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Economic Burden of Tuberculosis Diabetes Co-Morbidity in Tuberculosis Patients Attending Two Chest Clinics in Lagos State

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A – research concept and design; B – collection and/or assembly of data; C – data analysis and interpretation; D – writing the article; E – critical revision of the article; F – final approval of article.

Abstract

Background: Diabetes mellitus (DM) increases the risk of developing tuberculosis (TB) three-fold. The cost of accessing care for TB-DM co-morbidity poses a significant burden on patients, as they bear both direct and indirect costs of treatment, mostly of out-of-pocket.

Objective: To estimate the direct medical cost of illness in patients with TB-DM co-morbidity in two chest clinics in Lagos State.

Materials and Methods: An observational study, carried out in two chest clinics in Lagos State to evaluate direct medical costs associated with TBDM co-morbidity during TB treatment. A semi structured questionnaire, pharmacy price list of drugs and an online transportation service lara.ng was employed to document and quantify prescribed medications, laboratory investigations, number of clinic attendance and attendant transportation costs.

Results: Among the participants, 53.8% were females. The mean age was 50.7±9.7 years. The total direct medical and non-medical costs for TBDM management was NGN8,604,819 (USD24,585.20) for the duration of TB treatment. Average cost per patient (CPP) was NGN179,384.85 (USD512.53). This was equivalent to 49.8% of the current national minimum wage. Male patients incurred more mean direct medical cost than female patients (NGN26, 647.90 vs NGN24, 020.40), while female patients incurred more mean direct non-medical costs than the males (NGN22, 314.30 versus NGN13, 041.70). Patients aged 60 years and above incurred the highest mean direct costs compared to other age groups.

Conclusion: Direct medical costs are substantial in TBDM co-morbidity and increase with age.

Keywords: Tuberculosis; Diabetes-Mellitus; Cost; Chest clinic; Lagos.

INTRODUCTION

The global increase in diabetes mellitus (DM) is a perceived danger and challenge to tuberculosis (TB) global control efforts. TB, a killer bacterial disease and a major cause of ill health is the leading cause of death from a single infectious agent (WHO 2020). It is increasingly presenting as a co-morbidity in diabetic patients (Yorke *et al*., 2017). Globally, over ten million people become infected with TB annually, and between 5 - 30% of these infections are estimated to be as a result of DM depending on the prevalence of TB in the area (Stevenson *et al.*, 2007). Also, approximately 415 million adults currently live with diabetes, a leading non-communicable disease, and by 2040 this number is expected to rise to about 642 million (Ogurtsova *et al.*, 2017). Majority of patients with TB and DM co-morbidity live in low- and middle-income countries and continue to drive the fastest increase in people living with diabetes (WHO, 2016; Atun *et al.*, 2017). In 2019, Nigeria had the highest burden of TB in Africa with 299 infections out of every 100 000 persons (WHO 2020). Nigeria also has the third highest burden of DM in Africa (IDF, 2015), a situation which makes the interplay between the two diseases of significant importance, given the reported negative interaction between the two which results in mutual worsening of each other's

progression and outcomes (Niazi and Kalra, 2012). In Nigeria, TB is managed free under the Directly Observed Therapy, Short Course (DOTS) program, a program which controls TB spread through prompt detection of infectious cases and provision of effective therapy using quality-assured anti-TB drugs (FMOH, 2008; FMOH 2010). Management of DM on the other hand is not free, it is managed either under the National Insurance Health Scheme, or paid for out of patient's pocket.

Illness frequently places significant financial burden on patients, families and the society (Jo, 2014). Costs of illness studies are often carried out to evaluate the economic burden such illnesses impose in order to develop policies and programs that will aid to achieve set targets for both communicable and non-communicable diseases. Current global targets and milestones for reductions in the burden of TB and DM disease are set as part of WHO's End TB Strategy and the Sustainable Development Goal for 2030 (SDGs) (UN, 2015). Cost-of-illness studies include but are not limited to, direct medical costs (medication, diagnostic and laboratory investigations), direct non-medical costs (transportation) and indirect costs (productivity losses) borne while seeking cure and relief from illnesses (Jo, 2014). The economic burden, cost of care and poverty TB and DM places on patients and the healthcare system are well known. Tanimura *et al.* (2014) and Seuring *et al*. (2015) in two systematic reviews revealed a large economic and financial burden for both TB and DM disease.

Despite free access to TB care, many TB patients face high direct and indirect costs as a result of illness and in the quest to seek cure. Also, diabetes being a chronic disease, requires continuous care and management to achieve glycemic control and minimize associated microvascular and macrovascular complications which might further drive up the cost of care. Thus, TBDM co-morbidity place a great burden on affected patients. Estimation of the costs associated with TBDM co-morbidity is crucial to make progress towards meeting laid down targets, avoid worse prognosis and improve disease outcomes. The objective of this study is to evaluate the direct medical and non-medical costs of TB-DM co-infection from the healthcare's perspective during anti-TB treatment in two secondary chest clinics in Lagos state, Nigeria. This study is the first investigation of costs involving the co-morbidity in the state.

METHODOLOGY

Study setting and design

A prospective evaluation of costs incurred in the management of TB and DM diseases was conducted in two chest clinics of two secondary care hospitals in Lagos state, among TB out-patients co-infected with DM. Lagos State, situated in the south-western part of Nigeria is the commercial nerve center of the country and it is home to about 21 million people (LSG 2019). The study was part of a larger study carried out in the two chest clinics to determine the management and TB treatment outcomes of TBDM patients in a collaborative care setting. The two clinics run established Directly Observed Treatment, Short Course (DOTS) services and serve as both treatment and referral centres for diagnosed TB patients. Patients were managed under DOTS therapy, which consist of fixed dose combinations (FDC) of a 2-month, initial phase, daily supervised combination of four medications- Rifampicin (R), Isoniazid (H), Ethambutol (E) and Pyrazinamide (Z), followed by a 4-month, continuation phase (CP), comprising two drugs Rifampicin and Isoniazid (RH), commonly depicted as (2RHZE/4RH) (FMOH, 2008).

Study instrument

A semi-structured questionnaire based on extant literature and adapted from "The tool to estimate patient cost" (USAID) was developed to collect required data. The questionnaire consisted of two sections. Section A recorded patient socio-demographic data: age, gender, marital status, religion, educational status and occupation. Also recorded here were body weights, Body Mass Index (BMI), blood pressure and mean glycated hemoglobin of patients which was measured twice during the study. Section B recorded prescribed TB and DM medications at the start of anti-tuberculosis treatment (ATT), and any changes made during the duration of study, and till the end of study, the dose and duration of use, and any adverse effects experienced by patients. It also recorded laboratory investigations, costs, the number of clinic trips made by the patients for the duration of study, and costs incurred. For the purpose of this study, costs associated with illness were recorded as direct medical (medications, laboratory investigations) and direct non-medical (transportation) costs. Pharmacy price list of Lagos University Teaching Hospital (LUTH) was used to quantify the cost of medications, while an online transportation service, lara.ng, was used to quantify the cost of transportation. Duration of study was set at 6- to 8- months of TB treatment. Costs were calculated for the duration as applicable. All costs were calculated in local currency (Nigerian naira, 2019 prices) and converted to US dollars using an average

exchange rate for the period of study as calculated by OANDA currency converter (NGN1= USD350).

Study Procedure

All fifty-two (52) TBDM out-patients starting ATT who were involved in the larger study were included in this study. Inclusion criteria included newly diagnosed TB out-patients aged 18 years and above, known Type 2 DM patients recently diagnosed for TB, and newly diagnosed TB patients with previously undiagnosed DM who were diagnosed with DM at TB treatment initiation. Exclusion criteria included TB patients less than 18 years of age, known or suspected MDR-TB cases, patients on admission and patients diagnosed with any disease condition other than TB and DM. The study was conducted between June 2015 and January 2017. The developed questionnaires were pretested by administering them to five (5) TBDM patients before the commencement of the main study. These patients and questionnaires were exempted from the main study. Thereafter the pretested questionnaires were adjusted for clarity and easy readability and administered to the respondents to elicit the desired responses. Screening for TB patients was based on existing practices in the study centre (FMOH, 2010; WHO, 2017). Enrolled patients were screened for presence or absence of DM with an initial measurement of random blood glucose (RBG) at DOTS initiation. Those with RBG levels above 200mg/dL were further screened with fasting blood glucose (FBG) and glycated haemoglobin (HbA1c) tests one week after. They were then referred to the Endocrinology clinic closest to their place of abode if FBG $\geq$ 126mg/dL or HbA1c $\geq$ 6.5%, for appropriate diagnosis and management of DM in accordance with International diagnostic criteria (WHO, 2006; ADA, 2016). Number of trips made to both DOTS and Endocrinology clinics during the study period and the transportation costs were calculated. TB medications were given free in the DOTS clinic, however, the costs given for the duration of treatment were estimated. Costs of antidiabetic and other medications, diagnostic/monitoring investigations, fasting blood sugar, glycosylated haemoglobin, chest Xray and blood pressure measurement were recorded. Patients were then followed up for the duration of TB treatment. Estimated direct costs for patients in accessing TB and DM care during anti-TB treatment and DM care was calculated. National minimum wage was used to quantify the proportion of average cost per patient spent on direct costs of illness.

Ethical approval.

Ethical approval for the study was obtained from the Health research and Ethnics Committee of Lagos University Teaching Hospital LUTH (Health Research Committee Assigned No: ADM/DCST/HREC/APP/665). Informed consent was also obtained from each patient before recruitment into the study. Confidentiality and anonymity were assured.

Data Analysis

Collected data were entered, and analyzed using Statistical Package for Social Sciences software (SPSS) version 23.0 for windows. Costs incurred were calculated as total costs for TB, DM, and TBDM management, as well as mean costs per patient. Descriptive statistics such as mean (with standard deviation), and frequencies (with percentages) were used to describe relevant variables. Relationship between direct medical and non-medical costs with sociodemographic variables were determined.

RESULTS

This study set out to determine the economic burden of disease among TBDM patients during ATT. Results obtained show that there were more female patients, 28 (53.8%) than males. Majority of the respondents were older than 40 years, mean age was 50.7±9.7. Half of the respondents, 25 (50%) were educated up to secondary school level, and more than half, 28 (53.8%) were self-employed. Family history of DM (28.8%) was more rampant among respondents than family history of TB (9.6%). About half of the respondents also had high blood pressure, 24 (46.2%) while about a quarter, 12 (23.1%) were overweight. Ten patients (19.6%) had hyperlipidaemia. Other illnesses experienced were Ulcer, Gout and Infection (Table 1). Mean glycated haemoglobin was 10.8±2.3. Figure 1 presents the antidiabetic medications prescribed at TB treatment initiation and completion in addition to anti-tuberculous medications (2RHZE/4RH). The number of medications taken by patients varied from 1 to 11. The average number of medications per patient was 4. Twenty three percent (23%) of patients took seven or more medications, 35% took between five and seven, and 75% took between three and five medications. At TB treatment initiation, common antidiabetic medications taken were Insulin injection (9.6%) and Metformin oral tablets (42.3%). This increased to 55.8% and 80.8%

respectively by TB treatment completion. An additional 15.4% patients were prescribed Vildagliptin/Metformin combination. The range of other medications prescribed are shown in figure 2.

TABLE 1: Socio-demographic characteristics of patients

	Variable	Frequency (n = 52)	Percentage (%)
Age	< 30	1	1.9
	30 – 39	4	7.7
	40- 49	19	36.5
	50 – 59	18	34.6
	>60	10	19.2
	Mean ± SD	50.7 ± 9.7	
Gender	Male	24	46.2
	Female	28	53.8
Marital Status	Single	4	7.7
	Married	44	84.6
	Divorced	2	3.8
	Widowed	2	3.8
Religion	Christianity	33	63.5
	Islam	19	36.5
Education	Primary	19	36.5
	Secondary	26	50.0
	Tertiary	5	9.6
	Others	2	3.8
Occupation	Civil servant	6	11.5
	Self employed	28	53.8
	Unemployed	1	1.9
	Artisan	4	7.7
	Others	13	25.0
Family history of TB		5	9.6
Family history of DM		15	28.8
BMI	Underweight	12	23.1
	Normal	26	50.0
	Overweight	12	23.1
	Obese	2	3.8
Other Illnesses	Hypertension	24	46.2
	Hyperlipidaemia	10	19.6
	Ulcer	1	1.9
	Gout	1	1.9
	Infection	1	1.9
Mean HbA1c		10.8±2.3	

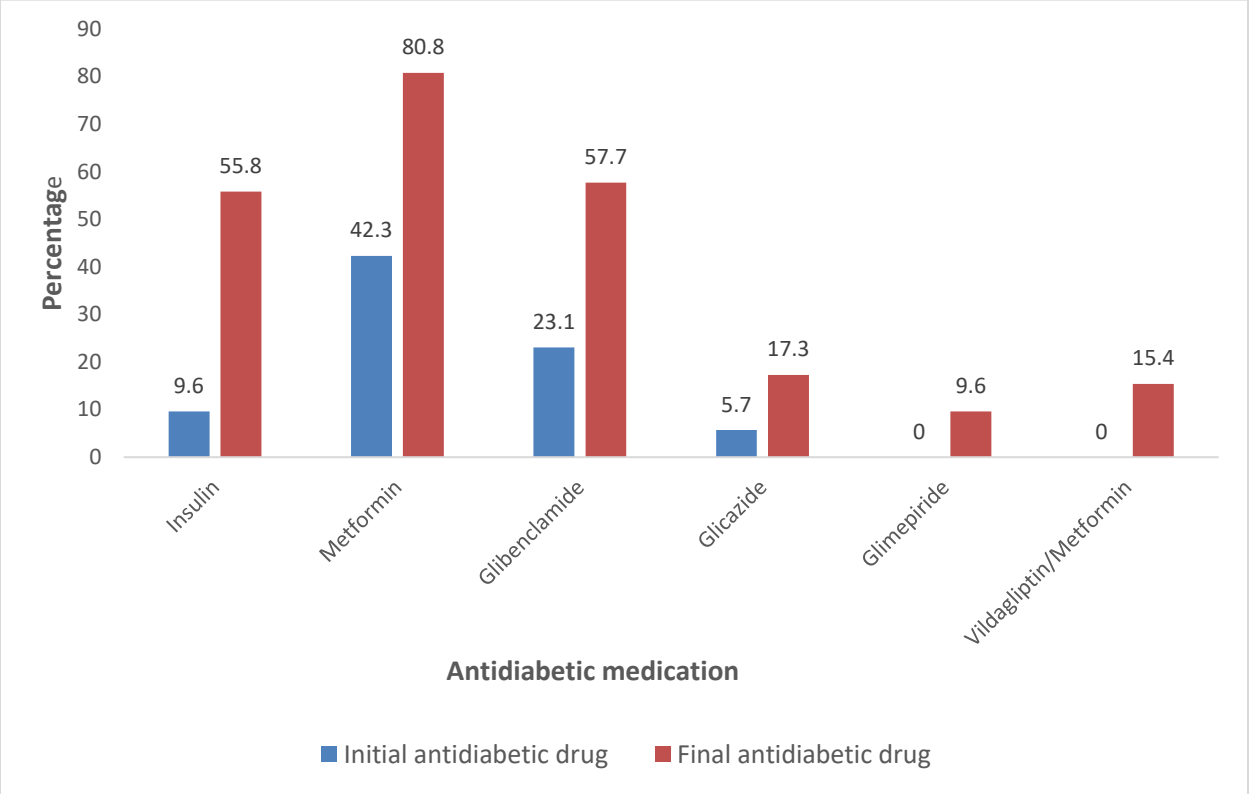

Figure 1: **Antidiabetic medications prescribed at TB treatment initiation and completion.**

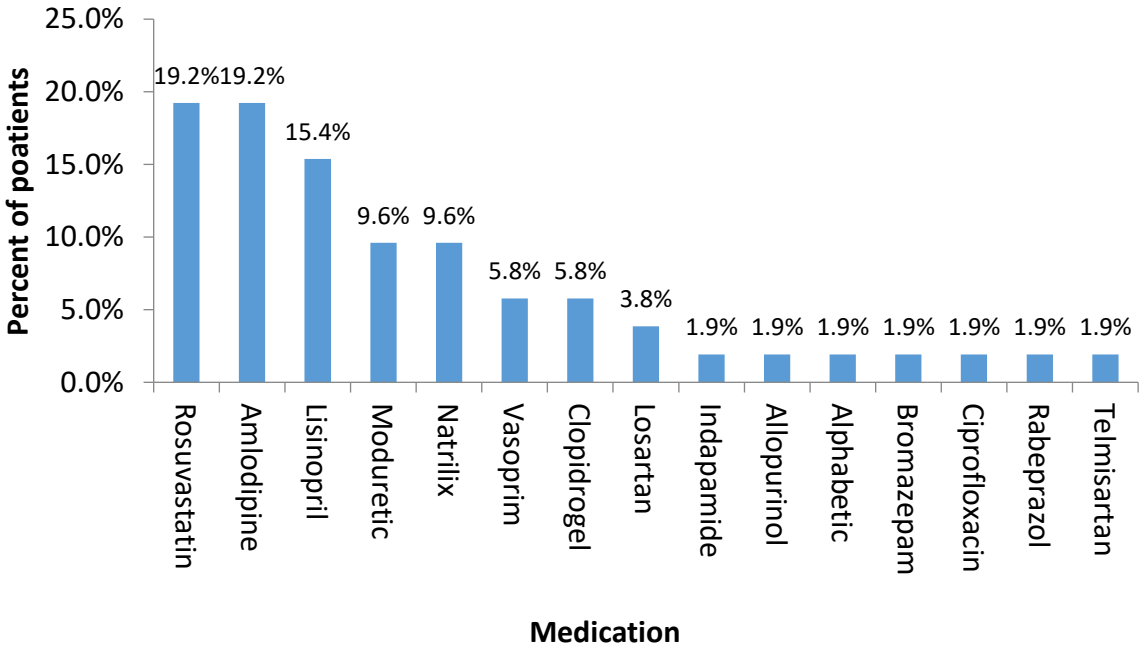

Figure 2: Frequency of other medication prescribed to TBDM patients (n=52)

The total direct medical and non-medical costs for TBDM management was NGN8,604,819 (USD24,585.20) for the duration of TB treatment (Table 2). This was equivalent to 49.8% of annual national minimum wage (Figure 3). Average cost per patient (CPP) was NGN179,384.85 (USD512.53). Of these, estimated total cost and CPP for ATT medications was NGN1,095,320 (USD3,129.49) and NGN21,063.85 (USD 60.18), and NGN3,221,664 (USD9,204.75) and NGN61,995.08 (USD177.13) for DM respectively.

Total and average CPP expended on TB investigations were NGN516,800 (USD 1,476.57) and NGN9,938.46 (USD28.40) respectively, and NGN1,310,400 (USD3,744.00) and NGN25,200 (USD 72.00) for DM investigations.

A higher proportion of estimated total cost was expended on medication purchase for both TB and DM medications, 48.8 and 58.7% respectively, while laboratory investigations had the least proportion. An average of NGN26, 99.311(USD77.13) and NGN3,579.31 (USD10.23) was spent on medications and investigations outside core ATT and DM management.

Total and average CPP incurred for transportation were NGN633,400 (USD1,809.71) and NGN12,180.77 (USD34.80) for TB patients, and NGN960,600 (USD2,744.57) and NGN18,473.10 (USD 52.78) for DM patients respectively.

Table 2: Total and average cost of medications, investigations and transportation for TB and DM patients

Variable		Direct Medical costs		Direct non-medical costs	Total direct medical cost	Total direct medical and non-medical costs
		Medications	Investigations	Transportation		
TB	CPP NGN (USD)	21,063.85 (60.18)	9,938.46 (28.40)	12,180.77 (34.80)	31,002.31 (88.58)	43,183.08 (123.38)
	Freq (%)	48.8	23.0	28.2	71.8	100.0
	Total cost NGN (USD)	1,095,320 (3,129.49)	516,800 (1,476.57)	633,400 (1,809.71)	1,612,120 (4,606.06)	2,245,520 (6,415.77)
DM	CPP NGN (USD)	61,995.08 (177.13)	25,200 (72.00)	18,473.08 (52.78)	87,155.08 (249.01)	105,628.15 (301.79)
	Freq (%)	58.7	23.9	17.5	82.5	100.0
	Total cost NGN (USD)	3,221,664 (9,204.75)	1,310,400 (3,744.00)	960,600 (2,744.57)	4,532,064 (12,948.75)	5,492,664 (15,693.33)
HTN/Others (n=29)	CPP NGN (USD)	26,994.31 (77.13)	3,579.31 (10.23)	NA	30,573.62 (87.35)	30,573.62 (87.35)
	Freq (%)	88.3	11.7		100.0	100.0
	Total cost NGN (USD)	782,835 (2,236.67)	103,800 (296.57)	NA	886,635 (2,533.24)	886,635 (2,533.24)
TBDM	CPP NGN (USD)	110,053.24 (314.44)	38,717.77 (110.62)	30,653.85 (87,558)	148,731.01 (424.95)	179,384.85 (512.53)
	Total cost NGN (USD)	5,099,819 (14,570.91)	1,931,000 (5,517.14)	1,594,000 (4,554.29)	7,030,819 (20,088.05)	8,604,819 (24,585.20)

CPP - Cost per patient

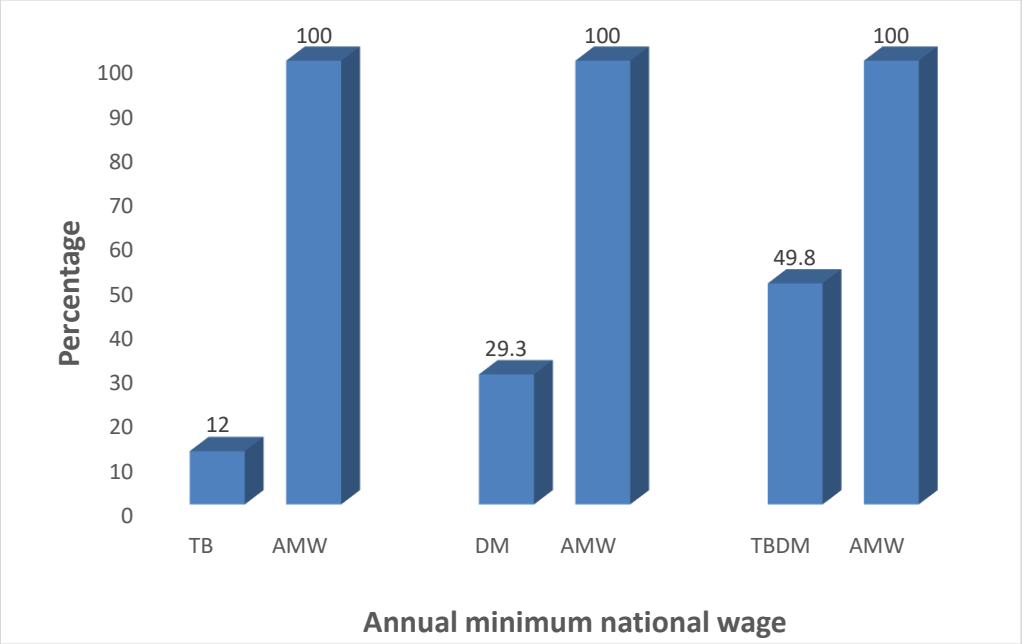

Figure 3: Proportion of cost per patient to annual minimum wage

Annual treatment costs associated with socio-demographic characteristics

The mean total TB cost for male and female patients (direct medical and direct non-medical) was NGN39,689.60 and NGN46,334.00 (Table 3), while the mean total cost for age groups 30-39, 40-49,50-59 and ≥60 years was NGN31,778.30, NGN39,990.00, NGN44,303.50, and NGN48,266.70 respectively.

Likewise, the mean total DM cost for male and female patients was NGN65,806.30 and NGN73,327.50 (Table 4). Mean total cost for age groups 30-39, 40-49,50-59 and ≥60 years was NGN60,478.30, NGN66,900.50, NGN70,131.30 and NGN73,526.70 respectively.

Table 3: Annual tuberculosis treatment costs associated with socio-demographic characteristics

Patient characteristics	Direct Medical Costs NGN (USD) Mean (CI)	Direct Non-Medical Costs NGN (USD) Mean (CI)	Total Costs NGN (USD) Mean (CI)
Gender			
Male	26,647.9(24,231.7-29,064.1)	13,041.7(11,208.8-14,874.6)	39,689.6(36,383.4-42,995.8)
Female	24,020.4(22,071.5-25,969.3)	22,314.3(19,615.8-25,012.8)	46,334.6(43,362.0-49,307.2)
Age (years)			
<30	16867.0	66000.0	82867.0
30-39	19,678.3(16,867.0-22,489.6)	12,100(72,21.8-16,978.2)	31,778.3(27,622.7-35,933.9)
40-49	23,958.4(21,697.3-26,219.5)	16,031.6(13,946.3-18,116.9)	39,990.0(37,281.1-42,698.9)
50-59	26,803.5(24,237.6-29,369.4)	17,500(15,260.8-19,739.2)	44,303.5(40,723.0-47,884.0)
≥60	27,886.7(23,188.9-32,584.5)	20,380.0(15,019.9-25,740.1)	48,266.7(41,537.7-54,995.7)

Table 4: Annual diabetes mellitus treatment costs associated with socio-demographic characteristics

Patient Characteristics	Direct Medical Costs NGN (USD) Mean (CI)	Direct Non-Medical Costs NGN (USD) Mean (CI)	Total Costs NGN (USD) Mean (CI)
Gender			
Male	50147.9 (1089.4 - 5437.1)	15658.3 (-18725.2 - 2815.2)	65806.3 (-15317.9 - 275.4)
Female	46898.9 (1016.7 - 5481.3)	26428.6 (-18469.4 - 3071.1)	73327.5 (-15151.9 - 109.4)
Age (years)			
30-39	46178.3 (42867- 54112)	14300 (5200 - 31200)	60478.3 (54267 - 74067)
40-49	47958.4 (46425.3-49489.6)	18942.1 (14378.1-23843.1)	66900.5 (62270.3-71704.8)
50-59	49347.9 (47190.3-51526.6)	20783.3 (15586.5-25880.7)	70131.3 (65455.5-75589.9)
>60	48866.7 (45884.5-51791.1)	24660 (14000.9-38994.0)	73526.7 (63734.3-86323.5)

DISCUSSION

Diabetes mellitus has become a major contributor to the global TB burden, placing a substantial financial burden on co-affected patients. This study found that the direct medical and non-medical cost of illness of tuberculosis-diabetes co-morbidity per patient was NGN179,384.85 (USD512.53). This accounts for the amount required to manage a patient with both TB and DM for the duration of TB treatment which lasted between 6 to 8 months. Of this, costs for TB accounted for 24% (NGN 43,183.08; USD123.38) and DM, 58.9% (NGN105,628.15; USD 301.79). In managing TBDM co-morbidity, expectedly, the cost of illness incurred in the management of DM was higher than that incurred for TB. Patients with TBDM co-morbidity face much higher costs than those being treated for TB or DM only since they will have to purchase medications and/or undergo investigations to manage both diseases as opposed to managing one, either TB only or DM only. Also, direct medical (medications and laboratory investigations) costs accounted for majority of the incurred costs (82.9%) while direct non-medical costs (transportation) accounted for 17 1%. A contributory factor to the substantial cost burden could have been as a result of patients attending both DOTS and the endocrinology clinics to access care. Collaborations by expanding TB treatment to include DM care for co-infected patients might lead to reductions in costs incurred during treatment of both diseases. Hence there is need to prioritize the management of this comorbidity and eliminate barriers to care so as to improve disease outcomes.

Not many studies have been carried out accessing the economic burden of TB-DM co-morbidity. However, Awei *et al*. (2013) in a study in Malaysia which assessed the economic burden of patients with coexisting DM and TB reported higher treatment costs than our study (USD1234.30) out of which 79% accounted for costs of medications. However, the study included costs for hospitalized patients which was not included in our study.

Corroborating the findings of this study is a study carried out in the South West of Nigeria that found a direct medical cost for TB treatment ranged between USD113 and 401with an average of USD161.28, which was equivalent to 10% of the patient's annual income (Abioye *et al*., 2009).

Similar published studies among TB patients reported lower costs than those observed in this study. Umar *et al.* (2012) in Bauchi state reported estimated median out of pocket costs borne by TB patients during treatment at USD94.16. These differences can be partly explained by the rising cost of living occasioned by inflation, increase in the prices of medicines and laboratory investigations, and the reduction of the purchasing power of the Nigerian naira to the United States dollar. Direct costs of illness in TB in Cambodia and Burkina Faso also reported similar values with this study, USD137 and USD120 respectively (Pichenda *et al.*, 2012; Laokri *et al.*, 2013).

In addition, average direct medical and direct non-medical costs for DM patients for this study revealed NGN87,155.08 (USD249.01) and NGN18,473.10 (USD52.78) respectively. As with costs for TB, costs for drugs were highest, followed by transportation costs. The average direct medical cost in this study was similar to reported average direct values of USD 284.57 in a previous study in Bayelsa state (Suleiman & Festus, 2015) and to USD 314.15 reported per diabetic patient in India (Akari *et al.*, 2013). However, it was lower than reported costs (USD864.7) per patient in Bangladesh (Afroz *et al.*, 2019) even though the proportion of medicines costs were similar (62.8 versus 60.7%). A possible reason for this might be because the studies assessed out patients who did not require hospitalization, so the drugs prescribed might have been fairly uniform. In contrast, Ng *et al.* (2015) reported higher direct medical costs in Singapore (US$1575.6) majority of which were attributed to in-patient costs.

The patients in this study were not on National Health Insurance Scheme, hence incurred costs were paid for

out of pocket. These costs accounted for 12, 29.3 and 49.8% of annual minimum wage for TB, DM and TB-DM co-morbidity respectively. This finding agreed with Arnold *et al.* (2016) who in a study explored the economic burden and financial coping strategies of households affected by Diabetes, TB and co-prevalence in Kyrgyzstan, and reported out of pocket costs as being moderate for TB patients, but severe for diabetic patients. Erzse (2019) in South Africa also reported that treatment of all prevalent DM cases incurred a cost equivalent to approximately12% of the total National Health Budget.

TBDM patients in this study consisted more of females, aged 40 – 49 years. Further analysis revealed tuberculous males incurred more mean direct medical costs than females, while tuberculous females incurred more mean direct non-medical costs than males. The same pattern was observed among diabetic males and females. This could be as a result of poor disease prognosis, side effects or adverse reactions to medications which warranted purchase of additional medications leading to increased costs, while females spent more on transportation, probably because they were more compliant to keeping clinic appointments.

Total direct medical, and direct non-medical costs were also found to increase with age. Patients older than 60 years incurred the highest costs compared to other age groups. This agrees with a study in Bangladesh which reported increased direct costs with increasing age among diabetic patients (Afroz *et al.*, 2019), and with Akari *et al*. (2013) in India where they found more economic burden in males, and in those aged older than 50 years. A possible reason for this could be increasing healthcare needs as age increases, or the development of side or adverse effects of treatments such as neuropathy, or some other illnesses such as fevers, chest and body pain which also needed to be managed, cost wise. There is need for continuous education and proper counselling of patients, especially those with chronic diseases such as DM as they advance in age, so as to encourage optimal management of disease and treatment outcomes. This might ultimately lead to reduced costs of illness.

To the best of our knowledge, no study till date has assessed the economic burden in tuberculosis patients with co-morbid diabetes mellitus in our environment. We acknowledge our limitations in the small sample size for this study. We also acknowledge that study participants were out patients who did not require hospitalization during the course of the study, hence other important costs might have been missed. Also, this study only assessed direct costs of illness of TBDM co-morbidity. A more robust study is recommended to validate these findings and throw more light on all costs incurred in the management of TBDM co-morbidity, so as to enhance informed policy decision making, reduce direct, indirect and other intangible costs, thus improving management and outcomes of disease.

CONCLUSION

This study revealed that the economic burden in TB-DM patients are substantial and increase with age. These costs are driven mainly by direct costs which are characterised by medications, laboratory investigations and transportation costs. It is important to develop strategies to mitigate the economic impact of managing this co-morbidity on patients. Considering also the effect the two diseases have on each other, provision of collaborative management which encourages early detection of DM in TB patients, or vice versa, and the provision of cost-effective treatment options may further drive down costs of illness, ultimately improving patient's quality of life.

REFERENCES

Abioye, A., Omotayo, M., and Alakija, W. (2009). Cost of Care Among Patients With Pulmonary Tuberculosis in Lagos, Nigeria. Nigerian Journal of Clinical Medicine. 2. 10.4314/njcm.v2i2.49273.

Afroz, A., Alam, K., Ali, L., Karim, A., Alramadan, M. J., Habib, S. H., Magliano, D. J. and Billah, B. (2019). Type 2 diabetes mellitus in Bangladesh: a prevalence based cost-of-illness study. BMC Health Services Research **19,** 601.

Akari, S., Mateti, U. V., and Kunduru, B. R. (2013). Health-care cost of diabetes in South India: A cost of illness study. Journal of research in pharmacy practice, 2(3), 114–117.

American Diabetes Association. (2016). Classification And Diagnosis Of Diabetes. Diabetes Care 40. Supplement 1 (2016): S11-S24.

Arnold, M., Beran, D., Haghparast-Bidgoli, H., Batura, N., Akkazieva, B., Abdraimova, A. and Skordis-Worrall, J. (2016). Coping with the economic burden of Diabetes, TB and co-prevalence: evidence from Bishkek, Kyrgyzstan. BMC Health Services Research **16,** 118.

Atun, R., Davies, J. I., Gale, E. A. M., Barnighausen, T., Beran, D., Kengne, A. P., Levitt. N. S., Mangugu, F. W., Nyirenda, M. J., Ogle, G. G., et al (2017). Diabetes in sub-Saharan Africa: from clinical care to health policy. Lancet Diabetes Endocrinol 2017; 5:622–67.

Aweis, D. M. I. and Suleiman, S. A. S. (2013). Economic Burden of Diabetic Tuberculosis Patients. British Journal of Medicine & Medical Research 3(4): 1598-1606

Federal Ministry of Health, (2008). The National Guidelines for Tuberculosis Infection Control.

Federal Ministry of Health, (2010). National Tuberculosis and Leprosy Control Programme (NTBLCP): Workers' Manual - Revised 5th Edition.

International Diabetes Federation. (2015) IDF Diabetes, 7 ed. Brussels, Belgium.

Jo, C. (2014). Cost-of-illness studies: concepts, scopes, and methods. Clinical and molecular hepatology, 20(4), 327–337.

Lagos State Government (2019). Population of Lagos State. Retrieved from www.lagosstate.gov.ng

Laokri, S., Drabo, M. K., Weil, O., Kafando, B., Dembélé, S. M., and Dujardin, B. (2013). Patients Are Paying Too Much for Tuberculosis: A Direct Cost-Burden Evaluation in Burkina Faso. PLoS One. 2013;8(2)

Ng, C. S., Toh, M. P. H. S., Ko, Y., and Lee J. Y-C. (2015). Direct medical cost of type 2 diabetes in Singapore. PLoS One. 2015;10(3):e0122795.

Niazi, A. K., and Kalra, S. (2012). Diabetes and tuberculosis: a review of the role of optimal glycemic control. Journal of Diabetes & Metabolic Disorders, 11(1), 28.

Ogurtsova, K., Da Rocha Fernandes, J. D., Huang, Y., Linnenkamp, U., Guariguata, L., Cho, N. H., Cavana, D., Shaw, J. E., and Makaroff, L. E. (2017). IDF Diabetes Atlas: Global estimates for the prevalence of diabetes for 2015 and 2040. Diabetes Research and Clinical Practice, 128, 40–50.

Pichenda, K., Nakamura, K., Morita, A., Kizuki, M., Seino, K., & Takano, T. (2012). Non-hospital DOT and early diagnosis of tuberculosis reduce costs while achieving treatment success. The international journal of tuberculosis and lung disease : the official journal of the International Union against Tuberculosis and Lung Disease, 16(6), 828–834. https://doi.org/10.5588/ijtld.11.0688

Seuring, T., Archangelidi, O., and Suhrcke, M. (2015). The Economic Costs of Type 2 Diabetes: A Global Systematic Review. PharmacoEconomics, 33(8), 811–831.

Stevenson, C. R., Forouhi, N. G., Roglic, G., Williams, B. G., Lauer J., Dye, C., and Unwin, N. (2007). Diabetes and tuberculosis: the impact of the diabetes epidemic on tuberculosis incidence. BMC Public Health, 7, 234.

Suleiman, I. A., and Festus, J. A. (2015). Cost of illness among diabetes mellitus patients in Niger Delta, Nigeria. Journal of Pharmaceutical Health Services Research, 6(1):53–60.

Tanimura, T., Jaramillo, E., Weil, D., Raviglione, M., & Lönnroth, K. (2014). Financial burden for tuberculosis patients in low- and middle-income countries: a systematic review. The European respiratory journal, 43(6), 1763–1775. https://doi.org/10.1183/09031936.00193413

Umar, N. A., Abubakar, I., Fordham, R., & Bachmann, M. (2012). Direct costs of pulmonary tuberculosis among patients receiving treatment in Bauchi State, Nigeria. The international journal of tuberculosis and lung disease : the official journal of the International Union against Tuberculosis and Lung Disease, 16(6), 835–840.

United Nations (2015). Transforming our world: the 2030agenda for sustainable development. Available from:http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E[10]

USAID. Tool to Estimate Patients' Costs Contents. Available at http://www.stoptb.org/wg/dots_expansion/tbandpoverty/assets/documents/Tool%20to%20estimate%20Patients'%20Costs.pdf

World Health Organization & International Diabetes Federation. (2006). Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia : report of a WHO/IDF consultation. Geneva : World Health Organization. http://www.who.int/iris/handle/10665/43588

World Health Organization. (2016). Global Report on Diabetes. WHO, Geneva. Isbn, 978, 88. Retrieved from: http://www.who.int/diabetes/global-report/en/ doi:org/ISBN 978 92 4 156525 7

World Health Organization (2017). Guidelines for Treatment Of Drug-Susceptible TB and Patient Care, 2017 Update. WHO/HTM/TB/2017.05

World Health Organization (2020). Global Tuberculosis Report 2020. Geneva: Licence: CC BY-NC-SA 3.0 IGO.

Yorke, E., Atiase, Y., Akpalu, J., Sarfo-Kantanka, O., Boima, V., and Dey, I. D. (2017). The Bidirectional Relationship between Tuberculosis and Diabetes. Tuberculosis Research and Treatment, Hindawi: 1–6. doi:org/10.1155/2017/1702578

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