observed that of the total study population (n = 225), 8.6% were newly diagnosed as patients with diabetes, whereas 5.3% were already known DM patients, bringing the crude TB diabetes rate in this study to 13.9%. Epidemiologically, this is a typical iceberg phenomenon, whereby majority of the cases are undetected.

What we obtained is higher than the prevalence of DM (8.0%) in the general population of this region as reported recently by Arugu and Maduka. In this same geo-political zone as this study, Isara and Okundia obtained a prevalence of 4.6% of DM among the general population. Both studies were conducted among rural communities.[31,32]

Among the new diabetics, 57.9% of them were male with the mean FBG level of 11.20 ± 2.70 mmol/L. Gender differences in glucose metabolism have been extensively studied with conflicting reports. Some researchers have reported no difference in terms of gender just as some reported higher frequency among males. The two studies cited from this region also supported the conflicting reports on gender differences in glucose metabolism such that Arugu and Maduka reported higher prevalence among males (8.7%) and 7.4% for females. On the other hand, Isara and Okundia obtained a prevalence of 1.9% for males and 5.8% for females.[31,32]

The higher prevalence of DM among men might be an accumulative effect of other risk factors such as smoking, tobacco use and excessive alcohol consumption which are more of male behaviour in our environment. The males in this study had higher mean age indicating that they were older since increasing age have been reported as a significant risk factor for diabetes.

CONCLUSION

A profile of FBG of TB patients in our locality showed the prevalence of undiagnosed frank diabetes mellitus among TB patients is high (8.6%). With the addition of known diabetics (5.3%) among the patients it can be seen that the burden of glucose metabolism derangement is high. IFG prevalence was also high (15.5%). Based on our findings, we, therefore, recommend that screening for abnormal glucose tolerance should be incorporated into the routine protocol of care for confirmed cases of TB. This finding contributes to the needed body of knowledge on this important relationship and should guide the proper management of these patients. Being the first report from our state, it is our hope that this preliminary report will serve as a springboard for a prospective large-scale study in future to garner evidence for the national control programmes of TB and DM to make policy decisions on managing this co-morbidity.

Limitations to the study

Findings in this study must be considered within the contents of the study's limitations. Specifically; first, it is important to note that this study was a cross-sectional survey, and there was no follow-up to determine the trend of blood glucose as treatment progressed and at the end of TB chemotherapy. Second, the inability of the study to distinguish other cofounders likely to potentiate hyperglycaemia before the FBG test. Third, the use of FBG for diagnosis is a limitation because FBG has low sensitivity and may underestimate the prevalence of DM. However, FBG has been recommended as the initial DM screening test in resource-limited settings.[5] The HbA1c which is a more reliable alternative is limited by being expensive, cumbersome to perform and inappropriate for screening individuals within routine general health services.[17]

Recommendation

Based on the conclusion from this study, the following recommendations are made:

- There is need to incorporate routine screening for diabetes just like we do for HIV into the national TB control programme
- This preliminary report should serve as a basis for more studies on this very important relationship.

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Conflicts of interest

There are no conflicts of interest

REFERENCES

1. Root HF. The association of diabetes and tuberculosis. New Engl J Med 1934;210:78, 192.
2. Nichols GP. Diabetes among young tuberculous patients; a review of the association of the two diseases. Am Rev Tuberc 1957;76:1016-30.
3. Restrepo BI. Convergence of the tuberculosis and diabetes epidemics: Renewal of old acquaintances. Clin Infect Dis 2007;45:436-8.
4. Dooley KE, Chaisson RE. Tuberculosis and diabetes mellitus: Convergence of two epidemics. Lancet Infect Dis 2009;9:737-46.
5. Nwabudike LC, Ionescu-Tîrgovişte C. Intradermal reactions to purified protein derivative in patients with diabetes mellitus. Rom J Intern Med 2005;43:127-32.
6. Sidibe EH. Main complications of diabetes mellitus in Africa. Ann Med Interne (Paris) 2000;151:624-8.
7. Root HP. The association of diabetes and tuberculosis. New Engl J Med 1934;210:1-13.
8. Ottmani SE, Murray MB, Jeon CY, Baker MA, Kapur A, Lönnroth K, *et al*. Consultation meeting on tuberculosis and diabetes mellitus: Meeting summary and recommendations. Int J Tuberc Lung Dis 2010;14:1513-7.
9. McMahon MM, Bistrian BR. Host defenses and susceptibility to infection in patients with diabetes mellitus. Infect Dis Clin North Am 1995;9:1-9.
10. Zack MB, Fulkerson LL, Stein E. Glucose intolerance in pulmonary tuberculosis. Am Rev Respir Dis 1973;108:1164-9.
11. Swai AB, McLarty DG, Mugusi F. Tuberculosis in diabetic patients in Tanzania. Trop Doct 1990;20:147-50.
12. Marais RM. Diabetes mellitus in black and coloured tuberculosis patients. S Afr Med J 1980;57:483-4.
13. Koo BK. Diabetes mellitus and tuberculosis. Diabetes Metab J 2013;37:249-51.
14. Ekeke N, Ukwaja KN, Chukwu JN, Nwafor CC, Meka AO, Egbagbe EE, *et al*. Screening for diabetes mellitus among tuberculosis patients in Southern Nigeria: A multi-centre implementation study under programme settings. Sci Rep 2017;7:44205.
15. Shamoon H, Hendler R, Sherwin RS. Synergistic interactions among antiinsulin hormones in the pathogenesis of stress hyperglycemia in humans. J Clin Endocrinol Metab 1981;52:1235-41.
16. Mollentze WF, Pansegrouw DF, Steyn AF. Diabetes mellitus, pulmonary tuberculosis and chronic calcific pancreatitis revisited. S Afr Med J 1990;78:235-6.
17. Jiménez-Corona ME, Cruz-Hervert LP, García-García L, Ferreyra-Reyes L, Delgado-Sánchez G, Bobadilla-Del-Valle M, *et al*. Association of diabetes and tuberculosis: Impact on treatment and post-treatment outcomes. Thorax 2013;68:214-20.
18. Başoğlu OK, Bacakoğlu F, Cok G, Sayiner A, Ateş M. The oral glucose tolerance test in patients with respiratory infections. Monaldi Arch Chest Dis 1999;54:307-10.
19. World Health Organization. Collaborative Framework for Care and Control of Tuberculosis and Diabetes: Report by WHO and IUATLD. Geneva: World Health Organization. Available from: http://www.whqlibdoc.who.int/publications/2011/9789241502252-eng.pdf. [Last accessed on 2017 Sep 15].
20. Jeon CY, Murray MB. Diabetes mellitus increases the risk of active tuberculosis: A systematic review of 13 observational studies. PLoS Med 2008;5:e152.
21. Baldé NM, Camara A, Camara LM, Diallo MM, Kaké A, Bah-Sow OY, *et al*. Associated tuberculosis and diabetes in Conakry, Guinea: Prevalence and clinical characteristics. Int J Tuberc Lung Dis 2006;10:1036-40.
22. World Health Organization; 2016. Available from: http://www.who.int/mediacentre/factsheet/fs140/en/. [Last accessed on 2017 Sep 13].
23. Harries AD, Lin Y, Satyanarayana S, Lönnroth K, Li L, Wilson N, *et al*. The looming epidemic of diabetes-associated tuberculosis: Learning lessons from HIV-associated tuberculosis. Int J Tuberc Lung Dis 2011;15:1436-44, i.
24. Olayinka AO, Anthonia O, Yetunde K. Prevalence of diabetes mellitus in persons with tuberculosis in a tertiary health centre in Lagos, Nigeria. Indian J Endocrinol Metab 2013;17:486-9.
25. Ogbera AO, Kapur A, Chinenye S, Fasanmade O, Uloko A, Odeyemi K, *et al*. Undiagnosed diabetes mellitus in tuberculosis: A Lagos report. Indian J Endocrinol Metab 2014;18:475-9.
26. Srivatana AB, Jain P, Jain S. Prevalence of diabetes mellitus in active pulmonary tuberculosis patients and clinico-radiological presentation of tubercular diabetic patients. Int J Res Med 2016;5:79-83.
27. Damtew E, Ali I, Meressa D. Prevalence of diabetes mellitus among active pulmonary tuberculosis patients, Addis Ababa, Ethiopia. World J Med Sci 2014;11:389-396, doi:10.5829/idosi.wjms2014.11.3.85152. Available from: https://doi.org/10.1093/ajcp/aqy104.324. [Last accessed on 2017 Sep 13].
28. Assefa G, Solomon M, Shiatye A, Hanan Y. High magnitude of diabetes mellitus among active pulmonary tuberculosis patients in Ethiopia. Br J Med Med Res 2013;4:862-72.
29. Mcebula V, Crowther NJ, Nagel SE, George JA. Diabetes and abnormal glucose tolerance in subjects with tuberculosis in a South African urban center. Int J Tuberc Lung Dis 2017;21:208-13.
30. Guptan A, Shah A. Tuberculosis and diabetes: Appraisal. Indian J Tuberculosis 2000;47:2-8.
31. Arugu GM, Maduka O. Risk factors for diabetes mellitus among adult residents of a rural district in Southern Nigeria: Implications for prevention and control. Niger J Clin Pract 2017;20:1544-9.
32. Isara AR, Okundia PO. The burden of hypertension and diabetes mellitus in rural communities in Southern Nigeria. Pan Afr Med J 2015;20:103.