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Effects of electroacupuncture on stress-related symptoms in medical students: a randomised placebo-controlled study

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This paper is dedicated to the memory of Dr Norton Moritz Carneiro, a deceased member of our group.

ABSTRACT

Objective To assess the effects of electroacupuncture (EA) on relieving stress-related symptoms—sleep disorders, anxiety, depression and burnout—in medical students.

Methods Eighty-two students were randomised into an EA treatment group (n=30), a sham TENS group (n=18) and an untreated control group (n=34). EA was applied at a continuous frequency of 2 Hz to the limbs, face, ears and scalp for 20 min once a week, over 6–8 weeks. Sham transcutaneous electrical nerve stimulation (TENS) was performed on similar sites for the same number of times in each session and for the same length of time. Outcome measurements included a comparison of the indices obtained by different self-applied questionnaires before and after treatment. The surveys used were the Mini-Sleep Questionnaire (MSQ), Pittsburgh Sleep Quality Index (PSQI), Epworth Sleepiness Scale (ESS), the Beck Depression and Anxiety Inventories (BDI and BAI) and the Maslach Burnout Inventory—Student Survey (MBI-SS), in addition to the Quality of Life Questionnaire —abbreviated version (WHOQOL-bref).

Results EA significantly improved scores on the MSQ, PSQI, BDI and the cynicism and academic efficacy (AE) dimensions of the MBI-SS in relation to the control. Sleep quality (MSQ) improved from 36.9 (SD 7.6) to 25.0 (5.7) with EA, 37.6 (6.0) to 32.1 (6.9) with sham TENS, and 36.5 (5.9) to 33.6 (6.7) in the controls (p=0.0000). Compared with the sham TENS group, EA significantly reduced scores on the PSQI. Score improvements in the sham TENS group in relation to control group were significant in the MSQ, BDI and AE. In the EA group, the number of students with better scores after intervention was significantly higher for the MSQ, PSQI, ESS and BAI. This only occurred for the MSQ in the sham TENS group and for the MSQ and ESS in the control group.

Conclusions EA significantly reduced stress-related mental symptoms. The improvement obtained by sham TENS compared with the control group confirmed the presence of a placebo effect resulting from the treatment ritual.

INTRODUCTION

Stress can cause a range of health disturbances or trigger manifestations of pre-existing diseases, such as mental disorders (insomnia, depression, anxiety), visceral function disturbances (cardiovascular, digestive, respiratory and urinary disorders) and disorders of the endocrine, immune and musculoskeletal system.[1–3]

Publications have pointed to a high prevalence of burnout syndrome, a consequence of stress, in medical students and resident physicians in the USA, estimated at 50% and 23–76%, respectively.[4 5] In Brazil, symptoms of stress and depression affect 49.7% and 79% of students and medical residents, respectively,[6 7] and the prevalence of sleep disorders is also high.[8 9]

Acupuncture and other forms of peripheral nerve stimulation have been used to treat stress-related disorders, including mental illnesses.[10–13]

In our pilot study,[14] EA significantly reduced insomnia, depression and burnout in medical students in comparison with untreated controls, though the contribution of needle stimulation could not be determined.

The aim of this study was to confirm the effects of EA on stress-related mental symptoms and assess the placebo effects of the treatment ritual. We therefore compared sham TENS, whose procedures, except for the needle, are identical to those of EA, and an untreated control group.

METHODS

The protocol was approved by the research ethics committee of the School of Medicine at the Fluminense Federal

University under protocol number 220/11 and registered with the Brazilian Ministry of Health under number 0229.0.258.000-11

Participants

The target population of this study (table 1) consisted of 159 medical students in the fourth semester at the Fluminense Federal University. Exclusion criteria were individuals with a history of significant bleeding, those using anticoagulants or antiplatelets, 'hard' drug users (cocaine, crack), pregnant women and patients with cardiac pacemakers. No participant was excluded by these criteria.

Research was conducted over three distinct school semesters. First, a randomised pilot study performed in 2010[14] compared stress symptoms before and after treatment between a group of students given EA and an untreated control group. In 2011 and 2012, also in randomised trials, EA was compared with sham TENS and with a third untreated group (control). The results of the pilot study were incorporated into this report; it involved manual randomisation, where students drew a piece of paper blindly from a basket to determine their assigned group. In subsequent semesters, randomisation was by computer-generated random numbers. Sample size was by convenience.

All participants in this trial gave written informed consent. First, the 159 students filled out self-administered questionnaires on stress symptoms. The instruments applied were the validated Portuguese version of the Mini-Sleep Questionnaire (MSQ), Pittsburgh Sleep Quality Index (PSQI, Epworth Sleepiness Scale (ESS), the Beck Depression and Anxiety Inventories (BDI and BAI) and the Maslach Burnout

Table 1 Target population characteristics and comparisons between EA, sham TENS and control groups in severity ratings score and gender proportions

Scales	Target population (N=159) N (%)	EA (N=30) N (%)	Sham TENS (N=18) N (%)	Control (N=34)+ N (%)
Gender				
Male	64 (40.3)	9 (30.0)	4 (22.2)	12 (35.3)
Female	95 (59.7)	21 (70.0)	14 (77.8)	22 (64.7)
Mean age	21.5 SD±2.4	21.6 SD±2.8	21.8 SD±3.4	21.0 SD±1.8
Sleep quality (MSQ)				
Good sleep quality (10–24)	41 (25.8)	0 (0.0)	0 (0.0)	0 (0.0)
Mild difficulties (25–27)	22 (13.8)	0 (0.0)	0 (0.0)	0 (0.0)
Moderate difficulties (28–30)	17 (10.7)	7 (23.3)	2 (11.1)	5 (14.7)
Severe difficulties (>30)	79 (49.7)	23 (76.7)	16 (88.9)	29 (85.3)
Sleep quality and disturbances (PSQI>5)				
No	75 (47.2)	7 (23.3)	2 (11.1)	12 (35.3)
Yes	84 (52.8)	23 (76.7)	16 (88.9)	22 (64.7)
Daytime sleepiness (ESS)				
No sleepiness (0–10)	55 (34.8)	5 (16.7)	5 (27.8)	9 (26.5)
Excessive (11–15)	64 (40.5)	16 (53.3)	5 (27.8)	17 (50.0)
High level (>15)	39 (24.7)	9 (30.0)	8 (44.4)	8 (23.5)
Depressive symptoms (BDI)				
No depression (0–9)	88 (55.3)	9 (30.0)	4 (22.2)	15 (44.1)
Mild–moderate (10–18)	52 (32.7)	15 (50.0)	10 (55.6)	15 (44.1)
Moderate–severe (19–29)	14 (8.8)	5 (16.7)	2 (11.1)	3 (8.8)
Severe (≥30)	5 (3.1)	1 (3.3)	2 (11.1)	1 (2.9)
Anxiety symptoms (BAI)				
No anxiety (0–9)	84 (52.8)	16 (53.3)	3 (16.7)	16 (47.1)
Mild–moderate (10–18)	43 (27.0)	1 (3.3)	11 (61.1)	11 (32.4)
Moderate–severe (19–29)	23 (14.5)	9 (30.0)	4 (22.2)	6 (17.6)
Severe (≥30)	9 (5.7)	4 (13.3)	0 (0.0)	1 (2.9)
Burnout (MBI-SS)				
Emotional exhaustion ≥3	142 (89.3)	27 (90.0)	18 (100.0)	34 (100.0)
Cynicism ≥3	53 (33.3)	14 (46.7)	7 (38.9)	17 (50.0)
Academic efficacy ≤3	30 (18.9)	6 (20.0)	8 (44.4)	6 (17.6)

BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; ESS, Epworth Sleepiness Scale; MBI-SS, Maslach Burnout Inventory-Student Survey; MSQ, Mini-Sleep Questionnaire; PSQI, Pittsburgh Sleep Quality Index.

Inventory—Student Survey (MBI-SS), in addition to the Quality of Life Questionnaire—abbreviated version (WHOQOL-bref).[15–22]

Ninety-six students with moderate (28–30) or severe (>30) sleep quality disturbance according to the MSQ (see table 1) were invited to take part in the trial; 87 accepted, but five left the study later. Thus, a total of 82 students were enrolled: 30 received EA, 18 sham TENS and 34 were untreated controls, see figure 1.

One student from the treatment group in the pilot study had already undergone acupuncture 2 years before the study. In 2011, one patient from the EA and one from the sham TENS group had been treated 1 year before.

Outcome measurements

The study assessed the effects of EA on stress-related mental symptoms. The difference in mean scores (which detect the presence or absence of these symptoms and their severity, see table 1), obtained before treatment and 1 week after its conclusion, at the end of the school semester, was the primary outcome measure.

Interventions

Treatment consisted of eight weekly sessions in 2010 and 2011; in 2012, the trial was interrupted after six sessions owing to a strike at the university.

Sterile, disposable stainless steel acupuncture needles measuring 40 mm by 0.25 mm (Arhon Din, Rio de Janeiro, Brazil) were inserted at standardised points using a guide tube and connected to a Sikuro DS100C electrostimulator (Sikuro Company, Rio de Janeiro, Brazil), generating an alternate rectangular/exponential asymmetric current of 0.6 ms duration. Electrical stimulation was delivered continuously at 2 Hz for 20 min, at an amplitude that was comfortable for the patient.

The needles were connected to the electrostimulator in pairs: ST36/ST36, 2 cm deep, manipulated to obtain contraction of the tibialis anterior muscle; PC6/PC6, 0.5 cm deep (inserted obliquely towards distal); GB14 on the left (inserted subcutaneously 1 cm towards the midpoint of the eyebrow) connected to the *Shenmen* in the triangular fossa of the ipsilateral ear and GB14 on the right, connected to the Heart point in the centre of the cavum of the ear on the same side. Needles were inserted 0.5 cm under the scalp at GV20 and four *Sishencong* points, directed caudally or rostrally and interconnected. The students were treated in the supine position.

The intervention using sham TENS was carried out with wired electrodes (figure 2) attached to the skin by microporous medical tape and connected to the electrostimulation device, adapted by the manufacturer to emit a beeping sound. The students were informed that the aim was to evaluate the efficacy of two electrostimulation methods in relieving stress, one of which was subliminal. The same points on the limbs were used (ST36 and PC6), connected to pairs and GB14 bilaterally, connected to the ipsilateral region of the neck under the mastoid process. Sessions were of the same duration and number as in the EA group.

All procedures were performed by one physician with more than 20 years' experience, either in his private office or at the outpatient clinic of the acupuncture specialisation course, at Fluminense Federal University.
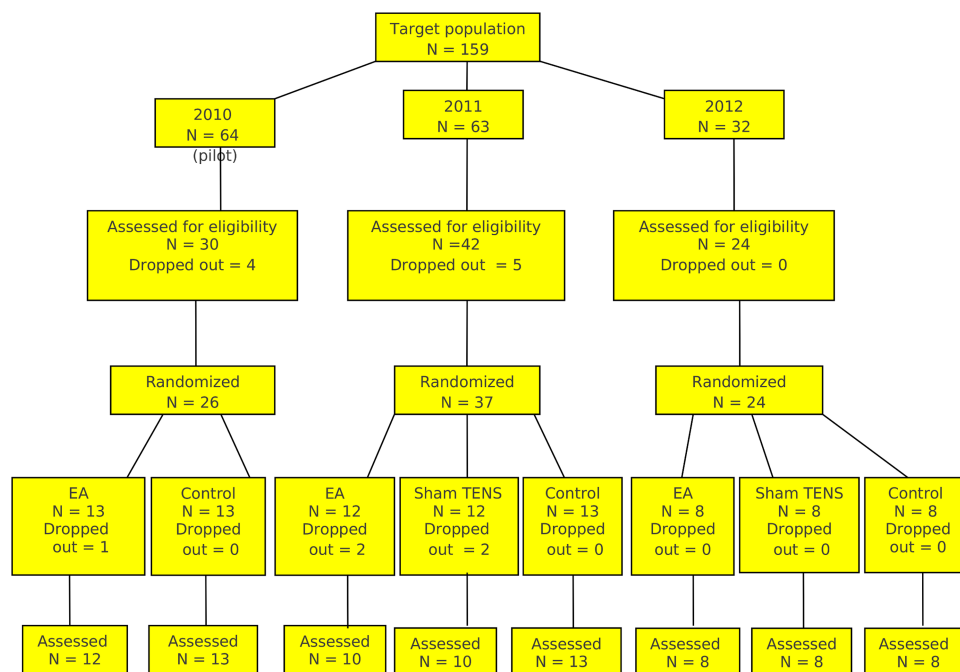

Figure 1 Diagram of stages of the study. EA, electroacupuncture.

Figure 2 Electrodes used in sham TENS treatment.

The control group received no intervention. At the end of the trial, participants in the EA and sham TENS groups were asked if they felt better and whether they believed the treatment had had any effect on alleviating their stress. The possible responses for each question were 'yes', 'no' and 'I don't know'. Participants were not given any additional instructions during the trial, but were advised to see the psychiatric outpatient service if needed. In this case, they were excluded from the study, but were able to continue treatment if they wished to.

The students who helped to apply the questionnaires and registered the data were unaware that their colleagues were taking part in a study involving a sham treatment.

Statistical analysis

Descriptive analyses were employed to characterise the target population and the different groups. The non-parametric Kruskal–Wallis test was used to compare the intergroup differences in average scores. When a difference was identified between the three groups, the Wilcoxon test was applied to compare scores two by two and the McNemar test was used to compare paired proportions in each group. The significance level established for all tests was $p \leq 0.05$. Data were analysed using S-Plus V.8.0 software.

RESULTS

The data analysed were obtained from the 82 students who remained until its conclusion. There were no adverse effects due to acupuncture treatment, but the student who dropped out in the first phase reported feeling 'distressed' by the needles. The other four withdrawals in 2011 occurred in the initial sessions, with the students stating they did not have the time to attend the weekly treatment sessions.

Table 1 shows the distribution of the target population and the three groups, according to gender, age and severity scores. Most students were female and

the mean age was around 21 years. Moderate to severe difficulties assessed by the MSQ were present in 60.4% of students, while 52.8% obtained scores higher than five on the PSQI, indicating poor sleep quality. In the ESS, 40.5% and 24.7% of students exhibited excessive or high levels of daytime sleepiness, respectively. One participant did not complete the ESS in the first phase of the trial.

The BDI showed that 32.7% students had mild to moderate levels of depression, 8.8% moderate to severe depression and 3.1% severe depression. The BAI identified mild to moderate anxiety in 27% of students, moderate to severe in 14.5% and severe anxiety in 5.7% of subjects.

The MBI-SS measures three dimensions. High scores in emotional exhaustion (EE) and cynicism (C) and low scores in academic efficacy (AE) indicate the presence of burnout. The cut-off point selected for this study was 3. Thus, applying this cut-off point, 89.3% and 33.3% of participants displayed moderate to high levels of EE and C, while 18.9% showed low AE (≤ 3).

There were no significant differences in mean scores between the three groups before intervention, with the exception of those related to AE ($p=0.002$—table 2).

After intervention, a statistical intergroup difference was recorded for scores evaluating sleep (MSQ, global score of the PSQI), depressive symptoms (BDI) and burnout in the dimensions cynicism (C) and AE. Table 2 shows that the MSQ improved significantly more in the EA group than in the sham TENS group ($p=0.001$) and control group ($p=0.000$). Thus, the mean score went from severe to mild difficulty levels in students treated with EA, while in the other groups it remained the same as the baseline score (severe difficulty). A decline was also seen in the overall mean score on the PSQI and the reduction was significant between EA×sham TENS ($p=0.05$) and EA×control ($p=0.001$), but not between sham TENS×control ($p=0.09$).

The reduction of scores for depression, comparing the groups EA×sham TENS was not significant ($p=0.15$), in contrast to those for the EA×control ($p=0.000$) and sham TENS×control ($p=0.02$).

In the burnout dimensions, the mean scores for cynicism (C) fell in the EA and sham TENS groups but remained at 2.8 in controls. Comparisons of EA with sham TENS and of sham TENS with control showed no statistical differences, although the difference was significant ($p=0.001$) between the EA group and the control group. AE showed a statistical difference between the three groups before intervention ($p=0.002$). This difference was significant in two by two comparisons between the groups (EA vs sham TENS, $p=0.02$; EA vs control, $p=0.01$; sham TENS vs control, $p=0.004$). After intervention, the AE score increased in the EA and sham TENS groups, but was

Table 2 Means scores and outcome comparisons between EA, sham TENS and control groups

Scales	Baseline				Endpoint				Wilcoxon test†
	EA (n=30) μ (SD)	Sham TENS (n=18) μ (SD)	Control (n=34) μ (SD)	p Value*	EA (n=34) μ (SD)	Sham TENS (n=18) μ (SD)	Control (n=34) μ (SD)	p Value*	
Sleep quality (MSQ)	36.9 (7.6)	37.6 (6.0)	36.5 (5.9)	0.85	25.0 (5.7)	32.1 (6.9)	33.6 (6.7)	0.0000	a
Sleep quality and disturbances (PSQI)									
Subjective sleep quality	1.3 (0.7)	1.6 (0.7)	1.1 (0.7)		1.0 (0.6)	1.1 (0.7)	1.4 (0.7)		
Sleep latency	1.0 (0.7)	0.8 (0.7)	1.0 (0.9)		0.5 (0.6)	0.8 (0.8)	0.8 (0.9)		
Sleep duration	1.7 (0.8)	1.8 (0.9)	1.4 (0.8)		1.3 (0.9)	1.6 (1.1)	1.3 (0.9)		
Habitual sleep efficiency	0.5 (1.2)	0.3 (0.5)	0.2 (0.5)		0.3 (0.8)	0.5 (0.7)	0.2 (0.5)		
Sleep disturbances	1.3 (0.5)	1.5 (0.5)	1.2 (0.5)		1.0 (0.4)	1.3 (0.4)	1.2 (0.6)		
Use of sleep medication	0.5 (0.9)	0.6 (0.7)	0.4 (0.8)		0.1 (0.4)	0.2 (0.8)	0.4 (1.0)		
Daytime dysfunction	1.4 (0.8)	1.9 (0.6)	1.5 (0.9)		0.9 (0.7)	1.2 (0.6)	1.3 (0.8)		
Global score	7.8 (0.8)	8.7 (2.5)	7.2 (3.1)	0.11	5.3 (2.5)	7.2 (3.2)	7.0 (3.2)	0.01	b
Daytime sleepiness (ESS)	13.7 (4.7)	13.9 (4.5)	12.6 (4.0)	0.39	9.6 (4.9)	10.5 (4.9)	10.9 (4.1)	0.08	
Depressive symptoms (BDI)	13.7 (9.2)	15.0 (8.1)	10.8 (6.3)	0.07	5.3 (5.4)	9.1 (6.3)	8.9 (9.0)	0.002	c
Anxiety symptoms (BAI)	15.6 (12.7)	14.7 (5.3)	12.3 (9.1)	0.31	7.9 (6.9)	11.0 (6.5)	10.8 (9.3)	0.23	
Burnout (MBI-SS)									
Emotional exhaustion	4.6 (0.9)	4.5 (0.7)	4.8 (0.9)	0.34	3.6 (1.3)	4.1 (1.0)	4.3 (0.9)	0.06	
Cynicism	3.0 (1.6)	2.6 (1.5)	2.8 (1.7)	0.75	2.1 (1.5)	2.2 (1.6)	2.8 (1.6)	0.02	d
Academic efficacy	3.5 (0.8)	3.0 (0.9)	3.9 (0.8)	0.002	3.9 (0.5)	3.8 (0.7)	3.9 (1.0)	0.002	e
Quality of life (WHOQOL-bref)									
Physical health	18.2 (3.0)	17.5 (2.3)	19.1 (2.9)	0.20	22.7 (3.4)	22.6 (5.1)	21.6 (4.3)	0.13	
Psychological	19.5 (2.5)	17.5 (2.6)	19.9 (2.5)	0.1	21.2 (3.0)	19.8 (3.6)	21.1 (3.2)	0.21	
Social relationships	10.7 (2.5)	9.4 (2.8)	10.3 (2.8)	0.22	11.8 (1.5)	10.8 (1.5)	11.5 (4.4)	0.73	
Environment	26.7 (4.8)	24.7 (4.6)	27.7 (4.3)	0.14	31.1 (10.3)	26.6 (2.3)	30.0 (7.7)	0.12	
Overall	6.6 (1.8)	6.3 (2.0)	6.7 (1.8)	0.54	7.0 (1.8)	7.3 (5.8)	7.0 (1.9)	0.75	

*Kruskal–Wallis rank sun test.
†Comparisons between EA×sham TENS, EA×control and sham TENS×control: (a) p=0.001, 0.0000 and 0.04; (b) p=0.05, 0.001 and 0.09; (c) p=0.15, 0.0001 and 0.02; (d) p=0.1, 0.001 and 0.08; (e) p=0.009, 0.032 and 0.0002, respectively.
BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; ESS, Epworth Sleepiness Scale; MBI-SS, Maslach Burnout Inventory-Student Survey; MSQ, Mini-Sleep Questionnaire; PSQI, Pittsburgh Sleep Quality Index; WHOQOL–bref, WHO quality of life assessment—abbreviated version.

unchanged in controls. Two by two comparisons between groups showed a significant difference for EA versus sham TENS (p=0.009), EA versus control (p=0.032) and sham TENS vs control (p=0.0002).

Mean scores for the other instruments used showed no significant changes.

Table 3 indicates that in the EA group, of the 30 students with baseline scores ≥28 in the MSQ, scores

Table 3 Comparison of the number of students with scores below the cut-off point considered as a condition of stress in different questionnaires before and after interventions in EA, sham TENS and control groups

Scales	EA (n=30)			Sham TENS (n=18)			Control (n=34)		
	Baseline N (%)	Endpoint N (%)	p Value*	Baseline N (%)	Endpoint N (%)	p Value*	Baseline N (%)	Endpoint N (%)	p Value*
MSQ<28	0 (0.0)	21 (70.0)	0.0000	0 (0.0)	6 (33.3)	0.04	0 (0.0)	5 (14.7)	0.007
PSQI≤5	7 (23.3)	19 (63.3)	0.003	2 (11.1)	5 (27.8)	0.24	12 (35.3)	13 (38.2)	1
ESS<11	5 (16.7)	20 (66.7)	0.0007	5 (27.7)	10 (55.6)	0.07	9 (26.5)	20 (58.8)	0.005
BDI<19	24 (80.0)	29 (96.7)	0.13	14 (77.7)	17 (94.4)	0.24	30 (88.2)	29 (85.3)	1
BAI<19	17 (56.7)	27 (90.0)	0.004	14 (77.7)	16 (88.9)	0.61	27 (79.4)	30 (88.2)	0.44
EE<3	3 (10.0)	7 (23.3)	0.22	0 (100.0)	4 (22.2)	0.13	0 (0.0)	2 (5.9)	0.47
Cyn<3	16 (53.3)	20 (66.7)	0.38	11 (61.1)	13 (72.2)	0.68	17 (50.0)	19 (55.9)	0.68
AE>3	24 (80.0)	27 (90.0)	0.44	10 (55.5)	14 (77.8)	0.28	28 (82.4)	26 (76.5)	0.61

*McNemar's test.
AE, academic efficacy; BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; Cyn, cynicism; EE, Emotional Exhaustion; ESS, Epworth Sleepiness Scale; MSQ, Mini-Sleep Questionnaire; PSQI, Pittsburgh Sleep Quality Index.

fell to <28 for 21 subjects, indicating that 70% of students went from experiencing moderate or severe sleep difficulties to moderate or good sleep quality. In this same group, 19 exhibited good-quality sleep (PSQI<5) after treatment, compared with seven beforehand, 20 demonstrated no daytime sleepiness (ESS<11) compared with five before treatment and 27 showed either no anxiety or light/moderate anxiety (BAI<19) compared with 17 at the outset. Differences between frequencies before and after treatment were significant (see table).

Among the 18 students given sham TENS, six achieved a lower MSQ score of <28 after intervention (p=0.04). The number of students with improved scores did not differ significantly for the other assessment instruments.

In the control group, scores for five of the 34 students declined for the MSQ to <28 (p=0.007), while 20 subjects showed no daytime sleepiness (ESS<11), compared with nine before intervention (p=0.005). No statistical differences were found for the other measurement instruments.

All students given EA and sham TENS, with the exception of one in each group, reported that their stress symptoms improved after the trial and attributed this to the interventions performed.

DISCUSSION

The most obvious effect of EA was improved sleep quality, which reduced daytime sleepiness[9] and other mental symptoms related to stress.[23–25] The MSQ, a recognised screening instrument in sleep quality surveys,[26] was used to select participants for this study precisely because of the known association between poor sleep quality and symptoms of stress. A decline was recorded in depression and cynicism, and an improvement in AE; however, final scores in the ESS, BAI and EE domain did not significantly improve. A longer period of adequate sleep may be needed for the remission of ESS and other symptoms. Interrupting treatment after six sessions (2012 group) might have contributed to this finding, but the small number of participants in this group did not allow this assessment. It is interesting to note that the students from all three groups gave better scores when filling out the questionnaires for the second time.

Thus, the results of this trial confirmed the effects of EA on stress-related mental symptoms identified in our pilot study.[14] The improvement of scores of the sham TENS group compared with the control group suggests that the treatment ritual, identical to that of the EA group (except for needling), may be responsible for the placebo effect of the technique (see below). This placebo effect could not be quantified owing to the methodology employed; however, the significant discrepancy (7.1) seen between the EA and sham TENS groups in MSQ dimension (table 2), with

the obtained data, guarantees a power of 0.963 and a significance level of 0.05.

A number of authors have debated the issue of blinding in clinical trials using physical therapies. Sham TENS has recently been applied in studies with acupuncture because the subjects receive similar clinical care to the treatment group, which allows the non-specific effects resulting from the doctor–patient relationship to be controlled.[10 27–33] Credibility scales are used to validate blinding,[10 28 29] and in this study both the EA and sham TENS groups attributed their improvement to the treatment performed.

Psychological, biochemical and neuroanatomical mechanisms associated with the placebo effect have been identified in different populations and experimental manipulations.[34–39]

The psychological processes studied in greater depth are conditioning and expectation. Different verbal commands influence different outcomes in placebo experiments and the effect of administering a drug is a combination of its pharmacological action and the psychological context in which it is applied. Individuals with a strong expectation of pain relief, for example, require lower doses for pain than those without this expectation.[24 35–39]

Psychological processes also affect the results of physical therapy, such as acupuncture,[33 37 39 40] where the effects of the technique combine with the placebo effect, as suggested in the outcome of this study. The expected improvement among participants treated with sham TENS, in turn, justified the procedure from an ethical standpoint.

Functional MRI (fMRI) research showed that the placebo effect modulates the perception of emotions in the same way that it modulates pain via common neural pathways, including the rostral anterior cingulate cortex and ventrolateral prefrontal cortex/orbitofrontal cortex.[39] Both these and other circuits controlled by the mesocortical mesolimbic dopaminergic system participate in the stress response by releasing different neuromodulators and neurotransmitters, modulating emotions, pain and a variety of clinical conditions. Therefore, there is evidence that the placebo effect is the result of a general modulation process, promoted by individual expectation.[36 37 39 41]

Acupuncture activates different neural pathways, producing local, segmental and supraspinal effects.[42–46] The supraspinal effects, which are the object of this study, also induce a general modulation process by acting on the hypothalamic–pituitary–adrenal axis, in which adaptive changes occur to accompany the shutdown of brain structures that maintain the sustained stress response. This might be one of the mechanisms by which acupuncture leads to a point of homeostatic regulation closer to physiological normality, affecting mood, sleep regulation and the immune system. These effects coincide with the release of a variety of opioid peptides and neurotransmitters and are more pronounced with the use of a low-

frequency electric current.[42–50] Stimulation should be painless.[48]

We found no publications on the effects of acupuncture on burnout. However, its efficacy in treating sleep disturbance, anxiety and depression is well documented and was discussed in our pilot study,[14] which presented reviews on insomnia,[51 52] depression[53–55] and anxiety with depression.[56 57] The variety of acupuncture points used in the mentioned studies suggests their lack of specificity, advocated by several authors[50 58 59] and also observed by the main author of this study.

The target population of this study was not sick, or at least most subjects had not sought medical care for the symptoms identified by the self-administered questionnaires. According to Elliot and Eisdorfer's classification of the types of stressors,[1] our target population comprises healthy individuals under chronic stress as a result of their medical studies, with a heavy workload requiring additional study time, often at night.

The question identified in the pilot study remains: can EA minimise the health consequences of stress[8 60] in medical students? Although it seems reasonable to suggest that it can, the definitive answer can only be obtained through longitudinal studies.

In conclusion, EA might be an effective tool to be offered to individuals exposed to stress related to their activities, such as medical students.

Summary points

▶ Medical students often experience stress, interfering with their sleep.
▶ We compared EA with sham TENS and with no treatment control.
▶ EA was better than both, for sleep and some aspects of burnout.

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