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Relation of unsupported and unsupervised exercise with anthropometric and biochemical indices among type 2 diabetic patients

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Background/aim: Type 2 diabetes is a lifestyle-related condition. Lifestyle modification in the management of type 2 diabetes incorporates exercise. The aim of this study was to find out how unsupported and unsupervised exercise relates to anthropometric indices and biochemical indices in type 2 diabetes patients.

Materials and methods: In the cross-sectional study, a structured questionnaire was used to access data on the exercise history of patients. Subjects were classified according to exercise intensity. The dietary intake of patients was obtained by 24-h recall. Standard measurements were taken of waist circumference and blood pressure. Blood samples were also collected to measure biochemical parameters.

Results: Waist circumference, body mass index, and triglycerides were significantly lower ($P < 0.05$) in type 2 diabetics who engaged in high-intensity exercise than in those who engaged in low-intensity exercise. Systolic blood pressure was significantly lower ($P < 0.05$) in the moderate-intensity exercise group than in the low-intensity exercise group.
Conclusion: Unsupported exercise was found to be related to favorable anthropometric indices (waist circumference and body mass index), blood pressure, and triglycerides.

Key words: Diabetes, exercise, metabolic risk

1. Introduction

Several studies have reported the effect of exercise training in type 2 diabetes. Different exercise treatment types have been shown to improve serum lipid profile, blood glucose, and some anthropometric indices of type 2 diabetes patients. Aerobic exercise training decreased LDL-cholesterol, triglyceride, and total cholesterol and increased HDL-cholesterol from baseline (1). Resistance training, aerobic training, and even light exercise were all effective in reducing blood pressure and fasting blood glucose (FBG) and improving lipid levels (2). Similarly, a regular aerobic exercise training program resulted in an improvement in lipid profile and blood pressure (3).

The goals of management for diabetics are to achieve and maintain favorable blood glucose levels, lipid profiles, and a healthy body weight in order to prevent chronic diabetic complications. Studies that have reported the effects of exercise in the amelioration of cardiovascular risk profile among type 2 diabetes patients were interventional. There is a need to find out how patients exercise on their own (without the support or supervision of an exercise therapist). The hypothesis for this study was that type 2 diabetes patients who are involved in at least an unsupported exercise regularly will have good anthropometric and biochemical indices.

The aim of this study was therefore to find out how unsupported and unsupervised exercise relates to anthropometric indices and biochemical indices in type 2 diabetes patients. The study also sought to find out the relation between patients' nutritional intake and their exercise patterns.

2. Materials and methods

2.1. Study design

The study protocol was forwarded to the Committee on Human Research, Publications, and Ethics of the School of Medical Sciences, Kwame Nkrumah University of Science and Technology, and Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana, who gave approval for the study. Informed written consent was obtained from all participants in the study. Type 2 diabetes patients who visit the Diabetes Centre of KATH were approached, and the reason for the study was explained to them for their informed consent. Those who consented to the study

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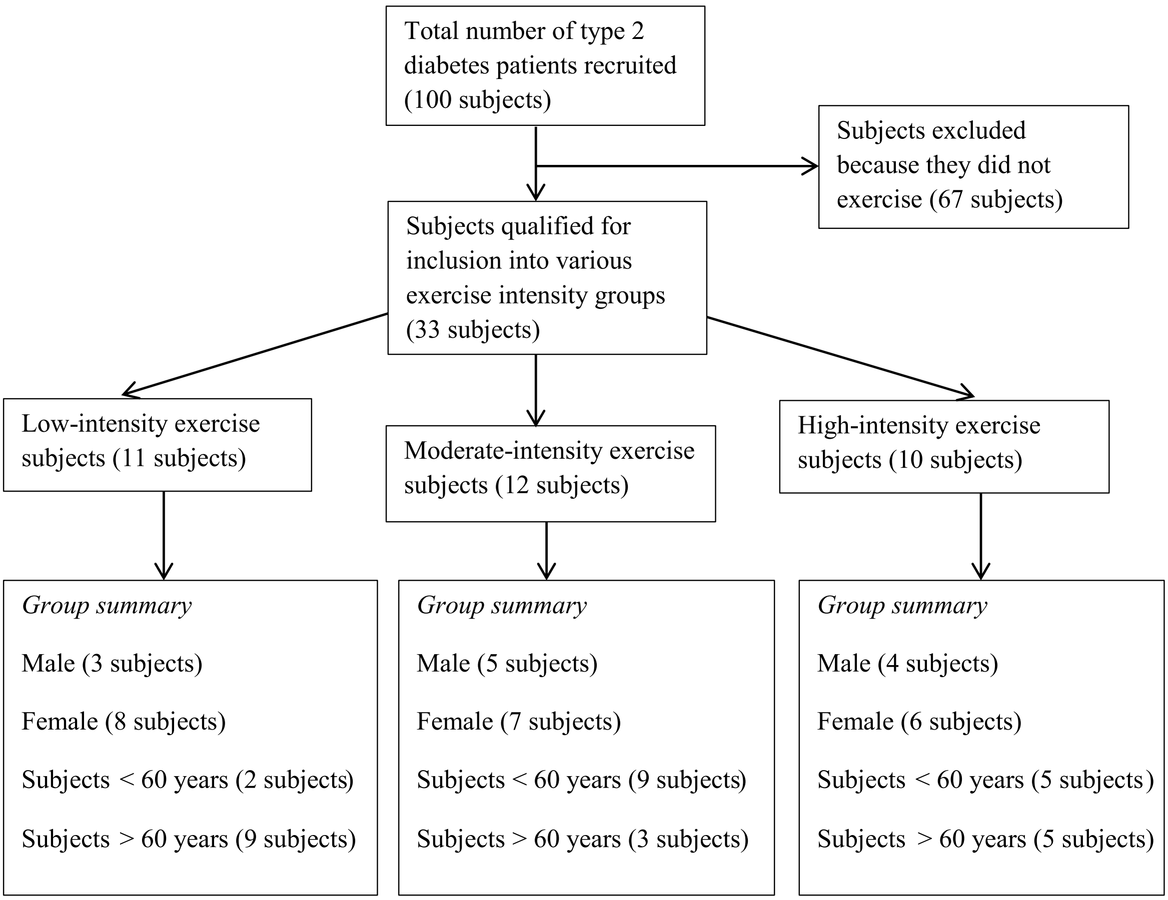
were recruited as participants in the study. Only type 2 diabetes patients who had been previously diagnosed by a medical doctor and were above 35 years of age qualified to be included in the cross-sectional study. Type 1 diabetes patients and gestational diabetics did not qualify for inclusion. The Figure is a summary of the recruitment process.

2.2. Data collection

Subjects were asked whether they exercised or not. Those who answered 'Yes' were asked the type of exercise they normally engaged in, how long each exercise session lasted, and how many times a week they exercised. The exercises included brisk walking, jogging, dancing, and skipping. The American Diabetes Association recommends that diabetics perform at least 150 min/week of moderate-intensity aerobic physical activity (4). Based on this recommendation, subjects were divided into three groups: the low-intensity exercise group (those who exercised for less than 150 min/week), moderate-intensity exercise group (those who exercised for 150 min/week), and high-intensity exercise group (those who exercised for more than 150 min/week). Low-intensity exercise was defined as <30-min exercise sessions for ≤5 days per week; moderate-intensity exercise was defined as ≥30-min exercise sessions for ≤5 days per week; high-intensity exercise was defined as >30-min exercise sessions for ≥5 days per week. Thus, subjects must have been exercising more than 30 min for less than 5 days or 30 min for 5 days every week to be included in the moderate-intensity exercise group. The product of their exercise sessions and the number of days should amount to 150. To be included in the high-intensity exercise group, subjects must have been exercising more than 30 min for at least 5 days per week. The product of their exercise sessions and the number of days must be greater than 150. In addition to the exercise data, other lifestyle factors were assessed using the structured questionnaire. They included tobacco smoking, alcohol consumption, meal frequency, and dietary data. The dietary intake of the



A total of 100 subjects who were 35 years or older were recruited. Some subjects did not exercise (67 subjects) and were excluded from the study. The remaining 33 subjects were then divided into three groups based on exercise intensities: low-intensity, moderate-intensity, and high-intensity as defined by this study.

Figure. Study design.

subjects was estimated using 24-h recall through a dietary history interview. Two weekdays and one weekend day, 24-h recall of all meals, snacks, time of intake, portion sizes, and preparation methods was taken. The portion sizes were demonstrated by graduated food models. The average intakes were calculated and this represented the daily dietary nutrient intakes of the subjects (5).

2.3. Anthropometric, blood pressure, and biochemical measurements

Anthropometric (weight, height, and waist circumference) data, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured. An electronic scale and stadiometer (Seca Ltd., Germany) were used to take weight and height measurements. The body mass index (BMI) of each participant was calculated as weight in kilograms divided by height in meters squared. The waist circumference was measured, in centimeters, using a tape measure. Blood pressures (SBP and DBP) were measured by standard methods using a mercury sphygmomanometer and a stethoscope with the patient in a sitting position. Blood samples (4 mL) were collected by a phlebotomist. Reagents used were from Fortress Diagnostics (UK). Biochemical parameters (FBG, total cholesterol, HDL-cholesterol, triglyceride, and uric acid) of blood samples were measured with a semiautomated spectrophotometer (Kenza BioChemisTry, BIOLABO Diagnostics, France). LDL-cholesterol concentration was calculated by Friedewald's formula (6).

2.4. Statistical analysis

Data were analyzed using SPSS 20.0 (IBM Corp., USA). Means and standard deviations for continuous variables were computed and compared by one-way ANOVA. Frequency counts and percentages for categorical variables were done with Student's t-test. $P < 0.05$ was considered significant for comparisons between groups. Pearson's correlation was used to find the association between the indices measured.

3. Results

More than half (about 64%) of the subjects who qualified for inclusion in the study were females (Figure). Sixteen subjects (48.5%) were below the age of 60 years and 17 subjects (51.5%) were above 60 years of age. None of the subjects was a smoker at the time of the study, but 12% had previously smoked. Eighteen percent of the subjects consumed alcohol occasionally and were all moderate drinkers. Twenty-seven percent of the subjects skipped one of three major meals (breakfast, lunch, or supper) at least once a week. None of the subjects within the high-intensity exercise group consumed alcohol or skipped any meals. Brisk walking dominated in the exercises (75.8% of the subjects). Jogging, dancing, and skipping were done by 15.2%, 6.1%, and 3.0% of the subjects, respectively. As shown in Table 1, the mean values of BMI, waist circumference, SBP, and triglyceride were significantly different between two groups of exercise intensities. Mean BMI, waist circumference, and triglyceride were significantly higher ($P < 0.05$) in the low-intensity exercise group than in the high-intensity exercise group and decreased with increasing exercise intensity. The moderate-intensity exercise group had high means for daily energy, protein, carbohydrate, and iron intakes (Table 2). The values were significantly different from those of the low-intensity exercise group. Table 3 shows the Pearson correlations between various anthropometric and biochemical indices.

4. Discussion

BMI was associated with waist circumference (Table 3). Similarly, waist circumference has been related with BMI among patients with metabolic syndrome (7). Patients who were generally obese were also likely to be centrally obese. High FBG was related to high triglyceride levels among patients. FBG and triglycerides have been associated among diabetes subjects (8) and even normal subjects (9). Total cholesterol was positively correlated with triglycerides, HDL-cholesterol, and LDL-cholesterol. Thus, patients with higher total cholesterol were hyperlipidemic. Exercise is an important nonpharmacological therapy in the management of type 2 diabetes (4). It has been shown to have a significant effect on anthropometric and biochemical indicators (10). Aerobic exercise and resistance training were demonstrated to improve lipid profiles and other metabolic risk indices among type 2 diabetes patients in earlier studies. However, many of these studies were trials (interventional) that involved supported or supervised exercises. The present study sought to find the relation of unsupported and unsupervised exercise with anthropometric and biochemical parameters, and how this influences nutritional intake. There is a paucity of data on such cross-sectional study.

Waist circumference, BMI, and triglyceride decreased with increasing exercise intensity. These indices were significantly higher ($P < 0.05$) in subjects who engaged in low-intensity exercise than those who engaged in high-intensity exercise (Table 1). The difference was not, however, significant between low-intensity exercise and moderate-intensity exercise. Thus, increasing the exercise duration while maintaining the number of days did not influence anthropometric and biochemical indices in type 2 diabetes patients. Even 2 days per week of supervised moderate-intensity exercise did not decrease the BMI, waist circumference, blood pressure, triglyceride, and LDL-cholesterol concentrations in type 2 diabetes patients (11). However, moderate exercise was associated with reduced SBP, DBP, waist circumference, total cholesterol,

Table 1. Mean anthropometric indices, blood pressure, lipid profile, and uric acid by exercise intensity.

Parameter	Low	Moderate	High	Total
n	11	12	10	33
BMI (kg/m²)	29.40 ± 5.35†	26.67 ± 3.92	24.08 ± 5.79‡	26.79 ± 5.32
WC (cm)	102.3 ± 12.2†	91.8 ± 17.1	88.3 ± 12.9‡	94.2 ± 15.1
FBG (mmol/L)	8.3 ± 4.1	10.1 ± 4.8	13.2 ± 6.0	10.7 ± 5.3
SBP (mmHg)	141.4 ± 12.3†	125.0 ± 16.7‡	139.0 ± 15.9	134.7 ± 16.5
DBP (mmHg)	86.4 ± 9.2	76.6 ± 14.3	77.0 ± 9.4	80.0 ± 11.9
TC (mmol/L)	5.0 ± 1.2	5.4 ± 1.2	5.3 ± 1.2	5.3 ± 1.2
TG (mmol/L)	2.1 ± 1.2†	1.8 ± 0.8	1.2 ± 0.3‡	1.7 ± 0.9
HDL-C (mmol/L)	1.5 ± 0.5	1.5 ± 0.2	1.5 ± 0.4	1.5 ± 0.4
LDL-C (mmol/L)	2.5 ± 0.9	3.0 ± 0.9	3.3 ± 1.1	3.0 ± 1.0
TC:HDL-C	3.4 ± 0.7	3.5 ± 0.5	3.6 ± 0.8	3.4 ± 0.7
Uric acid (μmol/L)	418.9 ± 239.5	427.4 ± 144.9	323.2 ± 113.4	395.6 ± 173.1

Values are recorded as mean ± standard deviation; n is the number of subjects in a particular category. Different superscripts († and ‡) between exercise intensities indicate that the exercise intensities were significantly different ($P < 0.05$). Body mass index: BMI, waist circumference: WC, fasting blood glucose: FBG, systolic blood pressure: SBP, diastolic blood pressure: DBP, total cholesterol: TC, triglyceride: TG, high-density lipoprotein cholesterol: HDL-C, low-density lipoprotein cholesterol: LDL-C.

Table 2. Mean daily energy and nutritional intake by exercise intensity.

Parameters	Low	Moderate	High	Total
n	11	12	10	33
Energy (kcal)	1480.0 ± 243.9†	1901.9 ± 386.8‡	1806 ± 670.4	1732.2 ± 480.4
Protein (g)	40.8 ± 5.6†	51.4 ± 13.9‡	45.6 ± 13.8	46.1 ± 12.3
Fat (g)	32.7 ± 7.9	47.9 ± 22.7	55.2 ± 46.5	45.0 ± 29.9
Carbohydrate(g)	259.8 ± 53.7†	326.4 ± 61.7‡	295.6 ± 83.5	294.9 ± 70.5
Calcium (mg)	248.3 ± 58.0	273.9 ± 85.4	239.5 ± 76.3	254.9 ± 73.6
Iron (mg)	8.6 ± 1.5†	11.9 ± 2.8‡	9.9 ± 2.3	10.2 ± 2.6
Vitamin A (μg)	241.0 ± 85.0	296.7 ± 185.7	266.5 ± 174.6	268.9 ± 152.5
Vitamin C (mg)	126.9 ± 36.7	145.0 ± 52.1	136.1 ± 76.6	136.3 ± 55.3
Vitamin E (mg)	5.6 ± 2.0	7.5 ± 3.7	6.5 ± 3.2	6.6 ± 3.1
Fiber (g)	22.6 ± 5.3	28.0 ± 6.5	24.8 ± 9.3	25.2 ± 7.3

Values are recorded as mean ± standard deviation; n is the number of subjects in a particular category. Different superscripts († and ‡) between exercise intensities indicate that the exercise intensities were significantly different ($P < 0.05$).

and uric acid and increased HDL-cholesterol among type 2 diabetes patients (1). In a study by Racil et al. conducted in obese young females, high-intensity training reduced waist circumference, triglycerides, and total cholesterol (12). The results of this cross-sectional study revealed that patients who exercised daily for more than 30 min (defined in the study as high-intensity) had good metabolic profiles (Table 1). Moderate-intensity exercise could also be good for the prevention of hypertension, as mean SBP was significantly lower among the moderate-exercise group compared to the low-intensity exercise group (Table 1). This contrasts with the finding of a study in which moderate-intensity exercise did not have any significant improvement on blood pressure (13). In a study by

Table 3. Correlations between indices.

Indices	BMI	SBP	DBP	FBG	TC	TG	HDL-C	LDL-C	Uric acid
WC	0.714**	0.201	–0.069	–0.073	–0.089	0.159	0.173	–0.237	0.309
BMI		0.202	0.160	–0.208	–0.089	–0.029	0.172	–0.257	0.257
SBP			0.261	–0.002	–0.237	–0.175	0.022	–0.220	0.313
DBP				–0.165	–0.224	–0.110	–0.258	0.132	0.039
FBG					0.254	0.380*	–0.121	0.193	0.048
TC						0.470**	0.369*	0.874**	–0.259
TG							0.123	0.105	0.253
HDL-C								0.028	0.058
LDL-C									–0.383

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed). Body mass index: BMI, waist circumference: WC, fasting blood glucose: FBG, systolic blood pressure: SBP, diastolic blood pressure: DBP, total cholesterol: TC, triglyceride: TG, high-density lipoprotein cholesterol: HDL-C, low-density lipoprotein cholesterol: LDL-C.

Bagheri et al., type 2 diabetes patients who were enrolled in 8 weeks of aerobic exercise had significant reduction in SBP (14). None of the exercise intensities influenced total cholesterol, HDL-cholesterol, LDL-cholesterol, (13), or uric acid significantly (Table 1). These findings also support the results of a study in Botswana, in which exercise did not significantly ameliorate the lipid profile of diabetes patients (15). However, moderate-intensity exercise reduced uric acid after 8 weeks of intervention (13). In another study, physical activity counseling was effective in promoting physical activity in type 2 diabetes patients, and the status of cardiovascular risk factors was improved in these patients (16). Lazarevic et al. also found that regular aerobic exercise, performed under supervision, had beneficial effects in improving overall cardiovascular risk profiles in previously sedentary and obese type 2 diabetic patients (17). In the present study, the patients were not involved in any programmed or supervised physical activity but the effect of their exercise was found on the anthropometric indices, blood pressure, and triglycerides. The effect of the exercises was not, however, seen on other measured lipid profiles and uric acid. Type 2 diabetes patients who exercised moderately had the highest intakes of daily energy, carbohydrates, protein, and iron (Table 2). Interestingly, the low-intensity exercise group had the lowest intakes of energy and these nutrients (Table 2). The low intensity of their exercise might have accounted for these low intakes. Conversely, their low daily intakes could have accounted for the low intensity of exercise; subjects might not have been physiologically motivated to exercise. High physical activity increases energy requirements. However, the high-intensity exercise group had daily energy and nutrient intakes lower (nonsignificantly) than those of the moderate-intensity exercise group. Subjects in the high-intensity exercise group did not drink alcohol or skip meals. These points suggest a health-conscious lifestyle among the high-intensity exercise group subjects. Even where pharmacological therapy is needed, patients should be advised on lifestyle changes that ameliorate the metabolic profile (4). In a study by Kirk et al., patients who were counseled for 6 to 12 months on physical activity had improvement in metabolic risk factors (16). The patients increased their physical activity level from baseline. When exercise and other lifestyle therapies are discussed and planned with patients, adherence becomes easier. Health care professionals should counsel type 2 diabetes patients on the need to include exercise in their daily schedules.

The study, however, has some limitations. One such limitation is that it was dependent on respondents' memory. The study did not also consider sex and age differences, or how long the subjects had been exercising since the diagnosis of type 2 diabetes. Measurements of anthropometric and biochemical parameters were not considered before and after exercise. Thus, the differences among the exercise groups might not be the outcome of only exercise.

In conclusion, waist circumference, BMI, and triglycerides were significantly lower ($P < 0.05$) in type 2 diabetics who engaged in high-intensity exercise than in those who engaged in low-intensity exercise. The low-intensity exercise group had higher SBP than the moderate-intensity exercise group. Public health education aimed at prevention and management of type 2 diabetes should put emphasis on the need to exercise at least 30 min daily.

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