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Changes in Mindfulness, Well-Being, and Sleep Quality in College Students Through *Taijiquan* Courses: A Cohort Control Study

Karen Caldwell, PhD,[1] Lisa Emery, PhD,[2] Mandy Harrison, PhD,[3] and Jeffrey Greeson, PhD[4]

Abstract

Objectives: This study sought to determine whether participants in *taijiquan* classes would report increases in mindfulness greater than that of a comparison group, and whether changes in mindfulness were associated with improvements in mood, perceived stress, self-regulatory self-efficacy, and sleep quality.
Design: The study design was quasi-experimental with repeated measures.
Settings/location: The study was set in a midsized public university.
Subjects: Students aged 18–48 years old enrolled in 15-week courses of either *taijiquan* ($n = 76$) or special recreation (control group, $n = 132$).
Intervention: Chen-style *taijiquan* classes were offered 2 times per week for 50 minutes each time.
Outcome measures: Self-report of mindfulness (Five Facet Mindfulness Questionnaire), mood (Four Dimensional Mood Scale), perceived stress (Perceived Stress Scale), self-regulatory self-efficacy (Self-regulatory Self-Efficacy Scale), and sleep quality (Pittsburgh Sleep Quality Index).
Results: Increases in total mindfulness scores occurred only in the *taijiquan* group, not in the control group. All well-being variables showed a pattern of improvement in the *taijiquan* group, with either stability or decline over time in the control group. Increases in mindfulness were significantly correlated with improvements on all well-being measures and with sleep quality.
Conclusions: Relative to a recreation control group, *taijiquan* classes for college students are associated with increased mindfulness and improved sleep quality, mood, and perceived stress, but not self-regulatory self-efficacy. Randomized control design studies are needed to substantiate the causal role of *taijiquan* exercise in the development of mindfulness and associated improvements in well-being.

Introduction

Mindfulness refers to the ability to attend to present-moment experience with a nonjudgmental quality.[1,2] A rapidly growing body of research supports the connection between mindfulness and well-being,[3] with both dispositional mindfulness and mindfulness interventions being associated with better outcomes on a number of measures of emotional well-being.[4,5] A number of recent studies have investigated mindfulness with samples of young adults.[4–14]

Although mindfulness is often taught through meditation, very little research has focused on increasing mindfulness through participation in somatic modalities. Meditative movement, or mindful physical exercise, is proposed by several groups as a special category of exercise,[15,16] and may be particularly effective at increasing mindfulness in participants. For example, Mindfulness-Based Stress Reduction (MBSR) programs typically include a yoga component, and one recent study found that yoga practice was associated with changes in more mindfulness facets than other practices taught in MBSR such as body scan or sitting meditation.[17] Yoga practice has also been associated with higher scores on a mindful eating questionnaire,[18] and recent studies by Caldwell and colleagues[19] found increases in mindfulness reported by college students engaged in *taijiquan* practice.

Taijiquan, also referred to as *t'ai chi*, *taiji*, or *t'ai chi chuan*, is a mind–body exercise that originated in China as a martial

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art based on Daoist philosophical principles and breathing techniques. Depending on practitioners' preferences, different aspects of the art can be practiced, but the "mind" component of *taijiquan* is an essential aspect of the practice and includes training in concentration or focus. The beneficial effects of *taijiquan* have been recognized for centuries in China, and a growing body of clinical research has begun to evaluate the efficacy and safety of *taijiquan* as a therapeutic modality for a variety of health issues including balance, aerobic fitness, immune function, strength, flexibility, and general stress management.[20,21]

A major limitation of current research into the health benefits of *taijiquan* available in the English language is that few studies have included young adult samples. Indeed, 80% of the studies use older adults.[22] A recent review of scientific literature reported a total of 27 randomized controlled trials (RCTs) of *taijiquan* and *qigong* effects on psychologic symptoms, and only 2 of these studies included young adult participants (<30 years of age).[21] In addition to these RCTs, there are several quasi-experimental studies of the effects of *taijiquan* on psychologic functioning of young adults. Jin found improvements in mood after a single practice session of *taijiquan*,[23] and Wang and colleagues[24] found that a 3-month intervention of *taijiquan* had positive effects on the mental health of college students. Caldwell and colleagues[19,25] also found improvements in self-reported mood and stress scores in college students engaged in *taijiquan* practice.

Poor sleep quality has been related closely to mood disturbance and a number of risk factors for poor health outcomes.[26] In a recent study of a large population of college students, poor-quality sleepers reported significantly more problems with physical and psychologic health than did good-quality sleepers.[27] Students in this study overwhelmingly stated that emotional and academic stress negatively impacted sleep. Tension and stress accounted for 24% of the variance in self-reported sleep quality scores, while exercise, alcohol, and caffeine consumption, as well as consistency of sleep schedule, were not significant predictors of sleep quality.

One behavioral intervention often recommended as an important sleep aid is exercise. Epidemiologic studies have consistently shown an association between self-reports of exercise and better sleep.[28] However, experimental studies reviewed by Youngstedt found only modest effects of exercise on sleep.[29] Many of these experimental studies were limited to good sleepers with little room for improvement. The research on individuals with insomnia or depression yielded more promising results for the effect of exercise on sleep. Additional promising behavioral interventions for treating poor sleep quality are those focusing on alleviating stress and reducing worry. *Taijiquan* has the potential to combine the benefits of both physical exercise and reductions in stress related to increases in mindfulness and reductions in worry. Li et al.[30] found that older adults with moderate sleep complaints improved self-rated sleep quality through participation in a *taijiquan* program, and similar findings in college students were recently reported by Caldwell et al.[25]

Given the potential link between current clinical research into the health benefits of mindfulness and the paucity of research on *taijiquan* with young adults, the purpose of the current study was to determine whether young adults participating in *taijiquan* classes would report increases in mindfulness greater than that of a comparison group and whether changes in mindfulness were associated with improvements in mood, perceived stress, self-regulatory self-efficacy, and sleep quality.

Methods

Study design

Participants for the study were recruited in the fall and spring semesters of the 2007–2008 and 2008–2009 academic year from two undergraduate classes: *taijiquan*, the experimental group; and special recreation, the control group. The *taijiquan* group included 76 participants, and the special recreation group included 132 participants.

The *taijiquan* class was an academic elective that fulfilled the Physical Activity/Wellness General Education requirement, while the special recreation class was required for students majoring in Recreation Management. Chen-style *taijiquan* classes met twice a week for 50 minutes each session for 15 weeks following principles outlined by Yang.[31] Thus, students who participated in the *taijiquan* classes received 25 hours of total in-class instruction. The 2 instructors had completed extensive training in *taijiquan* (>15 years each). One (1) was certified to teach by the St. Louis Chinese Internal Arts Center and 1 was certified to teach Evidence-Based Traditional *Taiji* by the Center for *Taiji* Studies.™

For the control group, subjects participated in one of two sections of special recreation: one section met once per week for 2½ hours, and the other section met twice per week for 1 hour and 15 minutes. Thus, students in the special recreation classes received 37.5 hours of total in-class instruction. For both sections, the class format was a mixture of lecture, discussion, and service learning experiences. The special recreation class was chosen as a comparison condition because it was comparable to the *taijiquan* class in that students were engaged in social interaction and similar levels of exercise, but without the training in mind–body awareness provided by *taijiquan*.

Procedures

Students in both conditions completed a survey instrument in class at the beginning, midpoint, and end of the semester. Study procedures were approved by the Institutional Review Board of the university prior to collection of data. All students who participated in the survey study provided informed consent.

Mindfulness. The Five Facet Mindfulness Questionnaire[32] is a 39-item instrument that uses a 5-point Likert-type scale. Items were developed from a factor analytic study of five previously developed mindfulness questionnaires. The five factors representing elements of mindfulness are (1) *observing* or attending to sensations, perceptions, thoughts, and feelings, (2) *describing* or labeling these internal experiences with words, (3) *acting with awareness* rather than on "automatic pilot," (4) *nonjudging* of inner experiences, and (5) *nonreactivity* to inner experience. A Total Mindfulness score was calculated by adding scores on each of the five scales. Higher scores indicate greater levels of mindfulness. For the present sample,

Table 1. Baseline Group Differences in Study Variables

	Taijiquan		*Special recreation*		
Variable	M	*SD*	M	*SD*	*Significance*
Mindfulness	132.51	17.23	129.10	14.34	$p = 0.15$
Sleep Quality	11.46	3.79	10.81	3.90	$p = 0.27$
Positive Energy	**13.04**	**3.35**	**14.14**	**2.23**	$\mathbf{p = 0.007}$
Tiredness	**13.50**	**4.22**	**12.10**	**3.32**	$\mathbf{p = 0.012}$
Negative Arousal	**12.71**	**4.13**	**11.24**	**3.44**	$\mathbf{p = 0.009}$
Relaxation	16.74	3.84	16.95	3.26	$p = 0.678$
Perceived Stress	6.39	2.64	5.85	2.64	$p = 0.250$
Self-regulatory Efficacy	**20.76**	**3.39**	**19.56**	**2.96**	$\mathbf{p = 0.011}$

Significant effects are in boldface.
SD, standard deviation.

Cronbach α for the five scales plus Total Mindfulness ranged from .740 to .908.

Mood. The Four Dimensional Mood Scale[33] is based on a circumplex model of dispositional mood measuring Positive Energy, Tiredness, Negative Arousal, and Relaxation.[27] This 20-item adjective checklist uses a 5-point Likert format (1 = not at all, 5 = extremely), and scores on each scale are the mean response to items on the scale. Examples of adjectives used in the scales are (1) Lively and Vigorous for Positive Energy, (2) Exhausted and Weary for Tiredness, (3) Aggravated and Irritable for Negative Arousal, and (d) Calm and Peaceful for Relaxation. There is evidence for generally good internal consistency of the scales as well as construct and discriminant validity.[33,34] For the present sample, Cronbach α for the four scales ranged from .744 to .898 across the semester.

Stress. The Perceived Stress Scale–4[35] is a 4-item Likert format scale designed to measure the degree to which situations in one's life are appraised as stressful. For the present sample, Cronbach α reliability coefficients were .792, .696, and .673 at the beginning, midpoint, and end of the semester. Elevated scores on the scale have been associated with self reported physical illness.[36]

Self-efficacy. The Self-Regulatory Self-Efficacy Scale[37] is a 4-item, Likert format instrument designed to measure self-regulatory self-efficacy (i.e., motivating oneself to keep trying difficult tasks). Scores range from 4 to 28, and the measure has been correlated with perceived performance and activity-specific self-efficacy.[37] Cronbach α reliability coefficients for the present sample were .696 at the beginning, .702 at the midpoint, and .791 at the end of the semester.

Sleep quality. The Pittsburgh Sleep Quality Index (PSQI)[38] consists of 19 self-rated questions related to normal sleep habits. Scores range from 0 to 21, and the instrument has strong temporal stability (Pearson $r = .85$ over 28 days). Higher numbers on the PSQI indicate greater sleep disturbance, or poorer sleep quality. A PSQI global score >5 has served as a marker to distinguish sleep disturbances in patients with insomnia versus controls. For the present sample, the seven component scores of the PSQI had overall reliability coefficients (Cronbach α) of .687 at the beginning, .727 at the midpoint, and .748 at the end of the semester.

Data analysis

A series of hierarchical linear models[39] was used to analyze the data, using SAS 9.1.3 "PROC MIXED."[40] In hierarchical linear modeling (HLM) of longitudinal data, a series of nested linear equations is used to estimate effects by occasion (time point) and person. In the first (Level 1) equation, the dependent variable is estimated using occasion-based independent variables. In the remaining (Level 2) equation(s), the intercept and the coefficient of each occasion-level variable become(s) the dependent variable(s), and various person-level independent variables can be used to predict these coefficients. Finally, HLMs allow the researcher to examine interactions between Level 1 and Level 2 variables (cross-level interactions).

For the current study, the order of HLM analysis was as follows. First, mindfulness and each well-being variable were analyzed using a "null" or unconditional model, in which only the intercept for each variable was estimated. The purpose of conducting null models was to determine whether there was significant variability in each variable both at level 1 (between occasions) and Level 2 (between people) to warrant conducting further models. Next, the authors examined whether changes over time in each variable differed between groups using an Intercepts and Slopes as Outcomes model[39] to test for cross-level interactions. Finally, the

Table 2. Results of Multilevel Analysis Examining Change Over Time in Study Variables

	Time		*Exercise group*		*Exercise group × time*	
Variable	*Coefficient*	p	*Coefficient*	p	*Coefficient*	p
Mindfulness	−0.24	0.69	**4.31**	**0.04**	**5.56**	**<0.001**
Sleep Disturbance	0.15	0.48	0.25	0.58	**−0.50**	**0.02**
Positive Energy	−0.13	0.11	**−1.19**	**<0.01**	**0.37**	**0.04**
Tiredness	**0.72**	**<0.001**	0.93	0.10	**−0.93**	**<0.01**
Negative Arousal	**0.70**	**<0.001**	**1.19**	**0.03**	**−1.55**	**<0.001**
Relaxation	−0.25	0.11	−0.26	0.61	**0.84**	**<0.01**
Perceived Stress	0.38	0.15	0.45	0.28	**−0.73**	**<0.01**
Self-regulatory Efficacy	0.01	0.92	**1.26**	**<0.01**	0.08	0.72

For group, Special Recreation = 0, *taijiquan* = 1. Significant effects are in boldface.

authors examined whether changes in mindfulness were related to changes in each of the well-being measures by first using a one-way analysis of covariance with Random Effects Model[39] with Mindfulness as a Level 1 variable and each well-being variable as a dependent variable, and then testing whether these relationships varied across groups by conducting another Intercepts and Slopes as Outcomes analysis, substituting Mindfulness for Time as the Level 1 variable. In each of the models, the slopes were constrained to be equal across participants, as initial analyses indicated that constraining the slopes provided a better fit than allowing the slopes to vary. All continuous variables were grand-mean centered before analysis so that the zero point of the independent variable (IV) can be interpreted as the grand mean of the variable across occasions and people, and the intercept of the dependent variable (DV) can be interpreted as the expected score of the DV when the IV is at the grand mean. Exercise group was dummy-coded with the special recreation class coded "0" and the *taijiquan* class coded "1."

Results

Demographics and baseline characteristics

The *taijiquan* group consisted of 76 participants, ages 18–48 years old ($M = 21.56$, standard deviation [SD] = 3.65), with 32 women and 44 men. The special recreation group consisted of 132 participants, ages 19–39 years old (M = 21.11, SD = 2.47), with 44 women and 88 men. There were no significant differences between the *taijiquan* and special recreation groups in age: $t(184) = 0.32$, $p = 0.32$, gender composition, $\chi^2(1) = 1.6$, $p = 0.21$, or hours of weekly exercise, $t(172) = -1.002$, $p = 0.32$.

Because there was no random assignment to treatment groups, possible baseline differences were first checked for between the two exercise groups on each outcome variable. As may be seen in Table 1, there were no baseline group differences for sleep quality, mindfulness, or the relaxation scale for the mood instrument. There were, however, baseline differences found for three of the four components of the mood instrument (Positive Energy, Negative Arousal, and Tiredness), with the Special Recreation group showing more positive energy, less negative arousal, and less tiredness than the *taijiquan* group. There was also a significant baseline difference in self-regulatory self-efficacy, with the *taijiquan* group reporting higher levels of self-regulatory self-efficacy than the Special Recreation group.

Preliminary analyses: Null models

The initial Null models indicated that each study variable showed both significant between-person variability (ranging from 43% for Perceived Stress, to 65% for total Mindfulness and Sleep Quality) and within-person variability (ranging from 35% for Mindfulness and Sleep Quality to 57% for Perceived Stress) to warrant conducting further models (all $ps < 0.001$).

Change over Time

As may be seen in Table 2, all variables except self-regulatory self-efficacy showed different patterns of change over time in the two exercise groups. Figures 1 and 2 plot the interactions for the seven variables showing significant Time × Exercise group interactions. These plots were made

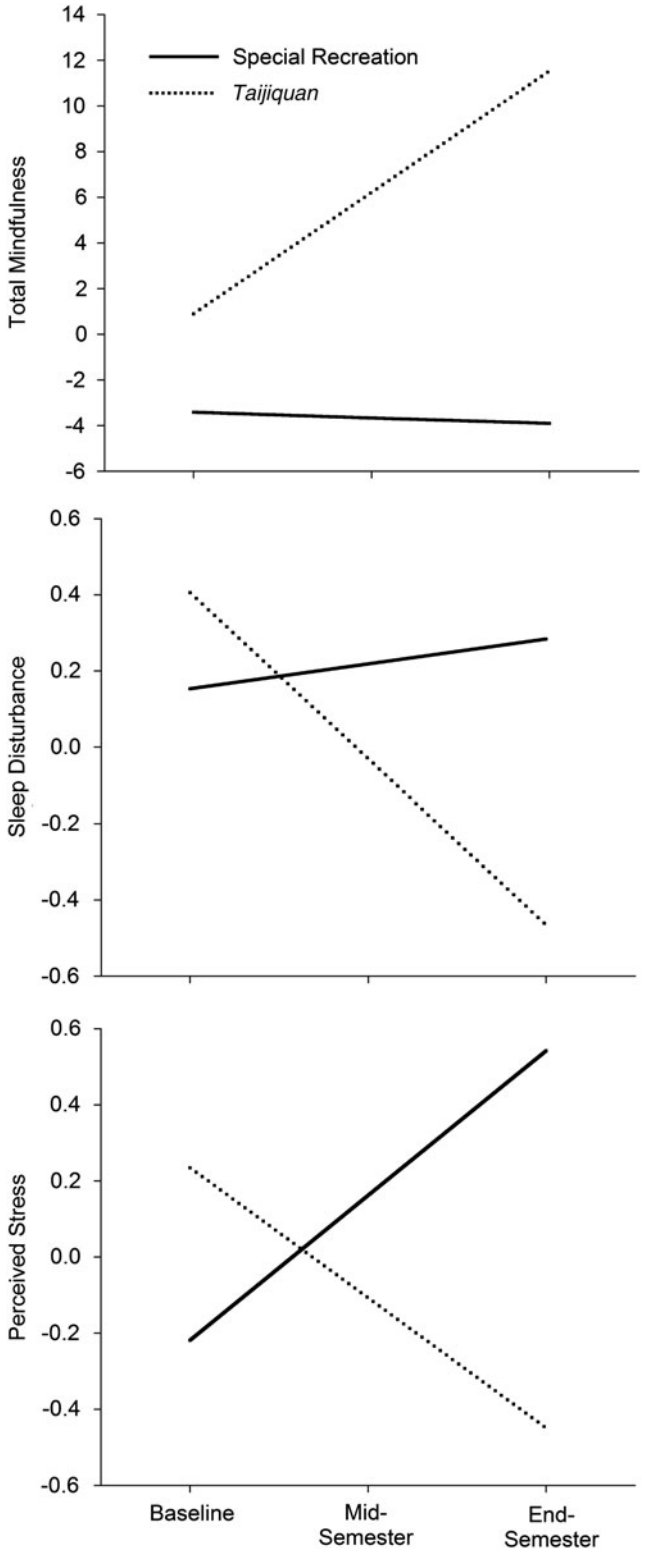

FIG. 1. Change in Total Mindfulness, Sleep Disturbance, and Perceived Stress over time in *Taijiquan* (dotted line) and Special Recreation (solid line) groups.

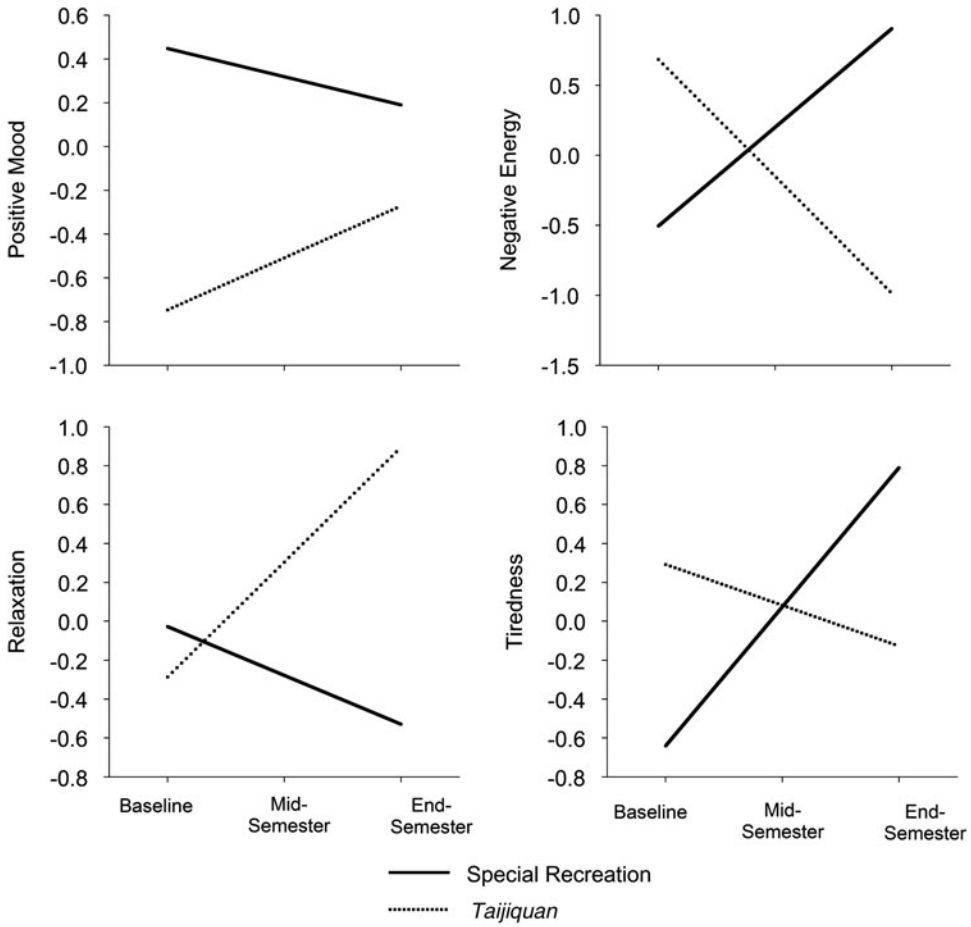

FIG. 2. Change in the four mood facets over time in *Taijiquan* (dotted line) and Special Recreation (solid line) groups.

using estimates from the HLM equations, substituting the appropriate time point (0, 1, or 2) and group value (0 or 1) for the IVs. All variables showed a similar pattern of improvements in the *taijiquan* group, with either stability or decline over time in the Special Recreation group. Of particular note, Mindfulness showed the expected improvements in the *taijiquan* group, but no change in the Special Recreation group. In addition, the significant baseline differences in negative energy and tiredness were actually reversed by the end of the semester.

Because there were baseline group differences in positive energy, tiredness, negative arousal, and self-regulatory efficacy, the analysis was repeated for these four variables with the baseline score included as a covariate. The only qualitative change in the results was that the Time × Exercise group interactions for positive energy dropped just below significance ($\gamma_{11} = .39$, $t = 1.74$, $p = 0.08$).

Association between changes in mindfulness and changes in well-being

Next, it was examined how changes in mindfulness may be linked to changes in well-being. As may be seen in Table 3, increases in mindfulness were significantly associated with improvements on all well-being measures. That is, on occasions that people reported higher mindfulness scores, they also reported decreases in perceived stress, tiredness, negative energy, and sleep disturbance, and increases in positive energy, relaxation, and self-regulatory efficacy. For two of the dependent variables (positive energy and relaxation), there were in addition differences in the relationship between changes in mindfulness and changes in well-being across the two groups. As may be seen in Figure 3, in both cases, the relationship between mindfulness and well-being were slightly stronger in the *taijiquan* group than in the Special Recreation group, with increases in mindfulness related to larger increases in positive energy and relaxation in the *taijiquan* group than in the special-recreation group. The plots were again made with estimates from the HLM equations, using the mean mindfulness value and ±1 SD for the high/low mindfulness values. Repeating these analyses with

Table 3. Relationship Between Changes in Mindfulness and Changes in Well-Being Variables

	Change w/Mindfulness	
Dependent Variable	*Coefficient*	p
Sleep Disturbance	−0.06	<.001
Positive Energy	0.04	<.001
Tiredness	−0.07	<.001
Negative Arousal	−0.10	<.001
Relaxation	0.08	<.001
Perceived Stress	−0.07	<.001
Self-regulatory Efficacy	0.06	<.001

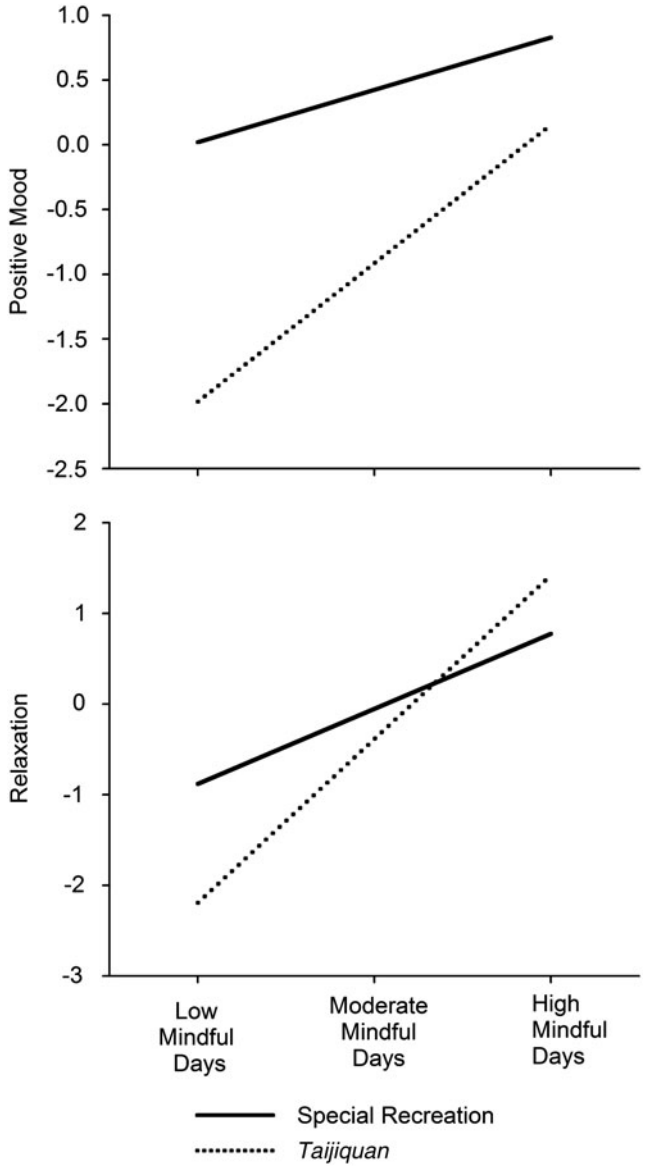

FIG. 3. Levels of Positive Mood and Relaxation on occasions when people showed low, moderate, or high levels of mindfulness. The *Taijiquan* group is represented by a dotted line, and the Special Recreation group is represented by a solid line.

the baseline measures included as covariates did not change the outcome.

Conclusions

The main findings of this study supported the hypothesis that *taiji* classes are associated with increases in mindfulness, well-being, and sleep quality among college students. Moreover, results indicated that these improvements are limited to students participating in *taiji*, and are not found in a demographically similar group of students participating in a different type of recreation class that does not include training in mind–body awareness. This finding is important because it helps fill a current gap in the empirical support for *taijiquan* training as an effective mind–body discipline for young adults. The current results are also important because they add to a nascent literature on the specific effect of *taiji*, versus the possible role of other "nonspecific" factors that may also contribute to beneficial changes in mindfulness and associated improvements in well-being and sleep quality. The use of a comparison group allowed us to control for a number of potentially confounding factors, including passage of time, attention from class instructors, and expected time and effort associated with both in-class and outside-of-class exercise. Nevertheless, because this study was limited by the lack of random assignment to the two groups, alternative explanations of the findings are possible. For example, although the groups were demographically similar, there were initial psychologic differences between the groups in terms of positive energy, negative arousal, tiredness, and self-efficacy. This finding suggests that there may have been a selection bias, such that students with lower mood and self-efficacy deliberately enrolled in the *taiji* classes. As a result, the specific benefits in mindfulness, well-being, and sleep quality may not generalize to other groups of students with better mood and psychosocial functioning at baseline. Additional studies are therefore needed to replicate these findings in more psychosocially and demographically diverse groups of students. An alternative interpretation of the observed baseline differences is that the differences were statistically significant, but perhaps not clinically meaningful. The initial differences in baseline mood scores between groups were only 7%–11%. Relatively large group sizes can make even nonmeaningful differences statistically significant, which is plausible in the present study. Finally, the baseline differences in negative energy and tiredness among the *taijiquan* group were reversed by the end of the semester. While this could be interpreted as reflecting a regression to the mean, if anything, stress, negative mood, and sleep disturbance should actually increase during the course of the semester without any intervention.

This study extends previous research on general trait mindfulness, showing that when students report being more mindful, they also report better sleep and less stress, regardless of what class they are enrolled in. Taking *taijiquan* may actually strengthen the relationship between mindfulness and good mood, as demonstrated by the cross-level interactions for predicting positive energy and relaxation. These findings suggest that the high levels of reported stress and sleep disturbance found in college student populations may be ameliorated by the inclusion of mindful-movement classes like *taiji* as part of the general education curriculum. Future research using random assignment is needed to control for expectancy bias, selection bias, and other possible explanatory factors in order to establish a specific, causal relationship between *taiji*, increased mindfulness, well-being, and sleep, as observed here.

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Disclosure Statement

No competing financial interests exist.

References

1. Bishop SR, Lau M, Shapiro SL, et al. Mindfulness: A proposed operational definition. Clin Psychol 2004;11: 230–241.
2. Kabat-Zinn J. Mindfulness-based interventions in context: Past, present, and future. Clin Psychol 2003;10:144–156.
3. Greeson J. Mindfulness research update: 2008. Complement Health Pract Rev 2009;14:10–18.
4. Vujanovic AA, Bonn-Miller MO, Bernstein A, et al. Incremental validity of mindfulness skills in relation to emotional dysregulation among a young adult community sample. Cogn Behav Ther 2010;39:203–213.
5. Walsh JJ, Balint MG, Smolira DR, et al. Predicting individual differences in mindfulness: The role of trait anxiety, attachment anxiety and attentional control. Pers Individ Dif 2009;46:94–99.
6. Coffey KA, Hartman M. Mechanisms of action in the inverse relationship between mindfulness and psychological distress. Complement Health Pract Rev 2008;13:79–91.
7. Kingston J, Chadwick P, Meron D, et al. A pilot randomized control trial investigating the effect of mindfulness practice on pain tolerance, psychological well-being, and physiological activity. J Psychosom Res 2007;62:297–300.
8. Lavender JM, Jardin BF, Anderson DA. Bulimic symptoms in undergraduate men and women: Contributions of mindfulness and thought suppression. Eat Behav 2009;10: 228–231.
9. McKee L, Zvolensky M, Solomon S, et al. Emotional-vulnerability and mindfulness: A preliminary test of associations among negative affectivity, anxiety sensitivity, and mindfulness skills. Cogn Behav Ther 2007;36:91–101.
10. Pace TW, Negi LT, Adame DD, et al. Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. Psychoneuroendocrinology 2009;34:87–98.
11. Piet J, Hougaard E, Hecksher MS, Rosenberg NK. A randomized pilot study of mindfulness-based cognitive therapy and group cognitive-behavioral therapy for young adults with social phobia. Scand J Psychol 2010;51:403–410.
12. Raes F, Dewulf D, Van Heeringen C, Williams JMG. Mindfulness and reduced cognitive reactivity to sad mood: Evidence from a correlational study and a non-randomized waiting list controlled study. Behav Res Ther 2009;47:623–627.
13. Rosenzweig S, Reibel DK, Greeson JM, et al. Mindfulness-based stress reduction lowers psychological distress in medical students. Teach Learn Med 2003;15:88–92.
14. Tanner MA, Travis F, Gaylord-King C, et al. The effects of the transcendental meditation program on mindfulness. J Clin Psychol 2009;65:574–589.
15. Forge RL. Aligning mind and body: Exploring the disciplines of mindful exercise. ACSM Health Fitness J 2005;9: 7–14.
16. Larkey L, Jahnke R, Etnier J, Gonzalez, J. Meditative movement as a category of exercise: Implications for research. J Phys Act Health 2009;6:230–238.
17. Carmody J, Baer RA. Relationships between mindfulness practice and levels of mindfulness, medical and psychological symptoms and well being in a mindfulness-based stress reduction program. J Behav Med 2008;31:23–33.
18. Framson C, Kristal A, Schenk J, et al. Development and validation of the Mindful Eating Questionnaire. J Am Diet Assoc 2009;109:1439–1444.
19. Caldwell K, Harrison M, Adams M, et al. Developing mindfulness in college students through movement based courses: Effects on self-regulatory self-efficacy, mood, stress, and sleep quality. J Am Coll Health 2010;58:433–442.
20. Wayne PM, Kaptchuk TJ. Challenges inherent to t'ai chi research: Part I. T'ai chi as a complex multicomponent intervention. J Altern Complement Med 2008;14:95–102.
21. Jahnke R, Larkey L, Rogers C, et al. A comprehensive review of health benefits of qigong and tai chi. Am J Health Promot 2010;24:e1–e25.
22. Sandlund ES, Norland T. The effects of tai chi chuan relaxation and exercise on stress responses and well-being: An overview of research. Int J Stress Manag 2000;7: 139–149.
23. Jin P. Changes in heart rate, noradrenaline, cortisol and mood during tai chi. J Psychosom Res 1989;33:197–206.
24. Wang Y, Taylor L, Pearl M, Chang L. Effects of tai chi exercise on physical and mental health of college students. Am J Chin Med 2004;32:453–459.
25. Caldwell K, Harrison M, Adams M, Triplett NT. Effect of Pilates and taiji quan training on self-efficacy, sleep quality, mood, and physical performance of college students. J Bodyw Mov Ther 2009;13:155–163.
26. Riedel BW, Lichstein KL. Insomnia and daytime functioning. Sleep Med Rev 2000;4:277–298.
27. Lund HG, Reider BD, Whiting AB, Prichard JR. Sleep patterns and predictors of disturbed sleep in a large population of college students. J Adolesc Health 2010;46:124–132.
28. Hublin C, Kaprio J, Partinen M, Koskenvuo M. Insufficient sleep: A population-based study in adults. Sleep 2001;24: 392–400.
29. Youngstedt SD. Effects of exercise on sleep. Clin Sports Med 2005;355–365.
30. Li F, Fisher J, Harmer P, et al. Tai chi and self-rated quality of sleep and daytime sleepiness in older adults: A randomized controlled trial. J Am Geriatr Soc 2004;52:892–900.
31. Yang Y. Taijiquan: The Art of Nurturing, the Science of Power. Champaign, IL: Zhenwu Publications, 2005.
32. Baer RA, Smith GT, Hopkins J, et al. Using self-report assessment methods to explore facets of mindfulness. Assessment 2006;13:27–45.
33. Huelsman TJ, Nemanick RC, Munz DC. Scales to measure four dimensions of dispositional mood: Positive energy, tiredness, negative activation, and relaxation. Educ Psychol Meas 1998;58:804–819.
34. Huelsman TJ, Furr RM, Nemanick RC. Measurement of dispositional affect: Construct validity and convergence with a circumplex model of affect. Educ Psychol Meas 2003;63:655–673.
35. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385–396.
36. Cohen S,Williamson G. Perceived stress in a probability sample of the United States. In: Spacapan S, Oskamp S, eds. The Social Psychology of Health: Claremont Symposium on Applied Social Psychology. Newbury Park, CA: Sage, 1988:31–67.
37. Harrison MB, McGuire FA. An investigation of the influence of vicarious experience on perceived self-efficacy. Am J Recreation Ther 2008;7:10–16.
38. Buysse DJ, Reynolds CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: A new instrument for

psychiatric practice and research. Psychiatry Res 1989;28: 193–213.
39. Raudenbush SW, Bryk AS. Hierarchical Linear Models: Applications and Data Analysis Methods. Thousand Oaks, CA: Sage Publications, 2002.
40. Singer JD. Using SAS PROC MIXED to Fit Multilevel Models, Hierarchical Models, and Individual Growth Models. J Educ Behav Stat 1998;23:323–355.

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