Effects of a Mat Pilates Programme on Body Composition in Elderly Women

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ABSTRACT

Background: *With ageing, the ability to mobilize fat is reduced and this, coupled with gradual decrease in lean body mass (LBM) from lessened exercise, allows for an increased body fat percentage (%BF). Exercising is considered a key to maintaining an appropriate body mass (BM), as it improves fat oxidation, while maintaining LBM. Although the effects of endurance and/or resistance training on fat mass (FM) and LBM in the elderly have well been established, limited data are forthcoming regarding the effects of Pilates as a training modality on these variables in the elderly.*

Objective: *The present study was therefore conducted to determine the effects of a mat Pilates programme on body fat in elderly women.*

Methods: *Fifty sedentary, apparently healthy females aged 60 years and older were randomly assigned a control (CG, n = 25) or an intervention (IG, n = 25) group. The IG took part in an eight-week progressive mat Pilates exercise programme, three times weekly while the CG were instructed to maintain their normal daily activities throughout the eight-week experimental period. All subjects underwent pre- and post-test in which FM and LBM were assessed.*

Results: *Eight weeks of mat Pilates demonstrated a significant (*$p \leq 0.05$*) decrease in % BF (*$p = 0.016$*) and FM (*$p = 0.038$*), with a significant increase in LBM (*$p = 0.006$*), while not showing any significant changes (*$p \geq 0.05$*) in BM (*$p = 0.979$*) and BMI (*$p = 0.992$*). The CG, however, did not produce any significant (*$p \geq 0.05$*) changes in any of the tested anthropometric variables (BM:* $p = 0.266$*; BMI:* $p = 0.123$*; % BF:* $p = 0.516$*; FM:* $p = 0.937$ *and LBM: (*$p = 0.522$*) after completion of the eight-week Pilates programme.*

Conclusion: *An eight-week mat Pilates exercise programme may contradict or even reverse some of the most serious consequences of ageing associated with an increased fat mass and reduced lean body mass in elderly females.*

Keywords: Aged, alternative medicine, anthropometry, complementary medicine, elderly, exercise

Efectos de un Programa de Pilates de Ejercicios Sobre Alfombra en la Composición Corporal en Mujeres de Edad Avanzada

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RESUMEN

Antecedentes: *Con el envejecimiento, se reduce la capacidad de movilizar la grasa y esto – junto con la disminución gradual de la masa corporal magra (MCM) por la falta de ejercicios – hace que aumente el porcentaje de grasa corporal (% GC). La realización de ejercicios se considera clave para mantener una masa corporal apropiada (MC), ya que mejora la oxidación de las grasas, a la par que mantiene la masa corporal magra (MCM). Aunque los efectos de los entrenamientos de fuerza y/o resistencia sobre la masa grasa (MG) y la masa corporal magra (MCM) en las personas de edad han quedado bien establecidos, se presentan datos limitados con respecto a los efectos de Pilates como una modalidad de entrenamiento, sobre estas variables en los ancianos.*

Objetivo: *El presente estudio se realizó, por tanto, para determinar los efectos de un programa de*

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Pilates de ejercicios en alfombra, sobre la grasa corporal en las mujeres mayores.
Métodos: *Cincuenta mujeres sedentarias, aparentemente sanas, de 60 años o más, fueron asignadas aleatoriamente a un control (CG, n = 25) o a un grupo de intervención (IG, n = 25). El grupo IG tomó parte en un programa de Pilates de ejercicios progresivos sobre alfombras, de ocho semanas de duración, tres veces por semana, mientras que a los miembros del CG se les instruyó que mantuvieran sus actividades diarias normales durante todo el período experimental de ocho semanas.*
Resultados: *Las ocho semanas de ejercicios de Pilates sobre alfombra, mostraron una disminución significativa (*$p \leq 0.05$*) en % GC (*$p = 0.016$*) y MG (*$p = 0.038$*), con un aumento significativo en MCM (*$p = 0.006$*), mientras que no se mostraron cambios significativos (*$p \geq 0,05$*) en MC (*$p = 0.979$*) y el IMC (*$p = 0.992$*). Sin embargo, el GC no produjo ningún cambio significativo (*$p \geq 0,05$*) en ninguna de las variables antropométricas sometidas a pruebas (MC: $p = 0.266$; IMC: $p = 0.123$; % GC: $p = 0.516$; MG: $p = 0.937$ y MCM: (*$p = 0.522$*) luego que se completara el programa de Pilates de ocho semanas.*
Conclusión: *Un programa Pilates de ocho semanas de ejercicios sobre alfombra puede contradecir o incluso revertir algunas de las más serias consecuencias del envejecimiento asociadas con aumento de la masa grasa y reducción la masa corporal magra en mujeres de edad avanzada.*

Palabras claves: Envejecido, medicina alternativa, medicina complementaria, antropometría, edad avanzada, ejercicio

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INTRODUCTION

In addition to its enormous impact on an individual's quality of life, obesity is a daunting health problem worldwide (1). However, the anthropometric standards derived from adult populations may not be appropriate for the elderly because of body composition changes that occur during ageing (2). In both men and women, important fat redistribution occurs between 45 and 54 years of age and in older women the increase in waist-to-hip ratio (WHR) mostly reflects a reduction of fat deposits in the hips (3). In general, the elderly have been found to have predominantly android-type (apple-shape) obesity as fat accumulation is more at the abdominal region. According to Folsom *et al* (4), truncal and abdominal fat storage sites are considered the most dangerous and are closely linked with disease, and changes in waist and stature girths capture increased abdominal adiposity and sarcopenia, respectively (5).

Lei *et al* (6) and Perisinotto *et al* (2) also found that with ageing, stature decreases, mainly due to spinal deformity and thinning of the intervertebral discs, with an increasing trend of total fat mass (FM) and various anthropometric measurements including waist circumference (WC), body mass index (BMI), WHR and conicity index (CI), where age and gender have the important effect on influencing this relationship. With ageing, the ability to mobilize fat is reduced and this, coupled with gradual decrease in lean body mass (LBM) from lessened exercise, allows for an increased body fat percentage [%BF] (7). Nakagawa *et al* (8) found that not only does body fat increase significantly with age, but so does intramyocellular lipid content which is positively related to %BF and WHR. Skinfold thickness measurements also decline with increasing age (9). In the study of Ballard *et al* (10), it was also revealed that with increasing age, body mass (BM) was less. This difference in BM was, however, attributed to significantly less total LBM rather than to less body fat. Ballard *et al* (10) stated that with increased age there is a simultaneous decrease in bone and LBM and the elderly should therefore be encouraged to maintain adequate LBM due to its association with bone mineral density and thus, risk of fractures.

Exercise results in many benefits, especially the improvement in FM and LBM (11–13). In addition to these more conventional exercise methods, Pilates is another non-conventional form of exercise that results in improvements in BMI and could reduce obesity (14). Pilates has also been shown to assist in the prevention of falls and recovery of injuries (15), especially in the elderly. However, despite the numerous popular press reports on Pilates, the existing scientific evidence for Pilates is limited (16). Therefore the aim of the present study was to evaluate the effects of a mat Pilates programme on body fat in elderly women.

SUBJECTS AND METHODS

A sample of 50 elderly female subjects (≥ 60 years of age), selected from care facilities within Pretoria, Gauteng Province, South Africa, were randomly assigned into one of two groups using a random numbers table; with 25 subjects undergoing an eight-week mat Pilates programme (IG), while the other 25 subjects participated as a non-exercising control group (CG). The research protocol was approved by the Institutional Review Boards of the Tshwane University of Technology, Pretoria, South Africa and was endorsed by the International Physical Activity Projects (IPAP). Permission to conduct the study at the care facilities was obtained from the relevant facilities and all subjects signed a written informed consent form indicating all the advantages and risks involved in participation in the study. All subjects were required to obtain medical clearance prior to commencement of

Table 1: Subject demographic data

	Non-exercising control group (CG) n = 25	Mat Pilates programme group (IG) n = 25
Age (years)	65.32 ± 5.01	66.12 ± 4.77
Body mass (kg)	75.19 ± 14.78	71.71 ± 14.92
Body mass index (kg.m^{-2})	29.32 ± 5.44	28.32 ± 6.77

Values are means ± standard deviation; kg.m^{-2}: kilograms per square metre

pre-testing procedures. Both groups took part in identical pre- and post-tests. Subject demographics at baseline are shown in Table 1.

Physical evaluation

All subjects were required to undergo anthropometric testing prior to and at completion of the eight-week treatment period. Anthropometric measurements were conducted according to the protocol of the International Society for the Advancement of Kinanthropometry [ISAK] (17). Body mass was measured in kilogrammes on a calibrated medical scale (Mettler DT Digitol, Mettler-Toledo AG, Ch-8606 GreiFensee, Switzerland) to the nearest 0.1 kilogramme (kg) and stature was measured to the nearest 0.01 centimetres (cm) using a standard wall-mounted stadiometer with the subjects wearing minimal clothing and no shoes. Skinfolds of the triceps, biceps, subscapular and iliac crest were measured to the nearest 0.2 millimetres with a Holtain skinfold calliper (Holtain Ltd Crymych, UK). Body fat percentage was calculated using the equations of Durnin and Womersley (18) to determine body density and then substituted in the equation of Siri (19) to calculate body fat percentage (20) as follows:

Density (g/cm3) = c – m (log SS)

Where:

* C and m = standard age and sex-specific coefficients
* SS = Sum triceps, biceps, sub-scapular and iliac-crest/supra-iliac skinfold measurements

Once body density was calculated, the Siri (19) equation was used to estimate body fat percentage:

Fat (%) women = [(5.01 / D) – 4.57] x 100

Where:

* D = Density

Body mass index was calculated by dividing body mass by stature squared (weight/stature^2) and expressed as kilogram per square metre (kg.m^{-2}). Fat mass was calculated by multiplying body mass by fat percentage, which was divided by 100 [body mass x (fat percentage/100)]. Lean body mass was calculated by subtracting body mass by fat mass [body mass kg – fat mass (kg).

Pilates programme testing

Mat Pilates exercises and exercise prescription variables were determined in accordance with the guidelines of Worth (21) in order to compile the supervised mat Pilates exercise programme with all sessions being conducted by a Pilates instructor registered with the South African Pilates Association and certified in essential, intermediate and advanced equipment and mat. The periodized, eight-week Pilates programme consisted of three non-consecutive sessions weekly each lasting 60 minutes in duration. Prior to commencement of the programme, all subjects in the intervention group were trained on how to perform the Pilates exercises by a qualified practitioner. For each of the exercises, subjects were firstly familiarized with the exercise programme and then provided with simple step-by-step written instructions, an explanation of the basics of mat Pilates and an explanation of the neutral position of the spine and also the correct breathing techniques to be used during Pilates. All sessions began with breathing, followed by a flowing system from standing, to sitting, to lying down exercises and ended with the rest position (21). Non-exercising control group subjects were instructed to maintain their normal daily activities throughout the eight-week experimental period and were phoned three times weekly to ensure compliance.

Statistical analysis

Statistical analysis consisted of basic statistics to determine pre- and post-test means and standard deviations. A paired samples *t*-test was used to determine if a significant change took place in the measurements at post-test. Differences in measurements were compared by using a one-way analysis of variance (ANOVA) using a Dunnett T3 *post-hoc* analysis. Data were analysed using commercial software (Statistical Package for Social Sciences (SPSS) version 17, Chicago, IL) and statistical significance set at $p \leq 0.05$.

RESULTS

At pre-test, the groups were found to be homogenous for body mass ($p = 0.412$), BMI ($p = 0.567$), %BF ($p = 0.364$), FM ($p = 0.951$) and LBM ($p = 0.061$). Following the eight-week mat Pilates programme, the IG demonstrated a significant ($p \leq 0.05$) decrease in %BF ($p = 0.016$) and FM ($p = 0.038$), with a significant increase in LBM ($p = 0.006$), while not showing any significant changes ($p \geq 0.05$) in BM ($p = 0.979$) and BMI ($p = 0.992$). The CG, however, did not produce any significant ($p \geq 0.05$) changes in any of the tested anthropometric variables (BM: $p = 0.266$; BMI: $p = 0.123$; %BF: $p = 0.516$; FM: $p = 0.937$ and LBM: ($p = 0.522$)

Table 2: Pre- and post-test muscular strength and endurance changes in the mat Pilates and non-exercising control groups

	Non-exercising control group (CG) n = 25			Mat Pilates programme group (IG) n = 25		
	Pre-test	**Post-test**	***p*-value**	**Pre-test**	**Post-test**	***p*-value**
Body mass (kg)	75.19 ± 14.8	72.03 ± 19.76	0.266	71.71 ± 14.92	71.70 ± 14.68	0.979
Body mass index (kg.m^{-2})	29.32 ± 5.44	29.15 ± 5.48	0.123	28.32 ± 6.77	28.32 ± 6.64	0.992
Body fat percentage (%)	32.22 ± 5.93	32.46 ± 5.79	0.516	33.85 ± 6.67	32.23 ± 5.82	0.016*
Fat mass (kg)	24.88 ± 8.66	24.85 ± 8.38	0.937	25.03 ± 9.53	23.69 ± 8.06	0.038*
Lean body mass (kg)	50.32 ± 7.08	49.86 ± 7.45	0.522	46.67 ± 6.33	48.04 ± 7.52	0.006*

Values are means ± standard deviation (± SD); *: indicates significant difference from pre- to post-test ($p \leq 0.05$)

after completion of the eight-week Pilates programme (Table 2).

DISCUSSION

Results obtained from the present study indicate that eight weeks of mat Pilates produced improvements in %BF, FM and LBM. This is of particular importance as mat Pilates may contradict or even reverse some of the most serious consequences of ageing; the loss of LBM (sarcopenia) can lead to major functional impairment, morbidity and mortality (22) whereas the normalization or reduction of increased body fat reverses the obesity-associated morbidities, such as hypertension, glucose intolerance, dyslipidaemia and fatty liver diseases (1).

The results obtained in the present study, following a period of Pilates training, are supported by Jago *et al* (14), Kloubec (23), Rogers and Gibson (24), Segal *et al* (25) and Sekendiz *et al* (26) who found non-significant changes in BM, following durations of four weeks to six months of Pilates training in various age groups. Similarly, Jago *et al* (14), Kloubec (23) and Sekendiz *et al* (26) also found non-significant changes in BMI, following durations from four weeks to 12 weeks of Pilates training in various age groups. However, Rogers and Gibson (24) found a significant decrease from 23.5 ± 5.0 % to 22.3 ± 4.0% in %BF, following eight weeks of Pilates training in adults, while the Sekendiz *et al* (26) study demonstrated no significant changes in %BF following five weeks of Pilates training in sedentary adult women. Similar to this contradiction was the non-significant changes observed in FM and LBM (25), following six months of Pilates training in subjects older than 18 years of age.

The lack of change in BMI is as a result of the unchanged BM found in the present study as stature did not change at post-test. In turn, the lack of change found in BM could be attributed to insufficient training volume and intensity as the present study's training volume and intensity is even lower compared to previous research which also found non-significant changes in both BM and BMI. In the present study, the IG exercised three times per week for eight weeks which is less when compared to the five times per week subjects trained in the study by Jago *et al* (14) and less than the 12-week duration in the Kloubec (23) study. The present study only utilized a beginner mat Pilates pro-gramme, increasing in the number of repetitions and sets, while the Rogers and Gibson (24) study progressed from beginner to more advanced programmes. However, in the present study, FM significantly decreased, while LBM sig-nificantly increased in the IG, therefore creating the pos-sibility that training volume and intensity cannot be con-sidered a sole factor for the unchanged BM as indicated in this study.

The improvements in FM, LBM and %BF observed in the present study could have been due to a change in skinfold thickness. This is since skinfolds obtained from subcutaneous fat tissue is based on the assumption that, as an individual gains adipose tissue, the increase in skinfold thickness will be proportional to the additional weight gain (27). The present study did not consist of any aerobic endurance exercises, but utilized own body weight and gravitational forces as means of resistance and thus, strength training. Also, the intensity of the programme increased in such a manner that a substantial amount of muscular endurance work was performed. Therefore, the significant improvements found in FM and LBM could be attributed to the muscular strength and muscular endurance training. Endurance exercises have been found to increase LBM by enhancing the capacity to oxidize fat by increasing the volume and function of mitochondria in skeletal muscles (11, 12), whereas resistance training decreases FM by increasing LBM (13), by means of muscle hypertrophy and stimulation of new bone growth and associated connective tissue (28, 29).

In conclusion, the present study indicates that eight weeks of mat Pilates programme produced significant improvements in %BF, FM and LBM in elderly females. This is of particular importance as mat Pilates may contradict or even reverse some of the most serious consequences of ageing in elderly females as the loss of LBM (sarcopenia) can lead to major functional impairment, morbidity and mortality (22). In addition, the normalization or reduction of increased body fat reverses the obesity-associated morbidities, such as hypertension, glucose intolerance, dyslipidaemia and fatty liver diseases (1).

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