Influence of callisthenic training on selected anthropometric variables in overweight and obese individuals

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Abstract

It is estimated that more than one billion adults are overweight in the world, of which at least 300 million are obese. Countries in economic transition from underdeveloped to developed, such as South Africa, are particularly affected and have an increased rate of obesity across all economic levels and age groups. The purpose of this study was to determine the effects of a home-based callisthenic exercise programme on anthropometric measures of total fatness and abdominal fat in overweight and obese individuals. Twenty-two male and female overweight and obese, young- and middle-aged volunteers aged 25 to 55 years with a body mass index (BMI) of 25 - 39.9 $kg.m^{-2}$ were assigned to either an eight-week home-based callisthenic training group (HBCT) ($n = 11$) or non-exercising control group (NECG) ($n = 11$). In the HBCT, significant ($p \leq 0.05$) improvements were found in sum of skinfolds ($p = 0.000$), percentage body fat ($p = 0.000$), fat mass ($p = 0.000$), lean mass ($p = 0.001$) and conicity index ($p = 0.012$) from pre- to post-test in the HBCT group. However, no significant changes were found in body mass ($p = 0.074$), BMI ($p = 0.070$), subscapular-triceps ratio ($p = 0.500$) and waist-to-hip (WHR) ($p = 1.000$) following the eight-week training programme. The present study demonstrated that callisthenic training can effectively alter some anthropometric measures of total fatness and abdominal fat in overweight and obese individuals in a home-based setting. This is noteworthy since the benefit of exercising at home extends to privacy and convenience for the individual.

Keywords: Body composition, body fat distribution, body weight training, physical activity, weight control.

Introduction

The increasing prevalence of overweight and obesity is a global health concern due to the associated health problems such as heart disease, diabetes, cancer, dyslipidernia, hypertension and hyperinsulinernia (American College of Sports Medicine (ACSM), 2001). With more than one billion adults being classified as overweight, of which at least 300 million are obese, countries in economic transition from underdeveloped to developed, such as China, Brazil and South Africa, are particularly affected and have an increased rate of obesity across all economic levels and age groups. Obesity and associated non-communicable diseases such as Type 2 diabetes, hypertension and ischaemic heart disease, which were thought to be a problem of affluent countries, are now increasingly becoming prevalent among all population groups in South Africa (Kruger, Puoane, Senekal & Van Der Merwe, 2005).

Maintaining and restoring the health and independence of this growing overweight and obese population in a cost-effective _ manner is essential, since this type of rehabilitation will increasingly be considered in the planning of health care services. A home-based testing protocol and exercise/rehabilitation programrile can be inexpensive, which is especially necessary in developing countries such as South Africa due to limited transport and home-based programmes not needing specialised equipment or personnel. Further, callisthenic training, when compared to a gymnasium, adds an element of privacy which is a major concern for most overweight and obese individuals while the wait for machines and convenience of using certain equipment will not be present when training at home compared to a gymnasium (Maran & Maran, 2005).

Calisthenics is a form of dynamic exercise consisting of a variety of simple, often rhythmical, movement generally using minimal equipment or apparatus. These exercises are intended to increase body strength and flexibility with movement such as bending, jumping, swinging, twisting or kicking using only one's body weight for resistance. These exercises are usually conducted in concert with stretches. Calisthenics, when performed vigorously and with variety, can benefit both muscular and cardiorespiratory endurance, in addition to improving psychomotor skills such as balance, agility and coordination (Ozer Kaya *et al.,* 2011).

Thus, the purpose of this study was to determine the effects of a home-based callisthenic exercise programme on anthropometric measures of total fatness and abdomimll fat in overweight and obese individuals.

Methodology

Subjects

A sample of 22 young- and middle-aged volunteers aged 25 to 55 years with a BMI of25 to 29.9 kilogranut]es per meter squared ($kg.m^{-2}$) and 30 to 39.9 $kg.m^{-2}$ (overweight and obese, respectively) were assigned to either an eight-week home-based callisthenic training group (HBCT) (Levinger *et a!.* 2004) (n = 11 or non-exercising control group (NECG) (n = 11) (Table I). The participants were required to be sedentary, weight stable and on no dietary intervention six months prior to their participation. Subjects were also required not to be using any pharmacological agents that could have an effect on the tested variables. Any participants self-reporting that they did not meet these criteria were excluded from participation in the study. Prior to participation in the study, all volunteers gave written informed consent and underwent a screening history and physical examination and were allowed to discontinue the study at any time. The study was approved by the Institutional Review Board at the Tshwane University of Technology.

Table 1: Subject baseline descriptive data

Variable	Home-based Callistbenic Training Group (HBCT) (n = 11)	Non-exercising Control Group (NECG) (n = 11)
Age (years)	32.82 ± 1.50	35.00 ± 2.28
Weight (kg)	85.96 ± 15.55	93.02 ± 22.13
BMI ($kg.m^{-2}$)	30.87 ± 3.66	31.91 ± 6.16

Values are means± standard deviation; kg: kilogrammes; $kg.m^{-2}$: kilogrammes per square meter

Anthropometric measurements

All subjects underwent an identical battery of tests before and after the 8-week intervention period. All subjects were evaluated in the post-absorptive state following a 12- to 14-hour fast and at least 48 hours prior to or following any exercise. Anthropometric measurements were carried out according to the methods proposed by the International Society for the Advancement of Kinanthropometry (ISAK) (Norton & Olds, 1996). Subjects were weighed in kilograrnmes (kg) (to the nearest 0.1 kg) on a calibrated medical scale (Mettler DT Digitol , Mettler-Toledo AG, Ch-8606 GreiFensee, Switzerland) wearing minimal clothing. Each subject's stature was measured in centimetres (em) (to the nearest 0.1 em) via a standard wall-mounted stadiometer. Each subject's body mass and stature were used to calculate BMI which was defined as the ratio of body mass to stature squared, expressed in kilogrammes per square meter (kg.m-2).

Percentage body fat (%BF) was calculated from seven-skinfold measurements (triceps, subscapular, supra-iliac, abdominal, frontal thigh, mid-axilla and pectoral skinfolds) using the equation of Jackson and Pollock (1978) to calculate percentage body fat: Percentage Fat= 100 (4.95/body density (Db)- 4.5). Where for males: Db (glee) = 1.112 – 0.00043499 (sum of the seven skinfolds in millimetres (:E7)) + 0.00000055 $(:E7)^2$ – 0.00028826 (age). Where for females:

Db (glee)= 1.097-0.00046971 (sum of the seven skinfolds in millimetres (l:7)) + 0.00000056 (l:7i – 0.00012828 (age). To convert to %BF, the Siri (1961) equation was used: %BF = (4.95/Db – 4.5) x 100. Skinfolds and waist and hip circumferences were measured prior to any exercise using a manual skinfold calliper (Harpenden John Bull, British Indicators Ltd., England) and a non-distendable measuring tape (Holtain Ltd.). Waist circumference was taken with the subject standing, by wrafping the tape at the level of the narrowest point between the lower costal (10 rib) border and the iliac crest. Hip circumference was taken at the level of the greatest posterior protuberance of the buttocks which usually corresponds anteriorly to about the level of the symphysis pubis.

Anthropometric measurements were carried out three times by a single tester. Waist-tohip ratio (WHR) was calculated using the following formula: WHR = waist circumference (cm)lhip circumference (em). Fat mass was calculated by multiplying body mass with body fat percentage which was divided by 100. Lean mass was calculated as total body mass in kilogrammes subtracted by fat mass in kilogrammes. Conicity index (CI) was computed using the following formula:
CI = waist circumference (meters (m))/(0.109)x--v[weight (kg)/stature (m)] (Valdez *et al*., 1993).

Training programmes

Due to the sedentary status of the subjects, in an attempt to avoid injuries and to develop an inexpensive home-based callisthenic exercise programme consisting of aerobic, mobility and flexibility exercises (Cancela Carral & Ayan Perez, 2007) for overweight and obese individuals. From week one to four, each subject in the HBCT group had to complete five minutes of walking on the spot; five minutes of stepping up and down; five minutes of walking forwards and backwards for about five meters, twice for the aerobic portion between nine and 13 on the Rate of Perceived Exertion (RPE) scale (Borg, 1998). Flexibility exercises had to be kept in a stretch without pain and each stretch was completed for three sets and was held for 30 seconds for each exercise (Alter, 1990). Flexibility consisted of the following exercises; neck stretch, early morning stretch, egg stretch and kick stretch (Alter, 1990). The strength exercises were performed for one set of each exercise, for 10 to 15 repetitions and consisted of the following; wall push-ups, back hyperextensions, lunges and bench dips.

Subjects were instructed to start at the lowest intensity and repetitions and then only increase at week four. The RPE scale was used to determine the recommended intensity for cardiorespiratory fitness. It was based on the physical sensations the subject experienced during physical activity, including increased heart rate, increased respiration or breathing rate, increased sweating and muscle fatigue. Perceived exertion (times ten) has been correlated with the actual heart rate during physical activity (Borg, 1998).

For weeks five to eight, the subjects had to perform five minutes of walking on the spot; five minutes of stepping up and down; five minutes of walking forwards and backwards for about five meters; this sequence had to be repeated twice. The aerobic exercises had to be performed at an intensity of between 13 and 15 on the RPE scale. Flexibility exercises had to be kept in a stretch without pain for three sets of each exercise and held for 30 seconds each (Alter, 1990). The strength exercises were performed for two set of each exercise, for 10 to 15 repetitions and consisted of the following; crunches, pelvic thrusts, air bike, kickbacks, knee push-ups, back hyperextensions, lunges and bench dips.

Statistical analysis

Statistical analysis consisted of basic statistics to determine baseline and post-training means and standard deviations. A paired samples t-test was applied to determine if a significant change took place at post-training. A probability value of::; 0.05 was considered significant. Data were analysed using the Statistical Package of Social Sciences (SPSS) Version 14 (Chicago, IL).

Results

At pre-test, the groups were homogenous for body mass ($p = 0.682$), body mass index (BMI) ($p = 0.268$), sum of skinfolds ($p = 0.074$), conicity index ($p = 0.413$), waist circumference ($p = 0.323$), hip circumference ($p = 0.516$), waist-to-hip ratio (WHR) ($p = 0.243$) and subscapular-triceps ratio ($p = 0.684$), but heterogeneous in terms of percentage body fat ($p = 0.029$).

Following the eight-week training programme, significant improvements were found in sum of skinfolds ($p = 0.000$), percentage body fat ($p = 0.000$), fat mass ($p = 0.000$), lean mass ($p = 0.001$) and conicity index ($p = 0.012$) in the HBCT group. However, no significant change was found in body mass ($p = 0.074$), BMI ($p = 0.070$), subscapular-triceps ratio ($p = 0.500$) and WHR ($p = 1.000$) from the pre- to post-test in the HBCT group.

Additionally, no significant changes were found in body mass ($p = 0.063$), BMI ($p = 0.059$), conicity index ($p = 0.058$), sum of skinfolds ($p = 0.684$), percentage body fat ($p = 0.380$), subscapular-triceps ratio ($p = 0.284$), fat mass ($p = 0.143$), lean mass ($p = 0.178$) and WHR ($p = 0.102$) from pre- to post-test in the NECG (Table 2).

Discussion

In order to determine the effectiveness of callisthenic training on anthropometry in overweight and obese individuals, the present study investigated the effects of eight weeks of callisthenic training on several measures of total and abdominal fat. Findings of the present study demonstrated that eight weeks of Pilates training improved six of the nine measured anthropometric variables. The present study's eight-week programme failed to elicit changes in body mass, BMI, subscapular-triceps ratio and WHR.

Table 2: Effect of home-based callisthenic training on anthropometric parameters in overweight and obese individuals

Variable	Control Group (NECG) (n=11)		Experimental Group (HBCT) (n=11)	
	Pre-test	Post-test	Pre-test	Post-test
Body mass (kg)	93.02 ± 22.13	96.72 ± 11.07	85.96 ± 15.55	84.70 ± 16.39
BMI (kg.m"2)	31.91±6.16	32.34±6.31	30.87 ± 3.66	30.40 ± 4.07
Sum of7 skinfolds (nun)	208.77 ± 37.53	210.03 ± 34.40	214.52±39.59	184.15± 36.23*
%BF (%)	34.00 ± 5.07	34.30 ± 4.85	33.95 ± 7.16	30.66 ± 7.07*
Subscapular-triceps ratio	1.03 ± 0.38	1.00± 0.32	1.62± 0.95	1.51 ± 0.71
FatMass(kg)	32.15± 10.78	32.81 ± 11.17	28.92±6.97	25.93±7.30*
Lean Mass (kg)	60.81 ± 12.59	61.43 ± 12.95	57.02 ± 13.52	58.85 ± 13.86*
WHR	0.80 ± 0.08	0.79 ± 0.08	0.83 ± 0.06	0.83 ± 0.08
Conicity index	115.75 ± 7.77	113.89 ± 8.97	115.77 ± 6.41	112.35 ± 7.46*

Values are means :1: standard deviation; •: Statistically significant difference between pre- and post-test (p !S *0.05)*; m: meters; kg: kilogrammes; BMI: body mass index; kg.m^{-1} :lcilogrammcs per square meter; mm: miUimeters; %8F: percentage body fat.

Similarly, Byrne and Wilmore (2000) and Nieman *et a/.* (2002) have previously failed to demonstrate body weight changes following their 12-week training programmes. Further, lrez (2011) also found no change in body weight and BMI after their 24-week training programme. While the present study and that of Byrne and Wilmore (2000), Nieman *et a/.* (2002) and Park *et a/.* (2003) demonstrated no change in BMI following eight weeks of callisthenic training, Bryner *et a/.* (1999) and Klijn *et a/.* (2007) demonstrated a significant improvement in BMI following 12 weeks, eight weeks and 12 weeks of training, respectively. While the lack of improvement in BMI in the present study could be related to a shorter programme duration compared to that of Bryner *et a/.* (1999) and Klijn *et a/.* (2007) whose programmes each lasted 12 weeks, Habibzadeh and Rahmani-nia (2010) too found an improved BMI following eight weeks of exercise training.

However, in classifying health risks associated with overweight and obesity, the National Institute of Health (NIH) guidelines consider body fat distribution and other risks in addition to BMI. Excess body fat in the abdominal section is of greater concern than adipose tissue in other areas. As such, the NIH guidelines use the measurement of the we for individuals with a large we to estimate cardiovascular disease. Further, We has been found to be a better indicator to body fat distribution than waist-to-hip ratio. A waist measurement of more than 102 centimeters (em) for males and 88cm for females and a waist-to-hip ratio of above 0.94 for males and 0.82 for females are associated with an increased risk of disease (Fahey *et al.,* 2005). The finding of the present study that eight weeks of callisthenic training failed to change WHR is of concern. This is so since Salgado *et al.* (2010) has previously found that overweight children and adolescents with an increased waist circumference are at a greater risk of high diastolic blood pressures during sleep and lower night dipping of both the systolic and diastolic blood pressures.

In addition to the traditional measures of anthropometry, the present study used the sum of seven skinfolds (pectoral, triceps, subscapular, mid-axilla, supra-illiac, abdominal and front thigh) as it is a more sensitive measure of total adiposity. The positive improvements in the sum ofskinfolds of the HBeT group is similar to the findings of Faigenbaum *e/ a/.* (1993) and Watts *eta/.* (2005) whose studies demonstrated improvements in sum of seven skinfolds and sum of three skinfolds (abdomen, iliac crest and triceps), respectively. However, the study of Watts *et al.* (2005) failed to illicit a change in the sum of four skinfolds (abdomen, iliac crest, triceps and front thigh). Further, while the fmdings of Park *eta/.* (2003) corroborate the findings of the present study regarding a decrease in percentage body fat (%BF), Byrne and Wilmore (2000) and Nieman *et a/.* (2002) have demonstrated that %BF was not significantly ch ged following their 12-week training programmes. In terms of lean mass and fat mass, while the present study demonstrated an increased lean mass and a decreased fat mass following the eight-week programme, Saremi *eta/.* (2010) showed a significant increase in lean mass or reduction in fat mass following their eight-week callisthenic training programme. No previous studies have to date evaluated the effect of their respective exercise training regimes on ei, WHR and subscapular-triceps ratio and as such, the present study's fmdings regarding these parameters cannot be refuted or confirmed.

Conclusions

The present study demonstrated that callisthenic training can effectively alter some anthropometric measures of total fatness and abdominal fat in overweight and obese individuals in a home-based setting. This is noteworthy since the benefit of exercising at home extends to privacy and convenience for the individual. This benefit of exercising at home also extends to convenience for the individual, rather than having to commit to the gymnasium after or before work. Furthermore, home-based programmes are inexpensive, especially when considering callisthenics. Home-based exercises are also done in private and some individuals, especially if overweight or obese, might not be comfortable exercising in a gymnasium.

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