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ORIGINAL ARTICLE

Predictability of physical activity and bodyweight on health-related quality of life amongst Nigerian type 2 diabetes mellitus

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Abstract Physical inactivity and adiposity had been shown to increase the risk and progression of diabetes mellitus whilst combined effect on health-related quality of life (HRQoL) amongst type 2 diabetes mellitus (T2DM) patients has not been highlighted. This study examined the impact of physical activity (PA) and body weight on HRQoL amongst T2DM. Amongst a cross-section of 119 participants, PA was assessed using the long form of the International Physical Activity Questionnaire and categorized as physically active or inactive. Their body weight and height were assessed whilst their HRQoL was assessed with the Short Form-36 Questionnaire. The *t* test, Pearson's correlation and regression analyses were performed. About 69 % of the participants were physically active whilst 61.8 % were overweight or obese. Role limitation due to physical health (RLDPHP) and role limitation due to emotional problems (RLDEP) were the worst affected domains of HRQoL. The HRQoL decreases in all domains with increasing bodyweight. The HRQoL of physically active participants were better than for physically inactive in all domains of the HRQoL scale. The effects of PA persisted on HRQoL when adjusted for bodyweight. Though HRQoL scores were better amongst physically active participants in all domains of normal weight and overweight/obese group, PA showed significant correlation with HRQoL in all domains except in emotional well-being, RLDEP and pain domains. Regression models showed that PA remains a significant predictor of HRQoL. This study affirms that physically active participants have better HRQoL than inactive patients, regardless of their bodyweight.

Keywords Health-related quality of life · Physical activity · Bodyweight · Type 2 diabetes mellitus · Nigeria

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Introduction

Type 2 diabetes mellitus (T2DM) has become a highly prevalent disease all over the world, and it has been recognized as a worldwide epidemic [1]. The International Diabetes Federation (IDF) estimated that in 2011, 366 million people had diabetes worldwide, a figure expected to reach 552 million by 2030 [2]. Physical inactivity and adiposity had been shown to increase the risk and progression of diabetes mellitus [3–7]. Increasing prevalence of obesity in the general population is reflected in increased population of patients with T2DM [8]. High prevalence (84.5 %) of obesity in hospitalized patients with T2DM has been reported [9]. About 85 % of overweight and obesity had been reported amongst diabetic population [10, 11]. Pronounced changes in the human environment, behaviour and lifestyle with accompanied globalization have been shown to be responsible for escalating rates of both obesity and diabetes, described as diabesity which reduces health-related quality of life (HRQoL) [12–15].

People with T2DM report reduced HRQoL compared with the general population [7]. HRQoL is negatively affected in

patients who are overweight or have diabetes, whilst physical activity (PA) is proven to have positive side effects on perceived HRQoL [8]. Accumulation of multiple healthy lifestyle habits such as not smoking, engaging in adequate leisure time physical activity (LTPA) and consuming five or more servings of fruits and vegetables per day were shown to have significant association with better HRQoL amongst T2DM [16]. Thus, effective control of diabetes, comorbid conditions with prevention of diabetic complications through pharmacologic management and lifestyle modification may improve HRQoL amongst T2DM [16].

Improved HRQoL and good glycaemic control has been recognised as independent and achievable outcomes in diabetes management [17]. HRQoL is an important health outcome not only because it captures a person's perception of overall health status, but also because it can inform decisions on resource allocation [18]. HRQoL has great potential as a clinical marker that could be used to identify individuals with diabetes and at higher risk of adverse outcomes and who therefore require more care [18]. Thus, improving HRQoL is a critical component of clinical management and public health services for people with diabetes. Studies have shown individual and combine effects of PA and bodyweight on HRQoL amongst T2DM [8, 16]. The studies were conducted in Western populations whilst little is reported about the combined effects of PA and bodyweight amongst Nigerian T2DM. This study was therefore undertaken to investigate the combine effect of PA and body weight on HRQoL amongst adult T2DM subjects attending a tertiary health facility in Sagamu, south-west Nigeria.

Patients and methods

This study was a cross-sectional analysis of data from 119 outpatients recruited from Dame Adebutu Diabetes Care Centre of Olabisi Onabanjo University Teaching Hospital (OOUTH), Sagamu, Nigeria. Only participants diagnosed as T2DM using the IDF criteria [2], are above 20 years of age, clinically stable and who give informed consent participated in the study. Excluded from the study were the acutely ill, the aged and those with obvious visual impairment and foot or leg amputation. In addition to personal data, weight, height, body mass index (BMI), HRQoL and PA level were assessed. The study was approved by the Ethics Committee of the OOUTH, Sagamu, Nigeria.

Measurements and outcomes

Physical activity

The International Physical Activity Questionnaire (IPAQ) long form was used to assess PA of the participants in walking, moderate-intensity and vigorous-intensity activity within each of the work, transportation, domestic chores, gardening (yard) and leisure-time domains [19]. The IPAQ was self administered by those who are literate and administered by the investigators by interview for those who are not literate in either of English or Yoruba languages. PA levels were initially classified as low, moderate or high intensity, defined by the IPAQ core group [19]. The three groups were thereafter categorized as physically active or inactive. The physically active group included participants in the moderate- or high-intensity categories who met the WHO PA recommendation.

Health-related quality of life

HRQoL was assessed by Short Form-36 (SF-36) Health Survey Questionnaire. The scale has repeatedly shown high reliability and validity in multiple studies in many languages [8, 18]. The 36 items cover a range of categories, including physical functioning (PF); role limitations due to physical health problems (RLDPHP); bodily pain (pain); general health; energy/fatigue; social functioning, role limitations due to emotional problems (RLDEP) and emotional well-being [7]. Each category is scored separately from 0 to 100. High scores indicate better self-reported HRQoL. Two summary scores exist, the physical composite summary (PCS) and mental composite summary (MCS).

Weight and height

The participants' body weight and height were measured with weighing scale and height metre, respectively. The BMI was subsequently calculated using the formula weight (kg)/height $(m)^2$. Normal weight was defined as BMI=18.5–24.9 kg/m^2, overweight as BMI=25–29.9 kg/m^2 and obesity as BMI≥ 30.0 kg/m^2 according to the WHO BMI cut-off values for adult [20].

Data analysis

Statistical analyses were performed using Statistical Package for Social Sciences (SPSS) for Windows version 16.0 (SPSS, Chicago, IL). The physical characteristics of the participants, PA levels and HRQoL scores were analyzed using descriptive statistics (means±SD, frequency and percentages). The physical characteristics and PA level of the participants were compared between sexes using a *t* test and chi-square as appropriate. Comparison of HRQoL between overweight and obese, active and inactive participants and between HRQoL adjusted for bodyweight of active and inactive were assessed using *t* test. Pearson's correlation test was used to explore bivariate relationships between HRQoL and BMI, age and PA level. Multiple linear regression analyses were conducted by block to ascertain the determinants of HRQoL amongst T2DM. The

subscales of PF, RLDPHP, RLDEP, general health, emotional well-being, PCS and MCS of HRQoL were chosen as outcome variables. Predictor variables used for the models included age, sex, PA and BMI. The demographic variables were entered in the first block, PA was entered in the second block and BMI was entered in the third block. Alpha level was set at 0.05.

Results

Table 1 presents physical characteristics of the participants. The mean age of the participants was 61.8±11.8 (years) with 60.5 % being female. Males are taller whilst females are more overweight. There were no sex differences found in age, weight, PA (Met min/week) and HRQoL of the participants. About 69 % of the participants were physically active with 61.8 % being overweight or obese (Table 1).

The RLDPHP and RLDEP were the worst affected domains of HRQoL (Table 2). The HRQoL decreases in all domains with increasing bodyweight though only significant for pain domain. The HRQoL of physically active participants were significantly higher (better) than in the physically inactive in both PCS, MCS and all domains of the HRQoL scale with the exception of pain domain (Table 2). When adjusted for bodyweight, the effects of PA persisted on HRQoL (Table 3). The HRQoL scores were higher (better) amongst physically active participants in all domains and both PCS and MCS in normal weight and overweight/obese group. There was significant differences in PF (P=0.01), energy/fatigue (P=0.04), emotional well-being (P=0.01), social functioning (P=0.01), general health (P=0.01), PCS (P=0.01) and MCS (P=0.01) sub-scales amongst normal weight physically active and inactive participants. Amongst physical active and inactive overweight/obese group, significant differences were found in the RLDPHP (P=0.05), RLDEP (P=0.02), energy/fatigue (P=0.05), general health (P=0.01), PCS (P=0.01) and MCS (P=0.02) of HRQoL.

PA (Met minute/week) showed significant correlation with HRQoL in all domains and both PCS and MCS with the exception of RLDEP, emotional well-being and pain domains (Table 4). Age and BMI does not show any significant correlation. Regression models (Tables 5 and 6), including all predicting factors (age, sex, PA and BMI), were significantly predictive of PF (R^2=0.21, P<0.001), RLDPHP (R^2=0.14, P<0.01), general health (R^2=0.13, P<0.01), RLDEP (R^2=0.11, P<0.02), emotional well-being (R^2=0.09, P<0.04), PCS (R^2=0.16, P<0.001) and MCS (R^2=0.13, P<0.01).

Discussion

This study assessed the combined effects of PA and bodyweight on HRQoL amongst Nigerian T2DM which is probably the first in Nigeria. About 62 % of participants are overweight or obese, a reflection of obesity as a comorbidity of T2DM. Similar prevalence rate was reported by previous study from Nigeria [21]. Earlier studies have also identified obesity as a risk factor for development and progression of diabetes mellitus [3, 6]. The prevalence of overweight and obesity in this study at 62 % is lower than in previous studies with prevalence rates of between 79 and 85 % [9, 11]. This is probably so, as prevalence of overweight and obesity in Nigerians' general population is lower than in the Western world [22].

The most affected HRQoL domains are RLDPHP and RLDEP. Though, the focus of this study was not on comorbidity of diabetes, substantial numbers of participants have

Table 1 Physical characteristics of the participants

	Male	Female	P	Both sexes
Age (year)	62.6±13.5	61.3±10.7	0.57*	61.8±11.8
Weight (kg)	76.7±13.6	73.9±18.9	0.38*	75.0±17.0
Height (m)	1.7±0.1	1.6±0.1	0.00*	1.6±0.1
BMI (Kg/m^2)	26.1±4.3	29.6±7.1	0.01*	28.2±6.4
PA (Met. min/week)	$3.1\times10^3\pm4.9\times10^3$	$2.6\times10^3\pm5.2\times10^3$	0.51*	$2.8\times10^3\pm5.1\times10^3$
PA [n (%)]				
Active	33 (70.2)	49 (68.1)	0.80**	82 (68.9)
Inactive	14 (29.8)	23 (31.9)		37 (31.1)
BMI group [n (%)]				
Normal weight	22 (50.0)	20 (30.3)	0.10**	42 (38.2)
Overweight	11 (25)	20 (30.3)		31 (28.2)
Obese	11 (25)	26 (39.4)		37 (33.6)

PA physical activity, *BMI* body mass index

*t test, **chi-square test

Table 2 Health-related quality of life amongst type 2 diabetes mellitus by physical activity and body weight

	Physical activity			BMI group			All
	Active	Inactive	*P*	Overweight	Obese	*P*	
Physical functioning	70.3±25.5	42.3±32.0	0.00	66.0±24.7	61.5±33.1	0.53	61.5±30.5
Role limitation due to physical health	51.3±44.3	26.4±37.7	0.01	49.4±42.7	46.6±43.8	0.79	43.5±43.8
Role limitation due to emotional problem	61.3±45.5	34.2±45.5	0.01	58.9±44.4	54.1±48.7	0.68	52.8±47.0
Energy/fatigue	61.9±19.3	50.1±19.4	0.01	64.0±18.1	57.6±21.8	0.20	58.2±20.0
Emotional well-being	82.6±13.2	75.9±19.8	0.03	82.5±15.0	83.1±14.4	0.88	80.5±16.0
Social functioning	79.9±23.4	58.8±40.8	0.00	77.8±26.0	76.7±29.2	0.87	73.3±31.3
Pain	73.2±26.5	64.5±33.4	0.13	82.9±22.5	65.1±27.7	0.01	70.5±29.0
General health	66.7±20.1	50.1±20.2	0.00	64.2±18.2	57.1±23.6	0.18	61.6±21.5
Physical composite summary	65.4±21.1	45.8±24.5	0.00	65.4±20.5	57.8±24.8	0.18	59.3±23.9
Mental composite summary	71.6±19.3	54.8±23.3	0.00	71.0±18.4	68.2±22.4	0.57	66.4±22.0

BMI body mass index

one or more comorbid factors. This might explain reasons for worst affectation of these domains of HRQoL. An earlier study had reported significantly lower HRQoL score amongst respondents with complications compared to respondents with no complication [15]. Physical functioning, RLDPHP and RLDEP were more significantly affected, and the differences were statistically significant [15]. There were no significant sex differences in HRQoL which was not consistent with a previous study that reported sex difference, with males demonstrating higher values [15]. Though male participants in this study showed higher HRQoL values than females, this was not statistically significant.

An important finding of this study is that PA correlates and predicts HRQoL. The positive impact of increased PA on PCS and MCS of HRQoL in T2DM, which was concentrated in scales measuring PF, RLDPHP, general health and RLDEP, is in agreement with previous studies which reported that PA attenuates HRQoL [7, 8]. It is important to note that HRQoL decreases with decreasing PA in all dimensions of the HRQoL. This corroborates the importance of regular PA in diabetics, not only to improve their HRQoL but also to reduce morbidity and mortality. Increased LTPA associated with reduced mortality in individuals with diabetes via several mechanisms had been previously reported as had engagement in regular PA improves insulin sensitivity, glycaemic control, cardio-respiratory fitness and physical function, as well as having favourable effects on hypertension and serum lipid profile [18]. Furthermore, several factors such as an older age, long duration of diabetes, hyperglycaemia, cardiovascular disease and diabetes complications may contribute to reduced scores on the domains of HRQoL, whilst benefits of becoming

Table 3 Health-related quality of life amongst type 2 diabetes mellitus by physical activity adjusted for body weight

	Normal weight			Overweight/obese		
	Active	Inactive	*P*	Active	Inactive	*P*
Physical functioning	76.8±18.9	32.3±31.6	0.01	67.7±27.6	52.3±31.9	0.06
Role limitation due to physical health	44.0±46.4	25.0±39.5	0.18	54.3±43.3	30.6±37.9	0.05
Role limitation due to emotional problem	57.3±47.6	37.5±48.4	0.19	63.9±45.0	35.2±45.0	0.02
Energy/fatigue	61.2±17.5	48.5±20.9	0.04	63.5±20.2	52.6±18.7	0.05
Emotional well-being	83.1±13.1	68.9±20.7	0.01	83.4±13.1	81.3±18.3	0.60
Social functioning	82.0±24.0	47.8±43.6	0.01	79.8±23.7	70.1±36.2	0.21
Pain	71.2±30.0	59.1±34.8	0.24	75.8±24.4	65.7±32.2	0.18
General health	70.1±18.1	51.2±22.3	0.01	64.6±20.6	48.5±19.6	0.01
Physical composite summary	65.5±20.4	41.9±26.4	0.01	65.6±21.3	49.3±24.2	0.01
Mental composite summary	70.9±18.6	50.6±26.2	0.01	72.9±19.5	59.8±20.8	0.02

BMI body mass index

Table 4 correlation matrixes between health-related quality of life domains, age, body mass index and physical activity (Met. min/week)

	BMI	PA	Age
Physical functioning	0.04	0.43[a]	−0.07
Role limitation due to physical health	0.05	0.31[a]	−0.02
Role limitation due to emotional problem	0.06	0.23	0.10
Energy/fatigue	0.04	0.24[a]	−0.01
Emotional well-being	0.17	0.08	0.16
Social functioning	0.10	0.19[b]	-0.03
Pain	0.01	0.04	0.11
General health	−0.16	0.29[a]	0.04
Physical composite summary	0.01	0.35[a]	0.01
Mental composite summary	0.11	0.25[a]	0.08

[a] Correlation is significant at the 0.01 level (2-tailed)

[b] Correlation is significant at the 0.05 level (2-tailed)

physically active may translate into protective effects against their impacts on mortality [18].

Higher levels of PA, more than lower BMI, attenuated much of the association of HRQoL with T2DM in most of HRQoL domains. When adjusted for bodyweight, physically active participants showed better HRQoL than physically inactive in all categories of bodyweight suggesting that PA programmes should be incorporated into standard medical care for obese patients as well as for diabetics [8]. In the emotional well-being domain, only bodyweight predicted the HRQoL. A possible explanation is that higher BMI may be accompanied by depressive symptoms, which effect is low cardiovascular capacity [8]. This underscores the important influence of diabetes with appearance of anxiety and depression [8].

Limitations of our study include the use of self reported measure to assess PA and HRQoL which engenders information bias as in the self measure. However, the SF-36 and IPAQ measures have been validated in diverse populations with excellent retest reliability [8, 18, 23]. The use of SF-36, a general and not diabetes-specific measure of HRQoL, may have been less responsive to diabetes-specific symptoms and aspects of life [24]. However, previous studies on HRQoL in people with T2DM have used SF-36 and found it suitable to measure HRQoL [7, 8, 25].

The public health and clinical implications of this study is that being physically active associated with patients' HRQoL than BMI [16]. Our study results suggest that higher levels of

Table 5 Physical activity and bodyweight predicting physical functioning, role limitation due to physical health and role limitation due emotional problem of HRQoL (multiple regressions of significant predictors, in blocks)

Variable	Model 1			Model 2			Model 3		
	B	SEB	*t*	*B*	SEB	*t*	*B*	SEB	*t*
Physical functioning									
Age	−0.21	0.24	−0.88	−0.10	0.22	−0.45	0.03	0.24	0.11
Sex	−8.07	5.75	−1.40	−6.26	5.26	−1.19	−9.33	5.70	−1.84
PA				0.002	0.001	4.91***	0.002	0.001	4.86***
BMI							0.67	0.44	1.52
R^2	0.022			0.19			0.21		
F	1.30			9.08***			6.81***		
Role limitation due to physical health									
Age	−0.10	0.34	−0.29	0.01	0.33	0.04	0.32	0.35	0.91
Sex	−11.28	8.25	−1.36	−9.50	7.91	−1.20	−14.67	8.39	−1.75
PA				0.003	0.001	3.42***	0.003	0.001	3.49***
BMI							0.97	0.65	1.49
R^2	0.02			0.11			0.14		
F	0.95			4.59**			4.11**		
Role limitation due to emotional problem									
Age	0.37	0.37	1.01	0.46	0.36	1.28	0.88	0.39	2.28
Sex	−5.96	8.87	0.67	−4.57	8.70	0.53	−9.08	9.22	0.98
PA				0.002	0.001	2.49**	0.002	0.001	2.51**
BMI							0.93	0.71	1.30
R^2	0.01			0.06			0.11		
F	0.78			2.62*			3.10*		

***$P<0.001$; **$P<0.01$; *$P<0.05$ (two-tailed)

Table 6 Physical activity and bodyweight predicting emotional well-being, general health, physical and mental composite summary of HRQoL (multiple regressions of significant predictors, in blocks)

Variable	Model 1			Model 2			Model 3		
	B	SEB	*t*	*B*	SEB	*t*	*B*	SEB	*t*
Emotional well-being									
Age	0.22	0.12	1.76	0.23	0.12	1.85	0.26	0.132	1.95
Sex	−2.32	2.94	−0.79	−2.13	2.95	−0.72	−4.09	3.15	−1.30
PA				0.00	0.00	0.97	0.00	0.00	1.25
BMI							0.58	0.25	2.36*
R^2	0.03			0.04			0.09		
F	1.93			1.60			2.60*		
General health									
Age	0.06	0.17	0.38	0.12	0.16	0.72	0.25	0.17	1.44
Sex	−4.24	4.05	−1.05	3.39	3.38	−0.87	−4.05	4.14	−0.98
PA				0.001	0.00	3.30***	0.001	0.00	3.14**
BMI							0.30	0.32	0.92
R^2	0.01			0.10			0.13		
F	0.64			4.08**			3.85**		
Physical composite summary									
Age	0.00	0.19	−0.002	0.07	0.18	0.41	0.18	0.19	0.95
Sex	−5.79	4.49	−1.27	−4.66	4.23	−1.10	−6.79	4.56	−1.49
PA				0.002	0.00	4.04***	0.002	0.00	4.06***
BMI							0.36	0.35	1.01
R^2	0.01			0.14			0.16		
F	0.83			6.05***			4.88***		
Mental composite summary									
Age	0.14	0.17	0.80	0.19	0.17	1.11	0.33	0.18	1.88
Sex	−3.31	4.14	−0.80	−2.55	4.03	−0.63	−5.59	4.25	−1.32
PA				0.001	0.00	2.87**	0.001	0.00	3.00**
BMI							0.65	0.33	1.97
R^2	0.01			0.08			0.13		
F	0.67			3.21*			3.79**		

***$P<0.001$; **$P<0.01$; *$P<0.5$ (two-tailed)

PA might also enhance HRQoL. This is especially important as a previous study has shown that both lower HRQoL scores and LTPA predict increased mortality in individuals with diabetes over 7 years of follow up [18]. Health-care providers may thus be motivated to assess HRQoL more frequently. In addition, patients with T2DM need be counselled that incorporating PA into their daily routine improves fitness, allows them to do more, feel better, as well as reduce their risk of cardiovascular disease and diabetes-related complications [7].

In conclusion, our study affirms that physically active T2DM have better HRQoL than inactive patients regardless of their BMI group. PA remains a significant predictor of HRQoL. Therefore, encouraging people with T2DM to engage in regular PA may improve their HRQoL. Future study should explore objective assessment of PA in T2DM to see if the effect will be more pronounced.

Contribution details Oyewole OO was involved in concepts, design, data acquisition, data analysis, statistical analysis and manuscript preparation. Odusan O participated in concepts, design, manuscript editing and manuscript review. Oritogun KS participated in data analysis, statistical analysis and manuscript review. Idowu AO helped in data acquisition and manuscript review. All authors approved the final copy.

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