The effect of Global Postural Reeducation on body weight distribution in sitting posture and on musculoskeletal pain. A pilot study

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Summary

Objective: *To quantify body weight distribution (BWD) in seated posture with an office chair instrumented with load cells and to evaluate the effects of ergonomic advice and Global Postural Reeducation (GPR) on seated BWD and on musculoskeletal pain.* Methods: *Nineteen healthy females were randomly assigned: nine to the experimental group and 10 to the control group. Control group (CG) received only ergonomic verbal advice (EVA) regarding BWD in a seated position. Experimental group (EG) also received EVA and furthermore attended eight GPR sessions. Difference in the effects of the different therapeutic approaches was investigated using the non-parametric Wilcoxon-Mann-Whitney test.* Results: *After treatments, there was no significant difference between the two groups as regards seated BWD. EG improved musculoskeletal pain significantly more than CG ($p<0.005$). Instead, musculoskeletal pain frequency decreased ($p<0.005$) only in EG (after EVA and GPR sessions), in neck, cervical, thoracic, lumbar, shoulders and wrists areas.* Conclusions: *Despite both interventions did not induce any significant improvement on seated BWD, adding GPR to EVA was related to a better reduction on musculoskeletal pain in young health females.*

Riassunto

«*Effetto della Rieducazione Posturale Globale sulla distribuzione del peso corporeo in posizione seduta e sul dolore muscoloscheletrico. Uno studio pilota*». Obiettivi: *Quantificare la distribuzione del peso corporeo (BWD) in posizione seduta mediante una sedia da ufficio dotata di celle di carico e valutare gli effetti di consigli ergonomici e della rieducazione posturale globale (GPR) sulla BWD da seduti e sul dolore muscoloscheletrico.* Metodi: *Diciannove donne in buona salute sono state assegnate a caso al gruppo sperimentale (nove soggetti) e al gruppo di controllo (10 soggetti). Il gruppo di controllo (CG) ha ricevuto solo consigli ergonomici verbali (EVA) relativi alla BWD in posizione seduta. Il gruppo sperimentale (EG) ha ricevuto EVA e, inoltre, ha partecipato a otto sessioni di GPR.*

La diversità di risultati dei differenti approcci terapeutici è stata investigata utilizzando il test non parametrico di Wilcoxson–Mann–Whitney. **Risultati:** *Dopo i trattamenti, non si è rilevata una differenza significativa tra i due gruppi per quanto riguarda la BWD da seduti. Nel gruppo sperimentale il dolore muscoloscheletico è migliorato molto più significativamente che nel CG (p<0.005). Invece, la frequenza del dolore muscoloscheletrico è diminuita (p<0.005) solo nell'EG (dopo EVA e sessioni di GPR), nel collo, spalle e polsi e nelle regioni cervicale, toracica e lombare.* **Conclusioni:** *Nonostante entrambi gli interventi non abbiano prodotto un miglioramento significativo della BWD da seduti, l'aggiungere GPR a EVA è correlato a una migliore riduzione del dolore muscoloscheletrico in giovani donne in buona salute.*

INTRODUCTION

Prolonged sitting has become a human habit (13), particularly in the digital age. Every day people sit in front of a computer at work and at home for extended periods of time (30), giving rise to the insight that the homo sapiens might also be considered *homo sedens* ("seated man") (20, 25). Time spent in sedentary behaviors (e.g. television viewing, computer and game-console use, workplace sitting, and driving) has been associated with musculoskeletal problems, especially on the lumbar spine which is heavily loaded in sitting (20, 37) as well as metabolic disorders such as diabetes and obesity (13, 12, 17). As a consequence, a sedentary lifestyle can be considered a public health problem (12).

Sitting posture modifies physiological spinal curvature, especially in the lower back region, as many individuals tend toward kyphosis in this position (36). A prolonged relaxed sitting posture with lumbar kyphosis is associated with increased tension in the lumbar, thoracic and cervical spine, and is often implicated as a cause of back pain (36, 21). Because sitting, particularly if held for long periods, exerts musculoskeletal stresses on the spine and pelvis, a better understanding of body weight distribution (BWD) in sitting can contribute to improvements in workplace seating design (6), given the ubiquitous propensity of modern humankind to sit during functional activities (1). Although some studies about pressure distribution in seated posture from an ergonomic point of view can be found in the current literature (37, 19), very few studies address body weight distribution (BWD) in a sitting position (6, 19, 10) and their results are inconclusive about own weight distribution.

Sitting posture can be corrected using different therapeutic and ergonomic strategies (22). Ergonomic verbal advice (EVA) is a tool to teach people how to sit properly, provide knowledge on how people should arrange their individual home and employment workspace, and promote proper sitting posture as part of healthy computer-use habits (29).

The effectiveness of ergonomic tools, advice and active exercise has been shown to reduce lumbar pain and disability in video display terminal operators (27, 26, 23).

Global Postural Reeducation (GPR) is another active physiotherapy intervention based on an integrated conception of muscles as organized by "neuromuscular coordination chains", which can become shortened as a result of constitutional, behavioral and psychological factors (24). GPR stretches shortened muscles using the creep property of viscoelastic tissue and enhances contraction of the antagonist muscles (24). GPR has been demonstrated to be an effective method to achieve positive clinical outcomes relative to pain, posture and range of motion and reduce disability from several musculoskeletal conditions (2, 9, 32).

The aims of this pilot study were to identify: 1) whether combined GPR and EVA affects the distribution of body weight in a seated position during activities of manual typing and computer-related activities using a mouse compared to EVA alone; and 2) whether combined GPR and EVA alters musculoskeletal pain compared to EVA alone. This study used a novel low cost method to quantify BWD during seated posture by load cells on the front and back part of the seat and the backrest before and after two different physiotherapy approaches: EVA and GPR.

Methods

Study design

We chose a randomized controlled trial design with two collection data points (Time 1 and Time 2) while subjects were seated at a computer workstation. At each time point, data were collected from both the experimental group (EG) receiving GPR and EVA and the control group (CG) receiving only EVA regarding BWD in a seated position. Musculoskeletal pain data were collected by and independent assessor from the EG after GPR and EVA and from the CG after EVA.

The Ethics Committee of the University of Sao Paulo State (UNESP, Sao Jose dos Campos, Brazil) approved the study protocol. All participants signed the consent form, which was established in accordance with the provisions of the Declaration of Helsinki.

Sample

Twenty volunteers were randomly assigned to two groups, after providing informed consent: 10 to the EG and 10 to the CG. One subject assigned to the EG dropped out before Time 1, leaving nine subjects in the EG.

Subjects were enrolled in the last year of Dentistry at the University of Sao Paulo State (UNESP, Sao Jose dos Campos, Brazil). They were included if they reported a sedentary life style, were female, aged 20-30 years, able to perform activities in sitting position for at least eight hours a day, and had had experience with typing and using a computer mouse. Subjects who were excluded based on the clinical history collection had known musculoskeletal or neurological diseases/dysfunctions, body weight more than 100 kg, or exhibited severe postural deviations such as structural scoliosis.

Physiotherapy interventions

EG Intervention

The EG group attended eight GPR sessions once a week for one hour at a physiotherapy outpatient clinic and received EVA about sitting posture by a physiotherapist, who had experience with both GPR and ergonomics. Two GPR therapeutic postures were chosen for each session: 1) lying posture with extension of the lower limbs at both the hips and the knees, and adduction of the upper limbs (figure 1), and 2) lying posture with flexion of the hips with slight knee extension and abduction of the upper limbs (31) (figure 2).

The physiotherapist applied manual traction to cervical and lumbar regions during both GPR treatment postures to align the spine along a straight axis. The physiotherapist used verbal commands and manual contact to maintain the alignment, and made the necessary postural corrections to optimize global stretching and eliminate postural compensatory movements (2).

Figure 1 - Lying supine GPR posture with adduction of the upper limbs and progressive extension of hips and knees, mainly stretching anterior muscles

Figure 2 - Lying supine GPR posture with abduction of the upper limbs and progressive hips flexion and knees extension, mainly stretching posterior muscles.

CG intervention

The CG received only EVA about sitting posture. The EVA was provided by a physiotherapist with clinical experience in Ergonomics in the same testing room used by the EG. EVA included verbal advice about monitor height, visual angle, proper position of upper and lower limbs during typing and using a mouse and proper hips position in sitting posture (4, 28).

Physical therapy approach to BDW measure

Although there is a lack of consensus about optimal spinal curves in sitting (3), the majority of investigators since 1996 have agreed that a lordotic lumbar posture is preferred for sitting (15) and assists in maintaining lumbar postural health and preventing low back pain (LBP) (28, 34, 33). Based on this consensus, a lordotic lumbar posture in sitting was chosen for the advice given to the sample in this study during the tests of BWD for both sets of tasks (typing and mouse use).

Data Collection on BWD

In order to record BWD in sitting posture, an ergonomic office chair (Martiflex, Sarandi - PR, Brazil) instrumented with load cells in the front and back of the seat and at backrest, and a data acquisition system (strain gauge channels, computer and software EMGLab) were used during the testing. The office chair followed the ABNT (Brazilian Association of Technical Standards) and NR-17/Ergonomics (Regulatory Standard – 17) rules. Each load cell was structured with two deformable bodies of steel strips, bent in the shape of the letter "u", on which the strain gauges were glued. The strain gauges (KFG 3-120-C1-11/KYOWA) were constructed within the load cells to measure the reaction force from the force of a subject's weight when seated on the seat and to measure the t vertical component of weight imposed on backrest.

During collections of the seated BWD, the equipment used for calibrating the load cells and recording the load cells' data was an eight-channel acquisition system (EMG model - 800 C; EMG System of Brazil/Ltda). Data acquisition proceeded by adapting the first four channels (channels 1 to 4) to collect strain gauge data (load cells) while the last four channels (channels 5 to 8) continued with the same original configuration to collect electromyography data.

Calibration tests were conducted on all load cells with ascendant and descendant loads, and other tests were made after calibration to ensure that the loads cells were properly functioning, using the data acquisition system and EMGLab software. Each load cell of the office chair was connected to a strain gauge. Loads were measured in "kgf" (kilogramforce) in the front and back portions of the seat and at the backrest. Backrest load was measured as the vertical component of the force.

Slumped sitting is known to potentially produce or increase LBP (35). For this reason a non-slumped sitting was used during the test by asking subjects to adopt a "proper sitting posture". They maintained this posture while typing a text for 5 minutes and while drawing with a mouse for other 5 minutes. During the typing and mouse use 5-minutes tasks the seated BWD was recorded. Data on seated BWD were collected twice: at baseline (Time 1) and after Interventions (Time 2): after GPR and EVA for the EG, and after EVA for the CG.

Data Collection on musculoskeletal pain

Body pain ratings data were also collected twice: at baseline (Time 1) and after physiotherapy interventions (Time 2): after GPR and EVA for the EG, and after EVA for the CG. Subjects were also asked to rate their degree of pain on an 1-to-5 scale separately for each of 28 parts of the body, according to the method proposed by Corlett and Manenica (5). The interval time between Time 1 and Time 2 was approximately three months for both groups.

Data analysis

The data have been analyzed using the SAS Enterprise Guide 5.1 software. The small number of patients in this study suggested the use of non-parametric statistical tests, which do not make assumptions on the distribution of the variables. Subjects

characteristics recorded at Time 1 were compared in order to assess baseline heterogeneity of the two groups using a Wilcoxon-Mann-Whitney test. The BWD in a seated position was evaluated by calculating two indicators. The first one is the ratio of the loads imposed on posterior and anterior seat portions ("Posterior vs Anterior Index"). The second one is the ratio of the loads imposed on backrest and on anterior seat portion ("Backrest vs Anterior Index"). Such indicators would not be influenced by weight changes between Time 1 and Time 2 and different loads imposed on other surfaces (floor, table) which were not recorded. An increase in these indicators indicates a better sitting posture. Differences between Time 1 and Time 2 in the proposed indicators of BWD were tested, separately in each group, using a Wilcoxon Signed Rank Test, while difference in the effects of the interventions was investigated with Wilcoxon-Mann-Whitney test. Differences in pain ratings between data collections were tested with a Wilcoxon Signed-Rank test, separately for the two groups. Difference in the effects of the interventions on musculoskeletal pain was investigated using the Wilcoxon-Mann-Whitney test. Confidence level was set to 95% for both analyses; results from musculoskeletal pain analysis were reported as strength of evidence against the null hypothesis shown by p-values.

RESULTS

The main characteristics of the sample (weight, height, and Body Mass Index) are illustrated in table 1. According to the statistical tests, subjects in the EG and in the CG appeared to be homogeneous with respect to these characteristics.

Seated BWD analysis

Groups were also tested for homogeneity in BWD at Time 1. Posterior seat load vs. anterior seat load and backrest load vs. anterior seat load ratios recorded at Time 1 were compared for both typing and mouse-related tasks. Results of Wilcoxon-Mann-Whitney test are reported in table 1. According to these results, subjects in the EG and in the CG appeared to be homogeneous with respect to the two proposed indicators for BWD at Time 1.

No statistically significant difference appeared while comparing the values of the proposed indicators for BWD between Time 1 and Time 2, for both CG and EG and for both typing and mouse-related tasks using a Wilcoxon Signed-Rank test. No evidence of change of BWD between the two groups was found for both typing and mouse-related tasks. In order not to lengthen this paper, only typing tasks results are reported (table 2).

Musculoskeletal pain analysis

Median pain ratings across the 28 parts of the body at Time 1 were also calculated, separately for the two groups (table 3). Generally, subjects more frequently reported pain or discomfort mostly located in the cervical, shoulders and wrists areas. Pain score differences across the two groups, in different anatomical areas were tested using a Wilcoxon-Mann-Whitney test, and the results highlighted a different degree of pain in the neck, cervical (p<0.01), left shoulder, left wrist, and lumbar areas (p<0.005) between subjects in the EG and in the CG.

Pain scores were tested for equality across data collection points separately for the two groups. Results from Wilcoxon Signed Rank test are reported in figure 3, according to the Corlett and Manenica's musculoskeletal pain map (17).

While no evidence of decreasing degree of pain was found in the CG, subjects in the EG reported a statistically significant decrease for pain at Time 2 with respect to Time 1. Moreover, for any area of the

Table 1 - Baseline demographics

	Experimental group (n=9)	Control group (n=10)	P-Value#
Height (cm)	161.0	164.0	0.16
Weight (Kg)	56.7	58.9	0.57
BMI (kg/m²)	22.6	22.2	0.93
Posterior vs. Anterior Index	0.97	0.79	0.15
Backrest vs. Anterior Index	0.10	0.11	0.31

Data are expressed as median; # Wilcoxon-Mann-Whitney Test

Abbreviations: BMI: Body Mass Index

Table 2 -Difference within Group

	Group	Time	Median	Difference within groups	Difference between groups
Posterior vs Anterior Index	EG	1	0.971		
		2	1.190		
				0.126 (p=0.65 [a])	
	CG	1	0.789		
		2	0.927		
				0.190 (p=0.16 [a])	
					p=0.35 [b]
Backrest vs Anterior Index	EG	1	0.096		
		2	0.110		
				0.014 (p=0.15 [a])	
	CG	1	0.114		
		2	0.115		
				0.023 (p=0.62 [a])	
					p=0.43 [b]

Note: EG=Experimental Group; CG=Control Group

Note: [a] Wilcoxon Signed-Rank test to compare Time 1 and Time 2 median values

Note: [b] Wilcoxon-Mann-Whitney test to compare the differences between groups

body in which a subject had reported pain at Time 1, only those subjects in the EG showed a significant decrease of symptoms at Time 2. In contrast, on CG no significant decreases were noted.

Pain ratings data were analyzed to assess the different effects of the two interventions on the subjects' degree of pain. Results from Wilcoxon-Mann-Whitney test for equality of scores differences from Time 1 to Time 2 in the two groups are reported in figure 4. The EG intervention was more effective than the CG one concerning the pain decrease, especially in neck, cervical, thoracic, lumbar, shoulders and wrists areas.

Discussion

This pilot study is the first one investigating the effects of GPR and EVA on BWD and musculoskeletal pain in sitting, using an office chair instrumented with load cells. This study showed no significant difference between the two groups regarding seated BWD. Concerning musculoskeletal pain, EG showed a significant reduction of the amount of complaints on some body regions such as neck,

cervical, shoulders, thoracic, lumbar and wrist, when compared to CG.

Body Weight Distribution (BWD)

BWD in seated posture is a little explored subject. According to Makhsous et al. (19), during seated posture the weight of head, upper limbs and trunk is supported mainly by ischial tuberosities and adjacent soft tissues. According to Couto (7), the "ideal" seated BWD should be 34% on the posterior surface of the thighs, 50% on ischial tuberosities and 16% on the floor. Otherwise, some of these areas will suffer overload, with resulting tissue injury.

Only female subjects were chosen because there are differences between men and women postural behaviors in sitting. According to Dunk and Callaghan (11), different postural alignments, mainly on the spine and the pelvis during office work in seated posture, appear between genders. Usually women sit with more pelvic anterior rotation, less lumbar flexion and just a little trunk flexion, when they are compared to men (11). The most evident difference among genders is on the use of backrest: men tend

Table 3 - Mean (SD) and median for outcomes at all study visits for each time, difference within Group

Body part	Time 1							Time 2						
	Control Group			Experimental Group			Diff	Control Group			Experimental Group			Diff
	Mean	S.D.	Median	Mean	S.D.	Median	P-value	Mean	S.D.	Median	Mean	S.D.	Median	P-value
Neck anterior	2.5	1.0	2.0	4.1	0.6	4.0	0.007#	2.4	1.0	2.0	1.6	0.5	2.0	0.053
Neck posterior	2.5	1.0	2.0	4.1	0.6	4.0	0.007#	2.4	1.0	2.0	1.6	0.5	2.0	0.053
Upper Back	2.0	1.2	1.5	3.0	1.0	3.0	0.099	2.5	0.7	2.0	1.2	0.4	1.0	0.004#
Mid Back	2.0	1.2	1.5	3.0	1.0	3.0	0.099	2.5	0.7	2.0	1.2	0.4	1.0	0.004#
Lower Back	2.9	1.2	3.0	2.2	0.4	2.0	0.139	2.3	1.3	2.0	1.2	0.4	1.0	0.044#
Buttocks	1.1	0.3	1.0	1.1	0.3	1.0	1.000	1.5	1.1	1.0	1.0	0.0	1.0	0.209
Right Shoulder	1.9	1.3	1.5	3.1	1.2	3.0	0.044#	1.8	0.6	2.0	1.2	0.4	1.0	0.057
Left Shoulder	1.9	1.4	1.0	2.4	0.7	2.0	0.131	2.1	0.9	2.0	1.2	0.4	1.0	0.038#
Right Upper Arm	1.3	0.7	1.0	1.0	0.0	1.0	0.209	1.0	0.0	1.0	1.1	0.3	1.0	0.355
Left Upper Arm	1.2	0.4	1.0	1.0	0.0	1.0	0.209	1.1	0.3	1.0	1.1	0.3	1.0	1.000
Right Elbow	1.3	0.7	1.0	1.0	0.0	1.0	0.209	1.2	0.6	1.0	1.0	0.0	1.0	0.410
Left Elbow	1.6	1.1	1.0	1.0	0.0	1.0	0.112	1.3	0.7	1.0	1.0	0.0	1.0	0.209
Right Lower Arm	1.2	0.4	1.0	1.0	0.0	1.0	0.209	1.1	0.3	1.0	1.0	0.0	1.0	0.410
Left Lower Arm	1.7	1.2	1.0	1.0	0.0	1.0	0.112	1.1	0.3	1.0	1.0	0.0	1.0	0.410
Right Wrist	1.4	0.7	1.0	2.0	0.5	2.0	0.048	1.3	0.5	1.0	1.0	0.0	1.0	0.111
Left Wrist	1.9	1.1	1.5	2.2	0.4	2.0	0.288	1.7	0.8	1.5	1.0	0.0	1.0	0.032#
Right Hand	1.1	0.3	1.0	1.0	0.0	1.0	0.410	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Left Hand	1.2	0.6	1.0	1.1	0.3	1.0	1.000	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Right Thigh	1.1	0.3	1.0	1.0	0.0	1.0	0.410	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Left Thigh	1.1	0.3	1.0	1.0	0.0	1.0	0.410	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Right Knee	1.3	0.5	1.0	1.4	0.7	1.0	0.805	1.0	0.0	1.0	1.1	0.3	1.0	0.355
Left Knee	1.4	0.7	1.0	1.4	0.7	1.0	0.922	1.3	0.7	1.0	1.1	0.3	1.0	0.613
Right Leg	1.0	0.0	1.0	1.0	0.0	1.0	1.000	1.1	0.3	1.0	1.0	0.0	1.0	0.410
Left Leg	1.0	0.0	1.0	1.0	0.0	1.0	1.000	1.1	0.3	1.0	1.0	0.0	1.0	0.410
Right Ankle	1.0	0.0	1.0	1.1	0.3	1.0	0.355	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Left Ankle	1.0	0.0	1.0	1.1	0.3	1.0	0.355	1.0	0.0	1.0	1.0	0.0	1.0	1.000
Right Foot	1.1	0.3	1.0	1.2	0.4	1.0	0.527	1.1	0.3	1.0	1.0	0.0	1.0	0.410
Left Foot	1.1	0.3	1.0	1.2	0.4	1.0	0.527	1.1	0.3	1.0	1.0	0.0	1.0	0.410

# p<0.05

to rest the spine against the backrest, while women sit closer to the front of the seat (11). It should also be noted that Kayis and Hoang's (17) found similarities in BWD between men and women in eleven variations of seated posture. However, Kingma and van Dieen (18) confirmed the large difference in lumbar flexion between genders and studied only female participants.

Biomechanical differences between genders on seated behavior can result in different load patterns and in experiencing different musculoskeletal dysfunctions. Therefore, gender-oriented modalities of treatment and training should be considered in ef-

forts to reduce musculoskeletal dysfunctions or to prevent pain (11). For example, women could be encouraged to use the backrest for longer periods to reduce muscle activity, while men need greater lumbar support to increase their lordosis in sitting.

Musculoskeletal pain

Dentistry students were chosen for this study because they were already exposed to prolonged sitting and they have not had any diagnosis of musculoskeletal diseases. Nevertheless, when pain questionnaire was filled at Time 1, some musculoskeletal neck-
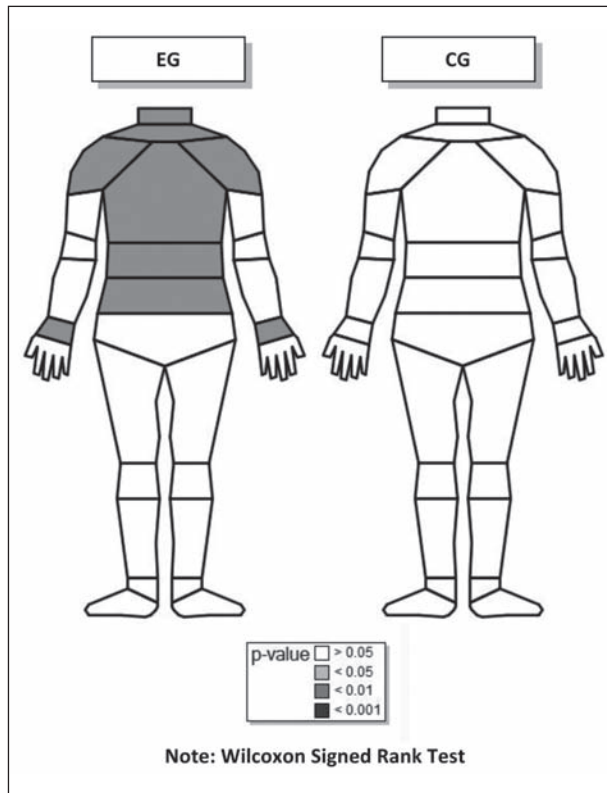
Figure 3 - Comparison of musculoskeletal pain ratings change between Time 1 and Time 2 on a human body map, separately for CG and EG, according to the strength of evidence against null hypothesis

Figure 4 - Comparison between treatments effects on musculoskeletal pain rating change from Time 1 to Time 2 on a human body map, according to the strength of evidence against null hypothesis

shoulder complaints were reported in both groups, probably due to their occupational duties. In fact, they used a computerized workstation at least eight hours a day and worked in a dental clinic about four hours a day, applying biomechanical overload on the neck and upper limbs, which are risk factors to develop musculoskeletal dysfunctions.

GPR seems to have a positive impact on perceived musculoskeletal pain, reducing it in all previously symptomatic areas. In particular, our results showed that GPR significantly reduces pain on some body regions such as neck, cervical, shoulders, thoracic, lumbar and wrist, when compared to EVA. In contrast, CG subjects showed no statistically significant difference in pain from Time 1 to 2. According to Pillastrini et al. (27), limited ergonomic education appears to be an insufficient intervention to improve work-related posture and reduce LBP point-prevalence. However, the teaching of a healthy seated
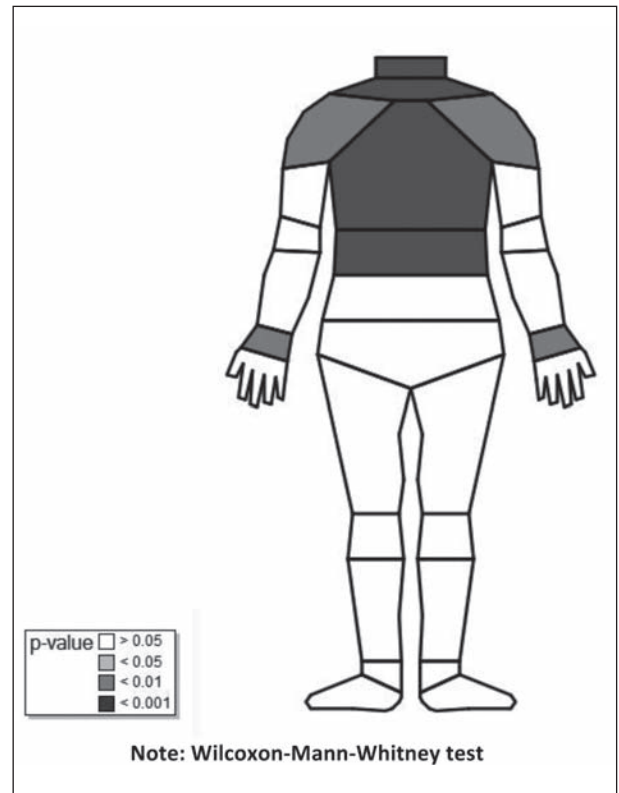
posture should be considered as both preventive and therapeutic approach (28).

Limitations and advantages of the study

A study's strength is the possibility to investigate global weight distribution with a quantitative postural weight device, probably really promising in ergonomics. Some limitations relative to statistical analysis of our data should be noted. The failure to find a difference in seated BWD between groups may be due to our small sample size, as it may be underpowered to show small differences. The body pain map used in this study (5) evaluates pain on a scale ranging from 1 to 5. Visual Analog Scale (VAS) from 0 to 100, commonly used in several other studies (2, 8, 14) might more accurately highlight change. Thus, a larger sample may have been preferable for showing differences in BWD.

Moreover, the difference in pain scores at Time 1 in some body areas between EG and CG might have affected our results.

On the other hand, probably the number of GPR sessions was not sufficient to induce changes in sitting BWD. However, our findings may also have been biased by our methods. Subjects were instructed to assume a proper sitting posture rather than to demonstrate their typical sitting posture. Thus, we are unable to identify whether EG subjects may have changed their daily sitting habits following GPR treatment while CG subjects did not it. Finally, our study was performed on healthy young female subjects that presented only some musculoskeletal complaints. Consequently, this has limited the external validity of our study.

CONCLUSIONS

Musculoskeletal pain, frequently associated with a prolonged sitting exposure, is an emergent health issue and requires a greater range of preventive and therapeutic options. In our study, combined intervention of GPR and EVA was shown to be effective on reducing musculoskeletal pain and discomfort compared to only EVA, even though we did not find any relevant difference on seated BWD. The relationship between BWD and pain and between BWD and ergonomic interventions should be further investigated. Our findings can stimulate further studies to quantify BWD using an instrumented office chair such as used in this study. Finally, future studies of GPR effect on seated BWD with larger and symptomatic clinical samples are suggested to study changes in postural habits following treatment.

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