Artículo original

Body composition and morphological characteristics in women reformer Pilates practitioners

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Summary

No investigations analyzing the reformer Pilates practitioners' body composition based on the years of practice have been undertaken; yet because all research conducted to date has rather focused on novice practitioners. Therefore, the aim of this study was to compare the anthropometric characteristics, somatotype, proportionality and body composition depending on the years of practice of women who practice reformer Pilates. Anthropometric characteristics, somatotype, proportionality and body composition were analyzed in a sample of 78 adult women (mean age: 44.00 ± 9.01 years) who practiced reformer Pilates 1 hour two times/week. Anthropometric variables were measured by a Level 2 anthropometrist certified by the International Society for the Advancement of Kinanthropometry. Two groups were made based on the women' years of practice: a group 1 (two or less years of practice) and a group 2 (more than two years of practice). The group 2 showed significant lower values in absolute size and Z-scores in body mass, six and eight skinfold sums, individual skinfolds and most of limbs and trunk girths (arm relaxed, chest, waist, gluteal, thighs and/or corrected calf girths) than the group 1. Significantly higher values in mesomorphy, ectomorphy and muscle mass and lower values in endomorphy and fat mass were also observed in the second group. In conclusion, the practice of reformer Pilates may generate positive adaptations in anthropometric characteristics, body composition and somatotype.

Key words:
Adipose tissue.
Body mass index.
Physical activity.
Quality of life. Weight.

Composición corporal y características morfológicas en mujeres que practican Pilates reformer

Resumen

Hasta el momento ninguna investigación ha analizado la composición corporal de los practicantes de Pilates reformer en función de sus años de práctica, ya que todos los estudios han analizado a practicantes nóveles. Por lo tanto, el objetivo de este trabajo fue comparar las características antropométricas, el somatotipo, la proporcionalidad y la composición corporal de un grupo de mujeres que hacían Pilates reformer en función de los años de práctica. Se analizaron las características antropométricas, el somatotipo, la proporcionalidad y la composición corporal de una muestra de 78 mujeres adultas (media de edad: 44.00 ± 9.01 años) que practicaban Pilates reformer 1 hora, dos veces por semana. Todas las variables antropométricas fueron tomadas por un antropometrista nivel 2 certificado por la Sociedad Internacional para el Avance de la Cineantropometría. Se dividió a la muestra en dos grupos en función de los años de práctica en: grupo 1 (2 o menos años de práctica) y grupo 2 (más de dos años de práctica). El grupo 2 mostró una valores significativamente inferiores en los valores absolutos y los valores Z del peso, el sumatorio de seis y ocho pliegues, los pliegues individuales, y la mayoría de los perímetros del tronco y las extremidades (perímetros de brazo relajado, mesoesternal, cintura, cadera, muslo y/o perímetro corregido de la pierna) que el grupo 1. El grupo 2 obtuvo valores significativamente más altos en la mesomorfia, la ectomorfia y la masa muscular, e inferiores en la endomorfia y la masa grasa. En conclusión, la practica de Pilates reformer puede generar adaptaciones positivas en las características antropométricas, la composición corporal y el somatotipo.

Palabras clave:
Tejido adiposo.
Índice de masa corporal.
Actividad física.
Calidad de vida. Peso.

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Introduction

Pilates' programs have grown considerably in the recent years around the world. Currently Pilates has an international presence and continues to attract new practitioners by workouts that mainly strengthen the "core", and can be tailored to meet individual needs, from professional athletes and senior citizens to pregnant women and youth[1].

Pilates method offers a "core" workout in which fitness components such as muscular strength and endurance, flexibility, balance and cardiorespiratory endurance are trained, with the aim of building a strong body under the philosophy of mind-over-body control[2,3]. Research about psychological, physiological and functional benefits of Pilates training is limited and most of the investigations have been focused on classic mat Pilates, which involves floor exercises using a mat[1,4-6]. Furthermore, the small number of participants who took part in these studies, the differences of procedures and the design limitations induce to interpret their results with caution.

Respect to the influence of Pilates practice on the anthropometric variables, previous studies found that Pilates method influences body composition, body mass index (BMI) and anthropometric characteristics[1,7-12]. However, these studies included small samples and novice participants. Moreover all these interventions were carried out using the classic mat Pilates.

Other studies have analyzed the effect of other Pilates modalities such as Segal *et al.*[13] who studied a sample of adults performing one Stott Pilates session of 60-minute, once a week during 24 weeks. However, no changes on body composition were determined. This Pilates modality is a contemporary adaptation of the classic mat Pilates but using different implements.

Also Erkal *et al.*[14] analyzed the effects of three sessions of 45-minutes a week at 45-60% of intensity during eight weeks of reformer Pilates in 10 women. This Pilates modality involves the use of a machine, the reformer, which provides a technical help to the practitioners when performing the exercises[15]. However, some limitations in Erkal *et al.'s* study[14] were observed such as the few participants and the low-to-moderate intensity of the program. Additionally the effects of their program were not analyzed due to the differences in anthropometric variables and body composition between both the intervention and the control groups before and after the intervention. So there are no studies regarding reformer Pilates practitioners developed with a sample of adult women without chronic diseases and with moderate exercise volume.

Furthermore, no investigations analyzing the subject's body composition based on the years of practice have been undertaken yet because all research conducted to date has rather focused on novice practitioners. Therefore, the aim of this study was to compare the anthropometric characteristics, somatotype, proportionality and body composition depending on the years of practice of women who practice reformer Pilates.

Material and method

Participants

A convenience sample of seventy-eight women, with ages between 23 and 63 years old (mean age: 44.00 ± 9.01 years old) who practiced reformer Pilates was recruited for this study. The sample was divided into two groups according to the years of practice: women with two or less years of reformer Pilates practice (group 1) (n=40) and women with more than two years of practice (group 2) (n=38) (Table 1). The characteristics of sample are described in Table 1. The inclusion criteria were: 1) training volume of one hour per season, two days per week; 2) not being or have been pregnant or on a diete in the last year; 3) the classes were directed by instructors certified in the reformer Pilates method and in Physiotherapy with almost one year of experience. The measures were taken between July and October of 2012.

Experimental design

The Institutional Bioethical Committee approved the study. All participants were informed of the standard instructions and measurements and signed an informed consent prior to the measurements. Anthropometric variables (body mass, heights, skinfolds, lengths and breadths) were measured by a Level 2 anthropometrist certified by the International Society for the Advancement of Kinanthropometry (ISAK), in accordance with the ISAK guidelines standard techniques[16].

Body mass was measured with the minimal clothing. The subject stood on the centre of the scale without support and with the weight distributed evenly on both feet. For measuring the stretch stature, the subject was standing with the feet together and the heels, buttocks and upper part of the back touching the scale; the head was placed in the Frankfort plane. The subject was instructed to take and hold a deep breath and while keeping the head in the Frankfort plane the measurer applied gentle upward lift through the mastoid processes. Sitting height was taken with the subject seated on a measuring box. This measure was taken using the same procedures as stretch stature. Arm span was measured with women extending the arms at their shoulders abduced in a 90-degree angle. Distance between dactylion point of both hands were taken.

Eight skinfolds were measures: triceps (most posterior part of the triceps when viewed from the side at the marked mid-acromiale-radiale level); biceps (most anterior part of the biceps when viewed from the side at the marked mid-acromiale-radiale level); subscapular (it was palpated the inferior angle of the scapula. The skinfold was located 2 cm from this point in a line 45º laterally downward), iliac crest (it was located the most lateral edge of the iliac crest. This skinfold is raised immediately superior to this point), supraspinale (at the intersection of a line from the anterior superior iliac spine to the anterior axillary border, and the horizontal line the level of the iliac crest point), abdominal (this was a vertical fold raised 5 cm from the right hand side of the omphalion), front

Table 1. Characteristics of reformer Pilates practitioners.

	Two or less years of practice (group 1)	More than 2 years of practice (group 2)	t and p values between both groups
N	40	38	-
Age (years)	42.55 ± 8.39	45.52 ± 9.49	t = -1.47; p = 0.16
Years of practice	1.01 ± 0.69	3.73 ± 0.99*	**t = -14.13; p < 0.001**

thigh (the skinfold is measured parallel to the long axis of the thigh at the mid-point of the distance between the Inguinal fold and the superior margin of the anterior surface of the patella) and medial calf skinfolds (the level of the maximum girth was determined and marked with a small horizontal line on the medial aspect of the calf).

Eleven girths were also measures: head (it was obtained in the Frankfort plane at the level immediately above the glabella with the tape perpendicular to the long axis of the head), neck (it was measured immediately superior to the thyroid cartilage -Adam's Apple-), arm relaxed (it was measured at the marked level of the mid-acromiale-radiale), arm flexed and tensed (it was measured at the level of the peak of the contracted biceps), forearm (maximum girth of the forearm distal to the humeral epicondyles), wrist (minimum girth distal to the styloid processes), chest (it was taken at the level of the mesosternale at the end of a normal expiration), waist (it was taken at the level of the narrowest point between the lower costal -10th rib- border and the iliac crest), gluteal (it 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), thigh -1 cm distance gluteal line- (it was taken 1 cm below the level of the gluteal fold, perpendicular to the long axis of the thigh), thigh -middle trochanter-tibiale laterale- (this was the right mid-thigh girth at the marked mid-trochanterion-tibiale-laterale site), calf (the maximum girth of the calf at the marked medial calf skinfold site) and ankle girths (the minimum girth of the ankle was taken at the narrowest point superior to the sphyrion tibiale).

Nine lengths were measured: acromiale-radiale (the arm length), radiale-stylion (the length of the forearm), midstylion-dactylion (the length of the hand), iliospinale height (the height from the floor to the anterior superior iliac spine), trochanterion height (the height from the floor to the trochanterion), trochanterion-tibiale laterale (the length of the thigh), tibiale laterale (the length of the leg), foot (the distance from the akropodion to the pternion) and tibiale mediale-sphyrion tibiale girths (the length of the tibia).

Seven breadths were also taken: biacromial (the distance between the most lateral points on the acromion processes), biiliocrestal (the distance between the most lateral points on the iliac crests), transverse chest (the distance was measured between the most lateral aspect of the thorax at the level of the mesosternale), anterior-posterior chest depth (the distance measured between the recurved or L-shaped branches of the caliper when positioned at the level of the mesosternale), biepicondylar humerus (the distance was measured between the medial and lateral epicondyles of the humerus), biepicondylar femur (the distance was measured between the medial and lateral epicondyles of the femur) and wrist breadths (the distance was measured between the medial and lateral bistuoid of the radius and ulna).

The variables were taken twice or three times, if the difference between the first two measures were greater than 5% for the skinfolds and 1% for the rest of the dimensions, with the mean values (or median in the last case) used for data analysis. The intra-rater technical error of measurement was set up at 3.05% for the skinfolds and 0.69% for the other variables. Investigator was blinded to measurements from women' previous Pilates practice experience.

Body mass was measured with a SECA 862 scale (SECA, Germany). Stretch stature, sitting height, arm span, direct lengths and breadths with a GPM anthropometer (Siber-Hegner, Switzerland) and a segmometer Cescorf (Cescorf, Brazil); girths with a metallic non-extensible tape Lufkin W606PM (Lufkin, USA) and skinfolds with a Harpenden skinfold caliper (British Indicators, UK). The instruments were calibrated in advance to avoid measurement errors. The temperature of the laboratory which the measurements were performed was standardized at 24 °C.

Means, standard deviations and Z-scores were calculated for all variables. The equations of Carter and Hearth[17] were used to calculate anthropometric somatotypes and the Phantom Stratagem[18] was used to calculate Z-scores of each raw variables. To determinate body composition strategy five components by Kerr[19] was used. Girths were corrected for the skinfold at the site using the formula: corrected girth = girth – (π • skinfold thickness). Body mass index (BMI) and the six and eight skinfold sums were also calculated.

Statistical analysis

Data were analyzed separately for both groups. Descriptive statistics including means and standard deviations were calculated. The hypothesis of normality was analyzed via Shapiro-Wilk test. An independent t-test was used to identify the differences between the two groups. The level of significance was set at $p \leq 0.05$ and data was analyzed using the Statistical Package for Social Sciences version 21.0 (SPSS Inc, Chicago, IL, USA).

Results

Table 2 presents the absolute anthropometric size of both two groups. A comparison between groups revealed that the group 2 showed significant lower values in body mass, six and eight skinfold sums, individual skinfolds, arm relaxed, chest (mesosternale), waist, gluteal and thighs (1 cm distance gluteal line and middle trochanter-tibiale laterale) and corrected calf girths than the group 1. The eight skinfolds profile is shown in Figure 1.

Relative size characteristics from Z-Scores of reformer Pilates practitioners are presented in Table 3. It was found significant differences in body mass, individual skinfolds, arm relaxed, thighs (1 cm distance gluteal line and middle trochanter-tibiale laterale), chest, waist and gluteal girths. The BMI values between both groups also showed significant differences observing lower values by the group 2 (Table 4).

As for the somatotype, the group 2 presented higher values in mesomorphy and ectomorphy and lower endomorphy values than the group 1. Significant differences in all components were observed (Table 4). The average somatotype of group 1 corresponded to mesomorphic endomorph morphotype, while the group 2' practitioners showed a mesomorph-endomorph morphotype. The attitudinal mean somatotype was obtained as a measure of average dispersion respect to the individual somatotypes (1.78 and 1.72 for the groups 1 and 2, respectively). Based on these results, reformer Pilates practitioners showed a moderate heterogeneity, which can be observed in Figure 2. The difference between the medium somatotypes of the two groups was 6.71.

The penta-compartmental components strategy by Kerr[19] was used to analyze the body composition. Significant differences in fat and muscle masses were determined showing the group-2 participants

Table 2. Absolute size of reformer Pilates practitioners.

Variable	Two or less years of practice (group 1)	More than 2 years of practice (group 2)	t and p values between both groups
Body mass (kg)	64.58 ± 1.23	59.83 ± 0.85	**t = 3.15; p = 0.002**
6 SF sum (mm)	118.43 ± 3.77	90.75 ± 1.74	**t = 5.94; p < 0.001**
8 SF sum (mm)	146.71 ± 4.72	111.97 ± 3.35	**t = 5.88; p < 0.001**
Stretch stature (cm)	163.98 ± 0.72	163.70 ± 0.75	t = 0.27; p = 0.78
Sitting height (cm)	85.38 ± 1.17	82.85 ± 0.51	t = 1.95; p = 0.08
Arm span (cm)	164.98 ± 0.94	164.46 ± 0.95	t = 0.39; p = 0.69
Triceps SF (mm)	18.73 ± 0.83	14.93 ± 0.50	**t = 3.83; p < 0.001**
Subscapular SF (mm)	15.86 ± 0.63	12.41 ± 0.56	**t = 4.06; p < 0.001**
Biceps SF (mm)	9.49 ± 0.55	7.30 ± 0.33	**t = 3.38; p = 0.001**
Iliac Crest SF (mm)	18.79 ± 0.70	13.91 ± 0.54	**t = 5.42; p < 0.001**
Supraspinale SF (mm)	16.43 ± 0.65	11.96 ± 0.62	**t = 4.92; p < 0.001**
Abdominal SF (mm)	22.68 ± 0.79	17.34 ± 0.66	**t = 5.12; p < 0.001**
Front thigh SF (mm)	25.49 ± 1.03	19.72 ± 0.65	**t = 4.63; p < 0.001**
Medial calf SF (mm)	19.23 ± 0.94	14.35 ± 0.52	**t = 4.43; p < 0.001**
Biacromial BR (cm)	34.49 ± 0.34	33.48 ± 0.28	t = 2.22; p = 0.29
Biiliocristal BR (cm)	25.43 ± 0.39	25.56 ± 0.34	t = -0.25; p = 0.80
Transverse chest BR (cm)	23.50 ± 0.32	22.92 ± 0.35	t = 1.21; p = 0.23
Antero-posterior chest depth (cm)	19.09 ± 0.27	18.39 ± 0.30	t = 1.69; p = 0.09
Humerus BR (biepicondylar) (cm)	6.02 ± 0.45	6.07 ± 0.38	t = -1.18; p = 0.34
Femur BR (biepicondylar) (cm)	8.83 ± 0.12	9.05 ± 0.59	t = -2.28; p = 0.09
Wrist BR (bistuloid) (cm)	5.04 ± 0.09	5.07 ± 0.05	t = -0.26; p = 0.79
Head G (cm)	54.43 ± 0.18	54.57 ± 0.30	t = -0.41; p = 0.69
Neck G (cm)	31.24 ± 0.31	31.63 ± 0.62	t = -0.57; p = 0.57
Arm G relaxed (cm)	27.49 ± 0.37	26.35 ± 0.32	**t = 2.30; p = 0.02**
Corrected arm G (cm)	21.63 ± 0.33	21.66 ± 0.30	t = -0.11; p = 0.91
Arm G flexed and tensed (cm)	28.52 ± 0.35	27.63 ± 0.33	t = -1.83; p = 0.07
Forearm G (cm)	23.87 ± 0.38	23.46 ± 0.25	t = 0.87; p = 0.38
Wrist G (distal styloid) (cm)	14.49 ± 0.10	14.86 ± 0.16	t = -1.93; p = 0.06
Chest G (mesosternale) (cm)	91.45 ± 0.96	87.03 ± 0.74	**t = 3.60; p = 0.001**
Waist G (cm)	74.71 ± 0.99	70.29 ± 0.90	**t = 3.27; p = 0.002**
Gluteal G (cm)	98.80 ± 0.97	95.38 ± 0.50	**t = 3.117; p = 0.003**
Thigh G (1 cm distance gluteal line) (cm)	55.11 ± 0.76	52.83 ± 0.41	**t = 2.59; p = 0.01**
Corrected thigh G (cm)	41.31 ± 0.46	41.46 ± 0.46	t = -0.24; p = 0.81
Thigh G (middle trochanter-tibiale laterale) (cm)	49.32 ± 0.61	47.66 ± 0.43	**t = 2.21; p = 0.03**
Calf G (max.) (cm)	34.70 ± 0.45	34.97 ± 0.31	t = -0.48; p = 0.63
Corrected calf G (cm)	28.66 ± 0.46	30.46 ± 0.34	**t = -3.09; p = 0.003**
Ankle G (cm)	20.84 ± 0.20	21.10 ± 0.13	t = -1.025; p = 0.30
Acromiale - radiale (cm)	31.16 ± 0.23	30.87 ± 0.30	t = 0.75; p = 0.45
Radiale - stylion (cm)	23.93 ± 0.17	23.80 ± 0.18	t = 0.524; p = 0.60
Midstylion - dactylion (cm)	18.95 ± 0.15	19.12 ± 0.13	t = -0.84; p = 0.40
Iliospinale HT (cm)	92.27 ± 0.61	92.31 ± 0.61	t = -0.41; p = 0.97
Trochanterion HT (cm)	81.78 ± 1.89	81.79 ± 1.81	t = -0.01; p = 0.99
Trochanterion - tibiale laterate (cm)	39.83 ± 0.45	42.34 ± 1.57	t = -1.53; p = 0.13
Tibiale laterate HT (cm)	43.84 ± 0.30	43.24 ± 0.41	t = 1.17; p = 0.24
Tibiale mediale – sphyrion tibiale (cm)	33.80 ± 0.30	34.04 ± 0.33	t = -0.53 p = 0.59
Foot length (akropodion-pternion) (cm)	22.35 ± 0.39	22.27 ± 0.31	t = 0.152; p = 0.80

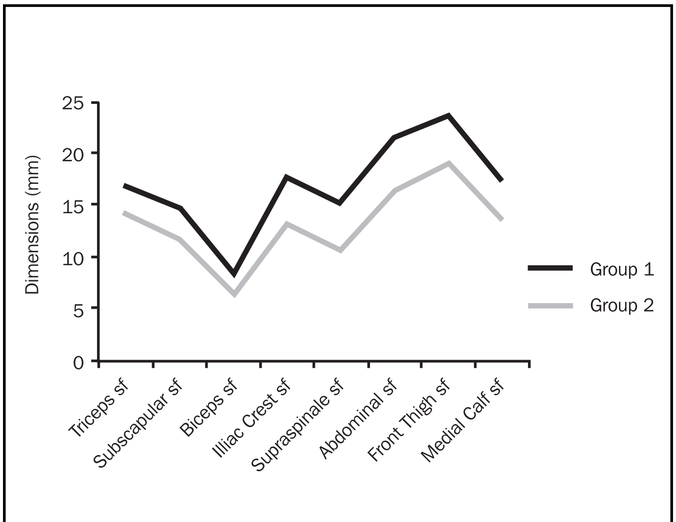
Mean ± standard deviation. SF: skinfold, G: girth, BR: breadth, HT: height.

higher values in muscle component and lower values in fat component than the group-1 practitioners. Although in this penta-compartmental model the total weight was not used for the calculation of any of the masses, the average error respect to the sum of the individual masses was 2.52 ± 2.95 kg, which supported the use of this methodology for the determination of body composition (Table 4).

Discussion

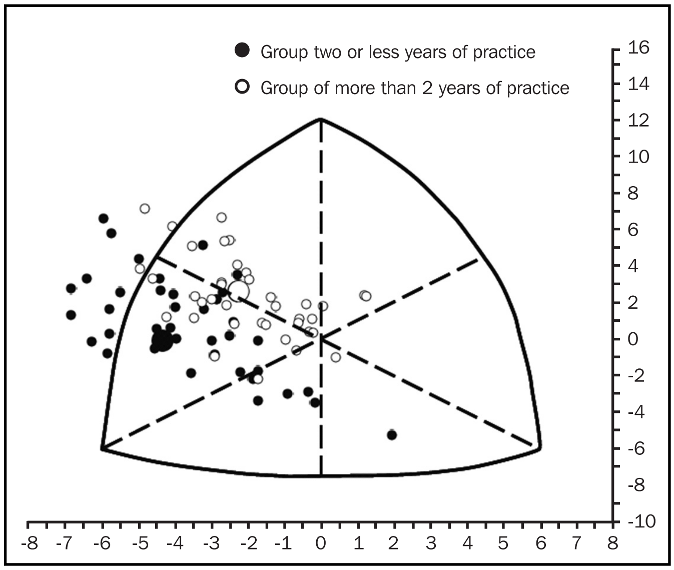
The purpose of this study was to determine anthropometric characteristics, somatotype and proportionality in women reformer Pilates practitioners with different levels of experience. The main finding was that more experienced women in the practice of reformer showed lower

Figure 1. Profile of eight skinfolds.



SF: skinfold.

Figure 2. Somatoplots of reformer Pilates practitioners



values in body mass, six and eight skinfold sums, individual skinfolds, most of limbs and trunk girths, and fat mass than the practitioners with less Pilates experience. Furthermore, group-2' women had higher values in the muscle mass than group-1' practitioners. Previous studies have found that Pilates reduces the total fat and/or the fat in extremities measured by bioimpedance[7] and by Dual-energy X-ray absorptiometry[9] as well as by using different anthropometric formula based on the three, four or six skinfold sums[1,8,10,14]. The results of these studies support the idea that long-term Pilates practice is associated with lower values in the six and eight skinfold sums, individual skinfolds and fat mass also observed in the present study. However, the current investigation is a cross-sectional study and a lot of factors such as the dietary habits can influence the results, so it is necessary to confirm these findings in a longitudinal reformer Pilates intervention.

As mentioned above, women with more Pilates experience showed higher values in muscle mass than the other group. Previous studies have identified that the practice of Pilates increases total and/or extremities lean body mass[8,9]. As lean body mass is the sum of muscle, skin, bone, and residual components, it can be concluded that changes in lean body mass might be consequence of muscle mass changes.

The findings of the current study are consistent with those of Cakmakçi[8] who observed that BMI values decreased after eight-week mat Pilates training program. Although BMI were calculated using body mass and stretch stature values, and the second variable is slightly modified in adults, published scientific evidence about the effects of Pilates exercises on body mass are not conclusive though. Baltaci *et al.'s* [7], Cakmakçi's[8] and Pan's[12] found that a mat Pilates training program of 60 minutes, 2-5 times per week during 4-8 weeks decreased weight values. In contrast, Cruz-Ferreira *et al.*[9], Erkal *et al.*[14] and Rogers *et al.*[1] did not observe significant changes with similar training programs. However, Baltaci *et al.´s*[7] and Pan´s[12] participants were older, and probably their fat mass were higher, while Cakmakçi´s[8] selected obese sedentary women. Subjects with lower body mass values tend to lose weight a slower rate than obese and overweight people[20]. This could explain differences among these studies. In the current study the group-2' participants showed lower weight values than the group-1' practitioners. However, this difference might be associated with dietary habits.

Another important finding is the lower values identified in waist-hip ratio, arm relaxed, chest (mesosternale), waist, gluteal and thighs and corrected calf girths in group 1 than in the group 2. Previous studies have found that mat Pilates reduced waist-hip ratio[8], waist girth[1,8,12], gluteal girth[8,12], arm relaxed and chest (mesosternale) girths[1] as a consequence of the reduction of fat mass. However, Rogers *et al.*[1] did not find changes in gluteal and thigh girths whereas no significant differences were observed by Erkal *et al.*[14] respect to a control group in the waist-hip ratio. The differences between Rogers *et al.'s*[1] and the current study results may be due to the different Pilates disciplines analyzed (traditional mat Pilates and reformer Pilates, respectively). This discipline performs lower extremity workouts at lower intensities than reformer Pilates, because in the first the principal role of the lower extremity is the stability, while in reformer Pilates the reformer provides a great stability and it is possible to develop resistance and endurance better, especially in people with stability deficiencies. Furthermore, Erkal *et al.*[14] intervention program was only eight weeks long at a low-moderate intensity (40-60%). This stimuli might have been insufficient to change waist-hip ratio.

Sekendiz *et al.*[6], Jago *et al.*[11] and Segal *et al.*[13] 's practitioners did not show changes in anthropometric variables may be due to the very short intervention program (only four and five weeks respectively)[6,11] or because of the frequency and the low intensity of the training program (one hour a week Pilates exercise)[13].

No differences in heights, breadths and depths were identified. Therefore, it is arguably that the differences found in the anthropometric variables, somatotype and body composition of women were not due to sample compositions but rather to external factors such as sport practice.

Differences in Z-Scores are very similar than those found in anthropometric variables. Perhaps due to all these measures of proportionality,

Table 3. Relative size characteristics from Z-Scores of reformer Pilates practitioners.

Variable	Two or less years of practice (group 1)	More than 2 years of practice (group 2)	t and p values between both groups
Z Body mass	0.89 ± 0.16	0.32 ± 1.22	**t = 2.77; p = 0.007**
Z Sitting height	-0.28 ± 0.27	-0.83 ± 0.10	t = 1.83; p = 0.07
Z Arm span	-0.15 ± 0.07	-0.18 ± 0.08	t = 0.27; p = 0.63
Z Triceps SF	0.91 ± 0.20	0.37 ± 0.12	**t = 3.68; p < 0.001**
Z Subscapular SF	-0.14 ± 0.13	-0.84 ± 0.11	**t = 3.99; p < 0.001**
Z Biceps SF	0.92 ± 0.28	-0.19 ± 0.18	**t = 4.00; p < 0.001**
Z Iliac crest SF	-0.42 ± 0.10	-1.16 ± 0.08	**t = 5.32; p <0.001**
Z Supraspinale SF	0.37 ± 0.15	-0.65 ± 0.14	**t = 4.85; p < 0.001**
Z Abdominal SF	-0.23 ± 0.10	-0.94 ± 0.90	**t = 5.02; p < 0.001**
Z Front thigh SF	-0.56 ± 0.13	-0.77 ± 0.85	**t = 4.44; p < 0.001**
Z Medial Calf SF	0.85 ± 0.21	-0.22 ± 0.12	**t = 4.32; p < 0.001**
Z Biacromial BR	-1.17 ± 0.14	-1.27 ± 0.16	t = 0.76; p = 0.27
Z Biiliocristal BR	-1.41 ± 0.20	-1.29 ± 0.20	t = -0,42; p = 0.67
Z Transverse chest BR	-2.03 ± 0.17	-2.34 ± 0.20	t = 1.17; p = 0.25
Z Antero-posterior chest depth	1.68 ± 0.21	1.18 ± 0.23	t = 1.54; p = 0.13
Z Humerus BR (biepicondylar)	-0,63 ± 0.14	-0.13 ± 0.11	t = -0,41; p = 0.10
Z Femur BR (biepicondylar)	-0.72 ± 0.28	-0.01 ± 0.14	t = -1.27; p = 0.10
Z Wrist BR (bistuloid)	0.95 ± 0.37	0.21 ± 0.15	t = -0.302; p = 0.76
Z Head G	0.37 ± 0.23	0.53 ± 0.25	t = 0.27; p = 0.63
Z Neck G	-1.41 ± 0.22	-1.16 ± 0.36	t = -0.59; p = 0.56
Z Arm G relaxed	0.71 ± 0.17	0.22 ± 0.15	**t = 2.04; p = 0.04**
Z Corrected arm G	2.38 ± 0.19	1.99 ± 0.18	t = 1.47; p = 0.15
Z Arm G flexed	0.88 ± 0.16	-0.27 ± 0.15	t = 1.62; p = 0.11
Z Forearm G	-0.24 ± 0.29	-0.52 ± 0.18	t = 0.78; p = 0.44
Z Wrist G	-1.79 ± 0.18	-1.24 ± 0.18	t = -2.12; p = 0.06
Z Chest G	1.36 ± 0.20	0.51 ± 0.16	**t = 3.25; p = 0.002**
Z Waist G	1.27 ± 0.24	0.28 ± 0.23	**t = 2.95; p = 0.004**
Z Gluteal G	1.41 ± 0.18	0.81 ± 0.12	**t = 2.66; p = 0.009**
Z Thigh G (1 cm distance gluteal line)	0.33 ± 0.19	-0.20 ± 1.05	**t = 2.41; p = 0.02**
Z Thigh G	-0.43 ± 0.15	-0.79 ± 0.97	**t = 2.02; p = 0.05**
Z Calf G	0.33 ± 0.20	0.48 ± 0.12	t = -0.60; p = 0.55
Z Corrected calf G	1.93 ± 0.22	2.35 ± 0.14	t = -1.56; p = 0.12
Z Ankle G	-0.56 ± 0.15	0.18 ± 0.12	t = -1.20; p = 0.23
Z Acromiale - radiale	-0.11 ± 0.10	-0.25 ± 0.15	t = 0.74; p = 0.46
Z Radiale - stylon	0.19 ± 0.11	0.12 ± 0.13	t = 0.40; p = 0.69
Z Midstylion - dactylion	0.95 ± 0.15	1.20 ± 0.14	t = -1.18; p = 0.24
Z Iliospinale HT	0.34 ± 0.07	0.39 ± 0.09	t = -0.38; p = 0.70
Z Trochanterion HT	-0.37 ± 0.43	-0.31 ± 0.42	t = -0.10; p = 0.92
Z Trochanterion – tibiale laterale	-0.15 ± 0.16	1.04 ± 0.63	t = -1.66; p = 0.10
Z Tibiale laterale HT	0.11 ± 0.07	-0.09 ± 0.12	t = 1.45; p = 0.15
Z Tibiale mediale – sphyrion tibiale	-0.82 ± 0.10	-0.67 ± 0.13	t = -0.89; p = 0.37
Z Foot length (akropodion-pternion)	-2.00 ± 0.31	-2.02 ± 0.25	t = 0.40; p = 0.97

Mean ± standard deviation. SF: skinfold, G: girth, BR: breadth, HT: height.

which are obtained by following the reference or the predefined model (Phantom), that used the stretch stature to calculate Z-Scores, booth groups showed very similar values in stretch stature.

Comparing the present results with other studies was not possible because participants of other studies have a very short Pilates experience, as normally there are sedentary and novices before to interventions. Also, some studies mixed dates of males and females despite the obvious anthropometric differences between them[1,10]. Additionally, the data was measured by bioelectric impedance in some previous studies[7,13]. Some investigations have supported the more validity of the lipometer respect to bioelectric impedance for body fat assessment[21].

This study had several potential limitations. Due to the nature of a cross-sectional study, it is difficult to affirm that all differences between both groups of participants occurred as a consequence of Pilates practice. This type of methodology was selected as the best because of the problems associated with involving subjects in training programs over

Table 4. Comparison and description of the somatotype, body composition, body mass index and waist/hip ratio of reformer Pilates practitioners.

Variable	Two or less years of practice (group 1)	More than 2 years of practice (group 2)	t and p values between both groups
BMI (kg/m^2)	24.02 ± 0.45	22.33 ± 0.30	**t = 3.06; p = 0.003**
Waist / hip ratio	0.75 ± 0.00	0.73 ± 0.00	t = 1.70; p = 0.09
Endomorphy	5.21 ± 0.16	4.13 ± 0.14	**t = 4.83; p < 0.001**
Mesomorphy	3.78 ± 0.18	4.25 ± 0.13	**t = -2.06; p = 0.04**
Ectomorphy	1.58 ± 0.16	2.13 ± 0.14	**t = -2.44; p = 0.02**
Skin mass (%	5.60 ± 0.37	5.62 ± 0.26	t = -0.33; p = 0.94
Bone mass (%)	8.87 ± 1.83	9.37 ± 1.56	t = -2.06; p = 0.05
Fat mass (%)	36.94 ± 3.72	32.67 ± 4.36	**t = 4.66; p = 0.04**
Muscle mass (%)	35.07 ± 3.05	36.87 ± 3.08	**t = -2.60; p = 0.01**
Residual mass (%)	9.45 ± 1.30	9.18 ± 1.53	t = 0.84; p = 0.40
Skin mass (kg)	3.59 ± 0.21	3.47 ± 0.17	t = 0.81; p = 0.16
Bone mass (kg)	5.69 ± 1.15	5.76 ± 0.88	t = -1.10; p = 0.21
Fat mass (kg)	23.87 ± 3.77	19.47 ± 2.67	**t = 5.35; p < 0.001**
Muscle mass (kg)	22.72 ± 3.84	22.11 ± 3.06	t = 1.00; p = 0.05
Residual mass (kg)	6.11 ± 1.15	5.52 ± 1.21	t = 0.83; p = 0.08
Differences between total mass and the sum of the five components (kg)	2.58 ± 2.72	2.48 ± 3.14	

Mean ± standard deviation. BMI: Body Mass Index.

long time periods. In addition, using anthropometry may be considered as a limitation despite the principal researcher good reliability. Other studies have employed more valise method like dual-energy x-ray absorptiometry[9].

However, the current investigation is the first in comparing women with different years of reformer Pilates practice. All previous studies had been conducted with an intervention of novice practitioners with different characteristics, of ordinary users of Pilates, who are usually health adult women that practice Pilates 1 hour, twice or three times per week, and they do not do other planned exercise. Also, these studies always investigated classic mat Pilates practitioners with different practice volumes. This investigation rather focus on body composition characterizes of reformer Pilates practitioners depending of years of practice. Future research endeavors would benefit from a reformer Pilates program along the time with novices and advanced large samples, and control group to avoid the sampling bias inherent in the current study sample. Other option will be include another Pilates modality (e.g., mat Pilates) or exercise class with similar characterizes (e.g. yoga) for reference purposes; using accelerometry during Pilates session, as well as using more sensitive methods to assess body composition (i.e., dual-energy x-ray absorptiometry).

In summary, women with higher reformer Pilates practice experience showed less fat mass, endomorphy six and eight skinfold sums; and higher muscle mass than women with less practice experience. Therefore, the practice of reformer Pilates may change the anthropometric characteristics, fat and muscle mass and somatotype.

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