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Feasibility of remission of type 2 diabetes mellitus using a wholly Nigerian dietary intervention at University of Port Harcourt Teaching Hospital, Nigeria

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***Abstract*---**Background: The diagnosis of Type 2 diabetes mellitus is commonly associated with denial followed by a search for instant cure by spiritual intervention or herbal remedies. In the absence of effective health insurance policies in Nigeria, most treatments are paid for as out of pocket expenses, causing many with non-communicable diseases to go into poverty. The aim of this study is to evaluate the efficacy of a wholly Nigerian diet in achieving remission of type 2 diabetes mellitus. Method: Sixty study participants were randomized into matched control (standard of care) and treatment (dietary caloric restriction intervention) groups. Participants were followed for 24 weeks and samples taken at baseline, midline and at the end of the study for analysis. Results: While there was no change in mean HbA1c levels between baseline and at 6 months (8.390 ± 2.0242 compared to 8.140±2.1229), there was a statistically significant decrease in HbA1c value between baseline and at 6 months (7.617±2.0773 compared to 6.017±1.2301). Also, there was significant weight loss in the intervention group (mean waist circumference decreased from 88.82cm to 80.0cm [p=0.001] while BMI decreased from 22.67 to 22.86kg/m2 [p=0.025]). Dietary intervention caused a remission of 3.5:1 compared to control with no change in HbA1c at the end of the

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study and this finding was statistically significant (p=0.007). Conclusion: In keeping with the definition of remission, Eighteen (60%) of patients maintained normal HBA1c for 6 months. Most (60.87%) of these participants also had significant weight loss. Caloric restriction appears to be an effective means of controlling type 2 diabetes mellitus.

***Keywords*---**Type 2 Diabetes, Dietary Intervention, Remission, HbA1c and BMI.

Introduction

Appropriate nutrition is essential for Healthy human growth and development, and contributes to health and wellness. Foods give the energy needed for daily activities and if consumed in amounts that are higher than are expended, effects such as excess weight gain occur and these can predispose to Type 2 diabetes mellitus (T2DM). In comparison with typical Western diets consisting of high intakes of red and processed meats, sweets, desserts, soft drinks, fatty foods and refined grains, it has been observed that food sources without the above but consisting of high intakes of fruit, salads, raw and cooked vegetables, and whole grains seems to protect against T2DM. [1-6] Diets that are said to be protective generally consist of high intakes of plant-based foods including legumes and soy as suggested in several studies. [7,8] When Mediterranean diet in patients with T2DM was studied, there was a reduction in HbA1c, reduced incidence of diabetes and improved insulin sensitivity. The Patients experienced a 20-30% reduced risk of developing T2DM. [9]

It has been established that Dietary and environmental factors can predispose to worsening diabetes from an alteration in DNA-methylation or histone micro-RNA, gene expression can be changed, leading to a change in insulin sensitivity leading to increased risk for T2DM. [10,11]. Although advances in medical science, knowledge, and therapeutic diet has evolved, disease and related dietary habits have more to do with a long-standing tradition of prescription, long-standing prescribing habits. The questioning of these practices are part of evidence-based medicine with a rational approach and, failing the latter, on expert opinions, as several Published scholars accept that the provision of therapeutic diet should be considered an essential component of patient treatment. [12,13] In many parts of the world over several decades, people have developed unique indigenous healing traditions adapted from and defined by their culture, beliefs and environment, which satisfy the health needs of their communities. [14] The World Health Organization is therefore encouraging research into alternative treatments of diabetes because of problems associated with insulin and toxic effects of currently available synthetic oral glucose-lowering agents. Furthermore, the role of natural antioxidants and free radical scavengers in controlling disease and maintaining health is also of paramount scientific interest. [15]

Diabetes mellitus is a chronic endocrine disorder characterized by hyperglycaemia resulting from either defect in insulin secretion, insulin action, or both. Regular physical activity and participation in team sports from a young age have been associated with reduced macrovascular complications in type-1 diabetes and a delay in the onset of type-2 diabetes. [16] Diabetes is a chronic condition in which the body has difficulty in maintaining normal blood sugar levels. By far T2DM is the most common type. It is most associated with inflammation and related to dietary choices. [17,18]

Knowledge on how T2DM develop and is managed is not new to modern science, however, what now investigate are safer less expensive, everyday measures that can cause T2DM to go into remission like foods we eat. T2DM has genetic determinants but it is not primarily a genetic disease, as there are populations that have existed with no T2DM. [19] T2DM is a lifestyle disease. The normalization of beta cell function can occur in association with decreased pancreas and liver triacylglycerol level, HbA1c and fasting blood sugar levels to non-diabetic levels with intentional weight loss in a home setting by motivated individuals. [20,21]

Diabetes mellitus (generally referred to as diabetes in this study) is a chronic metabolic disorder of multiple aetiologies, characterized by elevated levels of blood glucose, or hyperglycaemia. [22] The prevalence of diabetes is increasing globally at an alarming rate, from 153 million in 1980 to 347 million in 2008 to 463million in 2019 (IDF) and then to 537 million in 2021, exceeding the projection of 439 million by 2030. [22,23] Hyperglycaemia is the hallmark and diagnostic criterion of diabetes. It is well established as an independent risk factor for renal disease. [24,25] Blood Sugar is one of the most important markers of Health and wellness especially for T2DM. Diabetes may increase the risk of pancreatic ad renal disease and mortality in humans as it is a multisystem disorder. [26]

Pharmacological treatment of diabetes is based on the use of insulin and oral hypoglycaemic agents. These approaches control the glycaemic parameters and may not ameliorate the pancreatic and renal risk factors in diabetic patient. Madonna in 2004 documented an increase in insulin dosing being associated with an increased risk for cancer, CVD, and weight gain.The need to discover and develop more effective “normo-glycaemic” agents that are hepato-, pancreato- and nephroprotective, with minimal side effects is paramount.

Hughes documented an estimated increase in the number of people with diabetes to 592 million by 2035. [27] Lifestyle interventions, including physical activity, have been advocated as the cornerstone of primary and secondary prevention in diabetes management. [28] Patient self care is advocated and it’s been predicted to see increases in the number of exercising diabetics globally. As such, physicians who regularly engage with diabetic patients will need to know how to safely prescribe lifestyle in this population, and how to minimize and manage any complications associated with non-pharmacological management of T2DM. This study sets out to evaluate the feasibility of remission from wholly Nigerian diet on diagnosed adults with T2DM compared to standard of care, in the University of Port Harcourt Teaching Hospital, Rivers State, Nigeria.

Materials and Methods

Research Approach

The study had 60 study participants who were randomized and equally matched into 2 (Standard of Care - Control and Dietary Intervention- Treatment) Group. These participants were known diabetics attending diabetes clinic and were followed up for 24 complete weeks were randomized into matched control (standard of care) and treatment (dietary caloric restriction intervention) groups. The control group and Treatment group were tested at beginning of the study, mid-way through the study and at the end of the study. Test of significance was done using ANOVA in each of the two sets of observations (within the control and intervention group). Then, to ensure that significance in the treatment group is due to intervention, a more robust statistic with greater experimental sensitivity such as ANCOV was carried out for totally removing the effect of covariates on the treatment group. [29] Therefore, Kpolovie submits that the combination of randomization and ANCOVA provides exceptional control to the influence of covariate or extraneous variables. [29] This is supported by Khammar *et al.* who stated that ANCOVA is suitable for interventional study that needs to identify, measure and control pretest or covariates before the intervention. Sixty patients (30 in each arm) satisfactorily completed the study for duration of six months without missing the treatments administered. [30]

Recruitments

Participants were recruited from diabetic patients attending the General Outpatient and Diabetes Clinics at the University of Port Harcourt, Nigeria. To be included in the study, patients had to be known diabetics, 18 years of age or older, not on any herbal, traditional or complementary medicines in the last 2 weeks prior to commencement of the study and not any known medication that will impair Pancreatic or kidney function. Also, poorly controlled blood sugar or varying HbA1c typically HbA1c $\geq$ 6.5% at the last routine clinical check and Body Mass Index (BMI) >26 kg/m2 and <45 kg/m2. Patients with existing complications of diabetes or co-morbidities, severely ill patients and patients with mind altering medications were excluded.

Informed consent was obtained from each participant and then the 60 participants were randomized into open label control (Standard of care) and intervention arms of this study. The control arm consisted of diabetic patients with at least one oral hypoglycaemic agent while the intervention group received a calorie-restricted diet consisting of locally grown foods. Statistical tests were done to ensure that there was no significant difference between the control and intervention groups.

The study questionnaires which were divided into several parts including disease and medication history, frequency of consumption of various foods, physical activity or other lifestyle practices, level of education and income, were piloted around the University of Port Harcourt Teaching Hospital and the University of Port Harcourt residents for legibility, comprehension, cultural sensitivity and relevance.

All study participants were seen on a monthly basis for clinical evaluation and assessment of adherence and morbidity. Laboratory assessments were done at 0, 12 and 24 weeks (end of study) visits. Participants were free to withdraw from the study at any stage or time. All participants were called on their mobile phones, at least once a week, to follow up and deal with any concerns as they progressed with the study. Participants with deteriorating clinical conditions were removed from the study and placed on full pharmacological therapy under the supervision of an endocrinologist, until they were stable. Each participant had a bi-weekly self-reported fasting blood glucose test. The primary end point of the study was an HbA1c concentration consistently less than 6.5 for 6 months while the secondary end-point was weight loss equivalent to 10% of body weight.

Statistical Analysis

Statistical analysis was done using the computer software, Microsoft Office Excel 2017 for the graphs and Statistical Packages for Social Science (SPSS) version 22.0 for inferential statistics. The study adopted the following statistics for analysis of data-: descriptive statistics for data cleaning, stem-and leaf plot and box plot for detecting and removing outliers, Kolmogorov-smirnov test and histogram for normality. Crosstab and frequency, ANOVA and ANCOVA were used answer the research questions and test the hypotheses of the study, while significant variables were subjected to post hoc or pairwise comparison tests (i.e. Bonferroni test).

In order to determine statistical significance of the differences between means, the Wilcoxon signed-rank test for dependent samples (such as: HbA1c) and the Mann-Whitney U test for independent samples (such as anthropometric parameters) was used. Statistical significance between the means was set at $p<0.05$. The relationships between the indices was evaluated using Pearson's linear correlation with the level of statistical significance set at $p<0.05$ at 95% confidence.

Ethical Clearance

Ethical approval was sought and obtained from the Ethics Review Committee of the University of Port Harcourt (Annex 1) with reference number UPH/CEREMAD/REC/MM71/001.

Results and Discussion

Demographics

Demographic characteristics showed no statistically significant differences in age ($p=0.934$), gender ($p=0.605$), and the clinical group, as shown in Table 3.

Table 1: Demographics

Variable	Group		χ^2 *(p-value)*
	Intervention n_2=30	Control n_2=30	
	Freq (%)	Freq (%)	
Age Group			
30-49	11 (36.67)	9 (30.0)	
50-69	15 (50.0)	17 (56.67)	0.934[α]
≥70	4 (13.33)	4 (13.33)	
Mean (SD)	54.73 ± 11.29	57.6 ± 9.73	1.05 (0.292) [μ]
Gender			
Male	13 (43.33)	16 (53.33)	
Female	17 (56.67)	14 (46.67)	0.27 (0.605)

*Statistically significant ($p<0.05$); χ^2=Chi-Square; μ=Student t-test; α=Fishers Exact p

Association between clinical parameters for Standard of Care (Control) group over 6 months

The results indicate differences in the means of clinical parameters (HbA1c and BMI) of participants in the standard of care (Control) group over a 6month period (Table 2). This fluctuation of mean scores was noticed in most of the clinical parameters (HbA1c and waist circumference) in the standard of care group except for BMI that decreased progressively in mean values (from 26.90 to 25.41). Statistical analysis of these means (ANOVA) of the clinical parameters, however, indicated no statistically significant differences over the six months duration of the study.

Table 2: Descriptive Statistics showing an association between clinical parameters for the Standard of Care (Control) group

Variables	Standard of Care (Control) group		ANOVA (F-test)	p-value
	Mean	SD		
HbA1c Control				
Initial	8.390	2.0242		
3 Months	7.807	1.4619	0.718	0.491
6 Months	8.140	2.1229		
Overall	8.112	1.8862		
BMI Control				
Initial	26.907	4.5521		
3 Months	26.093	4.5572	0.763	0.469
6 Months	25.417	4.9173		
Overall	26.139	4.6662		

NS-Not Significant at $P > 0.01$; ANOVA=Analysis of variance

Association between clinical parameters for Intervention group over a 6 months Period

The results show mean differences in the clinical parameters (HbA1c and BMI) of participantswho were placed on the Wholly Nigerian diet (calorie restricted Intervention) over a 6 month period. The patients' HbA1C reduced from initial visit with mean = 7.617 to mean = 6.017 after six months, a significant drop in HbA1c (Table 3).

Table 3: Statistical descriptions of the association between clinical parameters in the Intervention group

Variables	Intervention group		ANOVA (F-test)	p-value
	Mean	SD		
HbA1cIntervention				
Initial	7.617	2.0773		
3 Months	6.455	1.4040	7.885	**0.001***
6 Months	6.017	1.2301		
Overall	6.696	1.7327		
BMI Intervention				
Initial	26.670	4.1194		
3 Months	24.920	4.0177	7.667	**0.001***
6 Months	22.857	3.1076		
Overall	24.816	4.0487		

*Statistically Significant at $P \leq 0.05$; ANOVA=Analysis of variance

Percentage of HbA1c Reduction at the Individual Level after six months of Standard of Care (Control) and Intervention

The Results show that after a period of six months, 18 (60%) of the participant in the intervention group had HbA1c consistently less than 6.5% without any medication with a percentage reduction seen with only 8(˜27%) participants; the Control group showed 5(-17%) (Table 4), Participants from the initial visit to end of study with no change in HbA1c throughout the study. The findings were statistically significant (p=0.007).

Table 4: Percentage of Reduction of HbA1c at an Individual Level using both Standard of Care (Control) and Intervention after a period of six months

Group	All participants n (%)	HbA1c Change n (%)	% Reduction (*No. of normal subjects after 6months – Initial no. of normal)*	Fishers exact p

		Initial	3 Months	6 Months		
Control	30 (100.0)	5/30 (16.67)	5/30 (16.67)	5/30 (16.67)	5-5 0 (0.0)	
Intervention	30 (100.0)	10/30 (33.33)	17/30 (56.67)	18/30 (60.0)	18-10 8 (26.67)	**0.007** µ *

*Statistically Significant at P≤0.05; µ=Fisher's exact p (recommended where cell values are <5)

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Percentage of Body Mass Index (BMI) Reduction at the Individual Level after six months of Standard of Care (Control) and Intervention

The result show that after a period of six months, the intervention controlled overweight by 16.67%, unlike the control group with a reduction of 6.67% in overweight. Obese observed a reduction of 23.3% in the intervention group and 10% in the standard of care controlled group (Table 5). This differences observed were not statistically significant (p=0.681).

Table 5: Percentage of Reduction of BMI at an Individual Level using Standard of Care (Control) after a period of six months

Group	All participants n (%) n=30	BMI Change n (%)			% Reduction (*No. of normal subjects after 6months – Initial no. of normal)*	Fishers exact p
		Initial	3 Months	6 Months		
Control						
Normal		12/30 (40.0)	15/30 (50)	17/30 (56.7)	17-12 5 (16.7)	
Overweight		8/30 (26.7)	8/30 (26.7)	6/30 (20)	6-8 -2 (6.67)	
Obese Class 1		10/30 (33.3)	6 (20.0)	7 (23.3)	7-10 -3 (10.0)	
Obese class 2		0/30 (0)	1/30 (3.3)	0/30 (0)	0-0 0 (0.0)	
Intervention						
Normal		11/30 (36.7)	16/30 (53.3)	23/30 (76.7)	23-11 5 (16.7)	**0.681**µ
Overweight		11/30 (26.7)	11/30 (26.7)	6/30 (20)	6-11 -5 (16.67)	
Obese class 1		8/30 (33.3)	2/30 (20)	1/30 (23.3)	1-8 -7 (23.33)	
Obese class 2		0/30 (0)	1/30 (3.3)	0/30 (0)	0-0 0 (0.0)	

µ=Fisher's exact p (recommended where cell values are <5)

Percentage of Normal Body Mass Index (BMI) that had Remission within the Standard of Care (Control) and Intervention

The results indicate the percentage of normal Body Mass Index (BMI) that had reduction is HbA1c within the Control and Intervention groups after a period of six months. The results show only 3 out of the 17 study participants who had controlled BMI had HbA1c< 6.5 while, the intervention group showed that 61% of participants with controlled the BMI with HbA1c <6.5% (Table 6).

Table 6: Percentage of Normal Body Mass Index (BMI) that had Remission within the Standard of Care (Control) and Intervention groups after a period of six months

Group	All participants n (%)	BMI Change n (%)			Fishers exact p
		Initial	3 Months	6 Months	
Control	30 (100.0)				
Normal		12/30 (40.0)	15/30 (50.0)	17/30 (56.7)	
Remission		0 (0)	3/15 (20.0)	3/17 (17.6)	**0.025**$^{\mu*}$
Intervention	30 (100.0)				
Normal		11/30 (36.7)	16/30 (53.3)	23/30 (76.7)	
Remission		2/11 (18.18)	9/16 (56.25)	14/23 (60.87)	

*Statistically Significant at P ≤ 0.05; μ=Fisher's exact p (recommended where cell values are <5)

Assessing the effect of Intervention on the HbA1c level of participants while controlling for the influence of standard of care

The analysis of covariance was conducted to investigate the effect of calorie restricted locally available food on the HbA1c level of T2DM patients over a period of six months while controlling for the influence of standard of care. ANCOVA results, presented in Table 7a, show a significant difference in mean HbA1c values amongst treatment groups [$F(2, 86) = 7.839$, $p < .01$, partial $\eta 2 = .154$], while controlling for standard of care or pretest HbA1c. However, the calculated effect size indicates a small proportion of variance accounted for by a 15.4% change in the treatment group (according to Cohen's guidelines 0.2 – small effect, 0.5 – moderate effect, 0.8 – large effect).

Table 7a: Assessing the effect of Intervention on the HbA1c level of T2DM patients over a period of six months while controlling for the influence of standard of care using the Analysis of covariance (ANCOVA)

Parameter	Intervention on the HbA1c level			F	P-value	Effect Size η^2
	Initial Visit	3 Months	6 Months			
	Mean ± SD	Mean ± SD	Mean ± SD			
HbA1c Intervention	7.62 ± 1.18	6.45 ± 1.18	6.02 ± 1.18	7.839	**0.001**	0.154

*Statistically Significant at P ≤ 0.05

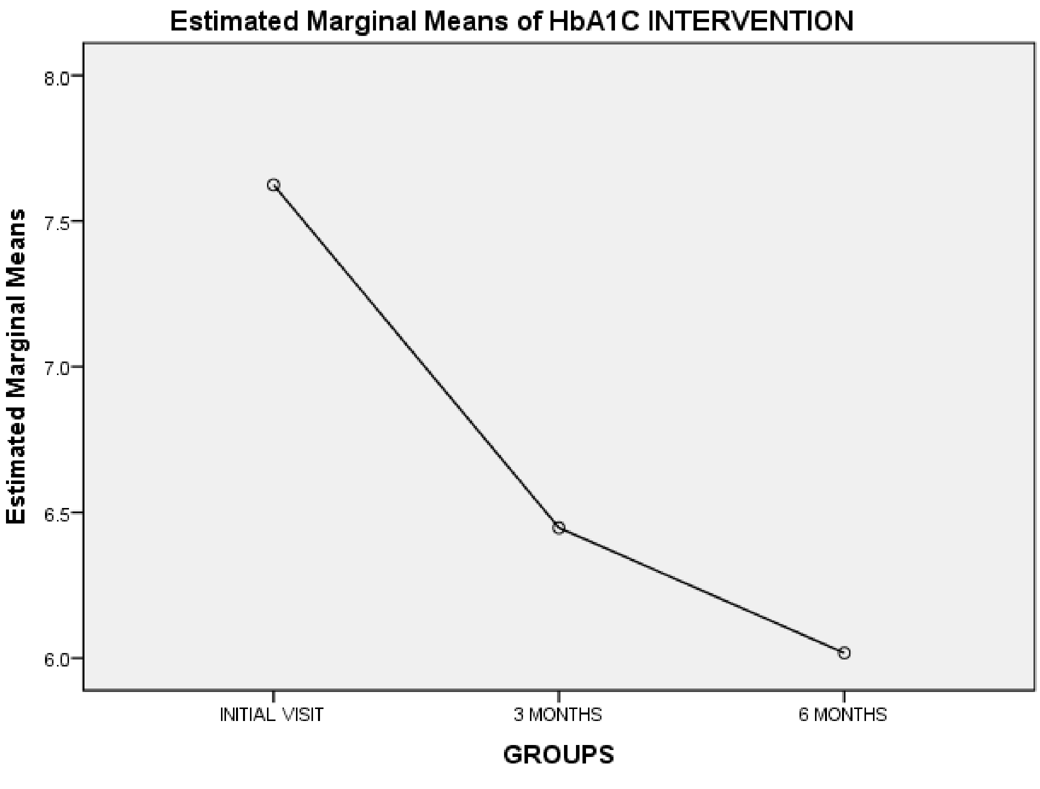

Figure 1: Estimated Marginal Means of HbA1c intervention

Assessing the effect of Intervention on the BMI level of T2DM patients while controlling for the influence of standard of care

The analysis of covariance was conducted to investigate the effect of the intervention on the Body Mass Index (BMI) of participants over a period of six months while controlling for the influence of standard of care. ANCOVA results show a significant difference in mean BMI amongIntervention (treatment) group

[F(2, 86) = 8.333, p < .01, partial $\eta 2$ = .162]. However, the calculated effect size indicates a small proportion of variance which accounted for about 16.2% change in the BMI of the treatment group (Table 8)

Table 8a: ANCOVA Summary of the effect of Intervention on BMI of T2DM patients

Parameter	Intervention on the BMI Control			F	P-value	Effect Size η^2
	Initial Visit	3 Months	6 Months			
	Mean ± SD	Mean ± SD	Mean ± SD			
BMI Intervention	26.76 ± 2.74	24.92 ± 2.73	22.77 ± 2.74	8.333	**0.001***	0.162

*Statistically Significant at P ≤ 0.05

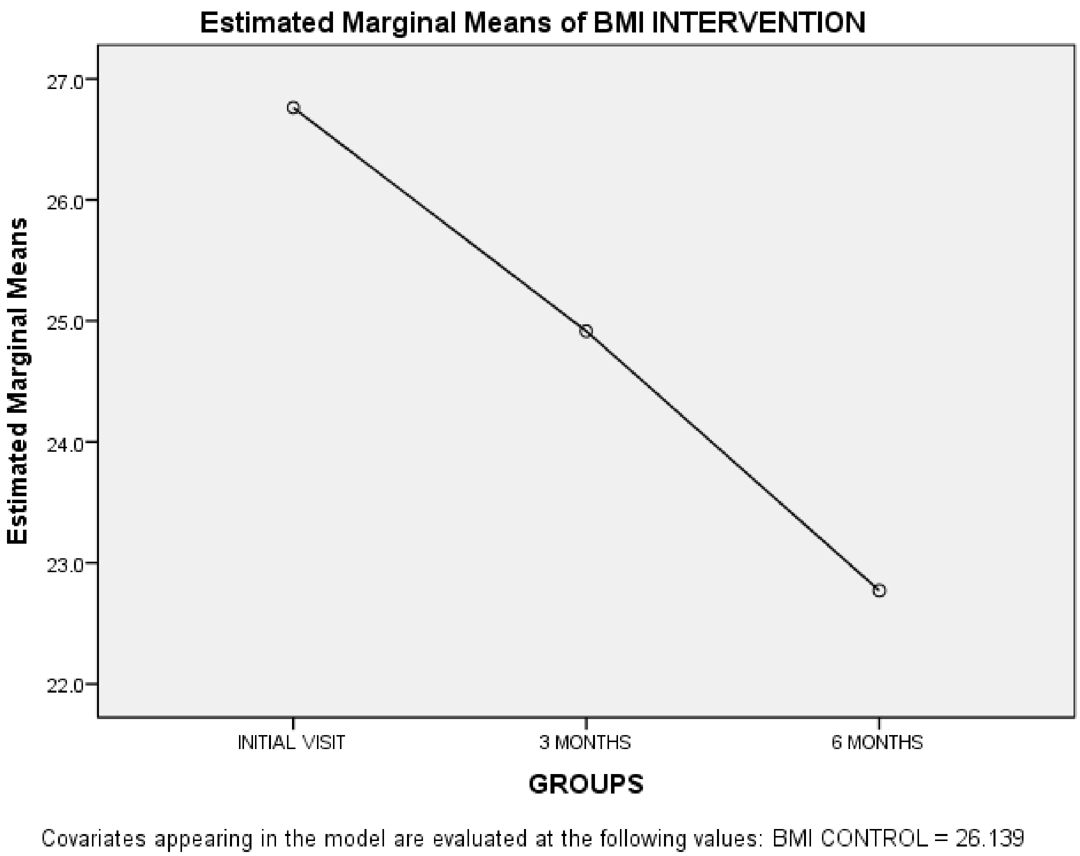

Figure 2: Estimated Marginal Means of BMI intervention

Discussion

More recently, T2DM was diagnosed and typically prevalent in older age groups but with poor lifestyle it is now seen in all ages. The Centers for Disease Control report on diabetic statistics clearly showed ages 45 and older had the highest number of new cases of diabetes in 2015. [31] This remission study done in Nigeria by Nigerians using locally available everyday food items is one of a few hospital based studies investigating patients with T2DM that included a small number of subjects with outcome for possible translation into further studies. Although this study looked at demographic factors, it did not show that sex and age affected HbA1c or weight reduction. These study had a mean age of 54.74±11.29 years for intervention group with gender equally matched (Table 1). Tonstad *et al.* after adjusting for BMI and socio demographic and lifestyle factors demonstrated that the right diets were associated with a substantial reduction in risk of diabetes compared to non-vegetarian diets that were even reported to have a 3.8times chance of having diabetes linked to their cause of death. [32,33]

Siminialayi and Eme-Chioma in 2006 confirmed that there are obviously an enormous number of drugs available for the treatment of type 2 diabetes mellitus, though some of these may not be readily available in our environment while others are still at developmental stages and they do not come without side effects. [34] Other factors such as cost and health seeking behaviours limits patients' frequent use of these drugs considering it's a lifelong therapy and compliance becomes challenging. [35,36] These challenges form part of what propels scholars to adopt measures that will reduce prevalence and even cause T2DM to seize in our population, a concept known as remission, which is HbA1c <6.5% consistently for 6months without use of any oral hypoglycaemic agents or insulin. The evidence that the right diet can contribute to remission and normalization of patients' health has been demonstrated by this study and was also affirmed by Pories *et al.*, reaffirmed in 2017 by Schauer *et al.* and later by the Diabetes Remission Clinical Trial (DiRECT) study. [37-39] Studies done using animal models also affirmed that supplementation of animal feed with plant enriched diets contribute to normalization of rats induced with diabetes. [40,41]

The principles of prevention and management in T2DM include frequent blood glucose monitoring, reduction in carbohydrate and Therapy adjustment. Blood glucose monitoring before and after meal will enable early recognition of glucose abnormalities and allow prompt action to prevent several diabetic complications. Patients with T2DM with poor compliance to therapy will have high HbA1c. [36] Generally, glycosylated haemoglobin (HbA1c) is performed up to four times a year in patients who are not meeting their glycaemic targets or who have changed their medication, as it is a better indication of long-term glucose control over the previous 3 months. A normal HbA1c in non-diabetics is <6.5%. This study found a glucose control for the intervention group to be significantly better than the control having controlled for all variables used in the analysis. Sixty Per cent representing 18 of the 30 participants in the intervention group had maintained HbA1c <6.5% (Remission) without medication for 6months at the end of this study. Of the 18 participant 10 of them may have benefited from the legacy effect of an overtime of well controlled glycaemic index in the intervention group such that withdrawal from medication and intervention may have accounted for the outcome observed, as they maintained fairly normal HbA1c from before the study commenced and had stayed off medication in the intervention group and still achieved remission. The remaining 8 (27%) participants also had remission (p=0.007) from the intervention (see Table 4).

The DiRECT study in 2018 by Lean *et al*, found that Diabetes remission was achieved in 68 participants (46%) in the intervention group and in six participants. [39] This study had a 60% diabetes remission in the intervention group and no change in control over a 6months period which was 3-4 times more effective than the control group. Knowler *et al.* and Salsa-Salvado diabetes prevention study agrees with this evidenced by caloric restrictions diet. [9,42]

Similarly, Dunaief *et al.* in 2012 retrospectively studied 13 patients who had an average HbA1c of 8.2% dropped their HbA1c average to 5.8% after 7 months of eating high diet high in greens, fruits, nuts/seeds and beans/legumes which is similar to what is available in Nigeria that the study participants ate daily. [43] Predominantly plant-based foods were shown to be superior to the American Diabetes Association (ADA) diet in controlling serum glucose in T2DM in a 22 weeks randomized control trial of 99 subjects with T2DM. Among 49 participants in the intervention group, 48% had HbA1c levels improved 0.38%. [44-47]

Furthermore, a reduction in calorie over several weeks to months may result in weight loss with a decrease in leptin production, decreased fatty acid infiltration into liver and muscles cells. All of these lead to weight loss and a fall in the mediators of inflammation. Western diet, antibiotics and other factors causes dysbiosis from disruption of the microbiome and a reduction in the production of short-chain fatty acid- butyrate that assists in blood sugar management. [48] Parker averred that a high protein, low carbohydrate diet in patients with T2DM can achieve weight loss, reduced insulin requirements and reduced HbA1c level. [49] Trapp *et al.* demonstrated that a high fibre-based diet helped to reverse diabetes despite no weight loss occurring implying the type of food consumed impacted blood sugar regulation. [50] The BMI is also known as the Quetelet's index with normal range of 18.5–24.9 kg/m2. BMI values below 18.5kg/m2 is underweight malnutrition. From 25.0–29.9 is overweight, 30–39.9 is obese, while 40.0 and above is severe obesity. BMI, however, as a measure of excess weight does not differentiate lean body mass from fat. [51] Of the twenty-three participants (77%) in the dietary intervention group with normal BMI at the end of 6months, 14 (61%) (p=0.025) had remission which was associated weight loss of 5-10% .The intervention proves to be more effective than standard of care in controlling BMI of T2DM patients as there is overwhelming evidence to the association between reduction in BMI and remission of T2DM patients after 6 months of intervention (Tables 5, 8a). Similar study by Lean *et al.* (2018) showed 25(41%) remission in participants with 5-10kg weight loss The limitations in this study are the small sample size and sustainability of the remission after 6months of achieved remission. The study confirmed the feasibility and showed the possibility of durability over the study period by successfully linking the changed observed in the intervention group to be responsible for remission when controlling for influences of standard of care (control group). Analysis of covariance for HbA1c (Table 7a and 7b); and BMI (Tables 8a) all show evidence.

Dietary modification has an important impact on HbA1c in patients with T2DM, and thus, strategies should be developed to prevent and sustain these changes. Cheng *et al.* study in a murine model, demonstrated that a fasting-mimicking diet can promote B-cell regeneration which may have future implications for the role of reversing insulin-dependent T2DM. [52] A complete intervention programme of this nature is most effective when diabetic patients take care of their health and other health professionals including family practitioners, physicians and endocrinologists, pharmacologist, nutritionists provide health coaching support. [53]

The barriers to successfully implementing a diabetes remission program in a Health care facility are an attitude towards change. How the health care worker treats lifestyle-related diseases needs to change. [54,55] An almost complete health and economic profits maybe sustained if a significant part of the population opt into an “optimal” lifestyle. This research shows evidence that lifestyle dietary intervention led to major reductions in BMI, and remission of type 2 diabetes. The (economic) benefits of a lifestyle-based therapy for type 2 diabetes have been demonstrated by a 10-year study, yet the introduction of a new healthcare system for preventing and treating lifestyle-related diseases has not materialized for a several reasons. [55]

Considering food as an essential part of treatment is fundamental, Patients with T2DM for instance can access evidence based practices in adjusting their calorie daily to better manage their health as this study has suggested. [12,13] There is an urgent need for our health decision-makers at all levels to implement adopted policies and plans of action to halt the escalating trend and burden of Diabetes through effective primary care, as this study clearly suggests for the remission of T2DM. [54]

Conclusion

The study on the feasibility of remission of type 2 diabetes mellitus using a wholly Nigerian dietary intervention at University of Port Harcourt Teaching Hospital was a robust and relatively new study worth researching. While medication adherence has been a concern for T2DM in this part of the world, Endocrinologist, Endocrine pharmacologist, Nutritionist, Lifestyle medicine physician and other related specialties have continued to find a lasting solution to health and wellness. Nutritional adjustment and weight control through diet and exercise is the new outlook for remission of T2DM. Strategies for managing T2DM begins with a simple health and public awareness, to health professionals making decisive and timely diagnosis and introduction of valid, verifiable healthful lifestyle options- Predominately Whole plant based diet, weight control, exercise and night time sleep are all channeled towards reduction of HbA1c to normal levels and ultimately leading to remission of T2DM. FBS, HbA1c and Liver function test are cardinal in monitoring progress in patients in remission fromT2DM.

It is safe to say that the everyday food of a typical Nigerian can be managed significantly as medicine through reduction in calories for possible remission of T2DM as Poor Adherence from high cost of medication, medication fatigue and side effects are barriers to successful management of T2DM.This is a renewed call for the altruistic public, relevant stakeholders to ensure making feasible option as dietary and lifestyle interventions more known and available patients in this part of the world with T2DM to hope in the possibilities of remission of a once life-long disease.

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