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The effect of pulsed electromagnetic frequency therapy on health-related quality of life in military service members with chronic low back pain

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ABSTRACT

Background: In the U.S. military, chronic low back pain is among the most frequent complaints for medical visits, lost work time, and attrition from active duty and the deployed setting by service members.

Purpose: The aim of this pilot study was to determine whether adjunctive treatment with pulsed electromagnetic frequency (PEMF) produced significant variability in chronic low back pain symptoms and secondary health-related quality of life, mental health and disability outcomes.

Methods: Prospective, randomized pilot study with repeated measures at baseline, post-treatment, and 1 month follow-up for two groups: usual care (UC) vs. UC + PEMF.

Findings: In a convenience sample of 75 service members, health-related quality of life mental and physical component scores were significant: $F(2, 104) = 4.20$, $p = .018$ ($\eta^2 = .075$) and $F(2, 104) = 4.75$, $p = .011$ ($\eta^2 = .084$), respectively; as was anxiety symptom severity: $F(2, 104) = 5.28$, $p = .007$ ($\eta^2 = .092$).

Discussion and Recommendations: Adjunctive treatment with PEMF demonstrated improvements in service members' overall physical health-related quality of life with expected, yet statistically nonsignificant improvements in reported pain and LBP-related disability. There were significant between group differences in anxiety symptom severity with higher symptoms reported by the UC + PEMF group, surprising findings that warrant further investigation.

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Background

In the U.S. Armed Services, mechanical low back pain (LBP) is a significant public health problem that affects the health and fitness of military service members (SMs) and overall mission readiness. It is one of the principal reasons SMs seek care in the deployed setting; and between 2000 and 2009, it was the primary diagnosis for more than 7 million ambulatory care

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visits and 31,625 hospitalizations (Clark & Hu, 2015). In addition, across all branches of the Armed Services, back-related injuries rank among the top five diagnoses seen for outpatient visits accounting for more than 2.35 million limited-duty days ordered by health care providers between 2000 and 2009 (Freburger et al., 2009; Stanton et al., 2008). Lost training time and limited duty are important indicators of the relative cost of LBP as it pertains to military readiness. Furthermore, current estimates are that approximately 25% of people with acute LBP experience recurrent episodes over the course of a year and 7% to 10% progress to a chronic state (Freburger et al., 2009; Stanton et al., 2008). For SMs who progress from acute to chronic low back pain (cLBP), they can experience significant physical, psychological, and social sequelae that affect their long-term functioning, quality of life, and employability (McGeary, McGeary, Moreno, & Gatchel, 2016; Outcalt et al., 2015).

In 2011, the Army Pain Task Force reported that military health care providers overprescribed opioid analgesic medications for the treatment of chronic pain conditions (Office of the Army Surgeon General, 2010). This trend resulted in higher rates of opioid abuse, misuse, and addiction as well as the development of performance-altering side effects among SMs when compared with a decade prior. As a better understanding of the physiologic basis of chronic pain perception and transmission has emerged, there has been a renewed emphasis in exploring alternatives to traditional pharmacologic pain management and documenting their treatment effectiveness.

Lack of scientifically derived evidence to explain the mechanism of action early in the development of devices that delivered electrical microcurrents to treat pain slowed the acceptance of pulsed electromagnetic frequency (PEMF) therapy as a complementary therapy by the U.S. mainstream medical community despite its widespread use in European countries. The Biomodulator (Senergy Medical Group, Irving, TX), although approved by the Food and Drug Administration as a transcutaneous electrical nerve stimulation (TENS) device, is not actually a TENS device in the traditional sense, other than it delivers an electrical current transcutaneously (Tennant, 2005). Unlike TENS devices that deliver 1 to 80 mA of electrical current, PEMF devices deliver short bursts of electrical microamperes (μA), which are millionths of an ampere, to injured tissues without producing heat or interfering with nerve or muscle function (Al-Mandeel & Watson, 2008). Microcurrent levels between 20 and 500 μA, such as those delivered by the Biomodulator device, appear to realign the natural electrical balance that exists within the cells that became disrupted because of injury (Strauch, Herman, Dabb, Ignarro, & Pilla, 2009). The proposed biophysical mechanism of action is that the PEMF waveform affects ion/ligand binding at cellular surfaces and modulates a cascade of biochemical effects that accelerates tissue repair, diminishes edema, and decreases pain by increasing blood and lymph flow (Hagendoorn et al., 2004), and promotes tissue regeneration and remodeling through the increased production of growth factors (Aaron, Boyan, Ciombor, Schwartz, & Simon, 2004). To date, studies demonstrated the efficacy of PEMF therapy in treating chronic pressure ulcers (Kloth et al., 1999); decreasing edema in acute ankle sprains (Martinelli et al., 2015); decreasing pain in acute whiplash injuries (Foley-Nolan et al., 1991); improving postmastectomy lymphedema (Mayrovitz, Macdonald, & Sims, 2002); and promoting bone growth for the treatment of nonunion fractures, failed fusions, and pseudoarthrosis (Brighton, 1981).

Borrowing from the Biopsychosocial Model of Chronic Pain (Turk & Monarch, 1996), comorbid mental health conditions and disability have been well-established correlates with chronic pain conditions (Kazis et al., 1998; Niles, Mori, Lambert, & Wolf, 2005; Otis et al., 2010; Phillips et al., 2016). Patients with a history of chronic depression, post-traumatic stress disorder (PTSD), and anxiety have a psychological vulnerability to developing chronic pain syndromes (Ratzliff, Unutzer, Katon, & Stephens, 2016). In addition, this affective vulnerability can increase the intensity of a person's response to pain or increase their likelihood of developing pain-related disability (Ratzliff et al., 2016). Given the 14 years of sustained war and multiple deployments, rates of depression, anxiety, and PTSD have increased dramatically among SMs, as have chronic pain conditions (Outcalt et al., 2015; Phillips et al., 2016). At the individual level, patient self-reports of health-related quality of life (HrQoL) have become important measures to assess treatment effectiveness, especially for patients with cLBP, because the complete absence of pain may not be an attainable treatment goal (Sofko, Currier, & Drescher, 2016). To date, no rigorous studies were found that demonstrated the effectiveness of PEMF in treating cLBP symptoms or explored the effect of PEMF treatment on the secondary biopsychosocial sequelae of chronic pain in military SMs. The purpose of this study was to determine whether quantitative differences in cLBP symptom intensity differ between individuals receiving usual care (UC) comprising medication management and cLBP education and those receiving UC plus adjunctive PEMF treatment delivered via the Biomodulator device. The secondary effects of these treatments on the biopsychosocial secondary sequelae of chronic pain (comorbid depression, anxiety, and PTSD symptoms, and mental and physical HrQoL) were also examined.

Methods

Design

This was an open-label prospective randomized controlled study with repeated measures at

pretreatment, post-treatment, and 1-month follow-up for two groups: UC or UC + PEMF.

Sample

Seventy-five military service members with a 3-month or greater history of chronic persistent or intermittent lower back pain (LBP) symptoms were recruited for study participation from a large military treatment facility in the southern United States. The mean age of participants was 38 years (standard deviation [SD], 8.9) with an age range from 19 to 60 years. Sixty-nine percent of participants were male ($n = 52$); 78.7% ($n = 59$) married, and most of them ($n = 46$) identified their race or ethnicity as Caucasian followed by 18.7% ($n = 14$) identifying as Hispanic. With regard to military rank, 53.3% ($n = 40$) of the sample were enlisted SMs and 38.7% ($n = 29$) were officers. For the full sample, the average length of pain was 62.93 months (SD, 58.62; range, 3–336 months) with an average intensity of 4 of 10 reported on the 11-point numerical rating scale (NRS), which is clinically indicative of moderate pain.

Procedure

Before recruitment, screening, and data collection, approval was obtained from a military institutional review board. Eligible participants who met inclusion/exclusion criteria and consented to study participation were randomly allocated to each treatment group based on a computer-generated random integer generator. To meet study eligibility inclusion criteria, SMs had to be serving on active duty; have a history of intermittent or continuous LBP symptoms present for 3 months or greater; and report weekly use of analgesic medications, either prescribed or over the counter, to treat their cLBP symptoms. SMs were excluded from study participation based on the following criteria: pacemaker or implanted electronic device; an open wound over their site of pain; current pregnancy; history of stroke, blood clots, cardiac arrhythmias, lumbar spinal surgery with hardware placement, prescription medication abuse, prior use of the Biomodulator device; or any participation in a clinical trial or treatment with TENS, biofeedback, or acupuncture within the past 30 days.

Participants in both treatment groups received UC, which consisted of education about routine medications used to manage cLBP symptoms; exercise and prevention strategies; and back stretching/strengthening exercises as outlined in the pamphlet "Chronic low back pain: Evaluation and management" published by the American Academy of Family Practice (Last & Hulbert, 2009). Participants randomized to receive adjunctive PEMF received verbal and written instructions about the proper self-administration of the PEMF therapy, and their first treatment was provided by a member of the study team. Study participants in the UC + PEMF group self-administered 30-min PEMF treatments, three times per week for 4 weeks. Treatment compliance and medication use were assessed using daily self-report diaries. At baseline, post-treatment, and 1-month follow-up, pain intensity was recorded by participants using the 0 to 10 NRS-11 recorded on a 4-day pain intensity diary. At baseline, post-treatment, and 1-month follow-up, participants completed a battery of instruments to measure the biopsychosocial sequelae often associated with cLBP. These instruments included the Post-Traumatic Stress Disorder Checklist—Military Version; The Primary Care Evaluation of Mental Disorders Patient Health Questionnaire (PHQ) Mood module (PHQ-9) and anxiety module (Generalized Anxiety Disorder-7 scale); and Short Form-12, version 2 (SF-12, v2) comprising a Mental Component Summary (MCS) score and Physical Component Summary (PCS) score.

Data Analysis

Data were analyzed using descriptive statistics and a two-factor generalized linear mixed model (treatment and time) with repeated measures on the factor time, followed by two-tailed nonparametric rank-based tests corrected for multiple comparisons. Confirmatory analyses of significant variables were performed using multilevel modeling (MLM) with the level of significance set at $p = .05$.

Findings

Effect of PEMF on Chronic Low Back Pain Symptom Intensity

To compute an average pain score for each phase, the participant had to have at least nine of 12 recorded pain scores on their pre-, post-, and 1-month follow-up pain logs. For the PEMF + UC group, there was a statistically nonsignificant decrease in mean pain intensity scores from 4.3 at baseline to 3.9 post-treatment; for the UC-only group, there was a statistically nonsignificant increase in mean pain scores from 3.5 to 3.8. At the 4-week follow-up post-treatment with PEMF, participants in the PEMF + UC group had a negligible decrease in mean pain intensity scores (from mean [M] = 3.9 post-treatment to M = 3.8 at follow-up); whereas, participants in the UC-only group had a downward trend from M = 3.8 to M = 3.4. Table 1 provides the means and SDs to examine variability in the phenomena over time, as well as the 2 × 3 analysis of variance (ANOVA) F statistic to examine whether significant group differences existed over time. For the mixed ANOVA of NRS-11 pain scores, the 2 × 3 (group × phase) interaction was neither significant: $F(2, 102) = 1.5$, $p = .228$ ($\eta^2 = 0.029$) nor were the main effects for time ($p = .279$, $\eta^2 = 0.025$) or group ($p = .305$, $\eta^2 = 0.021$). Although the interaction was not significant, the UC + PEMF group had higher mean pain scores across all three phases compared with UC.

Table 1 – Descriptive Statistics and Variability in Primary and Secondary Outcomes

Variable	Time 1: Baseline		Time 2: 4 Weeks Post-Treatment		Time 3: 8 Weeks 1-Month F/U		2 × 3 (Group × Time) Mixed ANOVA Interaction		
Group	UC + PEMF (n = 36) UC (n = 32)		UC + PEMF (n = 29) UC (n = 30)		UC + PEMF (n = 25) UC (n = 28)				
	M	SD	M	SD	M	SD	F	p	η^2
Pain intensity									
UC + PEMF	4.3	1.8	3.9	1.6	3.8	2.3	$F(2, 102) = 1.5$	.228	0.029
UC only	3.5	2.3	3.8	2.0	3.4	2.2			
Depression									
UC + PEMF	5.2	5.0	4.6	5.0	4.6	5.6	$F(2, 104) = 1.56$	.219	0.029
UC only	4.9	4.8	3.6	3.5	3.7	3.3			
Anxiety									
UC + PEMF	3.9	4.6	3.8	4.9	4.5	6.0	$F(2, 104) = 5.28$	.007*	0.092
UC only	4.3	4.7	2.4	2.6	2.6	3.4			
PTSD									
UC + PEMF	29.5	15.4	27.0	14.2	28.0	15.9	$F(2, 104) = 0.515$	.599	0.01
UC only	45.4	8.4	44.8	7.3	46.4	7.9			
Mental HrQoL									
UC + PEMF	54.8	5.8	54.0	8.9	53.8	9.8	$F(2, 104) = 4.02$	.018*	0.075
UC only	51.8	8.6	54.4	9.0	53.8	7.5			
Physical HrQoL									
UC + PEMF	42.8	9.9	45.5	10.3	43.5	11.6	$F(2,104) = 4.20$	.018*	0.075
UC only	45.4	8.4	44.8	7.3	46.4	7.9			

Note. ANOVA, analysis of variance; F/U, follow-up; HrQoL, health-related quality of life; M, mean; PEMF, pulsed electromagnetic frequency; PTSD, post-traumatic stress disorder; SD, standard deviation; UC, usual care.
* $p < .05$.

Effect of PEMF on Mental Health Symptoms and Health-related Quality of Life

Depression and PTSD symptom severity also demonstrated statistically nonsignificant variability and no between-group differences over time. Unexpectedly, anxiety symptom severity decreased in the UC group from an average of 4.3 (SD, 4.7) at baseline to 2.6 (SD, 3.4) at 1-month follow-up, yet increased in the UC + PEMF group from 3.9 (SD, 4.6) at baseline to 4.5 (SD, 6.0) at 1-month follow-up during active treatment with the device. When examining the estimated means for anxiety symptom severity, the UC group had a higher mean at baseline when compared with the UC + PEMF group, but the pattern was reversed for the subsequent two periods (i.e., higher means obtained for UC + PEMF group). The 2 × 3 mixed ANOVA for anxiety symptoms severity was significant: $F(2, 104) = 5.28$, $p = .007$ ($\eta^2 = 0.092$); however, the main effects for time ($p = .271$, $\eta^2 = 0.025$) or group ($p = .372$, $\eta^2 = 0.015$) were not significant, as is expected in repeated-measures designs. Confirmatory analysis using MLM of the anxiety findings showed that the crosslevel interaction of group × time remained significant for the anxiety outcome variable: $F(2, 110.68) = 4.78$, $p = .01$. Overall, neither of the individual predictors were significant, that is, for group: $F(1, 64.97) = 1.09$, $p = .301$ nor time: $F(2, 110.68) = 1.99$, $p = .142$. However, when examining the individual partial coefficients, significance was obtained for the coded vector for baseline scores when compared with 1-month follow-up scores: $b = -2.42$, $p = .013$. Moreover, the group × time interaction term yielded a significant coefficient when comparing baseline to 1-month follow-up data: $b = -0.27$, $p = .006$. (Note: when time is modeled as a continuous variable, the interaction was still significant: $b = 1.23$, $p = .005$). The conditional intraclass correlation coefficient (ICC = 0.748) indicated that 74.8% of the variability was accounted for by differences in the individual intercepts. Given the non-normality of the outcomes, a log (base 10) transformation was performed on each of the anxiety-dependent variables, and the group × time interaction was still significant ($p = .015$).

The SF-12, v2, Physical Health Component Scores (PCS) demonstrated significance between group differences over time. When examining the estimated means, the UC group had a higher mean at baseline and 1-month follow-up when compared with the UC + PEMF group, but the pattern was reversed for post-treatment PCS scores, where a higher mean was obtained for UC + PEMF group. The mixed ANOVA 2 × 3 (group × time) interaction was significant for the PCS: $F(2, 104) = 4.75$, $p = .011$ ($\eta^2 = 0.084$) and neither of the main effects were significant for time ($p = .237$, $\eta^2 = 0.027$) and group ($p = .445$, $\eta^2 = 0.011$). There was also a significant interaction for the quadratic term: $F(1, 52) = 10.23$, $p = .002$ ($\eta^2 = 0.164$). The UC group had a higher mean at baseline and 1-month follow-up when compared with the UC + PEMF group; however, the pattern was reversed insofar as a higher mean was obtained for UC + PEMF group at post-treatment. When

examining the simple effects analysis, there were no between-group differences at any of the specific waves of data collection. Secondary analysis using MLM confirmed that the crosslevel interaction of group × time was significant for the PCS: $F(2, 112.62) = 3.76$, $p = .026$. Overall, the individual predictors were significant neither for group: $F(1, 67.11) = 0.223$, $p = .638$ nor for time: $F(2, 112) = 1.37$, $p = .259$. Moreover, the interaction term yielded a significant coefficient when comparing post-treatment to 1-month follow-up: $b = 3.65$, $p = .034$. (Note: when time is modeled as a continuous variable, the interaction is not significant: $b = 0.35$, $p = .692$). The conditional ICC = 0.762 indicated that 76.2% of the variability was accounted for by differences in the individual intercepts.

The SF-12, v2, Mental Health Component Scores (MCS) demonstrated significant between group differences over time as well. The UC group has a higher mean at baseline when compared with the UC + PEMF group, but the pattern was reversed for the next two waves of data collection, with the UC-only group having higher means than the UC + PEMF group. When examining the simple effects analysis, there is a significant between-group difference at baseline: $F(1, 52) = 4.70$, $p = .035$ ($\eta^2 = 0.083$). The results of the 2 × 3 ANOVA interaction was significant: $F(2, 104) = 4.20$, $p = .018$ ($\eta^2 = 0.075$), and neither of the main effects were significant: for time ($p = .599$, $\eta^2 = 0.01$) nor group ($p = .605$, $\eta^2 = 0.005$). For the MLM secondary analysis, the crosslevel interaction of group × time was significant for the SF-12 MCS: $F(2, 112.5) = 3.26$, $p = .042$. Overall, the individual predictors were significant neither for group: $F(1, 65.71) = 0.074$, $p = .786$ nor for time: $F(2, 112.5) = 0.233$, $p = .783$. Moreover, neither of the group × time interaction terms yielded a significant coefficient, although when comparing baseline to 1-month follow-up scores: $b = 3.55$, $p = .051$. (Note: when time is modeled as a continuous variable, the interaction is still significant: $b = -1.84$, $p = .043$). The conditional ICC = 0.665 indicated that 66.5% of the variability was accounted for by differences in the individual intercepts. Given the non-normality of the outcomes (i.e. negative skewness), a log (base 10) transformation was performed on the MCS variables, and the group × time interaction remained significant ($p = .013$) as well as the effect for time ($p = .018$).

It is important to note that overall dropout rates were different between the two groups. Thirty percent of participants assigned to the PEMF + UC group did not perform their 4-week follow-up, whereas only 12% of participants assigned to receive UC only dropped out by the final visit.

Discussion

To date, there is no one-size-fits-all treatment approach for managing cLBP. Typically, UC consists of physical therapy with an ongoing regimen of back stretching and strengthening exercises, proper body mechanics, and pain medications as needed during acute exacerbations of the symptoms. Because of the relative lack of high-level evidence to validate prescribing complementary integrative medicine therapies to treat LBP symptoms, military health care providers have relied primarily on referring to physical therapy early in the course of their symptoms, and then prescribing pain medications and providing ongoing education on prevention and self-care when acute exacerbations of their chronic musculoskeletal symptoms occur. For SMs and the military organization at large, this overreliance on prescribing pain medications to treat chronic pain has resulted in serious consequences in the form of undesirable medication side effects, rising rates of addiction to prescribed opioid medications, and lost workplace productivity. Unfortunately, the results of this study demonstrate that the use of PEMF, when added to this UC regimen, did not decrease reported cLBP symptoms above and beyond UC alone. Relative to quality of life, those SMs who used adjunctive PEMF reported improvements in their physical health; however, they also reported poorer mental health with a subsequent rise in reported anxiety symptoms when compared with those following only the UC regimen.

PEMF and cLBP

It is important to note that the addition of PEMF only accounted for a one-half point decrease in reported pain intensity on an 11-point pain scale over the full 8 weeks of study participation. Farrar et al. (2001) reported that a reduction of approximately two points or 30% in an 11-point pain rating scale represents a clinically important difference. This result is not reflective of a 2016 randomized controlled study by Lee et al. (2006) in which PEMF produced a reduction in cLBP symptom intensity from 6.7 to 4.8 on the NRS-11 pain scale with 3 weeks of treatment and sustained improvement to 4.5 at week 4 follow-up.

There are several potential reasons for these findings. First, there were significant differences between groups in mean pain scores at baseline although participants were randomly allocated to treatment groups, and the participants in the study by Lee et al. (2006) started with higher baseline pain scores. In addition, the influence of treatment bias for participants enrolled in the PEMF group cannot be overlooked. Unlike the UC-only group, these participants received a device to add to their treatment regimen. Kaptchuk, Goldman, Stone, and Stason (2000) argued that participants receiving procedures or treatments in addition to standard of care treatments can experience heightened expectations; and in fact, the procedures, which the authors considered to be an estimate of the magnitude of the placebo effect under conditions of heightened expectations, can bias the results. Finally, there may have been quantitative

between-group differences in participants' intensity of weekly stretching and strengthening, continued medication use, or device usage that was not accurately captured in the self-report treatment and medication logs. Future studies in military samples should use a sham device to negate heightened expectations and study a larger sample size with witnessed treatment administration to control for these potential confounders.

PEMF and Mental Health

Comorbid mental health conditions have been well-established correlates of chronic pain conditions (Ratzliff et al., 2016). SMs have experienced rising rates of depression, anxiety, PTSD, and comorbid chronic pain conditions over the last two decades (Phillips et al., 2016; Ratzliff et al., 2016). Therefore, it was surprising in this sample of SMs that the baseline mean scores for these comorbid conditions were so low. Cutoff scores for mild symptoms on the instruments for measuring anxiety, depression, and PTSD symptom severity are 5, 10, and 50, respectively (Bliese et al., 2008). That being said, baseline mean scores for the full sample in this study were 4.1 (SD, 4.6) for anxiety; 5.0 (SD, 4.9) for depression; and 29.3 (SD, 13.5) for PTSD; lower mean scores than other studies of SMs with chronic pain conditions (Otis et al., 2010; Outcalt et al., 2015; Phillips et al., 2016).

Regarding between-group comparisons of anxiety severity scores, there were appreciable differences in participants receiving adjunctive PEMF when compared with UC alone. Those receiving medication management and education only experienced an appreciable decrease in anxiety symptoms during the first 4-week period with a slight increase during the last 4-week period, whereas those participants who included PEMF to the treatment regimen experienced a small but steady increase in anxiety symptoms over the full 9 weeks of study participation. The literature on electroanalgesia in general, or the Biomodulator device specifically, does not mention anxiety as a potential side effect of treatment (Al-Mandeel & Watson, 2008; Strauch et al., 2009; Tennant, 2005); however, no studies of PEMF were found that specifically examined anxiety as an outcome variable. Although self-treatment with a new device in and of itself could raise the anxiety symptoms in this group, one would not expect to see a sustained increase during the 4 weeks after active treatment when the PEMF treatment was stopped. In addition, it was the greater drop in anxiety symptom severity in the UC group over the small increase in anxiety symptoms reported by the group that also used PEMF that was more responsible for the significant between-group differences. Nonetheless, further examination of the side effects of treatment with PEMF is warranted given the increase in anxiety and decrease in overall mental HrQoL in this group.

PEMF and HrQoL

The concept of HrQoL and its determinants has evolved since the 1980s to encompass aspects of overall quality of life that clearly influence health outcomes, both physical and mental (Ware, Kosinski, & Keller, 1996). At the individual level, how a person views the quality of his or her own health has become an important aspect of assessing a treatment's effect on mental, physical, functional, and social functioning (Ware et al., 1996). Findings from this study indicate that adjunctive PEMF improved SMs' perceptions of their physical health. Unexpectedly, it also indicated that adjunctive PEMF diminished SMs' perceptions of the quality of their mental health. In support of this finding, there was a mild but sustained increase in anxiety symptoms throughout the course of treatment for those using PEMF that cannot be fully explained; and this finding contrasted with small clinically insignificant decreases in reported depression and post-traumatic stress symptom severity in this same group. Baseline HrQoL measurements of 77,047 U.S. SMs participating in The Millennium Cohort study found unadjusted mean physical and mental health component scores of 53.4 (95% confidence interval, 53.3–53.4) and 52.8 (95% confidence interval, 52.7–52.9), respectively; however, these baseline data were collected in 2001 to 2003 before the start of Operations Iraqi Freedom and New Dawn (Smith et al., 2007). SMs who participated in this study had a baseline mean PCS of 44.0 (SD, 8.8) and MCS of 53.4 (SD, 7.3). Physical component scores were less favorable in this military sample compared with scores of the general population of the United States of the same age and sex, and mental component scores were slightly more favorable. In contrast, studies of both Canadian military veterans and Persian Gulf veterans found relationships between the increased severity of chronic pain and musculoskeletal problems and poorer physical and mental component scores (Forman-Hoffman et al., 2005; Thompson et al., 2013).

Implications for Clinical Practice and Future Research

Findings from this study provided preliminary evidence to health care providers that there is insufficient scientific evidence to support prescribing adjunctive PEMF for treatment of chronic musculoskeletal LBP symptoms at this time. With the tremendous physical, emotional, and spiritual toll that 14 years of war have exacted on our military forces; the widespread reports of chronic pain among SMs; and the overreliance of military health care providers prescribing opioids to treat chronic pain, the military health care community has moved to the forefront of exploring complementary integrative pain treatment modalities. Results from this study will help direct future research endeavors on electroanalgesia treatments in hopes of finding viable alternatives to prescription opioids for pain control. Military nurse scientists, advanced practice nurses, and clinical nurses continually strive to

expand the boundaries of the traditional medical model of pain treatment and are the vanguard of advancing the science of holistic, patient-centered, and pain management nursing practice.

Future research should be focused on larger randomized controlled trials using sham treatments vs. UC as a comparator. This would provide stronger evidence as to the effectiveness of PEMF for treating cLBP symptoms in this population. In addition, future research of PEMF treatment must examine its effect on anxiety symptoms and overall mental health to validate whether increased anxiety is a newly emerging side effect of treatment. This is especially relevant given the high comorbidity between chronic pain, depression, anxiety, and PTSD in both military and civilian samples. The results of this study, although statistically and clinically not significant, were promising. Because of methodological issues and an inability to control for all confounders in this convenience sample recruited from a single military treatment facility, the results should be viewed in light of these study limitations.

Conclusion

For the Military Health System, chronic musculoskeletal LBP is a particularly salient public health problem in an otherwise young and healthy military population. It is among the most frequent complaints for medical visits, lost work time, and attrition from garrison duty and the combat theater. But more so, it degrades the health, fitness, and morale of the SMs who suffer from its lasting effects. Although analgesics and education have been effective for treating acute exacerbations, they have not been equally effective for treating chronic symptoms, leading to an overreliance on medications for treatment. Pulsed electromagnetic field therapy, a complementary modality previously unexplored in a military population, demonstrated efficacy in small-scale studies examining muscle recovery and function in injured athletes, pain control, and treatment of musculoskeletal pain and dysfunction. This study examined the efficacy of this adjunctive treatment for musculoskeletal cLBP symptoms in military SMs, and although it found trends in symptom improvement, they were neither clinically or statistically significant. However, this study also showed that the addition of PEMF to an UC treatment regimen significantly improved their physical HrQoL, perhaps a better indicator of improvement in this military population recognizing that complete pain relief may be an unattainable treatment goal. Surprisingly, this study also demonstrated the potential negative effects of this adjunctive treatment on mental-related quality of life, which was further validated by a sustained rise in reported anxiety symptoms; a finding that had not been previously reported in the literature and could affect who may or may not benefit from treatment with PEMF.

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