Body mass index, blood pressure, and cognitive impairment among type 2 diabetic patients in a primary care setting, North-Central Nigeria

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Abstract

The long-term effects of certain clinical factors on cognition cannot be overemphasized. The morbidity of Cognitive Impairment (CI) in patients with type 2 diabetes has been found to increase when associated with some clinical factors. The main objective of this study was to determine the relationship between CI and Body Mass Index (BMI) as well as CI and Blood Pressure (BP), among type 2 diabetic patients attending the primary care unit of a tertiary hospital. It was a descriptive hospital-based cross-sectional study. Ethical approval was obtained from the Ethical Review Committee of the University of Ilorin Teaching Hospital (UITH) before the commencement of the study. Data was collected from 274 adult type 2 diabetic patients attending the Family Medicine clinics of the hospital, from March through May 2017. Interviewer-administered structured and semi-structured questionnaires were used to obtain information from the respondents. The Mini-Mental State Examination (MMSE) was used to assess CI among respondents. The BMI and BP of participants were obtained following standard procedure. Data was collated and analyzed using the Statistical Package for Social Sciences version 21 (SPSS-21). The elderly constituted a higher proportion of participants 55.4%. Respondents were mainly females (70.8%), married (78.8%), and educated (78.1%). The clinical factor that had a statistically significant association with CI was the BMI of participants with a chi-square value (χ^2) of 11.139 and a p-value of 0.048. Blood pressure had no statistically significant association with CI (χ^2 of 5.181 and p-value of 0.159). CI is common in our clinics with a prevalence of 27% seen in this study. BMI had a statistically significant association with CI while BP was not. Hence, maintaining a normal weight may help in controlling CI. Physicians in primary care should routinely screen type 2 diabetic patients for CI as well as control risk factors for it.

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Informed consent: Written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article.

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Introduction

Cognitive impairment is a serious and often under-diagnosed and under-detected complication of type 2 diabetes.[1] Cognition assessment has not been given much priority as between 40% and 80% of dementia cases are undiagnosed in the primary care setting, which consequently does not get managed.[2] According to WHO, BMI is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m^2).[3] Both underweight and obesity have been associated with lower cognition.[4] Higher BMI in midlife is associated with structural brain changes including tau and amyloid beta-protein expression and cerebral hypoperfusion which can lead to cognitive decline.[5] Both high and low blood pressure have been linked with cognitive decline and dementia.[6,7] Studies have shown a high prevalence of hypertension among diabetics.[8,9] Hypertension has been associated with disruptions in neurovascular coupling, which lead to a decrease in vascular reserve capacity and can cause microvascular disease, stroke, cognitive decline, and dementia.[10] Most of the vascular alterations induced by hypertension contribute to cognitive impairment by leading to hypoperfusion, ischemic and hemorrhagic stroke, and white matter injury.[11] Hypertension is also associated with cerebrovascular disease including lacunar brain infarcts and white matter lesions, which may contribute to cognitive impairment in diabetics.[12]

Clinical factors associated with diabetes are of significant con-

cern as a study by Omotoye *et al.* in Oyo, Nigeria found that 64% of diabetics were either overweight or obese.[13] Also in Benin, Nigeria, Unadike *et al.* found that 54.2% of diabetics had elevated blood pressure.[14] However, 23.3% of type 2 diabetics had low blood pressure in another study in Enugu.[15] All these comorbidities have been found to increase CI among type 2 diabetics and should be detected and controlled at the primary care level, or referred if need be.[16–18]

In a study in Jos, Nigeria, patients with associated systolic hypertension had poorer cognition but hypertension was not associated with increased incidence of CI in Ebonyi.[19,20]Adequate BMI and blood pressure control have been found to help improve cognition as Chan *et al*. in China, reported that reduced obesity led to enhanced cognition.[21] Also, Novak *et al*. in Boston, found that control of blood pressure led to improvement in cognition in patients.[10] Therefore prompt detection of these factors in diabetic patients for adequate management is pertinent.

The objectives of this study are to determine the BMI and blood pressure of patients with type 2 diabetes and to assess the relationship between CI and BMI as well as the relationship between CI and blood pressure in the participants.

Materials and Methods

The study was conducted at the primary care unit of a tertiary health care facility in Oke-Ose, Kwara State. It was a hospital-based descriptive cross-sectional study involving 274 type 2 diabetic patients. The inclusion criterion for the study was all consenting type 2 diabetic patients above 18 years of age. Excluded from the study were patients with other forms of diabetes mellitus e.g. type 1 and gestational diabetes. Other patients excluded were patients that were too sick to participate in the study, in order not to delay early access to prompt care and patients with other psychiatric disorders such as schizophrenia and mania, as this may affect cognition assessment.

The formula for determining the minimum sample size for health studies by Leslie Kish (discussed in Charan *et al.*) was used: $n = Z^2pq/ d^2$.[22] The systematic random sampling method was used to recruit patients into the study. The first patient for the study, each day was chosen from the first 3 adult type 2 diabetic patients that presented on that day using the balloting technique. From a box of sealed numbers 1 to 3, the researcher randomly selected a paper, the number of which represented the first adult type 2 diabetic that was recruited, and subsequent third type 2 diabetic patients that met the inclusion criteria were given serial numbers and selected.

The financial burden of this research was borne by the authors. The study was approved by the Ethical Review Committee of UITH, on 31 May 2016 with reference number NHREC/02/05/2010. Each participant voluntarily gave informed consent.

Data collection and instruments

Data were collected using the structured and semi-structured interviewer-administered questionnaires, this included socio-demographics and cognitive assessment using the Mini-mental state examination (MMSE). Using the MMSE, the maximum score is 30, a score of

24 -30 is normal, while a score of 18 and below is indicative of CI.[23] Other instruments used were: a calibrated weighing scale (Hanson's bathroom weighing scale) with a sensitivity of 98%, a calibrated Seca 274 Free Standing Stadiometer for height measurement (made in the United Kingdom) with a sensitivity of 97%, Dekamet Accoson Mercury Sphygmomanometer, MK.3 (made in England), and Littmann Quality Stethoscope.

Clinical measurements

Weight measurement: Weight in kilograms was measured to the nearest 0.5kg using Hanson's bathroom weighing scale. The patients were lightly clothed, bare-footed, and devoid of any heavy objects such as handbags, cell phones, and bunches of keys. The scale was adjusted to zero point before each weighing.

Height measurement: Height in meters (m) was measured to the nearest 0.01m using a Stadiometer with the patient standing erect bare-footed against the Stadiometer. The patients were without cap or headgear. The horizontal bar of the Stadiometer was brought to rest lightly on the vertex of the patient's head and the height read off on the vertical ruler.

Body Mass Index Calculation: BMI of the patients was calculated from weight (kg)/height^2 (m^2). The values were categorized as follows: BMI less than 18.5kg/m^2, was classified as within the underweight range. BMI of 18.5kg/m^2 to 24.9kg/m^2 was within the normal range, BMI 25.0kg/m^2 to 29.9kg/m^2 was classified as overweight and BMI of 30.0kg/m^2 or higher was classified as obese. Obesity was subdivided into categories: Class 1; BMI of 30kg/m^2 to 34.9kg/m^2, Class 2; BMI of 35kg/m^2 to 39.9kg/m^2 and Class 3; BMI of 40kg/m^2 or higher.[24]

Blood pressure measurement: The blood pressure of each patient was measured by the auscultatory method using a standard mercury sphygmomanometer with an appropriately sized cuff and a Lithman stethoscope. This was done in keeping with recommended guidelines.[25] The mean of the BP measurements of each patient was categorized as follows: normal BP reading (systolic BP less than 120 and diastolic BP less than 80 mmHg), pre-hypertension (systolic BP between 120 and 139mmHg and diastolic BP between 80 and 89mmHg), stage 1 hypertension (systolic BP between 140 and 159mmHg and diastolic BP between 90-99mmHg) and stage 2 hypertension (systolic BP greater than or equal to 160 and diastolic BP greater than or equal to 100mmHg).[26]

Data analysis

The collected data were sorted, coded, and entered into IBM® SPSS® Statistics computer software (New York) version 21. Results were presented using frequency tables and charts. Chi-square was used to assess the association between CI and the clinical parameters and the level of significance of this study was set at 5% ($p < 0.05$).

Results

Socio-demographic characteristics of the participants

A total of 274 type 2 diabetic patients attending the Family Medicine Department participated in the study. Table 1 shows the socio-demographic characteristics of respondents. The elderly, aged 60 and above, constituted a greater percentage of the respondents 152 (55.4%), while only 4 (1.5%) were below or equal to 39 years of age with a mean age of 60±9.8. The gender distribution revealed a preponderance of female respondents of 194 (70.8%) with a female to male ratio of 2.4:1. Married individuals constituted 78.8% of respondents and a total of 78.1% of respondents had some form of education: 29.2% had tertiary education, 16.1% had

secondary education, 32.8% had primary education and 21.9% had no formal education.

Prevalence of cognitive impairment among respondents

Table 2 shows the prevalence of cognitive impairment amongst type 2 diabetics. The study revealed a prevalence of 27%, as 74 of the respondents had CI, while 200(73%) had no CI.

Clinical parameters of respondents (Body Mass Index and blood pressure)

Table 3 shows that underweight participants constituted 15 (5.5%), 84 (30.7%) had normal BMI, 99(36.1%) were overweight, while those in the obesity class 1, class 2, and class 3 categories were 17.2%, 6.9%, and 3.6% respectively. Participants who were normotensives were 51 (18.6%), pre-hypertension was found in 102 (37.2%), while stages 1 and 2 hypertension were found in 74 (27.0%) and 47 (17.2%) respectively.

Association between cognitive impairment and clinical parameters

Table 4 shows that using the BMI, the highest percentage of participants with CI (60%) was found among the underweight while participants with obesity stage 1 had the least percentage of participants with CI (19.1%). This association was statistically significant with χ^2 of 11.139 and a p-value of 0.048. However, by considering the blood pressure, CI was highest among participants with stage 2 hypertension (36.2%) while participants with normal blood pressure had the least percentage of individuals with C.I (17.6%). The association was however not statistically significant with χ^2 of 5.181 and a p-value of 0.159.

Discussion

This study revealed that more of the participants were in the overweight category (36.1%). Only a minority of the participants was in the underweight category. It is comparable to a study among type 2 diabetic patients attending a diabetes clinic in Tanzania by Damian *et al.* where the majority of the participants were overweight.[27] It is also comparable to a study by Parajuli et al in a health facility-based cross-sectional study among 277 type 2 diabetics in Nepal, where about one-third of the participant (37.1%) were also overweight.[28] The findings in the index study is also similar to a study by Omotoye *et al*. in a descriptive cross-sectional study among 50 consenting adults type 2 diabetic patients aged 40-

Table 1. Socio-demographic characteristics of the participants (N=274).

Variables	Frequency	Percentage
Age Groups		
≤ 39	4	1.5
40 – 59	118	43.1
≥ 60	152	55.4
Gender		
Male	80	29.2
Female	194	70.8
Marital Status		
Married	216	78.8
Unmarried	58	21.2
Level of Education		
Tertiary	80	29.2
Secondary	44	16.1
Primary	90	32.8
No formal education	60	21.9

Table 2. Prevalence of cognitive impairment.

Variables	Frequency	Percentage
Cognitive Impairment		
Present	74	27
Absent	200	73

Table 3. Clinical parameters of respondents.

Variables	Frequency	Percentage
Body Mass Index		
Underweight	15	5.5
Normal	84	30.7
Overweight	99	36.1
Obese stage 1	47	17.2
Obese stage 2	19	6.9
Obese stage 3	10	3.6
Blood Pressure		
Normal	51	18.6
Pre Hypertension	102	37.2
Stage 1 Hypertension	74	27.0
Stage 2 Hypertension	47	17.2

Table 4. Association between cognitive impairment and clinical parameters.

Clinical parameters	Cognitive impairment		Df	χ^2	p-value
	Present (%)	Absent (%)			
Body Mass Index					
Underweight	9 (60.0)	6 (40.0)			
Normal	21 (25.0)	63 (75.0)			
Overweight	25 (25.3)	74 (74.7)			
Obese stage 1	9 (19.1)	38 (80.9)			
Obese stage 2	6 (31.6)	13 (68.4)			
Obese stage 3	4 (40.0)	6 (60.0)	5	11.139	0.048*
Blood Pressure					
Normal	9 (17.6)	42 (82.4)			
Pre Hypertension	26 (25.5)	76 (74.5)			
Stage 1 Hypertension	22 (29.7)	52 (70.3)			
Stage 2 Hypertension	17 (36.2)	30 (63.8)	3	5.181	0.159

%, percentage of respondents in category; df, degree of freedom; χ^2, Chi square test ; p, significance; *, p value < 0.05.

72 years in Oyo, Nigeria, and Basukala *et al.* in a cross-sectional study conducted at National Public Health Laboratory (NPHL), Teku Kathmandu, Nepal among 160 type 2 diabetic patients, where more than half of the participants were either overweight or obese.[13,29] This may be because obesity or overweight is a risk factor for type 2 diabetes and may occur along with comorbidities as seen in metabolic syndrome.[30]

In the index study, the majority of the participants had prehypertension. This is similar to findings by Venugopal *et al*. in a hospital-based cross-sectional study of 250 patients in India, where a higher proportion of type 2 diabetics had prehypertension.[8] It is also comparable to findings by Onuoha *et al*., in a descriptive cross-sectional study among 300 participants in a primary care setting in South-Eastern Nigeria, where about one-third of type 2 diabetics had prehypertension.[9] The findings in the index study are however different from the study by Eze *et al*. in Abakaliki Nigeria, where a higher proportion of participants (78.67%) were normotensives.[20] Unadike *et al.* in a cross-sectional study among 450 participants in Benin, Nigeria, also reported that a higher percentage of diabetic patients had hypertension (54.2%), which was higher compared to the findings of the index study (44.1%).[14] Most of the participants that were hypertensive in the index study had stage 1 hypertension, this is similar to the finding by Venugopal *et al.* in India, where most of the type 2 diabetics who were hypertensive had stage 1 hypertension.[8] Risk factors that may be responsible for the presence of prehypertension and hypertension among participants in these studies are: hyperinsulinemia (with resulting increases in renal sodium retention and/or sympathetic nervous system activity) and metabolic syndrome. Similarity in the findings in these studies may be due to the similar study groups (type 2 diabetic patients) and methods used in the studies (cross-sectional hospital-based study). The higher proportion of normotensives found in Abakakaliki may be as a result of good BP control following management. The finding of the majority of participants having prehypertension in the index study may indicate probable hypertension in the future along with diabetes as a comorbidity.

There was a statistically significant relationship between CI and BMI (p=0.048), as the proportion of participants with CI was highest among the underweight and the least proportion was found among participants with obesity class 1. This is comparable to the findings by Qizilbash *et al.* in London, where being underweight was associated with a greater risk of cognitive decline.[31] The findings in the index study are also comparable to the findings by Sabia *et al.* in the United Kingdom where being underweight was associated with lower cognition in late midlife.[4] They however found a similar pattern among the obese group and their study was carried out among the general population.[4] Also, it is comparable to findings in the study by Kim *et al.* in Massachusetts, U.S.A, where obesity was associated with a lower risk of cognitive decline among the mid and old-age population.[32] However, the findings in the index study are different from those by Gao *et al*. in China and Guerchet *et al*. in Benin, West Africa, which showed no significant relationship between CI and BMI.[17,33] The findings in the index study may be as a result of the chronic effect of diabetes leading to weight loss with CI occurring concurrently in the underweight category. The difference in the results of the index study compared to that by Gao *et al.* and Guerchet *et al.* could also be due to the methodology used. For example, the study by Guerchret *et al*. used the Community Screening Instrument for Dementia (CSID) tool to assess cognition while in the index study MMSE was used. Gao *et al*. had a community-based study while the index study was hospital-based.

A higher proportion of participants with CI had blood pressure above 140/90mmHg, compared with participants with lower blood pressure. Likewise, the prevalence of CI increased from participants with normal blood pressure (17.6%) to prehypertensives (25.5%), and it continued to surge among stage 1 and stage 2 hypertensive respondents (29.7% and 36.2% respectively), although this relationship was not statistically significant. This finding is comparable with the findings by Eze *et al.* in Abakaliki, Nigeria, where there was no statistically significant association between CI and blood pressure.[20] It is also comparable to a study by Guerchet *et al*. in Benin, West Africa, in which no statistically significant association was found between CI and blood pressure.[33] Yarube *et al.* in Kano, Nigeria, found that most patients with type 2 diabetes had normal blood pressure.[34] This study and the index study were both hospital-based studies among type 2 diabetic patients. However, the difference in socio-demographic characteristics of participants and methods used in these studies may be reasons for the difference in the findings. Ugoya *et al.* in Jos, Nigeria, found a significant relationship between blood pressure (supine systolic BP) and CI.[19] The study by Ugoya *et al*. and the index study were both carried out in North-Central Nigeria and were hospital-based cross-sectional studies. However, the study in Jos involved patients in both primary care, other clinics, and those admitted in wards, this could be responsible for the differences seen in the studies. Also a study by Hazari *et al*. in Andhra Pradesh, India found a significant relationship between CI and blood pressure as there was a significant difference in P300 trends with the co-existence of diabetes and hypertension than diabetes alone.[18] Jalmania *et al*. in Southern Iran in a study among type 2 diabetic patients found a negative correlation between MMSE score and systolic and diastolic blood pressure.[35] Their study revealed that a unit rise in SBP led to a significant rise in mild CI when compared with subjects with normal blood pressure.[35] The finding from the index study may indicate that elevated blood pressure among diabetic patients may have a relationship with CI because of the observed trend, although it was not statistically proven.

Conclusions, Limitations, and Recommendations

In this study, cognitive impairment had a statistically significant association with BMI but had no significant association with blood pressure. This association, however, cannot be said to have a causal relationship as this was a cross-sectional descriptive study.

The study had some limitations. It had a descriptive cross-sectional study design, hence the outcome may not necessarily carry a causal relationship with the tested variables. A longitudinal study design would be required to establish causal relationships. It is however intended to add to the body of knowledge that will form a template for future studies as BMI may not have been considered to be a risk factor for CI and most times, only obesity may be seen as a cause of morbidity. However, findings from this study have shown that being underweight is a significant factor for CI.

The findings from this study also being a hospital-based study cannot be generalized as the findings for the entire community. There may be a need to carry out a community-based study with a larger sample size to have the findings in the community.

Patients should be counseled on the need to maintain a normal weight, as an abnormal weight may be a risk factor for CI, especially in type 2 diabetics. Likewise, BMI of type 2 diabetics should be assessed routinely and CI evaluated. Also, adequate monitoring and control of blood pressure are paramount to prevent further elevation and ensure blood pressure control among hypertensive patients. Physicians should ensure adequate evaluation of patients

for clinical factors that may affect cognition, to allow for prompt and adequate management.

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