A 10-week Aerobic Exercise Program Reduces Cardiometabolic Disease Risk in Overweight/Obese Female African University Students

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Objectives: The prevalence of obesity and associated cardiometabolic disease (CMD) is increasing among Black African women and requires urgent attention in the form of preventive strategies. To date, there is limited scientific evidence highlighting the efficacy of Tae-bo as an intervention for reducing weight and CMD risk factors.

Design: Prospective experimental.

Setting: South Africa, University of Zululand.

Participants: Sixty previously sedentary participants (25 ± 5 y) who were overweight (BMI>25–29.9 kg/m^2) or obese (BMI≥30–39.9 kg/m^2).

Intervention: Participants performed a 10-week aerobic (Tae-bo) program 60 min/day for three days a week at moderate intensity for the first five weeks and high intensity for the last five weeks.

Main Outcome Measures: Anthropometric parameters (height, weight, waist and hip circumference and sum of skinfolds), blood pressure, fasting glucose, and lipoproteins were measured at baseline, after six weeks and 24 hours after completion of the 10-week program. Data was analyzed using repeated measures ANOVA and a Tukey Post hoc test.

Results: The prevalence of metabolic syndrome was 26.7% pre-intervention and decreased to 16.3% post intervention. There was a statistically significant (P≤.05) improvement in weight, BMI, waist and hip circumference, glucose, triglycerides, total cholesterol, LDL-C, HDL-C, resting heart rate and resting systolic and diastolic blood pressures following the intervention.

Conclusion: A 10-week 30-session Tae-bo exercise program was effective in reducing traditional risk factors associated with cardiometabolic disease in overweight/obese university students. (*Ethn Dis*. 2013;23[2]:143–148)

Key Words: Aerobic, Cardiometabolic Disease, Obesity

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Introduction

It is well established that being overweight or obese increases the risk of developing cardiometabolic related diseases such as coronary artery disease, type 2 diabetes and hypertension.[1]

Research in South Africa indicates that 56.6% of the female population is overweight, 32.2% are obese and 4.8% are morbidly obese (BMI≥40.0 kg/m^2).[2] This is a significant health concern due to the increase in morbidity and mortality associated with being overweight. Data from the Behavioural Risk Factor Surveillance System revealed that the African population in South Africa, particularly women, show an increased risk of being overweight and obese compared with other racial groups[3] and in some instances the prevalence of obesity is greater in females compared with males living in the same geographical location.[4]

A major factor contributing to the obesity epidemic is physical inactivity.[5] According to World Health Organisation[6] an unhealthy lifestyle may lead to obesity, high blood pressure and diabetes. Poor aerobic fitness levels are associated with cardiometabolic disease (CMD) risk factors such as large waist circumferences, hypertension and elevated insulin and blood glucose and lipid levels.[4,7] The trend of low physical activity among African South African women has recently been highlighted and research confirms that approximately 48% of the females follow a sedentary livestyle.[8] There is also evidence indicating that obese African

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females are more likely to suffer from hypertension, increased vascular resistance and metabolic syndrome compared to their Caucasian counterparts.[9,10]

Tae-bo stands for Total Awareness Excellence Body Obedience and combines the moves of taekwondo, karate, boxing and hip-hop dancing. This non-contact sport is characterised by fast punches and high kicks[11] and is essentially a form of aerobic training which aims to enhance cardiorespiratory fitness and improve balance, coordination and flexibility. To date, there have been limited studies that have investigated the efficacy of Tae-bo in improving cardiometabolic disease risk factors. The purpose of our exploratory study was to determine the effects of an aerobic (Tae-bo) exercise program on reducing cardiometabolic disease risk factors in sedentary overweight and obese African female university students.

Methods and Participants

Sixty-seven overweight and obese, apparently healthy African female

Table 1. Outline of aerobic (Tae-bo) intervention program

Week	1–5	6–10
Intensity	Moderate	High
Borg RPE Scale	11–13	14–16
1.Warm up, 10min	Walking, step touch, double step touch, leg curl, double leg curl, knee up, double knee up.	Jogging, step touch, double step touch, leg curl, double leg curl, knee up, double knee up.
2. Workout, 40min	Routine: punches (jab, hook, cross, upper cut) and kicks (front, round, side and back) 135 beats per minutes (bpm) = 135 moves per minutes. Free arm curl, lateral pull down, lateral raises in elbow flexion, crunches, lunges, squats, knee flexion, star jumps, side punches, basic run.	Routine: punches (jab, hook, cross, upper cut) and kicks (front, back, round, side and hammer). (150 bpm= 150 moves per minutes).Free arm curl, lateral pull down, lateral raises in elbow flexion, crunches, lunges, squats, knee flexion, star jumps, side punches, basic run, walk forward and lift knee, jump up and down.
3. Cool down, 10 min	Static stretches (hold 15–20s × 2). Chest, triceps, upper back, hamstring, lower back and hip, inner thigh, quads, calf.	Static stretches (hold 15–20s × 2). Chest, triceps, upper back, hamstring, lower back and hip, inner thigh, quads, calf.

University of Zululand students (aged 25 ± 5 y) were recruited for participation in the study. All participants were sedentary for at least six months prior to beginning the intervention. Pre-participation screening in the form of a medical health history questionnaire was conducted on all participants. Of the original 67 that were recruited seven participants withdrew from the study due to personal reasons. All participants completed the physical activity readiness questionnaire (PAR-Q) and an informed consent. The participants were requested to adhere to their normal dietary practices for the duration of the study. Ethical clearance was obtained from the Institution's Faculty of Science and Agriculture Ethics Committee. Each participant was taught to use the Borg Rating of Perceived Exertion (RPE) scale[12] and this was recorded in individual log books following each exercise session.

The following American College of Sports Medicine (ACSM) and International Diabetes Federation (IDF) tools were utilised to calculate the risk factor classification and prevalence of metabolic syndrome amongst the participants. The ACSM,[13] utilises specific criteria to place individuals into low, moderate or high risk categories for coronary artery disease. Participants were classified as low risk if they had ≤1 cardiovascular disease risk factor, moderate risk if they had ≥2 cardiovascular disease risk factors and as high risk if they had known cardiovascular, pulmonary, or metabolic diseases. The risk factors that are utilised for placing a person into these categories are; hypertension, hypercholesterolemia, family history, cigarette smoking, impaired fasting glucose, obesity and a sedentary lifestyle.

According to the IDF[14] for a person to be diagnosed with metabolic syndrome (MS), they must first have elevated abdominal obesity or a waist circumference >80 cm (women), plus any two of the following: hypertriglyceridaemia (triglyceride ≥1.7mmol/L); elevated blood pressure (systolic blood pressure ≥130mm Hg and/or diastolic blood pressure ≥85 mm Hg); low HDL-C levels (≤1.29 mmol/L); impaired fasting glucose (≥5.6 mmol/L).

Intervention Program

The exercise intervention required participants to complete 30 supervised Tae-bo sessions. The sessions were conducted by experienced instructors three days a week for a period of 10 weeks. The duration of a session was sixty minutes. At each training session, warm-up exercises lasted for 10 minutes, followed by a 40 min workout, and 10 min cool-down consisting of light activities and stretching. Exercise intensity progressed from moderate intensity in the first five weeks (11–13 RPE) to high-intensity (14–16 RPE) during the last five weeks. Table 1 provides an outline of the program.

Anthropometric and Body Composition Measurements

Height (m) and weight (kg) were measured to calculate BMI as kg/m^2. Measurements were taken with participant wearing light clothes and in bare feet standing on a Growth Management scale (Genifis, China). The body fat measurements were obtained using a Lange skinfold caliper (Rosscraft, Canada) from the following sites: triceps, sub scapula, supra iliac crest, abdominal, thigh, calf. The caliper was placed one cm away from the thumb and finger, perpendicular to skinfold, and halfway between crest and base of fold and left for one to two seconds before reading the dial. Measurements were taken twice and averaged. Waist circumference was taken at the narrowest (minimum) point while the hip circumference was measured at the widest (maximum) part of the buttocks using a tape measure on a horizontal plane.[15]

Blood Pressure

Resting systolic and diastolic blood pressures were measured twice after participant was seated for 5 min in the laboratory. The brachial artery auscultation technique was used with an $ALPK_2$ sphygmomanometer and stethoscope auscultation (Microlife, Switzerland). The measurement procedures followed the criteria of the American College of Sport Medicine.[13] Resting heart rate was taken using stethoscope

Table 2. Group differences at pre, mid and post intervention

Variables	Pre (*n*=60)	Mid (*n*=60)	Post (*n*=60)	Effect Size	Δ% Mid	Δ% Post
Weight, kg	81.86 ± 15.85 (77.44–86.27)	79.81 ± 15.16[a] (75.59–84.03)	77.00 ± 15.15[a] (72.78–81.22)	.3	↓ 2.5[a]	↓ 5.9[a]
BMI, kg/m^2	32.26 ± 5.65 (30.8–33.72)	31.22 ± 5.55[a] (29.78–32.65)	30.11 ± 5.46[a] (28.70–31.52)	.2	↓ 3.1[a]	↓ 6.7[a]
Waist, cm	87.59 ± 9.95 (85.02–90.16)	83.63 ± 9.71[a] (81.13–86.14)	81.82 ± 10.02[a] (79.23–84.40)	.6	↓ 4.5[a]	↓ 6.6[a]
Hip, cm	118.60 ± 10.86 (115.8–121.40)	116.20 ± 10.66[a] (113.40–119.00)	116.20 ± 10.66[a] (113.40–119.00)	.4	↓ 2.0[a]	↓ 3.5[a]
SS, mm	212.20 ± 33.30 (203.77–220.99)	200.08 ± 34.97[a] (191.53–208.63)	187.43 ± 34.64[a] (178.78–196.09)	.7	↓ 5.7[a]	↓ 11.7[a]
RHR, bpm	79.23 ± 3.76 (78.26–80.21)	76.25 ± 2.75[a] (75.54–76.96)	73.27 ± 2.63[a] (72.59–73.95)	1.8	↓ 3.8[a]	↓ 7.5[a]
Glucose, mmol/L	3.99 ± .59 (3.84–4.15)	3.83 ± .74[a] (3.64–4.02)	3.61 ± .46[a] (3.49–3.73)	.7	↓ 4.0[a]	↓ 9.5[a]
LDL, mmol/L	2.12 ± .82 (1.89–2.32)	1.92 ± .79[a] (1.71–2.12)	1.68 ± .65[a] (1.51–1.85)	.6	↓ 9.4[a]	↓ 20.8[a]
HDL, mmol/L	1.35 ± .75 (2.52–2.91)	1.53 ± .49[a] (2.73–2.99)	1.61 ± .46[a] (2.69–2.93)	−1.0	↑ 13.3[a]	↑ 19.3[a]
TG, mmol/L	1.74 ± .92 (1.14–1.76)	1.46 ± 1.15[a] (1.16–1.76)	1.45 ± 1.23[a] (1.51–1.97)	.4	↓ 16.1[a]	↓ 16.7[a]
TC, mmol/L	3.76 ± 1.02 (3.49–4.02)	3.5 ± .82[a] (3.31–3.73)	3.36 ± .85[a] (3.14–3.58)	.4	↓ 6.9[a]	↓ 10.6[a]
TC/HDL, mmol/L	2.86 ± .49 (2.53–2.91)	2.81 ± .46[a] (2.73–2.99)	2.72 ± .75[a] (2.69–2.93)	−.2	↓ 1.7[a]	↓ 4.9[a]
SBP, mm Hg	106.30 ± 8.48 (104.10–108.50)	104.20 ± 11.02[a] (101.40–107.00)	100.60 ± 8.05[a] (98.55–102.70)	.7	↓ 1.9[a]	↓ 5.4[a]
DBP, mm Hg	66.73 ± 6.96 (64.93–68.53)	63.45 ± 9.38[a] (61.03–65.87)	62.45 ± 7.36[a] (60.55–64.35)	.6	↓ 5.2[a]	↓ 6.7[a]

Data are mean ± SD (95% confidence interval).

BMI, body mass index; RHR, resting heat rate; bpm, beats per minutes; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; TG, triglyceride; TC, total cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure; SS, sum of skinfold; TC/HDL, ratio of total cholesterol to high-density lipoprotein; CI, confidence interval; SD, standard deviation; % Δ, % change compared to; ↓ decrease; ↑ increase; ES, effect size (pre-post).

[a] $P<.05$ for difference between pre and mid, pre and post.

auscultation while participants were seated. Systolic blood pressure was measured at the point of appearance of the Korotkoff sounds (phase I) and diastolic BP at the point of disappearance (phase V).

Blood Sample Analysis

All participants reported for blood sampling in the morning between 8 am and 11 am after an overnight fast (9–12 hours). Blood samples were drawn at baseline (pre-intervention), at week 6 and then at week 10 (post-intervention). Post intervention blood samples were obtained 24h after the last exercise session. Fasting total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG) and glucose concentrations were analyzed in mmol/L, using a Cardio Check (PA system Polymer Technology Systems, Indianapolis, USA) and CareSens II blood glucose monitoring system (Seoul, Korea).

Statistical Analysis

Data are presented as means ± SD, 95% confidence intervals and effect sizes. Differences between the values at pre, mid and post-testing were analyzed using repeated measures analysis of variance and a Tukey post-hoc test. The level of statistical significance was set at $P\leq.05$.

RESULTS

Pre, mid and post test results are provided in Table 2. The prevalence of metabolic syndrome using the IDF criteria was 26% at pre testing and 16% after the 10-week Tae-bo intervention program. The cardiovascular disease risk classification results are presented in Table 2. Values for weight, BMI, waist circumference, glucose, triglyceride, total cholesterol, low-density lipoprotein cholesterol, and systolic and diastolic blood pressure from both baseline to mid and baseline to post showed significant ($P\leq.05$) improvements. The prevalence of participants in the moderate-risk category before the intervention was 68.3% and dropped to 42.3% after the intervention. Similarly, the prevalence of participants in the low risk was 31.7% pre-intervention and increased to 57.7% at post intervention (Table 3).

Table 3. Cardiovascular disease risk classification, %

	Pre (*n*=60)	Mid (*n*=60)	Post (*n*=60)
Low risk	31.7	45.4	57.7
Moderate risk	68.3	54.6	42.3

DISCUSSION

The objective of our study was to determine if 30 group-supervised sessions of Tae-bo would be effective in reducing traditional cardiometabolic disease risk factors in sedentary overweight/obese African female university students. It is well-established that engaging in physical activity reduces an individual's risk for diabetes and cardiovascular disease,[16,17] however, to the best of our knowledge, it is unknown if a relatively short intervention consisting of 30 sessions of Tae-bo can favorably modify the cardiometabolic disease risk profile in female African students.

Anthropometry

Although anecdotal, the majority of students enrolled at the University of Zululand do not meet the minimum recommended physical activity guidelines and as such it would be fair to say that this is a strong contributing factor towards the high prevalence of overweight/obesity. The US Department of Health and Human Services[18] has shown that overweight/obese individuals are at greater risk for developing diabetes, hypertension and CVD. In addition, Sampalis et al[19] have shown that relatively small reductions in weight can impart significant health benefits. Another study of a 4-week aerobic training program recorded a 4.3% reduction in body weight.[20] The participants in our study showed an almost 6% reduction in weight from pre to post intervention; reduction in weight mirrored the observations for BMI, waist and hip measurements with all these variables showing significant reductions after the 10-week intervention program. Interestingly, significant changes were already observed mid-intervention (ie, following 15 sessions or after 5 weeks) and this trend was similar for the other dependent variables.

To the best of our knowledge, it is unknown if a relatively short intervention consisting of 30 sessions of Tae-bo can favorably modify the cardiometabolic disease risk profile in female African students.

Blood Pressure and Resting Heart Rate

Elevated blood pressure or hypertension is estimated to affect approximately 55% of South Africans.[21] The deleterious effects of chronically elevated blood pressure are well documented,[22] and include increased risk of cardiovascular morbidity and mortality. Overweight/obese individuals are more at risk of developing hypertension. In our study, blood pressure (systolic and diastolic) was within the recommended range at all-time points. Surprisingly, the resting blood pressure pre-intervention was lower than anticipated for this group of overweight students. Studies conducted on other African females have shown a propensity towards elevated blood pressure.[23,24] Beneficial changes were observed post-intervention for both systolic and diastolic pressures with the mean systolic pressure dropping by 5% and the diastolic by almost 7%. From a clinical perspective these changes are meaningful as a recent study has shown that reductions of 9% can reduce the risk or incidence of coronary heart disease and all-cause mortality by 14% and 7%, respectively.[25] Significant reductions in the participants RHR was observed following the 10-week intervention. This drop together with reductions in BP would tend to suggest that cardiovascular efficiency had improved among the participants.

Blood Parameters

Glucose

As per the IDF criteria, elevated fasting blood glucose levels (≥5.6mmol/L) is one of the risk factors for developing metabolic syndrome. As a screening tool, fasting blood glucose levels can also give an indication if an individual is glucose intolerant (pre-diabetic) or diabetic. Both these conditions place individuals at greater risk of developing cardiovascular disease. One study reported that an 8.1% reduction in fasting blood glucose significantly reduced risk of metabolic syndrome and its associated conditions (eg, obesity, type 2 diabetes, heart disease) after a 4-week aerobic exercise program ($P<.01$).[17] The participants in our study exhibited a 9.5% reduction in blood glucose concentration following the intervention. This compares favorably with the results of a 12-week aerobics training which resulted in an improvement of insulin resistance by 4.7%.[26]

Lipoproteins

Elevations in TC, TG, LDL as well as the TC/HDL ratio are considered to be independent risk factors for the development of CVD and increased incidence of cardiac events.[27] The most pronounced change observed in our study for the lipoproteins was that of the LDL which dropped by 20% (ES=.6). Studies by Durrington et al[28] and Deibert et al[29] have reported similar findings with LDL-C decreasing by almost 35% and TG by almost 13%. This drop, together with reductions in TG, TC and increases in HDL are all significant in that it favorably alters the participant's lipoprotein profile and risk of disease. It was surprising to see such pronounced changes especially considering that the participants were not instructed to follow a specific diet or calorie restriction program. This of course does not rule out the possibility that the participants subconsciously altered the type and amount of food intake during the study. Similar to the changes in blood pressure, the alterations in the lipoproteins are of clinical significance. Zhan et al[30] have shown that a reduction of 3.77% TC or 5.25% LDL and 7.27% TG together with an increase in HDL are associated with a reduction in cardiac events.[26]

Overall the number of participants that modified their risk classification to such an extent that they would no longer meet the IDF criteria for metabolic syndrome was 10%. This is a substantial drop and when one considers the worldwide prevalence of metabolic syndrome a similar reduction globally would see millions of people significantly reduce their risk for premature morbidity and mortality. Similarly, using the ACSM[13] criteria (Table 3) there was a 38% reduction in the number of participants who were classified as moderate risk after the intervention.

CONCLUSION

The prevalence of cardiometabolic disease is increasing among urban and rural South African females. In rural settings, similar to where this intervention took place, there is a lack of infrastructure and limited opportunities exist for people to engage in organised physical activity programs. The intervention employed in our study was effective in reducing the cardiometabolic disease risk profile of overweight/obese African female university students.

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