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Effect of 30 pilates sessions on body posture, perception and dynamic balance in healthy women

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HIGHLIGHTS

- Pilates is a good alternative for healthy adult women looking for physical activity.
- Thirty Pilates sessions performed twice a week improve dynamic balance.
- Pilates promotes changes in posture, postural habits, and body image.

ABBREVIATIONS

BackPEI	Back Pain and Body Posture Evaluation Instrument
BPI	Body perception index
DIPA	Digital Image-based Postural Assessment
IMP	Image Marking Procedure
M1	30 days before the intervention Started
M2	One to four days before the first session
M3	One to four days after the last session
SEBT	Star Excursion Balance Test

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BACKGROUND: The development of research has not followed the increase in the number of Pilates practitioners. So, due to the popularity of the Pilates Method, especially among women, studies that verify the effects of exercises are important.
AIM: To verify the effect of 30 sessions of the Pilates Method on static body posture, postural habits, body image perception and dynamic balance in healthy adult women.
METHOD: This is a quasi-experimental study, characterized by a 15-week Pilates exercise intervention program, twice a week. Outcomes static body posture, postural habits, body image perception, and dynamic balance were evaluated in three moments: 30 days before the intervention started (M1), just before the intervention started (M2) and ended (M3).
RESULTS: Nineteen healthy women [26.8 (3.5) years, 57.9 (6.8) kg, 160.6 (6.9) cm] participated in the study. There were differences in M2 compared to M3, and this represented an increase in the balance score (p<0.001), in the proportion of individuals with aligned trunk postural balance (p=0.002), in the proportion of individuals with a neutral pattern to pick up an object from the floor (p<0.025), and a decrease in the perception of distance between trochanters (p=0.037).
CONCLUSION: Thirty Pilates sessions practiced twice a week by healthy adult women can improve dynamic balance, the postural habit of pick up an object from the floor, and static body posture.

KEYWORDS: Exercise movement techniques | Health promotion | Exercise

INTRODUCTION

Originally called Contrology, the Pilates Method was developed by Joseph Pilates [1]. The six principles of the Method are concentration, control, centering, flowing movement, precision and breathing [2] and the exercises can be divided into mat (where the exercises are performed on the ground) and apparatus work (where the exercises are performed against resistance provided by springs and pulley in the apparatus created by him) [3].

Due to the popularity of the Pilates Method, especially among women [4], and the expectation of practitioners, studies that verify the effects of exercises are important. In addition, the development of research has not followed the increase in the number of Pilates practitioners [4]. Joseph Pilates guaranteed that “in 30 sessions you will have a new body” [5].

Even today, this phrase has been used as marketing in many Pilates studios. However, there is much to be investigated about the real effects of the Method, especially in the public that most seeks this type of exercise [4,6].

Mazzarino et al. [6] critically analyze the benefits of Pilates on health outcomes in women with a health condition and found emerging evidence to show that Pilates may reduce pain, and may improve quality of life and low extremity endurance. However, there is still a paucity of evidence. In healthy women, no scientific evidence was found on the effect of Pilates on body posture [7], function of pelvic floor muscles [8] and sleep quality [9] and more studies investigating the effects of the Pilates Method on health outcomes are needed.

In this sense, we started to fill these gaps by conducting the present study with the aim of verifying the effect of 30 Pilates sessions on static body posture, postural habits, body image perception and dynamic balance in healthy adult women. We understand that these are important outcomes of interest among the female audience, especially body posture [4].

METHODS

The present study presented a quasi-experimental temporal series design with a quantitative approach, characterized by an intervention program with Pilates Method exercises on the ground, with 15 weeks duration, twice a week. The ethical precepts, provided for by resolution 466/12 of the National Health Council, were followed and activities only started after approval by the Research Ethics Committee (477.510).

Sample calculation was performed using the G*Power software (version 3.1.7). It was considered $\alpha = 0{,}05$ and $\beta = 0{,}20$ to detect a moderate effect ($f^2 > 0{,}5$), from the dynamic balance variable, in measures of central tendency (mean) and dispersion (standard deviation) [10]. The calculation resulted in a minimum sample of 19 individuals. With the addition of 25% related to possible sample losses, the sample calculation resulted in 24.

The sample consisted of 24 healthy adult women, aged between 21 and 35 years. Eligibility criteria were not having medical contraindications for exercising, not having practiced regular physical activity in the previous year, not having previous contact with Pilates, and not having childbirth or pregnancy in the last six months. The exclusion criterion was not attending the intervention, that is, having more than two consecutive absences and/or three sporadic absences.

A control period was carried out for the volunteers who underwent the intervention. The assessment took place in three moments: 30 days before the intervention starts (M1), one to four days before the first session (M2), and one to four days after the last session (M3). Dynamic balance was assessed through the Star Excursion Balance Test (SEBT) [11]; static body posture, by digital photogrammetry, based on the protocol and Digital Image-based Postural Assessment (DIPA) software [12]; postural habits, through the Back Pain and Body Posture Evaluation Instrument (BackPEI) questionnaire [13]; and the perceptual dimension of body image, through the Image Marking Procedure (IMP) [14].

Star Excursion Balance Test (SEBT)

The SEBT is a valid and reproducible instrument [11]. To perform the test, theindividual remains in unipedal support with the distal part of the hallux positioned in the center of the figure drawn on the ground with measuring tapes (Figure 1) and is instructed to reach the greatest distance in the anterior, posteromedial, and posterolateral directions, while remains with the foot of the limb to be evaluated resting on the ground [15]. Before the test, the evaluator provided verbal instructions and a visual demonstration. Then, three attempts were made on each limb, in all directions. The score for the right and left limbs was composed by the sum of the maximum reach in the 3 directions, divided by the multiplication value of three times the length of the individual's lower limb. This result was multiplied by 100 [16].

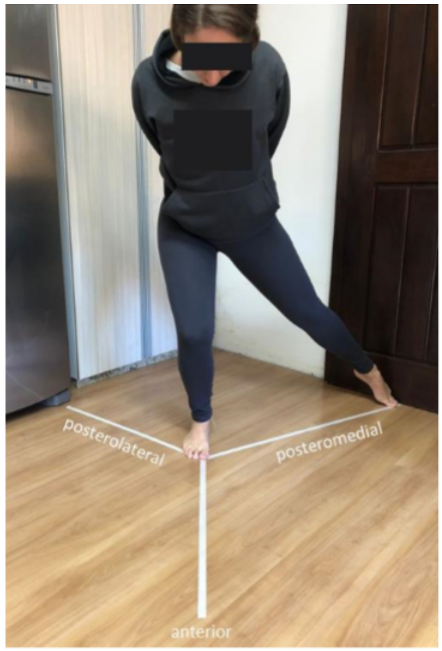

Figure 1. Star Excursion Balance Test – SEBT

Digital Image-based Postural Assessment (DIPA)

The DIPA is a valid and reproducible instrument 12. The protocol for the acquisition and analysis of photographs in the sagittal and frontal plane was followed. In summary, the individual is identified with markers at the following anatomical points: occipital protuberance, right tragus, acromions, inferior angles of the scapulae (RIAS and LIAS), posterior superior iliac spine (RPSIS and LPSIS), anterior superior iliac spine (RASIS and LASIS), greater trochanter of the right femur (GTRF), tuberosity of the lateral condyle of the right femur (TLCRF), right lateral malleolus, heels and C1, C2, C4, C6, C7, T1, T2, T4, T6, T8, T10, T12, L2, L4 and S2 spinous processes.

Then, photographs are taken with the individual in the sagittal and frontal planes. The images are analyzed in the DIPA software, which provides quantitative and qualitative information about the individual's static posture, such as: trunk postural balance (distance from T6 to a vertical line from S2), head alignment (angle formed between right tragus, C7 and a horizontal line from C7), pelvic tilt (angle between RPSIS and RASIS, with a horizontal line from RPSIS), pelvic pulsion (horizontal distance from GTRF to a vertical line from right lateral malleolus), knee position (angle between GTRF, TLCRF and right lateral malleolus) and angles of spinal curvatures (cervical, thoracic and lumbar) in the sagittal plane; shoulders (acromions height difference), scapulae (RIAS and LIAS height difference), and pelvis (RPSIS and LPSIS height difference) horizontal alignments and spine alignment in the frontal plane. Each of the static posture variables was classified as aligned or misaligned.

When classified as misaligned, the type of misalignment, such as right/left or anteversion/retroversion, for example, was still considered.

Back Pain and Body Posture Evaluation Instrument (BackPEI)

The BackPEI is a valid and reproducible questionnaire [13]. It assesses postural habits, back pain, and associated risk factors. Only the questions related to the postures adopted to pick up an object from the floor, to sit down to write at the table, to talk with friends and to use the computer were used. The answers were classified into flexor, neutral and extensor postural pattern according to the option indicated in the questionnaire by the individual. The neutral pattern corresponds to maintenance the pelvis in a neutral position, and both, lumbar lordosis and thoracic kyphosis in neutral (or physiologic) position, when the subject pick up an object from the floor. The flexor pattern is associate to spine flexion together with a pelvic retroversion, while the extensor pattern is associate to spine extension together with a pelvic anteversion [17].

Image Marking Procedure (IMP)

The IMP assesses the perceptual dimension of body image through sensory stimulation at seven points: the apex of the head, acromions, waist and trochanters by the evaluator. The individual must replicate the location of the stimulus on a whiteboard positioned in front of him with a pen, drawing a point that represents the projection of the stimulus location on his body, as if the individual were drawing his body image dimensions on the board. Right after, the distance between the trochanters and the internal area formed by the seven points is calculated, as suggested by Schmit et al. [14], both in the drawing (perceived size) and in the individual (real size). The body perception index (BPI) 18, which is the result of the test, was calculated through the ratio between the perceived and real size multiplied by 100 and classified into three categories: underestimation (<100%), normal (=100%) and overestimation (>100%).

Intervention

The Pilates mat exercises were based on the protocol proposed by Siler [19] and are detailed in Pivotto et al. [20]. Sessions were delivered by a trained physical educator with two years of experience in the Pilates methods, in groups of no more than four participants, twice a week for 15 weeks, lasting approximately 50 minutes. Progressions in the exercises were performed every five classes according to the individuality of each group. The participants had the option to reschedule sessions during the week.

Statistical analysis

Statistical analysis was performed using SPSS software (version 20.0). Descriptive (frequency distribution in percentage pointing the proportion of individuals with aligned/misaligned, mean and standard deviation) and inferential statistics were performed. Shapiro-Wilk and Mauchly tests were performed to assess normality and sphericity, respectively. Cochran's Q test (α<0.05) was performed for categorical data, followed by McNemar's test (α<0.025) for statistically significant results. Repeated measures ANOVA (α<0.05) was performed for parametric scalar data, and Friedman ANOVA (α<0.05) for non-parametric data, followed by Wilcoxon post hoc and Bonferroni correction (α<0.025).

RESULTS

Five participants were excluded for not attending the intervention. Therefore, 19 women with a mean age of 26.8 (3.5) years, mean body mass of 57.9 (6.8) kg and mean height of 160.6 (6.9) cm participated in the study.

The results showed that there was a statistically significant difference in the comparison between M2 and M3 in both limbs (right p<0.001; left p=0.001) for dynamic balance (Table 1) and this difference was not found in the comparison between M1 and M2. That is, there was an improvement in the women's dynamic balance after 30 Pilates sessions.

Table 1. Intervention results in dynamic balance (SEBT).

Member	Moments	Balance score Mean (SD)	Comparisons (p value)		
			Moments	Levels	
Right	M1	81.3 (21.8)	0.002*	M1xM2	1.000
	M2	78.6 (16.2)		M2XM3	<0.001*
	M3	96.4 (11.3)			
Left	M1	79.2 (13.5)	0.001*	M1xM2	0.500
	M2	81.1 (16.8)		M2XM3	0.001*
	M3	97.2 (11.4)			

M1: 30 days before the intervention starts; M2: just before the intervention starts; M3: after the intervention; *statistical significance.

Regarding postural habits, a statistically significant difference was found in the comparison between M2 and M3 in the postural pattern to pick up an object from the floor (p=0.008) (Table 2). This difference was not found in the comparison between M1 and M2. Study participants had a flexor pattern when performing this movement before the intervention and after the intervention they started to use the neutral postural pattern.

Table 2. Intervention results on postural habits (BackPEI).

Questions	Moment	Postural pattern adopted (%)			Comparisons (p value)		
		Flexor	Neutral	Extensor	Moments	Levels	
Sit down to write at the table	M1	85	0	15	0.111	M1XM2	na
	M2	85	10	5		M2xM3	na
	M3	68	32	0			
Sit down to talk with friends	M1	69	0	31	1.000	M1XM2	na
	M2	68	0	32		M2xM3	na
	M3	69	10	21			
Sit down to use the computer	M1	69	8	23	0.667	M1XM2	na
	M2	53	5	42		M2xM3	na
	M3	68	16	16			
Pick up an object from the floor	M1	85	15	0	0.008*	M1XM2	0.500
	M2	84	16	0		M2xM3	0.008*
	M3	47	53	0			

M1: 30 days before the intervention starts; M2: just before the intervention starts; M3: after the intervention; *statistical significance; na: not applicable.

Postural assessment results (Table 3 and 4) showed a statistically significant difference only in the comparison between M2 and M3 of the trunk postural balance variable in the sagittal plane (p=0.016). This difference was not found in the comparison between M1 and M2. There was an increase in the proportion of participants classified as aligned in relation to trunk postural balance after the intervention.

Table 3. Intervention results in static body posture (frontal plane).

<table>
<tr><th rowspan="3">Plan</th><th rowspan="3">Variable</th><th rowspan="3">Moment</th><th colspan="4">Classification</th><th colspan="3" rowspan="2">Comparisons (p value)</th></tr>
<tr><th rowspan="2">Aligned (%)</th><th colspan="3">Misaligned</th></tr>
<tr><th>Total (%)</th><th colspan="2">Type (%)</th><th>Moments</th><th colspan="2">Levels</th></tr>
<tr><td rowspan="24">FRONTAL</td><td rowspan="6">Shoulders alignment</td><td rowspan="2">M1</td><td rowspan="2">61</td><td rowspan="2">39</td><td>Left</td><td>(60)</td><td rowspan="6">0.276</td><td rowspan="3">M1XM2</td><td rowspan="3">na</td></tr>
<tr><td>Right</td><td>(40)</td></tr>
<tr><td rowspan="2">M2</td><td rowspan="2">68</td><td rowspan="2">32</td><td>Left</td><td>(83)</td></tr>
<tr><td>Right</td><td>(17)</td><td rowspan="3">M2xM3</td><td rowspan="3">na</td></tr>
<tr><td rowspan="2">M3</td><td rowspan="2">74</td><td rowspan="2">26</td><td>Left</td><td>(60)</td></tr>
<tr><td>Right</td><td>(40)</td></tr>
<tr><td rowspan="6">Scapulae alignment</td><td rowspan="2">M1</td><td rowspan="2">68</td><td rowspan="2">32</td><td>Left</td><td>(0)</td><td rowspan="6">0.264</td><td rowspan="3">M1XM2</td><td rowspan="3">na</td></tr>
<tr><td>Right</td><td>(100)</td></tr>
<tr><td rowspan="2">M2</td><td rowspan="2">79</td><td rowspan="2">21</td><td>Left</td><td>(100)</td></tr>
<tr><td>Right</td><td>(0)</td><td rowspan="3">M2xM3</td><td rowspan="3">na</td></tr>
<tr><td rowspan="2">M3</td><td rowspan="2">90</td><td rowspan="2">10</td><td>Left</td><td>(0)</td></tr>
<tr><td>Right</td><td>(100)</td></tr>
<tr><td rowspan="6">Pelvis alignment</td><td rowspan="2">M1</td><td rowspan="2">100</td><td rowspan="2">0</td><td>Left</td><td>(0)</td><td rowspan="6">na</td><td rowspan="3">M1XM2</td><td rowspan="3">na</td></tr>
<tr><td>Right</td><td>(0)</td></tr>
<tr><td rowspan="2">M2</td><td rowspan="2">100</td><td rowspan="2">0</td><td>Left</td><td>(0)</td></tr>
<tr><td>Right</td><td>(0)</td><td rowspan="3">M2xM3</td><td rowspan="3">na</td></tr>
<tr><td rowspan="2">M3</td><td rowspan="2">100</td><td rowspan="2">0</td><td>Left</td><td>(0)</td></tr>
<tr><td>Right</td><td>(0)</td></tr>
<tr><td rowspan="6">Spine alignment</td><td rowspan="2">M1</td><td rowspan="2">38</td><td rowspan="2">62</td><td>Left</td><td>(100)</td><td rowspan="6">0.121</td><td rowspan="3">M1XM2</td><td rowspan="3">na</td></tr>
<tr><td>Right</td><td>(0)</td></tr>
<tr><td rowspan="2">M2</td><td rowspan="2">32</td><td rowspan="2">68</td><td>Left</td><td>(100)</td></tr>
<tr><td>Right</td><td>(0)</td><td rowspan="3">M2xM3</td><td rowspan="3">na</td></tr>
<tr><td rowspan="2">M3</td><td rowspan="2">63</td><td rowspan="2">37</td><td>Left</td><td>(100)</td></tr>
<tr><td>Right</td><td>(0)</td></tr>
</table>

M1: 30 days before the intervention starts; M2: just before the intervention starts; M3: after the intervention; na: not applicable

Table 4. Intervention results in static body posture (sagittal plane).

Plan	Variable	Moment	Classification			Comparisons (p value)		
			Aligned (%)	Misaligned				
				Total (%)	Type (%)	Moments	Levels	
SAGITAL	Trunk postural balance	M1	0	100	Anterior (0)	0.002*	M1XM2	1.000
					Posterior (100)			
		M2	16	84	Anterior (0)			
					Posterior (100)		M2xM3	0.016*
		M3	53	47	Anterior (89)			
					Posterior (11)			
	Head alignment	M1	46	54	Anteriorization (100)	0.779	M1XM2	na
					Posteriorization (0)			
		M2	53	47	Anteriorization (100)			
					Posteriorization (0)		M2xM3	na
		M3	58	42	Anteriorization (87)			
					Posteriorization (13)			
	Cervical angle	M1	15	85	Hyperlordosis (77)	1.000	M1XM2	na
					Rectification (33)			
		M2	21	79	Hyperlordosis (77)			
					Rectification (33)		M2xM3	na
		M3	26	74	Hyperlordosis (36)			
					Rectification (64)			
	Thoracic angle	M1	100	0	Hyperkyphosis (0)	na	M1XM2	na
					Rectification (0)			
		M2	100	0	Hyperkyphosis (0)			
					Rectification (0)		M2xM3	na
		M3	95	5	Hyperkyphosis (0)			
					Rectification (100)			
	Lumbar angle	M1	92	8	Hyperlordosis (100)	0.368	M1XM2	na
					Rectification (0)			
		M2	100	0	Hyperlordosis (0)			
					Rectification (0)		M2xM3	na
		M3	100	0	Hyperlordosis (0)			
					Rectification (0)			
	Pelvic tilt	M1	100	0	Anteversion (0)	na	M1XM2	na
					Retroversion (0)			
		M2	100	0	Anteversion (0)			
					Retroversion (0)		M2xM3	na
		M3	100	0	Anteversion (0)			
					Retroversion (0)			
	Pelvic pulsion	M1	8	92	Antepulsion (100)	0.368	M1XM2	na
					Retropulsion (0)			
		M2	26	74	Antepulsion (100)			
					Retropulsion (0)		M2xM3	na
		M3	16	84	Antepulsion (94)			
					Retropulsion (6)			
	Knee position	M1	46	54	Hyperextension (57)	0.761	M1XM2	na
					Hyperflexion (43)			
		M2	42	58	Hyperextension (27)			
					Hyperflexion (73)		M2xM3	na
		M3	32	68	Hyperextension (8)			
					Hyperflexion (92)			

M1: 30 days before the intervention starts; M2: just before the intervention starts; M3: after the intervention; *statistical significance; na: not applicable.

Regarding perceptual dimension of body image, a statistically significant difference was found in the comparison between M2 and M3 in the distance between trochanters (p=0.037) (Table 5). This difference was not found in the comparison between M1 and M2. Participants overestimated the distance between the trochanters in M1 and underestimated in M3.

Table 5. Intervention results in body perception index.

	Moments	BPI score	BPI classification	Comparisons (p value)		
				Moments	Levels	
Area	M1	87.3 (21.8)	underestimation	0.198	M1xM2	na
	M2	91.9 (33.6)	underestimation			
	M3	84.7 (23.1)	underestimation		M2XM3	na
Distance between trocanters	M1	106.2 (23.5)	overestimation	0.001*	M1xM2	0.860
	M2	105.7 (24.7)	overestimation			
	M3	97.2 (16.1)	underestimation		M2XM3	0.037*

M1: 30 days before the intervention starts; M2: just before the intervention starts; M3: after the intervention; BPI: body perception index; *statistical significance.

DISCUSSION

The present study found an improvement in the dynamic balance of healthy adult women after 30 Pilates sessions when compared to a one-month control period of the same participants. It was also found a change in the postural habit of picking up an object on the floor, in the postural balance of the trunk and in the body image perception related to the distance between the trochanters.

The improvement found in dynamic balance in both lower limbs (Table 1) corroborates the findings of other studies that investigated the Pilates effects on this outcome in healthy adults of both sexes [10], in women over 65 years of age[21], and in older adults of both sexes [22]. Dynamic balance can be defined as the ability to perform a task while maintaining a stable position [23]. We suspect that the mechanism behind the improvement observed in this outcome may be related to the centering principle, which is the focus of the Pilates method. As stated by Kibler et al. [24], the core muscles create a "rigid cylinder" and a greater moment of inertia allowing a stable base for mobility. Thus, the core muscles provide stabilization for the spine and therefore a stronger base of support for lower extremity movement.

According to Souza and Vieira [4], posture was the most desired goal by people who look for the Pilates Method, being reported by 38.8% of the sample, followed by flexibility (32.1%), pain relief and treatment of musculoskeletal disorders (24.2%). That was the reason we investigated this outcome. We found that 30 Pilates sessions are effective in the postural habit of picking up an object on the floor and in the postural balance of the trunk. We found no effect on other variables such as postural habits of sitting to write at the table, talking with friends and using the computer, and on static posture in the frontal plane, head alignment, cervical, thoracic, and lumbar angle, pelvic tilt and pulsion, and knee position. In the task of picking up an object from the ground, a flexed posture leads to an increase in shear forces in the spine and an increase in ligament stress, around 50% to 75%, when compared to a posture with a neutral pattern [24,25], which may be associated with degenerative processes, such as herniated discs.

Schmit et al. [7] systematically reviewed the literature to verify the effect of the Pilates method on the static body posture of women. They found only 4 studies with divergent results and suggest further studies. In our study, the trunk postural balance was considered aligned when a single vertical line cross S2 and T6, and the anterior misaligned was considered when T6 is forward to S2. Our results showed that 53% of the participant were aligned at M3 compared to 16% at M2, showing the effect of Pilates sessions in this variable (Table 4). Considering that "axial growth" is stimulated in the Pilates sessions, we believe that the postural assessment of the static position would be a good way to assess this effect on the participants. Based on the intervention protocol [20], it is also possible to verify that several of the proposed exercises were aimed at body alignment.

However, as suggested by Vieira and Souza [27], postural assessments based on the orthostatic position and muscle length have limitations and must also take into account the muscle tensions present in various postural habits and the perceptions that the individual has of his own body. In order to reduce this limitation, we included the assessment of postural habits and body image perception, in addition to the assessment of static body posture through photogrammetry with the DIPA software. We found a significant change in the body image perception. The women who participated in the present study overestimated the distance between the trochanters in M1 and underestimated in M3 (Table 5). The intervention was able to promote a change in the women's body image after 30 sessions of the Pilates method. Both overestimation and underestimation classifications are considered distortions in body image. However, at this point, it is not possible to state if this change found in our study from overestimation to underestimation can be considered good or not. More studies are necessary to clarify this issue.

Finally, it is important to point out the limitations of the present study, such as the lack of a control group evaluated with a time interval equal to the intervention group, and the non-blinding of the evaluators. In this sense, caution is suggested when interpreting the results.

CONCLUSION

We concluded that 30 Pilates sessions practiced twice a week by healthy adult women can improve the dynamic balance, the postural habit of picking up an object on the floor, the postural balance of the trunk in the sagittal plane. Also, body perception index of the distance between the trochanters has changed, however more studies are necessary to understand the impact of this alteration. Pilates is an interesting alternative for healthy adult women looking for physical activity.

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