Original Article

Stepping Up Physical Exercise Among Nigerian Patients With Type 2 Diabetes: The Impact Of A Domesticated Type 2 Diabetes-Oriented Exercise Education Curriculum

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ABSTRACT

Background: Most diabetes patients in Nigeria either do not exercise at all or do not exercise appropriately and this is thought to be due partly to an inadequate exercise education.

Objectives: To investigate the impact of a type 2 diabetes-oriented exercise education curriculum (T2DEEC) on exercise performance and adiposity of type 2 diabetes patients.

Materials and Methods: The patients (n=86) were randomized into either the T2DEEC or the control groups. The T2DEEC was administered to patients in the T2DEEC group while the controls were encouraged to exercise but did not go through the T2DEEC. The participants continued exercises at home for 12 weeks. Outcomes were amount of time and days spent on each of aerobic, resistance, joint mobilization and foot care exercises per week; waist circumference, body mass index, and percent body fat.

Results: By the 12th week, the T2DEEC participants increased their exercise days from 1.2 to 3.8 days and increased aerobic, resistance, joint mobilization and foot care exercise times by 56.5, 42.3, 39.8 and 28.1 minutes respectively ($p<0.05$). The controls only increased their aerobic exercise time by 5.1 minutes ($p=0.141$) and maintained zero exercise times for resistance, joint mobilization and foot care exercises. Also the T2DEEC group but not the controls recorded significant improvements ($p<0.05$) in adiposity variables.

Conclusions: The participants who were taught with the T2DEEC unlike those who received verbal encouragement to exercise improved their exercise performance and adiposity parameters significantly. The T2DEEC is recommended for exercise education of type 2 diabetes patients.

Keywords: Type 2 diabetes, exercise education, joint mobilization, aerobic activities, curriculum.

Physical exercise is beneficial for patients with type 2 diabetes mellitus (T2DM) but this form of therapy has usually been poorly adopted by many of the patients. According to Colberg et al[1], although physical activity is a key element in the prevention and management of T2DM, many individuals with the disorder do not become, or remain regularly active. Consequently, health professionals have advised most patients with or at high risk for diabetes to exercise, suggesting recognition of its importance for the disease management[2]. Unfortunately however, exercise has not increased proportionally to exercise advice, and the challenge remains converting patients' awareness into behaviour change[2].

Education is known to play a pivotal role in the entrenchment of specific lifestyle behaviours, and this includes the recognition of the need to exercise among patients with T2DM. Physical activity and exercise prescription is an integral component of the diabetes self-management training plan for any patient with diabetes or anyone at risk for developing T2DM; consequently, diabetes educators from a variety of health care professions are responsible for the successful inclusion of exercise component into lifestyle behaviours[3]. Diabetes education that will encompass physical exercise requires a

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simple physical activity intervention template that is feasible, acceptable, and effective in a variety of settings.[4] The importance of a robust and carefully crafted curriculum in the delivery of any education cannot be overemphasized[5-7]. Currently, diabetes exercise curriculum developed for patients of Nigeria and other similar nations in the Sub-Saharan Africa is unavailable. Consequently, most patients with diabetes are only advised to exercise without being taught in practical terms how much and what type of exercise should be taken. Thus this study was carried out to investigate the impact of a domesticated T2DM-oriented exercise education curriculum (T2DEEC) on exercise performance parameters and adiposity variables of T2DM patients.

MATERIALS AND METHODS:

Design of the T2DEEC:

The T2DEEC evolved from a process that involved four stages:

Stage 1: *development of learning outcomes and gathering of course content through review of the literature*. The formative learning outcomes to be applied at the end of the education period to determine whether the participants understood the curriculum or not were developed (see Attachment). The outcomes also helped to ensure that all relevant contents of the curriculum were not left out during the teaching sessions. The course content was derived from an extensive search of the literature to identify, collate and synthesise the different exercise programmes that were administered on patients with T2DM.

Stage 2: *review and approval of the contents by a panel of experts made up of professionals involved in the care of patients with T2DM*. The content was reviewed by the panel which eventually decided on what aspects of the content should remain and which one to be expunged based on their experiences in the care of people with T2D. At this stage, consideration was given to contents that will be consistent with the culture and environment of the participants, and also reflect their prevailing social and economic backgrounds. It was unanimously agreed by the panel lists that activities in the curriculum should be the ones that the patients can undertake within their homes, the ones that will involve only minimal exercise gadget assembly if any, and involve minimal or no financial expenditure on the participants. Consideration was given to the implementation of the activities using locally available and adaptable resources such as sand bags as weights for resistance; and aerobic exercise using culturally friendly and acceptable activities such as dancing to indigenous music and brisk walking.

Stage 3: *pilot application of the curriculum on a few patients with T2DM*.Seventeen patients with T2DM were taken through the curriculum and the areas of difficulties, redundancies and overlaps were noted for amendment.

Stage 4: *review of the pilot performance, amendments and approval of the final curriculum.* The panel met again to review the performance of the curriculum, its applicability and comprehension as were identified in stage 3. All issues were resolved and the final curriculum was arrived at.

Selection of participants:

The participants for this study were T2DM patients who were being managed at the Endocrinology Clinic of the University College Hospital Ibadan, Nigeria. For a participant to be eligible for the study, such individual must have been advised to be physically active by his or her physician. Those who were presenting with other complications that will limit participation in the exercise programme such as visual impairment, advanced peripheral neuropathy, amputation and any other physical disability were excluded. Patients that had been previously asked to stay off physical activity for medical reasons were excluded. A total of 86 participants met the inclusion criteria at the end of the 24 week recruitment period, and they all signed the informed consent for participation. The participants were thereafter randomly assigned into either the T2DEEC or the control group using a randomly generated set of numbers. Those who were assigned into

the T2DEEC group were thereafter taught all the exercise details through the use of the curriculum. Those who were assigned into the control group were only asked to exercise and be physically active, which is the usual manner by which many patients are introduced to exercise, but they did not partake in the exercise education through the T2DEEC.

The exercise education:

The exercise education took place in the meeting room of the Diabetes Association of Nigeria within the Medical Outpatient Department of the University College Hospital, Ibadan, and it involved two theoretical and two practical sessions. The theoretical component of the training included teaching the participants in the T2DEEC group the basics of exercise participation in the co-management of T2DM. They were theoretically taken step-by-step through the entire contents of T2DEEC (Attachment). The practical sessions included demonstration to the participants how each of the exercise mentioned in the T2DEEC should be undertaken. There were non-patient models on whom the practical sessions were first demonstrated to the participants. This was then followed by asking some randomly picked participants to demonstrate the techniques. The practical sessions included taking the patients through aerobic activities (such as dancing, brisk walking, upper and lower limb cycling in the air etc), active joint mobilization exercises (covering joints of the lower limbs, joints of the hips, the fingers and entire upper limbs and the neck), resistance exercises (for the muscles of the upper and lower limbs using locally made sandbags as resistance), and finally, the foot care programme (mobilization of the toes in water, cleaning and moisturisation)[8-14]. Aspects of the T2DEEC that could not be demonstrated appropriately by the participants in addition to the areas of the curriculum where they had questions were all attended to.

Procedure for data collection:

Ethical approval for the study was obtained from the University of Ibadan/University College Hospital Research Ethics Committee (ID: UI/EC/13/0020). The data from the participants in both groups were taken at the beginning (baseline), midway (6^{th} week) and end of the study (12^{th} week). Each participant thereafter spent 12 weeks in the study. The data included the socio-demographic characteristics of the participants (age, sex, marital status and educational attainment), adiposity variables (weight, body mass index (BMI), waist circumference and percent body fat), and exercise performance parameters (types of exercise being undertaken, amount of time spent on the activity and number of days in a week for which the activity was performed).

The weight, BMI, waist circumference and percent body fat were taken using standard procedures[15-18]. Each of the participants in both groups was given exercise diaries to document their activities. The participants were taught how to use the diaries and were asked to document the type of exercise that was undertaken, the amount of time spent on the activity and the days in which the activities were undertaken in each week. The participants presented to the clinic for re-assessment and documentations during the assessment periods.

Study design and ethical consideration:

This study was a randomized control trial. However, for ethical reasons, the participants in the control group were given the opportunity to benefit from the exercise curriculum at the end of the study period when all data had already been taken. This gave them the opportunity to also receive the exercise education for the enhancement of their health.

Analysis of data:

The data were analysed using both descriptive and inferential statistics. The socio-demographic characteristics of the participants were analysed and presented using mean, standard deviations and percentages. Using the paired t-test, the adiposity and exercise performance data at baseline were first compared with that of the 6^{th}week and then compared with that of

the12th week for each of the groups. Level of significance was set at 0.05.

RESULTS:

A total of 79 (91.9%) out of the 86 participants who commenced the study completed it. Three of them relocated out of town and the remaining four withdrew from the study, citing lack of time as the main constraint. There were more women than men in both groups with mean age of the participants in the T2DEEC and control groups being 56 ± 6.3 and 58 ± 4.9 years respectively (Table 1).At baseline, participants in both groups had BMI values in the range of overweight to moderately obese with the lowest (27.5 ± 4.2 Kg/m^2) seen among the male participants and the highest (30.6 ± 4.7 Kg/m^2) seen among the female participants. It was also observed that the participants reported only a short time of aerobic exercise at baseline with those in the T2DEEC group spending close to 9 minutes and those in the control group spending about 13 minutes on the average in a typical week. The activities at baseline were spread over a period of 1.2 days and 2.4 days per week in the T2DEEC and control groups respectively. Apart from the short time spent on aerobic activities, none of the participants in both groups reported any time spent on resistance, joint mobilization or foot care exercises at baseline. Table 1 contains other details on socio-demographic, adiposity and exercise variables of the participants at baseline.

The baseline values of the participants were compared with that of the 6th week, which was midway into the programme, and also compared with that of the 12th week which was the end of the programme (Table 2). Participants in the T2DEEC group recorded significant reductions in their weight and BMI by the end of the 6th week ($p < 0.05$), while on the contrary, the female participants in the control group within the same period recorded a 3.3% increase in their weight ($p = 0.04$). Also, within the first 6 weeks of the programme, the average weekly time on aerobic programme for the T2DEEC group had more than tripled with a mean increase of 29.2 ± 6.3 minutes. The average times per week on resistance, joint mobilization and foot care exercises also increased within the first 6 weeks, from zero time to 18.9, 17.7 and 20.6 minutes respectively. The increase in weekly average times of exercise by participants in the T2DEEC group continued progressively for all the exercise types till the 12th week ($p < 0.05$), but the highest increase was seen in the aerobic exercise type; which by the 12th week had increased by 56.5 ± 8.9 minutes compared to baseline ($p = 0.0001$). The control group in contrast, maintained the zero time for resistance, joint mobilization and foot care exercises at both the 6th and 12th weeks but only increased the weekly aerobic exercise time at the 12th week by an average of 5.1 ± 2.4 minute compared to baseline ($p = 0.141$).

DISCUSSION:

The following observations were made from this study: i) At baseline, the participants in both T2DEEC and control groups presented with high risk waist circumference and percent body fat, and ranged from overweight to obese, ii) they used to spend only an average of 9 to 13 minutes across 1 to 2 days per week on aerobic exercises but none of them was involved in any resistance, joint mobilization and foot care exercises, iii) by the 6th week, participants in the T2DEEC group demonstrated significant increase in number of exercise days and amount of exercise time for all the exercise types in addition to a significant improvement in a few of the adiposity variables, iv) the exercise performance parameters maintained their improvement, and the remaining adiposity variables demonstrated significant improvement by the 12th week, v) in the control group, only the female participants demonstrated a significant reduction in weight only in the 12th week, while all the other adiposity and exercise parameters did not improve significantly.

The fact that the participants in both groups presented with high levels of adiposity variables is not surprising considering the strong links that have been demonstrated

Table (1): Socio-demographic, adiposity and exercise characteristics of the participants at baseline

	T2DEEC Group (n = 41)	Control Group (n = 38)
Demographic characteristics		
Mean age (years)	56 ± 6.3	58 ± 4.9
Sex		
Male	12 (29.3%)	16 (42.1%)
Female	29 (70.7%)	24 (57.9%)
Marital status		
Married	32 (78.1%)	26 (68.4%)
Not married	9 (21.9%	12 (31.6%)
Educational level		
Educated	27 (65.9%)	22 (57.9%)
Not educated	14 (34.1%)	16 (42.1%)
Duration since diagnosis of diabetes (years)	7.5 ± 5.2	5.9 ± 3.6
Clinical characteristics		
Weight (Kg)		
Male	68.1 ± 8.2	71.4 ± 5.1
Female	76.9 ± 5.8	73.8 ± 9.3
Body mass index (Kg/m^2)		
Male	27.5 ± 4.2	28.8 ± 5.3
Female	30.6 ± 4.7	29.4 ± 2.9
Waist circumference (cm)		
Male	103.7 ± 6.3	102.2 ± 4.8
Female	96.4 ± 5.5	94.7 ± 4.1
Percent body fat (%)		
Male	30.2 ± 5.8	29.8 ± 6.6
Female	33.3 ± 5.9	35.5 ± 4.1
Exercise characteristics (Average)		
Aerobic exercise time/week (mins)	8.7 ± 2.5	12.7 ± 3.6
Resistance exercise time/week (mins)	0.0	0.0
Joint mobilization exercise time/week (mins)	0.0	0.0
Foot care exercise time/week (mins)	0.0	0.00
Number of exercise days/week	1.2 ± 0.4	2.4 ± 0.6

between T2DM and those variables.[19-23] Since the participants in this study were patients with T2DM, this situation would not have been completely out of place. However, a generally better adiposity outlook would have been expected considering that the participants were already being managed for diabetes for a varying length of time. One of the possible explanations for the inadequate adiposity profile is the fact that at baseline, they were found to have spent little or no time on physical exercises; whereas this mode of treatment has been documented as important in taking care of the myriads of health problems of people with T2DM.[12, 24-29] The only sub-optimal time expended on exercise was seen in activities that can be categorized as aerobic exercises. Aerobic exercise of about 9 or 13 minutes per week is not likely to bring forth any health benefit as this is way below the prescribed duration[30-31]. There is no doubt that aerobic exercise is beneficial for patients with T2DM[11, 13] but it is also important that they engage in other forms of exercises that have been shown to demonstrate benefits to the patients. Such exercises include resistance exercises[9, 11, 14], and joint mobilization and foot care exercises[8,10,12]. At baseline, participants in both groups spent zero time on these other

Table 2: Comparison of baseline adiposity and exercise characteristics of participants with that of the 6th and 12th weeks of study

	End of 6th week data compared with baseline		End of 12th week data compared with baseline	
	T2DEEC Group Mean difference p-value	Control Group Mean difference p-value	T2DEEC Group Mean difference p-value	Control Group Mean difference p-value
Adiposity variables				
Weight (kg)				
Male	-4.6 ± 2.4* p = 0.001	-1.2 ± 0.8 p = 0.212	-8.2 ± 3.5* p = 0.0001	-2.1 ± 1.2 p = 0.06
Female	-1.8 ± 1.1* p = 0.003	2.5 ± 9.3* p = 0.04	-12.5 ± 4.6* p = 0.0001	-2.4 ± 1.2* p = 0.03
Body mass index (Kg/m^2)				
Male	-1.6 ± 0.9* p = 0.003	-0.6 ± 0.1 p = 0.103	-4.7 ± 2.3* p = 0.0002	-1.5 ± 0.8 p = 0.06
Female	-2.7 ± 1.5* p = 0.002	1.8 ± 0.5 p = 0.204	-6.1 ± 3.9* p = 0.0001	-1.2 ± 0.3 p = 0.211
Waist circumference (cm)				
Male	-2.3 ± 1.4* p = 0.004	0.5 ± 0.1 p = 0.344	-3.1 ± 1.5* p = 0.002	-0.8 ± 0.3 p = 0.08
Female	-0.8 ± 0.2 p = 0.524	0.7 ± 0.3 p = 0.451	-2.5 ± 1.4* p = 0.04	0.8 ± 0.1 p = 0.256
Percent body fat (%)				
Male	-5.6 ± 2.0 p = 0.08	1.3 ± 0.8 p = 0.07	-8.7 ± 2.5* p = 0.0001	-1.4 ± 1.8 p = 0.06
Female	-4.9 ± 2.8 p = 0.06	-1.2 ± 1.4 p = 0.28	-6.0 ± 4.1* p = 0.0001	3.1 ± 1.4 p = 0.08
Exercise characteristics				
Aerobic exercise time/week (mins)	29.2 ± 6.3* p = 0.0001	2.3 ± 1.1 p = 0.186	56.5 ± 8.9* p = 0.0001	5.1 ± 2.4 p = 0.141
Resistance exercise time/week (mins)	18.9 ± 4.1* p = 0.0001	0.0	42.3 ± 7.6* p = 0.0001	0.0
Mobilization exercise time/week (mins)	17.7 ± 4.8* p = 0.0001	0.0	39.8 ± 4.2* p = 0.0003	0.0
Foot care exercise time/week (mins)	20.6 ± 5.3* p = 0.0001	0.00	28.1 ± 4.8* p = 0.002	0.00
Number of exercise days/week	3.1 ± 1.6* p = 0.0001	-0.8 ± 0.2 p = 0.233	3.8 ± 1.0* p = 0.0001	-0.6 ± 0.2 p = 0.241

*Significant differences are asterisked

types of exercises, a situation that suggests the need for exercise education among the patients. Physical exercise had long been documented as an important component of the diabetes self-care effort, but a previous study reported by Safford et al[32] had reported a limited allocation of time to self-care efforts by patients with diabetes. According to the study, many patients skipped individual self-care elements with 37.9% reporting no foot care, and 37.7% reporting no exercise. The participants in the T2DEEC group improved

in their exercise performance following the administration of the T2DEEC. They were observed to have spent significantly longer time exercising, with time increment at the 12th week reaching over 50 minutes of aerobic exercise, over 40 minutes for resistance exercise, close to 40 minutes for joint mobilization exercise, and close to 30 minutes for foot care exercises giving a total average of about 160 minutes per week of exercises. This falls within the weekly range of exercise duration prescribed for health enhancement.[30-31] On the other hand, the participants in the control group accumulated only an additional average duration of about 5 minutes per week on aerobic exercise with zero time maintained for the other three types of exercises throughout the 12 weeks. The significant accumulation of time in all the four types of exercise protocols may be the reason why there were significant improvements in the adiposity variables of participants in the T2DEEC group compared to that of the participants in the control group which recorded no significant improvements in adiposity variables. Individual and combined use of aerobic and resistance exercise have been shown to be particularly effective in improving adiposity variables of patients with T2DM[25,33]. Joint mobilization and foot care exercises in water have also been documented to be of benefit to the neuromusculoskeletal health of patients with T2DM[8,10,12].

The clinical application of this study is in its ability to demonstrate the usefulness of applying physical exercise education curriculum for the improvement of health of patients with T2DM. The study suggests that the T2DEEC when introduced to patients with T2DM is capable of increasing their physical exercise performance and also provides clinical benefits on adiposity variables of the participants. A major strength of the study is the fact that it demonstrates the usefulness of a simple but comprehensive curriculum for the teaching of physical exercise to patients with T2DM in a routine diabetes clinic. The fact that the curriculum compiled simple and locally adaptable resources, and translated different research findings into a single curriculum for the execution of exercises without sophistication of equipment made it useful for application at primary care settings. Another important strength of the curriculum is that apart from teaching the patients how to exercise, the curriculum also presented basic knowledge about various exercise issues which helped the patients to take informed decision to adhere to the exercise programmes. A limitation of the study is the fact that the participants went through the programmes unsupervised after they had received the education. It was a home based exercise programme and strict monitoring was not possible except when they came around for check-up. The exercise programme was deliberately made to be home programme in order to erode the feelings that physical exercise could only be done effectively within the confines of the clinic or gymnasium. However, the fact that the participants in the T2DEEC group performed better in respect of the adiposity markers may signal the fact they were able to adhere to the programme. Another limitation is that this curriculum was designed for and tested on patients with T2DM, hence its applicability on patients with other forms of diabetes needs to be verified.

CONCLUSIONS:

In conclusion, the participants in the T2DEEC group were able to achieve the pre-set learning objectives of the curriculum. The curriculum facilitated their increased exercise performance with respect to the type of exercise, accumulated time spent on the exercises and the number of days spent doing the exercises. The improved adherence to the exercise programme by the participants in the T2DEEC group also provided an expanded benefit of improving their adiposity variables. In addition to merely telling patients with T2DM to exercise, the T2DEEC is recommended for use as a hands-on teaching guide in physical exercise education for patients with T2DM.

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Any conflict of interest:
Authors declare no conflict of interests.

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