Co-Morbidity of Chronic and Communicable Diseases in Nigeria: A Study on the Relationship between Diabetes and Tuberculosis

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Abstract

Aim: This study provides comprehensive insights into the co-morbidity of diabetes and tuberculosis in Nigeria.

Methodology: This study was cross-sectional in design. The population under study consisted of individuals in Nigeria diagnosed with diabetes and/or tuberculosis. A purposive sampling technique was employed for data collection. The inclusion criteria for the study were individuals who were diagnosed with diabetes and/or tuberculosis and were receiving treatment for the condition(s). A structured questionnaire was administered to three hundred and eighty (380) patients diagnosed with diabetes and/or tuberculosis and attending the outpatient clinic of the University College Hospital (UCH), Ibadan, Nigeria. Data collected were coded and entered into SPSS (version 26.0) for analysis. Descriptive statistics (frequencies, percentages) were calculated for each variable in the study. Cross-tabulation was performed to examine the relationships between variables and Chi-square tests were used to test for statistical significance. The p-value was set at 0.05 for statistical significance.

Results: The results showed that 70.73% of the respondents were diagnosed with diabetes and 36.86% with tuberculosis. Among the participants with both diseases, 39.29% were diagnosed with tuberculosis before diabetes, 46.43% after, and 14.29% at the same time. An important finding of this study revealed that 64.29% of participants with both conditions noticed interactions or effects between their diabetes and tuberculosis conditions. Factors such as age, sex, occupation, smoking habits, and alcohol consumption significantly influenced the co-morbidity of these diseases. The study noted a lack of awareness about the link between diabetes and tuberculosis among 47.15% of the participants, whereas 76.15% felt more should be done to raise awareness in Nigeria. Healthcare access and quality survey showed that 75% of those with both diseases faced challenges in managing the conditions, yet 89.29% were receiving specialized medical care. Statistical analysis identified significant correlations between the co-morbidity of diabetes and tuberculosis with age ($p = 0.033$), sex ($p = 0.019$), occupation ($p = 0.037$), smoking ($p = 0.008$), and alcohol consumption ($p = 0.044$).

Conclusion: This study found that diabetes and tuberculosis are prevalent in Nigeria, and there is a significant correlation between them. There is a need for increased awareness and education about the co-morbidity of these diseases, as well as improved health-care access and quality.

Keywords: Co-Morbidity; Diabetes; Risk Factors; Tuberculosis

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Introduction

Chronic diseases and communicable diseases pose significant public health problems worldwide. While much focus has been directed towards the individual management of chronic and communicable diseases, little emphasis has been put on the co-morbidity of these diseases and their interplay. Among these, the co-morbidity of Diabetes Mellitus (DM) and Tuberculosis (TB) is of particular concern due to their high global prevalence and their bidirectional relationship, where DM increases the risk of TB and TB worsens glycaemic control [1,2]. This relationship has been identified as a looming co-epidemic by the World Health Organization and the International Union Against Tuberculosis and Lung Disease [3].

Diabetes and tuberculosis (TB) are two significant public health issues in Nigeria, posing considerable challenges to the country's healthcare system [4]. Diabetes, a chronic non-communicable disease, is emerging as a significant health concern in Nigeria, with an estimated prevalence of 5.77%. This disease affects a person's ability to regulate blood sugar levels, leading to long-term complications such as cardiovascular disease, kidney damage, and blindness if not managed effectively [5].

On the other hand, Tuberculosis, a communicable disease caused by Mycobacterium tuberculosis, is the most common cause of death from a single infectious agent globally [6]. In Nigeria, Tuberculosis is a major public health problem, with the country ranking sixth among the 30 high TB burden countries and second in Africa [7].

The co-morbidity of these diseases is an emerging area of interest in health research due to their bidirectional relationship. The immune suppression caused by diabetes increases the risk of developing active TB [2], while TB can lead to glucose intolerance, worsening the control of diabetes [8]. This interaction complicates the management of both diseases and necessitates comprehensive interventions to tackle both effectively.

Previous research studies have shown a potential link between diabetes and tuberculosis, where diabetes has been identified as a risk factor for developing tuberculosis [2,8]. The co-morbidity of these two diseases, as well as their associated healthcare challenges, underscore the need for integrated disease management strategies and public awareness campaigns in Nigeria.

The burden of diabetes and tuberculosis in Nigeria cannot be underestimated. Diabetes is a significant public health issue, with an estimated 5 million people living with the disease as of 2019, according to the International Diabetes Federation [9]. On the other hand, Nigeria ranks sixth among the 30 high TB burden countries and second in Africa [7]. The co-morbidity of these diseases could potentially exacerbate healthcare challenges in the country, making disease management more complex. Moreover, patients with co-morbidity often have a poorer prognosis and lower quality of life than those with a single disease [10,11].

Epidemiological studies suggest that people with diabetes have a three-fold increased risk of developing tuberculosis [1]. Diabetes impairs the immune system, making individuals more susceptible to infections, including TB [12]. Additionally, TB may worsen glucose control in people with diabetes, thereby leading to poorer treatment outcomes and higher death rates [13]. Moreover, both diseases share common risk factors, such as malnutrition and smoking [14].

In Nigeria, a country burdened with a high prevalence of both TB and DM, the interplay between these diseases could amplify the public health consequences, impede disease control efforts, and exacerbate the disease burden on the individual and healthcare system. Despite these potential implications, there is limited research on the co-morbidity of DM and TB in Nigeria, with most studies focusing on either disease in isolation. The aim of this study was to investigate the relationship between DM and TB in Nigeria and to identify factors that might influence their co-morbidity. The study also assessed participants' awareness of the relationship between DM and TB, the quality of healthcare services received for both diseases, and how co-morbidity affected their overall health and quality of life. This research provides important insights into the co-morbidity of DM and TB in Nigeria, offering valuable data for healthcare providers and policy-makers to address this significant public health concern.

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Methodology

This study was cross-sectional in design and aimed at exploring the relationship and comorbidity of diabetes and tuberculosis in Nigeria. The population under study consisted of individuals in Nigeria with the focus on those diagnosed with diabetes and/or tuberculosis. A purposive sampling technique was employed for data collection. Patients attending the outpatient department of the University College Hospital (UCH), Ibadan, Nigeria were chosen. The inclusion criteria for the study were individuals who were diagnosed with diabetes and/or tuberculosis and were receiving treatment for the conditions. Informed consent was obtained from all participants before data collection, and confidentiality and anonymity were assured.

A structured questionnaire was administered to three hundred and eighty (380) patients diagnosed with diabetes and/or tuberculosis who attended the outpatient clinic of UCH between January 1 and December 31, 2022. The questionnaire included sections for demographic information, lifestyle and health habits, chronic disease (diabetes) status, communicable disease (tuberculosis) status, healthcare access and quality, and awareness and perception of the comorbidity of diabetes and tuberculosis. Additionally, participants were asked about the management of their health conditions, treatment received, and overall perception of their healthcare services. The questionnaire's content validity was ensured through expert review. The questionnaire was pilot-tested on a small group of diabetes and tuberculosis patients to evaluate its clarity, relevance, comprehensiveness and reliability. Necessary modifications were made based on the feedback received. After obtaining the required ethical approvals and permissions, the researchers visited the outpatient clinic of UCH. The purpose of the study was explained to the participants, and their informed consent was obtained. Participants were given the self-administered questionnaire to fill out in a private space, ensuring confidentiality. Participants were given sufficient time to complete the questionnaire, and their anonymity and confidentiality were maintained throughout the study.

Data analysis

Data collected were coded and entered into SPSS for Windows Version 26.0 for analysis. Descriptive statistics (frequencies, percentages) were calculated for each variable in the study. Cross-tabulation was performed to examine the relationships between variables and Chi-square tests were used to test for statistical significance. The p-value was set at 0.05 for statistical significance.

Ethical considerations

The research was conducted in accordance with ethical principles, including informed consent, confidentiality, and data protection. Participants were informed of the purpose of the research and had the option to withdraw at any time without any consequences.

Results

A total of three hundred and eighty (380) questionnaires were administered to respondents of which only three hundred and sixty-nine (369) were valid. This was due to irregular, incomplete and inappropriate responses to some questionnaires. These 369 questionnaires were validated for the analysis. Results of the study suggest that there was a substantial number of individuals who have been diagnosed with either diabetes, tuberculosis or both. Out of the 369 valid respondents, 70.73% have been diagnosed with diabetes, 36.86% have been diagnosed with tuberculosis, 7.59% of the participants were found to have both diseases (Figure 1). Among those diagnosed with diabetes, most have type II diabetes (95.40%). Around 57.18% have experienced complications due to diabetes, and 54.74% have been hospitalized due to diabetes-related complications (Table 2). Similarly, for tuberculosis, most participants were diagnosed with pulmonary TB (69.85%) (Table 3).

Those who have both conditions reported a noticeable interaction or effects between their diabetes and tuberculosis conditions (64.29%). However, a large portion of the population wasn't sure about the relationship between diabetes and TB (66.94% in case of risk association and 39.57% in case of treatment effect). In the same vein, 58.27% believed there was insufficient public awareness about the relationship between diabetes and TB in their community (Table 5).

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The study also explored the impacts of having both conditions on individuals' health and quality of life (Table 6). The presence of both diabetes and TB significantly worsened or worsened the overall health and quality of life for 78.57% of those with both conditions. Furthermore, 75.00% reported facing challenges in managing both conditions simultaneously.

In terms of healthcare access and quality, most individuals with both conditions are receiving specialized medical care (89.29%) and have received education or counselling regarding managing both diseases (96.43%). All participants (100.00%) believed their healthcare providers are knowledgeable about the co-morbidity of diabetes and TB.

Significant relationships were found between the co-morbidity of diabetes and tuberculosis and several demographic and lifestyle factors including age, sex, occupation, smoking habits, and alcohol consumption (Table 7). For instance, age above 60 years, being female, and being unemployed were significantly associated with the co-morbidity of diabetes and tuberculosis. Also, smoking and alcohol consumption showed significant association with co-morbidity.

Demographic Information	Frequency (369)	Percentage (%)
Age (in years)		
Under 18	28	7.58
18 - 30	54	14.63
31 - 45	77	20.87
46 - 60	116	31.44
Above 60	94	25.47
Sex		
Male	161	43.63
Female	208	56.37
Marital Status		
Single	13	3.52
Married	221	59.89
Widowed	71	19.24
Divorced/Separated	64	17.34
Educational Level		
No Formal Education	21	5.69
Primary Education	52	14.09
Secondary Education	208	56.39
Tertiary Education	88	23.85
Occupation		
Students	46	12.47
Self-Employed	96	26.02
Civil Servants	129	34.96
Unemployed	33	8.94
Retiree	65	17.62

Table 1: Demographic information of participants.

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Variable	Frequency (369)	Percentage (%)
Have you been diagnosed with diabetes?		
Yes	261	70.73
No	108	29.27
If yes, what type of diabetes were you diagnosed with?		
Type I	4	1.53
Type II	249	95.40
Gestational diabetes	8	3.07
If yes, how long have you been diagnosed with diabetes?		
Less than a year	27	10.34
1 - 5 years	68	26.05
6 - 10 years	87	33.33
More than 10 years	79	30.37
Are you currently taking medication for diabetes?		
Yes	248	67.21
No	13	3.52
Not applicable/No diabetes	108	29.27
***How do you manage your diabetes? (Select all that apply to you) (n = 557*)**		
Insulin injections	120	21.54
Oral medication	111	19.93
Diet and exercise	196	35.19
Others	22	3.95
Not applicable/No diabetes	108	19.39
Have you experienced any complications related to diabetes?		
Yes	211	57.18
No	50	13.55
Not applicable/No diabetes	108	29.27
Have you ever been hospitalized due to diabetes-related complications?		
Yes	202	54.74
No	59	15.20
Not applicable/No diabetes	108	29.27

Table 2: Chronic disease (Diabetes).

* = Multiple Responses.

Variable	Frequency (369)	Percentage (%)
Have you been diagnosed with tuberculosis?		
Yes	136	36.86
No	233	63.14
If yes, what type of tuberculosis have you been diagnosed with?		
Pulmonary (affects the lungs)	95	69.85
Extrapulmonary (affects other organs)	41	30.15
If diagnosed with tuberculosis, have you completed the full course of tuberculosis treatment?		
Yes	82	60.29
No	54	39.71

Table 3: Communicable disease (Tuberculosis).

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Variable	Frequency (369)	Percentage (%)
How would you describe your current diet?		
High in carbohydrate	56	15.18
High in protein	89	24.12
High in fat	74	20.05
Balanced	150	40.65
Others	00	0.00
Do you smoke cigarettes?		
Yes	59	15.99
No	310	84.01
If yes, how many per day?		
1 - 3 sticks	37	62.71
4 - 6 sticks	22	37.29
7 - 9 sticks	00	
10 and above	00	
Do you consume alcohol?		
Yes	72	19.51
No	297	80.49
How frequently do you exercise?		
Always	44	11.92
Often	127	34.42
Sometimes	108	29.27
Rarely	90	24.39
Never	00	0.00
How many hours of sleep do you get on average per night?		
Less than 4 hours	41	11.11
4 - 6 hours	259	70.19
7 - 9 hours	65	17.62
10 hours and above	4	1.08

Table 4: *Lifestyle and health habits.*

Variable	Frequency (369)	Percentage (%)
Have you ever been diagnosed with diabetes, tuberculosis or both		
Diabetes only	233	63.14
Tuberculosis only	108	29.27
Both Diabetes and Tuberculosis	28	7.59
If you have both diabetes and tuberculosis, were you diagnosed with tuberculosis before or after being diagnosed with diabetes?		
Before diabetes	11	39.29
After diabetes	13	46.43

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Same time	4	14.29
If you have both diabetes and tuberculosis, have you noticed any interactions or effects between your diabetes and tuberculosis conditions?		
Yes	18	64.29
No	10	35.71
Are you aware of the relationship between diabetes and tuberculosis?		
Yes	109	29.54
No	174	47.15
I'm not sure	86	23.31
Do you think having diabetes increases the risk of having tuberculosis?		
Yes	21	5.69
No	101	27.37
I don't know	247	66.94
Did the treatment for diabetes affect tuberculosis in any way or vice versa?		
Yes	15	4.07
No	208	56.37
Not sure	146	39.57
Did your health provider indicate that having diabetes could have influenced your susceptibility to tuberculosis, or vice versa?		
Yes	273	73.98
No	96	26.02
Have you noticed any changes in the management or control of your diabetes after being diagnosed with tuberculosis, or vice versa?		
Yes	19	5.15
No	9	2.44
Not Applicable	341	92.41
If yes, what is the nature of change noticed?		
Positive	6	31.58
Negative	13	68.42
Not sure		
In your opinion, is there sufficient public awareness about the relationship between diabetes and tuberculosis in your community?		
Yes	62	16.80
No	215	58.27
I don't know	92	24.93
Do you think more should be done to raise awareness of this potential link in Nigeria?		
Yes	281	76.15
No	00	0.00
I don't know	88	23.85

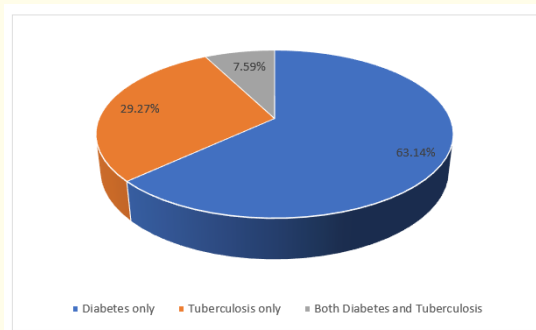*Table 5:* Co-morbidity of diabetes and tuberculosis.

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Figure 1: Co-morbidity of diabetes and tuberculosis.

Variable	Frequency (n = 28)	Percentage (%)
How has the presence of both diabetes and tuberculosis affected your overall health and quality of life?		
Significantly worsened	6	21.43
Worsened	16	57.14
No significant change	6	21.43
Improved	00	0.00
Do you face any challenges in managing both conditions simultaneously?		
Yes	21	75.00
No	7	25.00
Are you currently receiving specialized medical care that addresses the co-morbidity of both diseases?		
Yes	25	89.29
No	3	10.71
Have you received any education or counselling regarding the management of diabetes and tuberculosis together?		
Yes	27	96.43
Not	1	3.57
How would you rate the healthcare services you have received for diabetes and tuberculosis?		
Excellent	7	25.00
Good	15	53.57
Fair	6	21.43
Poor	00	0.00
Very poor	00	0.00
Do you feel that your healthcare providers are knowledgeable about the co-morbidity of diabetes and tuberculosis?		
Yes	28	100.00
No	00	0.00
How would you rate your overall health?		
Excellent	2	7.14
Good	10	35.71
Fair	9	32.14
Poor	7	25.00

Table 6: Access and quality of healthcare by patients with co-morbidity of diabetes and tuberculosis.

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Variable	Diabetes only	Tuberculosis only	Diabetes and Tuberculosis	χ^2	P-value
Age (in years)					
Under 18	19	9	0	8.152	0.033*
18 - 30	36	18	0		
31 - 45	42	31	4		
46 - 60	68	39	9		
Above 60	68	11	15		
Sex					
Male	105	49	7	9.014	0.019*
Female	128	59	21		
Marital Status					
Single	8	5	0	3.758	1.296
Married	149	55	17		
Widowed	45	20	6		
Divorced/Separated	31	28	5		
Educational Level					
No Formal Education	13	6	2	2.213	4.012
Primary Education	34	13	5		
Secondary Education	130	61	17		
Tertiary Education	56	28	4		
Occupation					
Students	30	11	5	6.918	0.037*
Self-Employed	64	30	2		
Civil Servants	86	39	4		
Unemployed	14	10	9		
Retiree	39	18	8		
How frequently do you exercise?					
Always	11	29	4	1.894	6.721
Often	83	34	10		
Sometimes	85	15	8		
Rarely	54	30	6		
Never	0	0	0		
Do you smoke cigarettes?					
Yes	17	31	11	6.664	0.008*
No	216	77	17		
Do you consume alcohol?					
Yes	39	12	21	8.392	0.044*
No	194	96	7		

Table 7: *Factors affecting the co-morbidity of diabetes and tuberculosis.*
*Statistical significance.

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Discussion

This study investigated the co-morbidity of chronic (diabetes) and communicable (tuberculosis) diseases in Nigeria, an endeavour that holds critical significance for public health. The demographic information for the sample population, with a total of 369 valid respondents is presented in table 1. The age distribution showed a balanced representation of different age groups, with a majority of the participants aged between 46 - 60 years, contributing to 31.44% of the population. The next largest group is those above 60 years old (25.47%), followed by the age group of 31 - 45 years (20.87%). The youngest age groups (under 18 and 18 - 30 years) represented 7.58% and 14.63% respectively.

There was a gender skew towards female participants, with females accounting for 56.37% of the sample, while males made up 43.63%. This could reflect a higher willingness or availability among women to participate in the study, or it might indicate a higher prevalence of co-morbidity of diabetes and tuberculosis among women, which could be an interesting avenue for further research. In terms of marital status, a significant proportion of the participants were married (59.89%), followed by widowed (19.24%) and divorced/separated (17.34%) participants. Only a small proportion of the population was single (3.52%).

Educational levels among the study population were diverse. Most participants had secondary education (56.39%), followed by those with tertiary education (23.85%). A small group had no formal education (5.69%), while some completed primary education (14.09%). The high level of secondary and tertiary education among the participants could have implications on the level of health awareness and healthcare-seeking behaviour, which is an interesting aspect that could be further explored.

In regards to the occupation of participants, civil servants made up the largest group (34.96%), followed by the self-employed (26.02%) and retirees (17.62%). A small proportion of participants were students (12.47%) and unemployed (8.94%). The occupational distribution can offer insights into the potential socio-economic factors that may be associated with the co-morbidity of diabetes and tuberculosis.

Understanding the demographic profile of the study population is critical as it helps understand the context of the study's findings. Age, gender, marital status, educational level, and occupation could influence health outcomes and disease susceptibility [15]. For instance, previous research indicates that age and gender can influence susceptibility to diabetes and tuberculosis [16]. Likewise, marital status and educational levels may relate to health literacy and access to health care services [17]. Occupation could also affect health through exposure to certain risk factors or through socio-economic pathways [18]. Therefore, the demographic composition of this study could play a significant role in the study's findings and conclusions on the co-morbidity of diabetes and tuberculosis.

The study provides significant insights into the state of diabetes in Nigeria, an issue that is of utmost relevance given the increasing global burden of chronic diseases [6,7]. In the group, 70.73% (n = 261) reported a diabetes diagnosis. This number is significantly higher than the estimated national prevalence of 5.77% as reported by the International Diabetes Federation in 2019 [9]. This disparity suggests a rising trend in diabetes cases within the specific area where the study was conducted. This high rate emphasizes the pervasiveness of the condition in Nigeria, which reflects the growing global trend of increasing diabetes prevalence [5].

The vast majority of the participants with diabetes were diagnosed with type II (95.40%). This is consistent with the global pattern where type II diabetes is considerably more common than type I [5]. Few participants had been diagnosed with type I (1.53%) or gestational diabetes (3.07%), which might suggest a relative underdiagnosis of these forms of diabetes in the population. This prevalence of type II diabetes is in line with global estimates that suggest the majority of people with diabetes have type II [9].

The disease duration data shows that the majority of diagnosed individuals have been living with diabetes for more than 5 years (63.70%). This fact underlines the chronic nature of the disease and emphasizes the need for effective long-term management strategies [5].

Interestingly, the majority of respondents (67.21%) reported that they were currently on medication for diabetes, while a small minority (3.52%) were not on medication. This high percentage might indicate good patient adherence to treatment regimes, though it also

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could hint at the severity of the disease requiring pharmacological intervention. It aligns with global guidelines that recommend medication, in combination with lifestyle changes, for managing diabetes [5].

It is noteworthy that the preferred management strategy for diabetes was through diet and exercise (35.19%), followed by insulin injections (21.54%), and oral medication (19.93%). These findings reflect the importance of lifestyle modifications in managing diabetes [19] and the prevalence of insulin-dependent diabetes management, which is commonly associated with type II diabetes [9].

More than half of the participants (57.18%) reported experiencing complications related to diabetes, and a similar percentage (54.74%) had been hospitalized due to such complications. This finding highlights the potential for severe morbidity and healthcare utilization associated with diabetes and reinforces the importance of effective disease management and preventive strategies [5].

The results presented in table 3 suggest a high prevalence of tuberculosis among the studied population, with nearly 37% of respondents reporting a diagnosis of the disease. This is an alarming figure given the serious public health implications of tuberculosis. This percentage reflects a substantial TB burden within the sampled population, highlighting its significance as a pressing public health issue in Nigeria. This percentage aligns with existing research indicating the high prevalence of TB in Nigeria, which has one of the highest TB burdens globally [7].

Tuberculosis is a communicable disease caused by the bacterium Mycobacterium tuberculosis. It primarily affects the lungs (pulmonary tuberculosis), but it can also affect other parts of the body (extrapulmonary tuberculosis) [7]. With respect to the type of TB, 69.85% of TB-diagnosed participants had pulmonary TB (which affects the lungs), and 30.15% had extrapulmonary TB (which affects other organs). This is consistent with the literature which indicates that pulmonary TB is the most common form of TB, though extrapulmonary TB remains significant as it often leads to more severe health consequences [20].

The study also investigated whether the participants had completed their full course of TB treatment. Our results showed that only 60.29% of those diagnosed with TB completed the treatment, while 39.71% did not. This is a significant concern as incomplete treatment is a well-known driver of drug-resistant TB and TB relapse [21,22]. Therefore, efforts should be directed towards promoting adherence to TB treatment among this population.

As the study aimed at understanding the co-morbidity of diabetes and tuberculosis, these findings underscore the urgency to integrate communicable and non-communicable disease control efforts. The high prevalence of tuberculosis among the studied population, along with the indication of possible treatment non-adherence, highlights the need for comprehensive care that addresses both communicable and chronic diseases, like diabetes. This is crucial considering studies have indicated that diabetes triples the risk of developing tuberculosis and complicates its treatment [2]. Moreover, it is also known that tuberculosis can worsen glycaemic control in people with diabetes [8]. Our study reaffirms the necessity of comprehensive TB screening and management strategies within the diabetic population. Therefore, a synergistic approach towards the management of diabetes and tuberculosis, including early diagnosis, regular monitoring, and ensuring treatment adherence, is of utmost importance in managing this dual burden in Nigeria.

The data obtained on the lifestyle and health habits of the population present vital information on factors potentially influencing the disease incidence in the Nigerian population (Table 4). In terms of dietary habits, most of the participants (40.65%) reported having a balanced diet. However, a significant proportion consumed a diet high in protein (24.12%), high in fat (20.05%), or high in carbohydrates (15.18%). Diet plays a crucial role in the development and management of diseases such as diabetes, as a balanced diet can help maintain healthy blood glucose levels [5]. Consequently, individuals whose diets are disproportionately high in carbohydrates, fats, or proteins may be at a higher risk of developing diabetes [23,24]. This finding aligns with research indicating that dietary habits, particularly the consumption of foods high in saturated fats and sugars, can lead to obesity, a significant risk factor for type 2 diabetes [25].

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Smoking was reported by 15.99% of the participants, with the majority of these smokers consuming 1 - 3 cigarettes per day. Previous studies have shown that smoking increases the risk of tuberculosis due to the adverse effects on the respiratory and immune systems [26]. This finding is supported by our results, suggesting that smoking may be contributing to the prevalence of tuberculosis in this population. Cigarette smoking has been linked with an increased risk of diabetes and tuberculosis, potentially escalating the complications associated with these diseases [26].

Similarly, the consumption of alcohol, reported by 19.51% of participants, has been linked to an increased risk of developing tuberculosis and poor diabetes control [18]. Alcohol consumption can suppress the immune system and compromise the body's ability to fight off infections, which is especially problematic for diseases like tuberculosis [18].

The majority of participants reported regular physical activity, with only 11.92% exercising "always" and 34.42% exercising "often". This is a concerning observation, as regular physical activity has been shown to play a crucial role in the prevention and management of diabetes [19]. It also contributes to overall immune function, which is critical in managing tuberculosis [27]. Regular exercise is well-documented for reducing the risk of chronic diseases like diabetes, and this habit might contribute to the population's disease management and prevention strategies [19].

Sleep habits also displayed considerable variation, with 70.19% of participants getting an average of 4 - 6 hours per night. Adequate sleep is critical for proper health maintenance, and deprivation is linked to many health issues, including an increased risk of diabetes [28]. Sleep deprivation, typically categorized as less than 6 hours of sleep per night, has been linked to an increased risk of diabetes [29]. Interestingly, 11.11% of respondents reported sleeping less than 4 hours per night, indicating a potentially higher risk group. The role of sleep in tuberculosis management is less clear, but adequate sleep is known to support overall immune function [30].

The observed co-morbidity of diabetes and tuberculosis (TB) among the study population reinforces existing evidence of a significant relationship between the two diseases [8]. Out of the total respondents, approximately 7.59% were diagnosed with both diseases, revealing the critical public health concern this co-morbidity presents, particularly in a country like Nigeria, which grapples with the dual burden of communicable and non-communicable diseases. These findings align with existing global literature which indicates the high prevalence of diabetes and TB individually, as well as their co-occurrence [8,10].

Interestingly, among the participants who had both conditions, the timing of the diagnoses was roughly equal between those diagnosed with TB before diabetes (39.29%) and those diagnosed with TB after diabetes (46.43%). However, there was also a subset diagnosed with both at the same time (14.29%), indicating a potential simultaneous progression of these conditions. This could be supported by previous research suggesting that diabetes can impair the immune response to TB, thereby increasing the susceptibility to TB [31].

Notably, most of the co-morbid patients (64.29%) reported interactions or effects between their diabetes and TB conditions, indicating potential complexities in disease management. It might also imply a perceived mutual influence of these diseases on each other. It's important to consider this in the clinical setting as the co-management of these diseases may be complex and require nuanced strategies [2].

Despite the majority (73.98%) of patients being informed by their health providers about the influence of diabetes on susceptibility to TB (or vice versa), the overall awareness about the relationship between the two diseases was relatively low, with 47.15% of respondents being unaware, and 23.31% unsure. Furthermore, only a small fraction (5.69%) believed that diabetes increases the risk of TB. This disconnect highlights a need for increased patient education regarding the interplay between these diseases, which is critical to fostering better self-management and health outcomes [32].

A crucial finding is that there was a perceived change in the management of diabetes after being diagnosed with TB (or vice versa) in some patients (5.15%), with a majority (68.42%) observing a negative impact. This underscores the need for integrated care models that

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can address the unique needs of patients with both conditions, ensuring that the management of one does not detrimentally affect the other [33].

The study also revealed a lack of public awareness about the link between diabetes and TB in Nigeria, with 58.27% of respondents stating insufficient community awareness. This coupled with a unanimous (76.15%) call for more to be done to raise awareness of this potential link underscores a crucial public health need for education and awareness initiatives [10]. The discrepancy between the awareness of healthcare providers and the public could be due to a lack of effective communication strategies or public health education initiatives. The findings of this study underscore the urgent need for comprehensive public health interventions to increase awareness and improve disease management for individuals with diabetes and TB co-morbidity in Nigeria.

The majority of participants (78.57%) reported a negative impact on their overall health and quality of life due to the co-morbidity of diabetes and TB. This highlights the severe burden imposed by these two diseases when they coexist [11]. This is consistent with previous studies indicating the detrimental impact of multiple chronic conditions on individual health and quality of life [34,35].

Despite the complexity of managing two significant health conditions concurrently, a notable proportion (75%) of participants stated that they faced challenges in managing both diseases simultaneously, implying a need for more comprehensive and integrated health services for individuals with co-morbid conditions [36]. This underscores the need for more streamlined care models and patient support systems to aid in the dual management of diabetes and TB [1].

A positive outcome was the high frequency of participants (89.29%) receiving specialized care that addresses the co-morbidity of both diseases. This finding suggests that there is a strong healthcare system response in terms of clinical management of both conditions, which is an encouraging sign [10]. This underscores the importance of patient education and the role of integrated healthcare in managing co-morbidities [37,38].

The vast majority (96.43%) of participants reported that they received education or counselling about managing diabetes and TB together, indicating a strong emphasis on patient education. This is crucial, as patient education is known to improve treatment adherence and health outcomes [39].

When rating the healthcare services received for diabetes and TB, the majority (78.57%) of participants considered their care to be either excellent or good. Interestingly, all participants (100%) felt that their healthcare providers were knowledgeable about the co-morbidity of diabetes and TB. This high level of patient satisfaction indicates a strong knowledge base among healthcare professionals and a good patient-physician relationship, which are crucial for disease management and patient outcomes [40]. These findings imply that healthcare providers are well-versed in managing co-morbid diabetes and TB, which translates into high-quality patient care [41].

However, despite the apparent quality of healthcare services, the overall health status of participants was suboptimal, with only 42.85% reporting their health as excellent or good, while 57.14% rated their health as fair or poor. This discrepancy might be due to the inherent challenges and complications associated with managing co-morbid diabetes and tuberculosis, despite high-quality care. This observation is consistent with the self-reported negative impact of the co-morbidity on health and quality of life and highlights the need for continuous improvement of the healthcare services [42].

This study highlights the need for comprehensive strategies to manage co-morbid conditions, especially in low-resource settings. Policies aimed at patient education, integrated care, and resource allocation for co-morbid conditions might enhance health outcomes and quality of life for these patients [7].

The results obtained from this study provide valuable insights into the relationship between diabetes and tuberculosis and the variables that contribute to their co-existence. The age of the participants showed a statistically significant association with the co-morbidity

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of diabetes and tuberculosis (χ^2 = 8.152, p = 0.033). The data showed that as age increases, the co-morbidity of diabetes and tuberculosis also increases, with the highest co-morbidity observed in individuals above 60 years of age. This indicates that older age may be a risk factor for comorbidity of diabetes and TB [43]. This result aligns with previous research which has established that the risk of tuberculosis is increased in individuals with diabetes, especially in older populations [2].

The sex of the individual also showed a statistically significant difference (χ^2 = 9.014, p = 0.019). The data showed that females were more likely to have both diabetes and TB as compared to males. This might be due to the physiological differences between sexes, or may reflect differences in health-seeking behaviour, exposure, or access to healthcare [2].

Interestingly, occupation also showed a statistically significant relationship with the co-morbidity of diabetes and tuberculosis (χ^2 = 6.918, p = 0.037). Specifically, individuals who were unemployed had a higher prevalence of co-morbidity. This could potentially be linked to financial constraints leading to poor healthcare, nutritional deficiencies, and heightened stress levels, although more investigation is needed in this area.

Cigarette smoking was associated with higher co-morbidity rates (χ^2 = 6.664, p = 0.008). It appears that those who smoke cigarettes were more likely to have both diabetes and TB. Smoking has long been established as a risk factor for TB and more recently for diabetes as well [26]. This observation aligns with a large body of research showing that smoking is a risk factor for both tuberculosis and diabetes, and it increases the risk of complications [44,45]. Therefore, smoking cessation might be a potential avenue for prevention or management of both conditions.

Similarly, alcohol consumption was also associated with a higher rate of co-morbidity (χ^2 = 8.392, p = 0.044), in line with existing literature linking alcohol misuse with an increased risk of both conditions [11,46]. Alcohol can contribute to a weakened immune system, making an individual more susceptible to infections like TB. Moreover, heavy alcohol use is a risk factor for diabetes [18].

Frequency of exercise, though not reaching a level of statistical significance, showed an interesting pattern. Those who 'rarely' or 'never' exercise had more instances of co-morbidity compared to those who 'always' or 'often' exercise. This finding aligns with the broader literature suggesting physical activity may protect against various health conditions, including diabetes and possibly TB [47].

No significant associations were found between the co-morbidity of diabetes and tuberculosis and the variables of marital status and educational level. These results suggest that these factors do not have a significant effect on the co-morbidity of these two diseases within the study's sample.

Conclusion

This study illustrates the significant co-morbidity of diabetes and tuberculosis in Nigeria, impacted by various demographic and lifestyle factors. While the healthcare services appear to be effectively addressing this co- morbidity through specialized care and patient education, there are challenges regarding managing both diseases simultaneously, suggesting a need for more integrated care models. The findings underscore the need for integrated health services and public awareness programs addressing these co-morbidities.

Recommendations

Based on the analysis of the data gathered for the study, the following recommendations can be made:

1. **Increase public awareness**: It is apparent from the data that there is a lack of awareness about the relationship between diabetes and tuberculosis. 58.27% of the participants believed that there was not enough public awareness about the relationship between these two diseases in their community. Additionally, 76.15% of participants thought that more should be done to raise awareness about this potential link in Nigeria. Public health campaigns, educational programs, and other forms of public outreach should be instituted to inform the public about this correlation.

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2. **Integrate care for diabetes and tuberculosis:** Approximately 7.59% of the population studied have been diagnosed with both diabetes and tuberculosis. Furthermore, 21.43% of those with both conditions reported their overall health and quality of life had significantly worsened, and 75% faced challenges managing both conditions simultaneously. Therefore, healthcare services should be more integrated to provide comprehensive care for these patients, focusing on the co-management of both conditions.

3. **Lifestyle intervention programs**: Lifestyle factors seem to play a significant role in the co-morbidity of diabetes and tuberculosis. The study found statistically significant associations between smoking, alcohol consumption, occupation, and frequency of exercise with the co-morbidity of diabetes and tuberculosis. Therefore, it is essential to develop lifestyle intervention programs aimed at promoting a healthy diet, regular exercise, and cessation of harmful behaviours such as smoking and excessive alcohol consumption.

4. **Further research**: This study has provided crucial insights into the relationship between diabetes and tuberculosis in Nigeria. However, further research is needed to understand more fully the underlying mechanisms of this relationship and to develop effective strategies for prevention and treatment of these conditions when they occur together. Future research should also focus on the impact of other socioeconomic factors, environmental conditions, genetic predispositions, and access to healthcare services on the co-morbidity of these diseases.

Limitations of the Study

Some limitations were inherent in this study. Recall bias may have affected the accuracy of self-reported data, and not all potential confounding factors (e.g., other comorbidities, genetic predispositions) were controlled for. Additionally, as this was a hospital-based study, it may not reflect the situation of individuals in the wider community who have these conditions but do not seek medical care at a hospital. Furthermore, it does not capture individuals who may have these conditions but are undiagnosed.

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