

## Original Article

## Plaster body wrap: effects on abdominal fat



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## ABSTRACT

**Background:** Abdominal fat is associated with metabolic disorders, leading to cardiovascular risk factors and numerous diseases. This study aimed to analyze the effect of plaster body wrap in combination with aerobic exercise on abdominal fat.

**Methods:** Nineteen female volunteers were randomly divided into intervention group (IG;  $n=10$ ) performing aerobic exercise with plaster body wrap, and control group (CG;  $n=9$ ) performing only exercise. Subcutaneous and visceral fat were measured using ultrasound; subcutaneous fat was also estimated on analysis of skinfolds and abdominal perimeters.

**Results:** At the end of the 10-sessions protocol, the IG demonstrated a significant decrease ( $p \leq 0.05$ ) in subcutaneous fat at the left anterior superior iliac spine (ASIS) level and in iliac crest perimeter measurements. A large intervention effect size strength (0.80) was found in subcutaneous fat below the navel and a moderate effect size strength on the vertical abdominal skinfold (0.62) and the perimeter of the most prominent abdominal point (0.57). Comparing the initial and final data of each group, the IG showed a significant decrease in numerous variables including visceral and subcutaneous fat above and below the navel measured by ultrasound ( $p \leq 0.05$ ).

**Conclusion:** Plaster body wrap in combination with aerobic exercise seems to be effective for abdominal fat reduction.

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## 1. Introduction

Research demonstrates that fat location, namely abdominal fat or central adiposity, is more related to adverse metabolic consequences than fat quantity.<sup>1,2</sup> Abdominal fat

(divided into visceral and subcutaneous fat) is associated with metabolic disorders, characterized by insulin resistance, glucose intolerance, and risk factors for type 2 diabetes mellitus, dyslipidemia, hypertension, and atherosclerosis.<sup>2</sup>

In order to metabolize fat, aerobic exercise is recommended, increasing free fatty acid oxidation and muscle

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glycogen preservation.<sup>3,4</sup> To complement exercise, plaster body wrap, a clinically used technique involving a composition of green tea, green clay, magnesium sulfate, and calcium, can be used to maximize abdominal fat loss. Green tea contains catechins, which inhibit the enzyme that degrades norepinephrine and, consequently, leads to an increase in energy expenditure and an increase in fat oxidation. It also has caffeine that affects the sympathetic nervous system by enhancing the action of norepinephrine.<sup>5–7</sup> Both components can be absorbed by the skin.<sup>8–10</sup>

Green clay contains minerals such as iron and magnesium that contribute to lipolysis. Iron increases the lipolysis rate in adipocytes.<sup>11,12</sup> Magnesium, which appears to be absorbed by the skin, is picked up by adipocytes during lipolysis.<sup>13,14</sup> Green clay also contains calcium, and despite the lack of evidence regarding the reduction of intracellular calcium via its action on parathyroid hormone (PTH) and 1,25 dihydroxyvitamin D by the topical absorption of calcium by means of plaster bandage, Laudańska et al<sup>13</sup> found that calcium ions were able to cross the human skin barrier. Moreover, an association was found between increased calcium intake and decreased fat mass.<sup>15–17</sup>

The purpose of this study was to analyze the effect of plaster body wrap in combination with aerobic exercise on abdominal fat.

## 2. Methods

### 2.1. Sample

The controlled trial sample was composed of 19 female volunteers, selected through a questionnaire, and divided randomly into intervention (IG,  $n=10$ ) and control (CG,  $n=9$ ) groups. Volunteers were selected with body mass index (BMI) within the range 18.5–29.9, corresponding to normal range and pre-obese.<sup>18</sup> All volunteers were taking oral contraceptives. Those who practiced regular physical activity, who had a disease or risk factor that may influence lipid metabolism, as well as those who regularly smoked or consumed alcohol were excluded.

### 2.2. Instruments

A pilot study was done to analyze instrument intraobserver reliability by intraclass correlation coefficient (ICC) and standard error of the mean (SEM).

A nonstretchable measuring tape was used to measure height and perimeters (SEM=0.1 cm; ICC=0.99). Bioelectrical impedance Tanita BC-545 InnerScan was used to register weight.

Skinfolds, used to measure subcutaneous fat, were calculated using Harpenden analog caliper (SEM=0.2 mm; ICC=0.96). For the measurement of abdominal visceral and subcutaneous fat, the Echograph Viamo (Toshiba Medical Systems, Minato-ku, Tokyo, Japan) and a 7.5-Hz transducer (SEM=0.3 mm; ICC=0.97) were used.

A food frequency questionnaire (FFQ; Cronbach's  $\alpha=0.70$ ) was used in order to assess if participants' eating habits remained stable during the study.<sup>19</sup>

A plaster body wrap was prepared using the following components: green tea (Brazilian, ElivaPura, lot 01MAT 177103S), alcohol, magnesium sulfate, distilled water, plaster bandage, and green clay [from 00137 lot, Seara, Portugal – a smectite clay with chemical composition in %: SiO<sub>2</sub> (27.8); CaO (25.5); Al<sub>2</sub>O<sub>3</sub> (11.2); MgO (4.6); Fe<sub>2</sub>O<sub>3</sub> (2.3); K<sub>2</sub>O (1.57); TiO<sub>2</sub> (0.37); Na<sub>2</sub>O (0.05); loss on ignition (26.0)].

### 2.3. Procedures

The study lasted 5 weeks, with two sessions performed per week. Assessments were done prior to (M0) and after (M1) each of the 10 sessions. Ultrasound evaluated the areas between the xiphoid apophysis and above the navel for visceral and subcutaneous fat and below the navel and above the anterior superior iliac spine (ASIS) for subcutaneous fat.<sup>20</sup> Perimeters were measured for the waist (the narrowest point between the last rib and the iliac crests), the area above the iliac crests, the most prominent abdominal point, and the trochanter level; the waist to hip ratio was calculated (waist/trochanter level perimeter).<sup>21</sup>

Skinfolds were measured at the triceps, suprailiac, abdominal (horizontal and vertical), and thigh areas.<sup>21</sup> The percentage of body fat was estimated using skinfold measures according to the following formula:

$$\text{Body fat \%} = 1.1470292 - 0.0009376 \times (X1) + 0.0000030 \times (X1) \times 2 - 0.0001156 \times (X2) - 0.0005839 \times (X3)$$

where X1 is the sum of triceps, suprailiac, and thigh skinfolds in millimeters, X2 is age in years, and X3 is the circumference at the trochanter level in centimeters.<sup>21</sup>

Height and weight were also measured. The FFQ was self-applied and the participants were asked to maintain their eating and exercise habits.

The IG intervention protocol began with dynamic abdominal massage (5 minutes, with circular movements, to promote blood circulation) with an alcoholic extract of green tea (alcohol at 96%). Then, a solution of 33.79 g of green clay combined with 18.56 g of magnesium sulfate in 16.67 mL of distilled water was applied in order to improve clay element mobility.

The plaster bandage was then applied, impregnated with 3.12 g of green tea infusion, 6.94 g of magnesium sulfate in 0.5 L of water, and with more pressure in the center than in the periphery. Finally, cellophane was applied around the plaster bandage to keep it moist and retain body temperature.

While using the plaster body wrap, participants performed 30 minutes of moderate-intensity aerobic exercise on a cycle ergometer, monitored by Polar heart monitors and a Borg scale. The exercise was performed using Karvonen's formula, at 50% of the reserve heart rate (HR):

$$\text{HR during training} = \text{HR in the resting state} + (0.50 \times \text{HR reserve}), \text{ where HR reserve} = \text{HR maximum} - \text{HR resting state}.^4$$

The CG only performed aerobic exercise following the same criteria as the IG.

### 2.4. Ethics

Permission to carry out the study was granted by the School of Allied Health Sciences Ethics Committee (approval number 1360/2011) and all volunteers signed informed consent accord-

**Table 1 – Sample characterization (n = 19) in the intervention group (IG, n = 10) and the control group (CG, n = 9) at the initial moment.**

Variable	Group	Median	IQD	Minimum	Maximum	U	p
Age (y)	Intervention	21	1.63	19	23	34.5	NS
	Control	21	1	18	23		
Height (m)	Intervention	1.67	0.05	1.59	1.74	40.5	NS
	Control	1.67	0.05	1.55	1.75		
Weight (kg)	Intervention	58.35	5.49	51.8	73.7	36.5	NS
	Control	56	2.5	51.1	62.6		
BMI (kg/m <sup>2</sup> )	Intervention	21.2	2.2	19.0	24.6	36	NS
	Control	20.4	0.3	19.4	23.4		
FFQ (Kcal/d)	Intervention	1758.3	491.5	1127.1	2368.3	40	NS
	Control	1569	280.3	1059.9	2942.9		

BMI, body mass index; FFQ, food frequency questionnaire; IQD, interquartile deviation; NS, not significant.

ing to the Declaration of Helsinki. For use of the Portuguese version of the FFQ, permission was granted from its author.

The CG was invited to undertake the IG protocol at the end of the study.

### 2.5. Statistical analysis

Statistical analysis was done with Predictive Analytics Software (PASW Statistics version 18; Quarry Bay, Hong Kong, China), with a significance level of 5% ( $p \leq 0.05$ ). Given the small sample size, nonparametric tests were applied.<sup>22</sup> All severe outliers were excluded from the sample ( $n = 1$ ).

A new variable was calculated using differences between initial and final values in each group. A Mann-Whitney test was applied to compare groups and a Wilcoxon test allowed comparison between initial and final measures in each group. Effect size was calculated using the following formula:<sup>23</sup>

Cohen's difference = (IG final moment mean – CG final moment mean) / standard deviation.

Where, standard deviation is calculated for both groups at final moment.

## 3. Results

The sample ( $n = 19$ ) was characterized as shown in Table 1, and no significant differences were found between groups, making them comparable. When analyzing both groups after 10 sessions of intervention, a significant decrease was found in subcutaneous fat at the left ASIS (measured by ultrasound) and above the iliac crest perimeter (Table 2).

Considering that two statistically significant results were observed in a total of 17 variables, it was important to perform an analysis of variable behavior in each group after 10 intervention sessions (Table 3).

The significant IG improvements were seen in variables measured by ultrasound such as subcutaneous and visceral fat above the navel and subcutaneous fat below the navel. On IG skinfold measurements, a significant decrease in subcutaneous fat on the supriliac skinfold and on body fat percentage was also observed. IG perimeter measures decreased significantly at waist level, most prominently abdominal point level, and on waist to hip ratio. The CG also showed significant statistical results, namely in terms of subcutaneous fat below the navel (ultrasound), vertical

abdominal skinfold, total fat percentage, and waist, above the iliac crest, and most prominent abdominal point perimeters.

In order to understand the real effect of the plaster body wrap in combination with aerobic exercise, the intervention effect size was calculated. This quantifies the true magnitude of the measured intervention, by providing a dedicated value (a numeric score) when comparing the two groups.<sup>23</sup> Therefore, a moderate intervention effect size strength was found on the vertical abdominal skinfold (0.62) and the perimeter of the most prominent abdominal point (0.57). Subcutaneous fat below the navel presented a large intervention effect size strength (0.80).

The FFQ showed no significant differences between M0 and M1 in both groups, revealing that participants' eating habits remained stable during the study.

## 4. Discussion

While analyzing the study's results, it was possible to verify a significant decrease in abdominal fat in the IG compared with the CG, confirmed by ultrasound at the left ASIS level and by the perimeter above the iliac crest measurement. It is important to emphasize that one of the variables with significant statistical differences was measured by ultrasound, a valid method for abdominal fat measurement compared to computerized tomography.<sup>24,25</sup>

With a larger sample, a higher number of significant statistical results could probably have been observed. However, this was not possible once one set of restricted inclusion and exclusion criteria was adopted (so that no external influences could interfere with lipid metabolism). Hence, the intervention effect size calculation allowed verification of a moderate intervention effect size on the vertical abdominal skinfold, and a large intervention effect size was found for subcutaneous fat below the navel. These results reinforce the notion that the plaster body wrap has a positive action on reducing abdominal fat.

When comparing skinfold measurements at the initial and final moments, both groups showed statistically significant decreases on total fat percentage and on one of the skinfolds. Furthermore, perimeter measurements showed, for both groups, significant statistical results in three of the four variables. However, the similarity between the two groups' differences may be explained by the fact that exercise is indeed

**Table 2 – Median, interquartile deviation (IQD), Mann-Whitney test (U) value, and comparison test between the control group (CG, n = 9) and the intervention group (IG, n = 10) after 10 sessions of intervention.**

Variable		Group	Median	IQD	U	p
Ultrasound (mm)	Subcutaneous fat above the navel	Intervention	-1.2	1.11	35.5	NS
		Control	-0.9	1.08		
	Visceral fat above the navel	Intervention	-1.8	0.78	32.5	NS
		Control	-0.8	1.08		
	Below the navel	Intervention	-2.9	1.73	43	NS
		Control	-3	1.53		
	Right ASIS	Intervention	-0.5	0.88	42.5	NS
		Control	-0.7	0.43		
	Left ASIS	Intervention	-0.6	0.69	21.50	0.045
		Control	0.1	0.45		
Skinfold measurement (mm)	Suprailiac	Intervention	-0.2	0.15	23	NS
		Control	-0.06	0.1		
	Vertical abdominal	Intervention	-0.04	0.15	37	NS
		Control	-0.1	0.05		
	Horizontal abdominal	Intervention	-0.15	0.16	35.5	NS
		Control	-0.07	0.08		
	% Body fat	Intervention	-1.43	1.92	43	NS
		Control	-1.87	1.19		
Perimeter (cm)	Waist	Intervention	-1.68	1.42	32	NS
		Control	0.87	0.91		
	Above the iliac crests	Intervention	-0.02	0.67	17	0.022
		Control	1.8	1.1		
	Most prominent abdominal point	Intervention	-0.53	0.87	37	NS
		Control	-0.53	0.38		
	Waist to hip ratio	Intervention	-0.01	0.02	30	NS
		Control	-0.002	0.01		

ASIS, anterior superior iliac spine; NS, not significant.

**Table 3 – Median, interquartile deviation (IQD) values at moment 0 and moment 1 of the control group (CG) and the intervention group (IG). Wilcoxon test (Z value) and comparison values between initial and final moment after 10 intervention sessions.**

Variable			Moment 0		Moment 1		Z	p		
			Median	IQD	Median	IQD				
Ultrasound (mm)	IG	Subcutaneous fat above the navel	12.8	4.06	9.8	4.11	-2.805	0.002		
		Visceral fat above the navel	5.7	1.88	3.7	0.95	-2.807	0.002		
		Below the navel	5.7	1.88	3.7	0.95	-2.701	0.004		
		Right ASIS	8.7	1.65	7.8	1.91	-1.429	NS		
		Left ASIS	8.6	1.43	7.8	1.03	-1.888	NS		
	CG	Subcutaneous fat above the navel	11.0	1.43	10.1	1.00	-1.840	NS		
		Visceral fat above the navel	5.8	2.53	4.2	1.98	-1.899	NS		
		Below the navel	18.0	3.65	15.2	2.60	-2.524	0.008		
		Right ASIS	5.6	1.83	5.0	1.68	-1.185	NS		
		Left ASIS	5.6	1.48	5.3	1.18	-0.773	NS		
Skinfold measurement (mm)	IG	Suprailiac	17.9	2.68	16.2	1.16	-2.599	0.006		
		Vertical abdominal	17.5	2.00	16.8	1.85	-1.224	NS		
		Horizontal abdominal	17.1	1.45	15.4	1.80	-1.682	NS		
		% Body fat	29.8	3.50	27.5	1.44	-2.803	0.002		
	CG	Suprailiac	17.9	1.70	17.4	1.18	-1.304	NS		
		Vertical abdominal	16.8	0.64	15.6	0.92	-2.547	0.008		
		Horizontal abdominal	15.7	0.95	15.5	0.58	-1.599	NS		
		% Body fat	28.3	1.95	28.3	1.20	-2.547	0.008		
		Perimeter (cm)	IG	Waist	69.5	2.93	67.8	2.32	-2.601	0.006
				Above the iliac crests	75.8	3.71	75.0	2.83	-0.663	NS
Most prominent abdominal point	84.2			3.26	83.1	3.21	-2.666	0.004		
CG	Waist to hip ratio		0.70	0.03	0.68	0.02	-2.191	0.027		
	Waist		69.3	3.37	69.0	3.60	-2.666	0.004		
	Above the iliac crests		73.6	2.03	75.0	2.93	-2.073	0.039		
Most prominent abdominal point	82.5	2.01	81.2	2.04	-2.547	0.008				
	Waist to hip ratio	0.70	0.05	0.68	0.04	-0.415	NS			

ASIS, anterior superior iliac spine; NS, not significant.

one of the most important components for the metabolism of fat. However, when using the ultrasound, a specific instrument for measuring abdominal fat thickness on location, a significant statistical decrease was observed in the IG considering the subcutaneous fat above the navel, visceral fat above the navel, and subcutaneous fat below the navel, whereas in the CG this only occurred in the subcutaneous fat below the navel. Taking into account the validity of ultrasound and the fact that Horowitz<sup>3</sup> suggests that aerobic exercise promotes the uptake of fatty acids, especially from subcutaneous adipose tissue, it is possible that this difference in results between the two groups might be due to the consumption of fatty acids across the abdominal region (visceral and subcutaneous) when exercise is performed along with the use of plaster body wrap.

Plaster body wrap results are due to the individual action of each of its components after topical application. Green tea catechins and xanthines present good penetration and retention in the skin, allowing effective application of safe component concentrations.<sup>8,9</sup> The skin also appears to be permeable to calcium and magnesium ions.<sup>13</sup>

Concerning green tea, Chantre and Lairon<sup>26</sup> analyzed its effect in moderately obese participants, and found a decrease in body weight and waist circumference. Venables et al<sup>27</sup> compared green tea and placebo ingestion, and showed that the former could increase fat oxidation by 17% during moderate intensity exercise (30 minutes of cycling). The calcium of the plaster body wrap may play a role in explaining the results of this study. When extracellular calcium level increases, PTH and 1,25 dihydroxyvitamin D decrease, which leads to a decrease in intracellular calcium in adipocytes, stimulating lipolysis and lipogenesis inhibition.<sup>15–17,28</sup> Nevertheless, it is not known if calcium ions have the potential to penetrate human skin and, if they cross it, does this cause an increase in extracellular calcium; this aspect needs further investigation. Magnesium plays an important role once it is picked up by adipocytes to perform lipolysis, and as fatty acids are mobilized, its concentration decreases, especially during aerobic exercise; this is the reason why the application of body wrap can favor the lipolysis process.<sup>14</sup>

However, all studies refer to the action of these components on fat when they are ingested but not through topical absorption, and there is a lack of studies on component action in adipose tissue after its application on skin. In the future, it will be important to perform an analysis of the absorbed quantities of each compound and subsequent action on the tissues.

According to Nafisi et al,<sup>29</sup> in aqueous solution, xanthines have limited interaction with calcium and magnesium, which suggests that the concomitant use of these components does not seem to affect the action of each component on its own.

During abdominal region plaster wrap application, there was a concern about the chest wall and diaphragm restrictions. Studies on abdominal movement restrictions found no changes in endurance and exercise time, breathing pattern, and postexercise transdiaphragmatic pressure.<sup>30,31</sup> Another study added chest to abdominal restriction and observed the impairment of stroke volume and the reduction in cardiac output.<sup>32</sup> Thus, considering that the plaster wrap does not completely restrict abdominal movements and chest movements are completely free, it appears that breathing and diaphragmatic activity are not compromised. Moreover, none

of the patients reported any adverse effects and the compounds (and portions) used to perform plaster body wrap do not seem to present any risks to health on the quantities and time periods analyzed.<sup>33–36</sup>

In spite of the focus on abdominal fat in this study, once it is associated with numerous diseases, especially in women, it would be important to study the effect of plaster body wrap in combination with exercise around gluteal–femoral subcutaneous fat in women. In reality, fat deposits in women are located preferentially in the femoral–gluteal region.<sup>37,38</sup> This adaptation can be applied with the necessary studies, because the lipolytic activity of the two regions is different.

Further investigations may be conducted in order to modify the intensity or time to perform aerobic exercise, the influence of the temperature increase, and possible abdominal lymphatic drainage. For better understanding of each component's role, studies on its separate actions should be conducted.

Taking into account the results of this study, it seems that plaster body wrap can function as an adjunct to physical exercise in reducing abdominal fat. Therefore, it is important to highlight the results of this study so that physiotherapists may consider a new tool for enhancing lipolysis, allowing treatment and prevention of fat excess and its associated pathologies.

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## Conflict of Interest

The authors have no conflicts of interest to declare.

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