

Impact of educational intervention study among adult diabetic patients in Southeastern Nigeria

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ABSTRACT

Introduction: Diabetes mellitus, characterized by various risk factors, stands as a chronic metabolic disorder. In regions with limited resources, individuals grappling with diabetes often lack a comprehensive understanding of the imperative nature of diabetes management. Consequently, patients encounter difficulties adhering to their prescribed treatment regimens, resulting in suboptimal glycemic control and heightened morbidity and mortality rates. This study endeavors to evaluate the impact of an educational intervention on the knowledge, attitudes, and practices of individuals living with diabetes in Umuahia, Abia State. **Method:** This study quasi-experimental design, comprising 232 adult diabetic patients from Umuahia South LGA. The investigation determined the effectiveness of educational intervention programme based among adults with type 2 diabetes. Data analysis was done using descriptive statistics while baseline and endline differences were done using chi-square and t-test, $p < 0.05$. **Result:** Among the 232 diabetic patients, 131 (56.6%) were male, falling below the age of 40 years (49.3%), and possessed at least a secondary school education (87.5%). A substantial proportion, 170 (73.7%), exhibited poor knowledge of diabetes, reflected in a mean diabetes knowledge score of 24.95, which markedly improved to 45.53 following the intervention. The mean scores for diabetes attitudes and practices, initially recorded at 11.4 and 6.50, demonstrated positive enhancements to 12.49 and 7.51, respectively, in the post-intervention phase. Noteworthy differences emerged between the baseline and post-intervention assessments for diabetes knowledge ($t = 64.294$; $p < 0.05$), control ($t = 4.363$; $p < 0.05$), and practices ($t = -5.615$; $p < 0.001$). **Conclusion:** Upon the completion of the educational instruction, a discernible enhancement in the diabetes management of the participants was evident. Systematic diabetes education constitutes a pivotal stride in mitigating diabetic complications, concurrently elevating patients' self-efficacy, an indispensable component in the effective management of diabetes.

KEYWORDS: Educational intervention, Healthcare, Type 2 Diabetes, Patients

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Introduction

Type 2 diabetes mellitus (T2DM) accounts for more than 90% of all recorded diabetes cases globally, emerging as a prominent public health challenge across diverse regions in Africa and Asia [1]. The rate of increase in Nigeria is very high. Its growth is contributing significantly to morbidity, mortality, and disease burden. T2DM manifests due to a combination of impaired insulin secretion and reduced insulin efficacy in hepatic and peripheral tissues, marked by insulin resistance and dysfunction. Genetic predisposition, lifestyle (diet and physical activity), insulin resistance, and environmental influences play a pivotal role in the intricate web of factors associated with the onset of T2DM.

Glucotoxicity and lipotoxicity, intricately linked with T2DM, contribute to the gradual decline in insulin secretion by diminishing the quantity of insulin secretory granules in the pancreas [2]. The escalating prevalence of T2DM is intricately tied to lifestyle choices, dietary habits, and physical inactivity [3]. Individuals falling within the range of impaired glucose tolerance and impaired fasting glucose are particularly susceptible to the manifestation of T2DM, stroke, and heart diseases. Moreover, a sedentary lifestyle is a gradual catalyst for diabetes onset, compounded by genetic predispositions and familial history.

The surge in T2DM prevalence can also be attributed to advancements in disease detection and overall management strategies [4]. This progress in disease detection and management methods, as well as recognition of the genetic and lifestyle components of T2DM, emphasizes the extreme need for a public health intervention. The relentless prevalence of the disease exerts a profound impact on the lives and overall well-being of individuals, families, and societies. Within low and middle-income countries, diabetes emerges as a primary driver of renal failure, markedly increasing the incidence of lower limb amputations among individuals diagnosed with diabetes compared to their non-diabetic counterparts [5]. Additionally, those diagnosed with diabetes face an elevated risk of visual impairment and blindness. The specter of cardiovascular-related diseases looms large, emerging as a prominent cause of mortality among individuals grappling with diabetes in developing countries [3, 6]. This underscores the urgent need for targeted interventions and heightened awareness to curb the escalating impact

of diabetes, not only on individual health but on the broader fabric of societies in these regions.

Diabetes education constitutes the comprehensive dissemination of essential knowledge and skills requisite for the effective management of the disease. This encompassing education spans various domains, including the vigilant monitoring of blood glucose levels, meticulous attention to the quantity and composition of dietary intake, engagement in appropriate physical activities, conscientious weight management, adoption of a prudent attitude towards smoking, and the cultivation of other personalized skills crucial for disease management [7]. Conversely, health-seeking behavior encapsulates the diverse spectrum of actions undertaken by patients to address or ameliorate an ailment. This behavioral pattern is intricately interwoven with socio-cultural, economic, and environmental influences, compounded by the accessibility of healthcare providers. It represents a collective endeavor, involving the active participation of the individual, their family, and the broader community, synergizing towards achieving optimal medical outcomes [8].

In the evolving landscape of diabetes management, education has metamorphosed into a paradigm of self-management. Patients are now expected to proactively cultivate self-care behaviors, encompassing not only exercise but also a steadfast adherence to prescribed medications, nuanced nutritional practices, and the adept management of various skills developed by the individual [9]. In this dynamic milieu, educators shoulder the responsibility of fulfilling their role by equipping patients with the requisite information, empowering them to navigate the intricate terrain of diabetes self-management. While T2DM currently lacks a definitive cure, effective management strategies can mitigate its severity and alleviate symptoms. The multifaceted approach to diabetes management involves a judicious combination of adaptive measures and pharmacotherapy. Primary pharmaceutical interventions encompass biguanides (metformin), thiazolidinediones, sulfonylureas, and meglitinides, representing the forefront of diabetes treatment modalities [10, 11]. Concurrently, diabetes education programs, incorporating essential components such as nutrition therapy and exercise, are strongly advocated for diabetic patients [12, 13]. The escalating prevalence of diabetes in Nigeria underscores the pressing need for comprehensive interventions. In 2011, diabetes affected 3.1 million individuals aged 20-79 years, surging to over 3.6

million by 2021 according to the International Federation Diabetes (IFD). Across Africa, diabetes prevalence reached 527 million in 2021, projected to escalate to 696 million and 1.05 billion by 2030 and 2045, respectively [14]. Disturbingly, diabetes-related deaths in Nigeria approached fifty thousand, with an average expenditure of 1,390 USD per patient in 2021. Numerous studies in Abia State have delved into facets such as prevalence, glycemic control, feeding habits, exercise, and lifestyle to enhance diabetes management [15–18]. Despite these efforts, the study area grapples with limited data on diabetes self-management through educational interventions. The inadequacy of knowledge, awareness, and behavioural practices concerning diabetes management poses a substantial challenge, contributing to an elevated risk of complications such as eye, kidney, and cardiovascular diseases [19]. In addressing this gap, this study endeavours to rigorously assess the impact of a specific educational intervention on the knowledge, attitudes, and practices of type 2 diabetic patients in Umuahia, Abia State, offering valuable insights to enhance diabetes care in the region.

Methods

Study Design

The study used a quasi-experimental before-and-after design from October 2022 to June 2023, to determine the efficacy of a structured education intervention aimed at enhancing knowledge, attitudes, and practices among adults with type 2 diabetes mellitus (T2DM) in Umuahia South Local Government Area (LGA). The educational intervention was meticulously crafted through a community outreach approach, underscoring a comprehensive strategy to address the multifaceted dimensions of diabetes awareness and management. Data were collected at two points in time. At baseline (Pre-intervention), participants completed the baseline survey that measured knowledge, attitudes, and practices in relation to diabetes before the educational intervention started. While endline (Post-intervention) data was collected six weeks after intervention completion, using the same survey tool among the same baseline participants to assess change in outcomes.

Sample Size Determination and Sampling Strategy

Sample Size Determination:

The minimum sample size for this study will be calculated as follows:

$$N = \frac{Z^2 \cdot p(1-p)}{d^2}$$

$N = [20]$ Where N is the sample size, Z is the level of significance that corresponds to the 95% confidence level which is 1.96, p is the prevalence of hypertension in Nigeria, and the tolerance error (0.05). The awareness rate of hypertension among adults 18 years and above in Nigeria is 15.4%

$$N = \frac{1.96^2 \times 0.154 \times 0.826}{0.05^2}$$

$N = 195.47$
adjusting for a 10% non-response rate

$$N_{\text{new}} = \frac{n}{1-0.10}$$

$= 217.17 \approx 217$

Given the finite population of adults with T2DM in the selected communities and anticipated non-response, a correction formula was applied and a 10% non-response rate was added, resulting in a final minimum sample size of 232, which was achieved in this study.

Sampling Strategy

A multistage sampling approach was employed. It started with the purposive selection of communities in Umuahia South LGA based on accessibility and availability of community outreach programs. Within the chosen communities, eligible adults with T2DM who were registered through outreach programs were invited to participate. All consenting eligible individuals were recruited consecutively up to the required sample size. The approach offered a broad representation of the target population while permitting logistical feasibility.

Intervention Description and Administration

The intervention was a multi-session community-based diabetes education intervention to increase awareness, knowledge, and self-management skills. It included different components as highlighted below.

Ambassador Model: Community members were empowered as ambassadors to facilitate interpersonal communication, generate awareness, dispel myths, and assist in behaviour change regarding diabetes via one-on-one, group, and outreach sessions.

Community Mobilization: Gatekeepers, leaders, and town criers promoted free medical outreaches such as diabetes education, blood pressure and glucose screening, distribution of free routine medication, and referral to primary health care units.

Educational Sessions: Participants attended weekly 40-minute sessions for four consecutive weeks with healthcare providers. Content comprised:

- Week 1: Diabetes fundamentals, glucose control, medication, and the role of traditional medicine.
- Week 2: Dietary control, portion sizes, and meal planning.
- Week 3: Exercise benefits, initiation, and adherence strategies.
- Week 4: Complications, problem-solving, skin care, and stress management.

Peer Leaders: Recruited from within the community, peer leaders who had personal histories of T2DM led group discussions and offered continuous support.

The intervention used a variety of instructional techniques to promote knowledge gain and practical skill attainment of the participants. The instructional techniques consisted of demonstrations, visual aids, and group discussion.

Study Population

The study cohort consisted of adults aged 18 years and older who resided in the chosen communities of Umuahia South LGA. Specifically, participants included adults diagnosed with diabetes during a community outreach initiative, with their consent obtained prior to study commencement. Those exhibiting elevated levels of sugar and/or high blood pressure were enrolled and subsequently referred to healthcare services. Trained data collectors conducted follow-up visits to participants months post-referral, engaging those who willingly participated in the study within the comfort of their homes.

Inclusion and Exclusion Criteria

The study participants consisted of individuals definitively diagnosed with T2DM, demonstrating

consistently elevated HbA1c levels surpassing the normal threshold of 6.5% for a minimum duration of three months preceding commencement of the study. This diverse cohort, based in Nigeria, specifically in Abia State, encompassed both genders and various ethnic backgrounds, with all participants being 18 years and older.

Exclusion from project participation was granted to: T2DM patients opting not to participate voluntarily, those discontinuing their involvement in educational lessons, individuals concurrently engaged in other research endeavors that might introduce confounding variables, and those undergoing insulin therapy. The decision to exclude individuals under 18 years old stemmed from the consideration of potential dependency, potentially necessitating additional support or guardianship. Additionally, individuals currently experiencing illness were omitted from the study, aligning with the perspective of McCance and colleagues [21], which recognizes the impact of illness on metabolic processes, including blood glucose levels.

Study Tool and data collection

A semi-structured questionnaire was crafted in English and thoughtfully compartmentalized into four sections: (1) personal information, (2) diabetes awareness and lifestyle characteristics, (3) diabetes awareness, treatment, and control knowledge; and (4) diabetes-related attitudes and behaviour. The fourth section addressed the attitude of the participants towards diabetes control and participants' reported diabetes-related behaviour, thereby addressing these significant study outcomes comprehensively.

The section on diabetes knowledge was adopted from validated questionnaires utilized in prior studies, including the 24-item STARR County Diabetes Test [22] and the WHO STEPS survey tool (WHO STEPS Instrument version 2.1) [23]. The personal information section was designed to obtain the most important demographic and background variables relevant to describing the study population as well as subgroup differences; the diabetes awareness and lifestyle factors section drew lessons from diabetes risk factor and behavioural research to include items that would capture local context as well as prevailing lifestyle habits; and the knowledge section borrowed from established measures such as the STARR County Diabetes Test and the WHO STEPS survey tool, to ensure provision of dependable and comprehensive measurement of

participants' knowledge around diabetes awareness, treatment, and control.

Diabetes awareness and knowledge, while related, are distinct concepts. Awareness is a general awareness or recognition of diabetes as a disease—e.g., being aware that diabetes exists, being aware that diabetes is a common disease in the population, or being aware of its simple symptoms. On the other hand, knowledge entails more profound and specific awareness of the disease, its etiology, risk factors, complications, treatment methods, and effective self-care habits. Awareness, in short, is all about being aware of diabetes's existence and significance, whereas knowledge is the detailed information and understanding required for prevention and management.

The questionnaire was translated into the respondent's indigenous language for use among the non-literate respondents. These questionnaires were administered to eligible participants seeking healthcare services in the study locations. Data acquisition employed a two-pronged approach comprising the utilization of self-administered questionnaires to the literate respondents and interviewer-administered questionnaires for the non-literate respondents. The combination of self-administered and interviewer-administered questionnaires increased accessibility, limited selection bias, and improved validity of collected data, as well as enhanced understanding by adapting tested tools to fit in the local environment, hence an integrated and culturally appropriate measure of diabetes knowledge, attitude, and practices in our study population.

Data Management and Analysis

Quality control measures were implemented during data collection, with daily reviews of questionnaires to rectify errors or omissions. The collected data were subsequently synchronised with the Kobo Collect server. At the culmination of data collection, the synchronised data were downloaded and securely stored in a password-protected computer to uphold confidentiality. Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 28.0, facilitating the generation of tables and comprehensive results.

Continuous data were succinctly summarized, presenting means \pm standard deviation, range, and proportions, while categorical data were encapsulated as frequencies and percentages. Each item was scored as follows: correct response

garnered a score of 1, whereas an incorrect response received a score of 0. This scoring system allowed for a maximum attainable score of 48 for each respondent. Individuals answering 75% or more questions on disease knowledge were classified as possessing high knowledge, while the remainder were categorized as having average (fair) or low knowledge of the disease.

Baseline characteristics were succinctly summarized using means and standard deviations for continuous variables and counts and percentages for categorical variables. T-tests were employed to discern differences in mean scores based on personal information, and Chi-square tests were utilized to explore variations in socio-demographic characteristics between baseline and endline results. The associations between knowledge (grouped), awareness of the disease, and socio-demographic characteristics of respondents, along with practices related to the disease, were scrutinized using Chi-square tests. Effect size was calculated employing Cohen's *d*, with 0.2 representing a small effect, 0.5 indicating a medium effect size, and 0.8 signifying a large effect size. Statistical significance was set at a threshold of *p*-values less than 0.05.

Ethical Considerations

The study was approved by the Research Ethics Committee, University of Port Harcourt, with UPH/CEREMAD/REC/MM79/047 ON THE 24TH August 2021 and the Ethics Committee for Public Health Research, Abia State Ministry of Health, with ref ASMH/EC/23+/015 ON 13TH Nov 2022. Informed consent was obtained from participants.

Results

Socio-demographic characteristics

Out of the 232 respondents, 131 (56.6%) were males; more than a third (35.1%) were below 30 years of age; 33 (14.2%) were aged between 31-40 years; and 64 (26.3%) were between the ages of 41 and 50 years as of their last birthday. A larger proportion of the respondents (139, 59.9%) had secondary education, 15 (6.5%) had primary education, and 64 (27.6%) had a higher education. The socio-demographic characteristics of the respondents are shown in Table 1.

Pre and Post Diabetes Knowledge among participants

Generally, the percentage of respondents with poor knowledge of diabetes is high in this study. The baseline mean diabetes knowledge scores for males and females were 24.37 and 25.70, respectively. Males had a higher mean gain score (21.8) compared to females. The mean gain of diabetes knowledge among males differed significantly between the endline and baseline ($p < 0.001$), but no significant mean difference existed among the female respondents ($p = 0.752$).

Across all age groups, the mean knowledge of diabetes is higher in the post-test than the pre-test; however, the mean knowledge gain score for those aged over 50 years was higher than other age groups and statistically significant ($p < 0.001$). Regarding education level, at baseline respondents with secondary education had the lowest mean knowledge score and those with higher education had the highest while at post-test those with no education had the lowest mean knowledge score and those with higher education scored highest. Notably, respondents with primary education had the lowest mean knowledge gain, those with secondary education had the highest mean gain while those with a higher education had the second highest mean knowledge gain score and it was also statistically significant ($p < 0.001$).

Although the mean gain score on diabetes knowledge was higher among respondents with no education after the educational intervention, this finding must be interpreted in the context of the actual baseline and post-intervention scores across all education groups. Specifically, the baseline knowledge score for the no education group (25.55) was higher than that of the secondary education group (24.26), but lower than those of the primary and higher education groups. Furthermore, despite the greater mean gain, the post-intervention knowledge score for the no education group (45.27) remained the lowest compared to the other three education categories. This indicates that while individuals with no education demonstrated substantial improvement relative to their own baseline, their absolute knowledge level after the intervention was still lower than those of participants with higher educational attainment.

Of particular note is that despite mean knowledge gains across all education groups, none achieved post-test score at 50% or higher, indicating there remained widespread gaps in knowledge across all groups. Additionally the only

statistically significant gains were in those with higher educational qualifications.

Respondents who are employed scored lowest at baseline but had a higher diabetes knowledge mean gain score compared to those without employment. There was no significant knowledge mean score difference among the unemployed ($p = 0.370$), but a significant difference occurred among the employed after the intervention ($p = 0.013$). (Table 2)

Evaluation of the overall diabetes knowledge scores showed that the baseline mean knowledge score was 24.95; and the value improved to 45.53 after the intervention study. A paired t-test result showed a significant difference between the baseline and the post-intervention scores ($p < 0.001$). The estimated effect size of diabetes knowledge was large among the respondents (Table 3).

Diabetes-related attitude scores of respondents before and after educational intervention

The mean attitude gain scores for males and females were positive. The mean gain score for diabetes control attitude was higher in females (3.05) than in males (0.05). The mean difference between the baseline and the post-educational intervention scores was not significant for both genders. Across all age groups, the mean control attitude scores for diabetes were higher in the post-test than the pre-test except for over 50 years group. The mean gain score for 31-40 years was highest than other age groups. There was no significant mean difference among the age groups for baseline and post-intervention studies.

The mean gain score of diabetes control attitude was highest among the respondents without education after the educational intervention. No significant difference occurred between the baseline and the endline study. Respondents who are employed had a negative diabetes control attitude mean gain score unlike those without employment who had a 4.04 mean gain score after the education intervention. There was no significant difference between the unemployed and employed after the intervention study. (Tables 4).

The attitude of diabetes control among the respondents showed a mean score of 11.14 and 12.49 at baseline and post-intervention respectively. There was also a significant difference between the mean baseline and post-intervention scores ($t = -4.363$; $p < 0.001$). The estimated effect size of diabetes attitude was small (0.37) among the respondents (Table 5).

Diabetes-related practices scores of respondents before and after educational intervention

Both males and females had a positive mean gain score. The mean gain score of diabetes practice was higher in females (1.08) than in males (0.53). A significant difference occurred between the mean endline and baseline scores for males ($p < 0.001$), while there was no significant difference for females during the study. Across all age groups, the mean diabetes practice scores was higher in the post-test than the pre-test; however, the mean gain score for those aged over 50 years was lower than all other age groups. There were significant mean differences in diabetes practices between the baseline and post-intervention scores among 31-40 years ($p = 0.015$) and above 50 years age groups ($p = 0.021$).

The mean gain score for diabetes related practices after the intervention was highest at 1.32 and statistically significant among those who had higher education ($p = 0.025$), followed by the no education group at 1.18, though not statistically significant ($p = 0.083$). The mean gain for the secondary education group came in third and was statistically significant ($p = 0.001$). Respondents who are employed had a higher diabetes practice mean gain score compared to those without employment. There was no significant difference among the unemployed, but a significant difference occurred among the employed after the intervention study ($p < 0.001$) (Table 6). A significant difference ($t = -5.615$; $p < 0.001$) occurred between baseline and post-intervention studies for diabetes practices among the participants (Table 7). The estimated effect size for treatment among respondents was medium (0.56).

Discussion

Diabetes self-management education is critical to improved outcomes in individuals with type 2 diabetes [24]. In the majority of areas in Nigeria, including Abia State, there is limited evidence on the efficacy of educational interventions in enhancing patients' knowledge, attitude, and practice [22, 25]. This study determined the significant characteristics that were peculiar to the knowledge, attitudes and treatment practices of persons living with T2DM who sought health care in Abia State, South-Eastern Nigeria, following an educational intervention program. Our findings show significant knowledge change, but limited attitudinal and practice change, highlighting the need for long-term, multi-faceted education [26]. While the educational intervention resulted in significant improvements in participants'

knowledge, no statistically significant mean gain scores were observed in any of the attitude-related categories. This suggests that, although short-term educational interventions can effectively improve knowledge, attitudes may be more deeply rooted and require longer-term or more integrated strategies to effect meaningful change. These findings are consistent with previous research, which has demonstrated that increases in knowledge among people with diabetes do not always translate into major changes in attitude [2]. In similar contexts, attitudes toward chronic disease management are often influenced by ingrained beliefs, cultural norms, and personal experiences—factors that are not easily altered by a single intervention.

The limited shift in attitudes observed in our study may be attributable to the short duration of the intervention, the need for ongoing reinforcement, or the fact that the majority of the educational content focused primarily on knowledge rather than attitudinal change. Furthermore, while some improvements in self-management strategies were noted, these did not reach statistical significance in every area. Collectively, these results suggest that while short-term educational interventions can improve knowledge, they may be insufficient to effect significant changes in attitudes. Future studies should explore whether incorporating motivational components, continuous support, or culturally relevant approaches—strategies shown to be effective in other contexts—could more effectively influence attitudes and promote sustained self-management behaviours among adults with type 2 diabetes.

These results are consistent with findings from similar interventions in sub-Saharan Africa, where knowledge gains are often more pronounced than changes in attitudes or practices [14, 27, 28]. For instance, studies in Ghana and Kenya reported significant improvements in diabetes knowledge following structured education, yet observed only modest or non-significant shifts in attitudes and self-management behaviours [14]. This pattern may reflect the influence of cultural beliefs, health literacy, and the need for ongoing, contextually tailored support to reinforce attitudinal and behavioural change. Our study adds to this literature by highlighting the persistent gap between knowledge acquisition and sustained changes in attitude and practice among adults with type 2 diabetes in southeastern Nigeria.

Among the 232 participants, 170 (73.7%) exhibited poor knowledge of diabetes during the pre-test, registering a mean diabetes knowledge score of 24.95. This baseline ignorance significantly improved to a mean score of 45.53 post educational intervention study, revealing substantial effects with large, small, and medium effect sizes for diabetes knowledge, control, and treatment, respectively. This underscores the profound impact of a health education program on influencing poor knowledge of diabetes. The knowledge categorization cut-off employed in this study aligns with previous research among Type 2 diabetes patients in other African regions administering more than twenty questionnaires to respondents [29].

Following the health education intervention, the mean knowledge score elevated from a baseline of 6.50 to 7.51, denoting a noteworthy mean gain score of 1.01. This highlights the efficacy of the educational intervention in enhancing participants' understanding of diabetes. Several studies conducted in Nigeria have demonstrated the positive impact of Diabetes Self-Management Education (DSME) programs on adults with type 2 diabetes, showing improvements in quality of life, self-efficacy, glycemic control, and self-care behaviours [30]. For example, a quasi-experimental study at Olabisi Onabanjo University Teaching Hospital reported significant gains in patients' self-management competence and quality of life following DSME interventions, wherein knowledge of diabetes improved by over 50% following an educational intervention. Notably, the low baseline knowledge prevailed irrespective of sex, educational level, age, or employment status among diabetic patients. This trend aligns with the observations of [29] in Uyo, South-South Nigeria, where nearly 80% of participants demonstrated poor knowledge of diabetes. However, it contrasts with a study in a southwestern Nigeria, where approximately 90% of respondents were knowledgeable about diabetes [31]. The prevalent poor knowledge during the pre-intervention within the studied population suggests a deficiency in diabetic education, a common issue in many underdeveloped or developing countries [32, 33].

To bridge the knowledge gap between health information and health practice, health education emerges as a pivotal step. Recognizing predisposing factors such as knowledge, practice, and various sociodemographic characteristics of patients becomes imperative in planning health education

interventions. By furnishing patients with essential information and influencing their attitudes, health education significantly enhances the health outcomes of diabetic patients, empowering them with the tools necessary for effective condition management. This study's results align with similar research in southwestern Nigeria, where an improvement in knowledge about diabetes was observed [6]. Furthermore, Chawla et al. [31] underscored the effectiveness of health education in enhancing knowledge about diabetes management and lifestyle modification, contributing to delayed disease progression and achieving optimal glycemic control.

Following the educational intervention study, both males and females exhibited a commendable improvement in diabetes knowledge, with 45.65 for males and 45.39 for females. The mean difference in knowledge scores post intervention was 21.28 for males and 19.69 for females, showcasing the positive impact of the intervention. Although the mean knowledge gain score was higher and statistically significant among males who are traditionally perceived as being less expressive about health-related matters, our study countered the prevalent belief that women excel at recognizing health threats suggests and anticipated improvement in their knowledge post-intervention. However, the observed result may be influenced by external factors related to social systems and caregiving responsibilities for children, potentially diverting women's attention during the diabetes education study. This outcome aligns with the findings of Herath et al. [32], who noted a considerably higher mean gain score for males in knowledge tests compared to females.

Surprisingly, the highest knowledge of diabetes (93.3%) was observed among individuals aged 41-50 years, surpassing those under 30 years. This unexpected finding challenges the common notion that younger individuals possess greater knowledge. The explanation may lie in the increased awareness and interest in health improvement as people age, particularly due to the impact of aging on physical health. The elevated mean score among adults over 40 years indicates that diabetes education resonates more with this age group, possibly due to the higher prevalence of diabetes in older individuals, making them more receptive to health information. This result aligns with Pal et al. [33], who observed a greater improvement in knowledge scores among older age groups following diabetes educational

interventions, contrary to the findings of Muhammad et al. [34] in North-western Nigeria.

An anticipated significant difference emerged among respondents with secondary school education and above compared to those with primary school education and below, aligning with expectations. Surprisingly, the uneducated group exhibited high mean gain scores for knowledge, awareness, and treatment methods post-intervention, challenging the common notion that low education serves as a barrier to health improvement. This unexpected outcome may signify the uneducated participants' newfound commitment to take charge of their healthcare management. The overall positive mean gain score across all educational levels could be attributed to the awareness created before the research and the free screenings provided during the study. These results resonate with Muhammad et al. [34], who found that higher education levels correlated with higher knowledge scores following diabetes education but differ from Ahmed et al. [35], who observed better post-test mean scores among individuals with low education levels following intervention. The divergence in results may be attributed to variations in research methodologies and geographic contexts across studies.

The awareness of diabetes among the study participants was found to be low during the baseline study; the majority of the respondents (71.1%) agreed to the fact that the disease could be caused by eating too much sugar and other sweet food materials, while a larger percentage (65.9%) were also of the opinion that insulin is produced by the kidney. Also, close to 75% of our respondents said diabetes is curable; about a quarter of our study participants were not aware of the accurate fasting sugar level during the process of diagnosis. This forms a knowledge gap in the management and diagnosis of diabetes among respondents. These baseline assertions are consistent with similar studies in Pakistan and Zimbabwe where the awareness of diabetes among respondents was generally poor [36, 37]. The American Diabetic Association defined self-management education as the process of providing adequate knowledge and skill regarding self-care, management of the crisis, and an informed quality lifestyle [38, 39]. When knowledge about diabetes management is low, the patient's capacity to use a self-management approach is impaired. Unlimited access to diabetic education, on the other hand, enables the patient to practice self-care management, embrace a healthy lifestyle, and have

good feeding habits. In addition, adequate knowledge about diabetes control strategies enhances prompt physical activity and prevents a sedentary lifestyle [40, 41].

After the education intervention, close to half of the respondents knew that kidneys produce insulin, one hundred per cent agreed that in untreated diabetes, the amount of sugar in the blood usually increases, and all the participants knew about the accurate diagnosis of diabetes. In this study, respondents who are older than 50 years had a higher daily exercise of 30-60 minutes, either working, climbing, or climbing staircases. This result was surprising because participants who are under 40 years were expected to engage in physical activities compared to those who are elderly. However, the observed result could be a conscious effort to improve health status since the elderly are more predisposed to disease than the younger age groups. Similar improvements in the control of diabetes were reported by some researchers [42–44]. Although more males are aware of diabetes, knowledge regarding the control of the disease is higher among females than among males, with females having a mean gain score of 3.05. Also, respondents who are below 50 years old have a positive mean gain score, but individuals who are above 50 years old have a negative mean gain score. The negative mean gain score among elderly respondents could be because of their old age and lack of interest in some activities that are beyond their capacity. Evidence showed that old diabetic patients often have sub-optimal diabetes outcomes due to inadequate health education; Khunti et al. [41] recommended the need for more structured diabetes health education and follow-up sessions that required sound health personnel to aid compliance. For knowledge on control and treatment of diabetes stratified by educational level, the mean gain score is positive, showing the importance of a health education intervention study. The result of this study aligns with previous studies [21, 45]. However, the negative mean gain score observed among the employed and their knowledge of diabetes control was surprising. This could be due to a lack of focus or concentration regarding the management of diabetes by the employed.

Effective diabetes management practices, encompassing activities such as monitoring blood pressure, checking blood glucose levels, adhering to prescribed medications, and avoiding sugary foods, stand out as crucial components in the pursuit of optimal health for individuals with diabetes [46].

This study revealed that respondents, irrespective of socioeconomic variables such as age, gender, educational level, and employment status, exhibited a positive mean gain score in diabetes management practices. The unsurprising finding that more males possessed a high knowledge of diabetes treatment aligns with prevailing gender norms.

Participants aged over 40 demonstrated a heightened awareness of diabetes practices, underscoring their increased interest in healthcare compared to other potentially distracting social characteristics. However, the unexpected higher mean gain score among those under 30 years suggests a receptiveness to health education interventions in this age group. Notably, individuals with a secondary education or higher showcased good diabetes management practices, illustrating the positive influence of health education interventions on diabetes knowledge and practices. Intriguingly, although respondents who attended secondary school demonstrated high awareness, their actual knowledge of diabetes practices was lower than that of the uneducated. This suggests that a low educational level may pose a barrier to comprehensive understanding, limiting the assimilation of transmitted health information.

The finding that employed respondents exhibited higher knowledge of diabetes practices underscores the positive impact of employment status on disease management. However, the minimal differences in mean scores before and after educational interventions align with similar results from a Swedish study, highlighting the substantial contribution of employed individuals to diabetes management knowledge compared to the unemployed [47].

Among participants aged over 50, a higher percentage engaged in regular blood sugar checks and the avoidance of sugary foods, indicative of robust knowledge and practice within this age cohort. Longitudinal research conducted in England, spanning over six years, corroborates the positive impact of lifestyle changes among the elderly, resulting in significant reductions in weight, blood pressure, lipid profiles, and glycated hemoglobin (HbA1c) among individuals with diabetes and pre-diabetes. This multifaceted improvement also led to a reduction in the budget allocated for purchasing drugs.

Conversely, the lower levels of physical activity, irregular blood sugar checks, and limited avoidance of sugary foods among participants under 30 years signal inadequate or lacking knowledge about

diabetes management strategies. Existing studies have indicated that young individuals often struggle with poor glycemic control, attributing this to their insufficient knowledge about diabetes control and practices [48, 49].

Study Limitation

The study was conducted in the Umuahia Local Government Area of Abia State, Nigeria. This setting and population may potentially limit the generalizability of findings to other populations or regions with different socio-demographic profiles, access to health care, or cultural backgrounds. The duration of the intervention, from October 2022 to June 2023, might be insufficient to screen for long-term effects on diabetes care behavior and health outcomes. The quasi-experimental design of the study, with the lack of an actual control group, reduces the feasibility of irrefutably attributing the observed improvements to the educational intervention as a standalone factor. Other factors, such as secular trends or concurrent initiatives, could have been responsible for the improvements.

Conclusion

In conclusion, the findings underscore a substantial deficiency in information and understanding concerning diabetes, encompassing its causes, symptoms, and recommended management strategies observed during the baseline study. This knowledge gap is intricately linked to the low health literacy levels prevalent among the study participants. The diabetes education intervention program tailored to the specific needs of the community in Abia State demonstrated significant improvement in knowledge and awareness in the post-intervention phase. For future programs, a comprehensive approach covering diverse facets of diabetes, including its etiology, symptoms, treatment modalities, and lifestyle adjustments, is recommended. By imparting individuals with essential knowledge and skills, these educational interventions empower them to actively engage in their diabetes care.

What is already known about the topic

- Type 2 diabetes mellitus (T2DM) is a major public health problem worldwide.
- T2DM is caused by defective insulin secretion and decreased insulin sensitivity, which are determined by genetics, lifestyle, diet, and exercise.

- Impaired fasting glucose and impaired glucose tolerance are more likely to suffer from T2DM, stroke, and cardiovascular disease.
- Diabetes is a major reason behind kidney failure and adds to the risk of amputations in lower limbs, blindness, and cardiovascular disease, particularly in low- and middle-income countries.
- Diabetes education that includes self-management knowledge and skills (diet, exercise, blood sugar monitoring, weight management, and smoking prevention) is crucial to provide effective control of the disease.

What this study adds

- Rigorous assessment of how an educational program influences the diabetes patients' knowledge, attitudes, and practices in Umuahia, Abia State, Nigeria.
- Closes the gap in data on diabetes self-care through education interventions in the research location.
- Provides information for the enhancement of diabetes care within the area where inadequate knowledge, awareness, and practices of behavior cause a high risk of complications.
- Presents accurate data on the effect of a community outreach-based education intervention on diabetes knowledge among adults with T2DM in the Umuahia Local Government Area.
- Demonstrates an improvement in scores of diabetes knowledge following the education intervention, particularly among males, older people, educated, and employed individuals.

Competing Interest

The authors of this work declare no competing interest

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Authors' contributions

Dr. Charles CE and Professor Ordinoha B contribute equally to this study as co-first authors. Charles CE designed the research, did the investigation, conceptualisation and provided resources; Charles CE and Ordinoha B. performed the research; Charles CE, OnuohaUS, and Simon Agongo Azure wrote and reviewed the manuscript.

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Table 1: Socio-demographic characteristics of respondents, N=232		
Variables	Frequency	Percentage
Gender		
Male	131	56.5
Female	100	43.1
Age (years)		
≤ 30	35	15.1
31 – 40	33	14.2
41 – 50	61	26.3
> 50	103	44.4
Education level		
No education	11	4.7
Primary education	15	6.5
Secondary education	139	59.9
Higher education	64	27.6
Employment status		
Employed	142	62.1
Unemployed	88	37.9

Table 2: Diabetes-Related Knowledge Scores of Respondents Before and After Educational Intervention, N=232

Variables	Pre-intervention			Post-intervention			Mean Gain Score	χ^2 value	p-value
	n	Mean	SD	n	Mean	SD			
Gender									
Male	131	24.37	3.45	131	45.65	2.71	21.28	159.0	< 0.001
Female	101	25.70	4.29	101	45.39	2.61	19.69	85.3	0.752
Age									
≤ 30 years	35	8.97	3.13	35	13.89	0.47	4.92	46.4	0.619
31–40 years	33	27.36	4.31	33	45.21	2.55	17.85	50.5	0.804
41–50 years	71	25.18	4.20	71	45.63	1.98	20.45	65.1	0.887
>50 years	93	23.46	3.04	93	46.22	2.46	22.76	179.4	< 0.001
Level of Education									
No education	11	25.55	4.03	11	45.27	3.93	19.72	28.111	0.137
Primary	16	25.75	3.91	16	45.38	3.07	19.63	13.224	0.353
Secondary	141	24.26	3.28	141	45.39	2.85	21.13	95.169	0.505
Higher education	64	26.16	4.74	64	45.94	1.78	19.78	138.007	< 0.001
Employment Status									
Unemployed	90	26.16	3.69	90	44.80	3.22	18.64	99.974	0.370
Employed	142	24.18	3.83	142	46.00	2.13	21.82	128.493	0.013

Table 3: Overall Knowledge Scores at Pre- and Post-Educational Intervention Program

Study Stage	N	Minimum Score	Maximum Score	Mean Diabetes Knowledge Score	Std. Deviation	df	Paired t-test (p-value)	Cohen's h
Baseline	232	18.00	39.00	24.95	3.89	231	-64.294 (< 0.001)	6.175
Endline	232	36.00	48.00	45.53	2.67			

Table 4: Diabetes-Related Attitude Scores of Respondents Before and After Health Education Intervention, N=232

Variables	n (Pre)	Mean (Pre)	SD (Pre)	n (Post)	Mean (Post)	SD (Post)	Mean Gain Score	χ^2 value	p-value
Gender									
Male	131	11.89	3.32	131	11.94	2.75	0.05	27.4	0.993
Female	101	10.16	3.34	131	13.21	1.83	3.05	20.0	0.916
Age									
≤ 30 years	35	6.40	2.30	35	7.60	1.93	1.20	8.485	0.388
31–40 years	33	9.36	3.83	33	13.39	1.77	4.03	17.448	0.493
41–50 years	71	10.76	3.53	71	11.66	2.87	0.90	22.286	0.768
>50 years	93	12.87	2.29	93	12.28	2.51	-0.59	30.180	0.179
Level of Education									
No education	11	10.46	2.98	11	12.73	2.41	2.27	18.563	0.100
Primary	16	12.06	2.69	16	12.63	2.28	0.57	5.327	0.946
Secondary	141	11.14	3.49	141	12.58	2.42	1.44	38.097	0.722
Higher education	64	11.02	3.55	64	12.22	2.67	1.20	19.081	0.975
Employment Status									
Unemployed	90	11.74	3.42	90	12.38	2.48	0.64	9.815	0.824
Employed	142	10.68	3.49	142	12.27	2.62	1.59	37.187	0.721

Table 5: Attitude Scores at Pre- and Post-Educational Intervention Program

Study stage	N	Minimum Score	Maximum Score	Mean Diabetes Control Score	Std. Deviation	df	Paired t-test (p-value)	Cohen's h
Baseline	232	2.00	14.00	11.14	3.43	231	-4.363 (<0.001)	0.37
Endline	232	6.00	14.00	12.49	2.47			

Table 6: Diabetes-related Practices Scores of Respondents Before and After Health Education Intervention, N=232									
Characteristics	n	Mean	SD	n	Mean	SD	Mean Gain score	χ^2 value	P-value
Gender									
Male	131	6.83	1.62	131	7.41	1.62	0.53	65.9	< 0.001
Female	101	6.06	2.24	101	7.64	1.75	1.58	48.0	0.554
Age									
≤ 30 years	35	26.14	3.25	35	43.83	3.67	17.69	28.677	0.636
31-40 years	33	5.73	2.50	33	8.36	1.90	2.63	61.822	0.015
41-50 years	71	6.79	2.00	71	7.61	1.52	0.82	34.508	0.872
>50 years	93	6.58	1.45	93	7.10	1.49	0.52	50.222	0.021
Level of education									
No education	11	6.09	1.70	11	7.27	1.62	1.18	19.250	0.083
Primary	16	6.81	1.80	16	7.50	1.55	0.69	17.401	0.066
Secondary	141	6.46	1.95	141	7.36	1.73	0.90	92.778	0.001
Higher education	64	6.56	2.06	64	7.88	1.59	1.32	59.324	0.025
Employment status									
Unemployed	90	6.62	2.43	90	7.62	1.75	1.00	52.906	0.363
Employed	142	6.42	1.58	142	7.44	1.64	1.22	94.888	< 0.001

Table 7: Practice Mean Scores at Pre- and Post-Educational Intervention Program								
Intervention	N	Minimum Score	Maximum Score	Mean Diabetes Treatment Score	Std. Deviation	df	Paired t-test (p-value)	Cohen's h
Baseline	232	0.00	12.00	6.50	1.95	231	-5.615 (<0.001)	0.56
Endline	232	2.00	12.00	7.51	1.68			