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Comparative Effectiveness of Mind-Body Exercise Versus Cognitive Behavioral Therapy for College Students with Problematic Smartphone Use: A Randomized Controlled Trial

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Abstract: *Purpose:* The purpose of the present study was to compare the effectiveness of mind-body exercise (ME) and cognitive behavioral therapy (CBT) on addiction level and psychological well-being among college students with problematic smartphone use (PSU). *Methods:* A 12-week randomized controlled study was carried out at a university in central China. A total of 95 PSU college students who met the inclusion criteria were randomly assigned to a ME group (ME, n = 31), CBT group (CBT, n = 30), or control group (CG, n = 34). Both ME intervention and CBT, twice per week for 90 min per session, lasting for 12 weeks were administered by a certified therapist respectively. Participants in the CG group were asked to maintain their original lifestyle. *Results:* A significant reduction in addiction level ($p < 0.001$ for ME *vs*. CBT; $p < 0.001$ for ME *vs*. CG), loneliness ($p < 0.001$ for ME *vs*. CG), anxiety ($p < 0.001$ for ME *vs*. CG; $p < 0.001$ for CBT *vs*. CG) was found. Only significant stress reduction was observed in ME and CBT between baseline and Week 12 (*ps* < 0.001). *Conclusions:* ME and CBT (mainstream psychotherapy) may effectively overcome PSU of college students, and reduced the level of smartphone addiction, loneliness, anxiety, and stress. Furthermore, as a culture-specific, low-cost, and readily accessible training program with multiple components (gentle movement, anatomic alignment, mental focus, deep breathing, and

meditative state of mind that is similar to mindfulness emphasizing noncompetitive, present-moment, and nonjudgmental introspective component), ME seems to be superior to CBT in terms of PSU.

Keywords: Qigong; cognitive behavioral therapy; smartphone addiction; psychological health

1 Introduction

Smartphones have become one of the most rapidly used devices in recent decades because of the rapid development of science and technology, and the number of smartphone users has grown markedly around the world. Smartphones provide individuals with an efficient and convenient way to enhance their social life [1]. For example, smartphones allow individuals to search for information, send emails, edit documents, shop online, watch videos, play games, engage in virtual social relationships, and use many other useful applications [2,3]. However, while enjoying the convenience and advantages of smartphones, problematic smartphone use has quietly become a great health concern [2,4]. Although there are no formal diagnostic criteria for problematic smartphone use (PSU), a number behavioral and psychological characteristics related to addiction (e.g., tolerance, relapse, craving, escape, and withdrawal from other problems, and emotional change) have been employed to evaluate PSU [5–7].

Irrespective of the psychometric tool used, there is considerable evidence that vulnerable individuals (e.g., college students) who have lower self-control are easily addicted to the overuse of smartphone, which results in poor mental health such as anxiety [8,9], depression [10] and loneliness [11]. On the contrary, mental health problems can also drive the PSU because of increased relapse of addiction with low emotion regulation. Early studies have supported that people with defect in emotion regulation are more likely to have the increasing time on PSU [12] and the negative psychological health outcomes (e.g., stress, anxiety, etc.) [2,13]. Therefore, effective interventions are needed to add to the treatment of PSU individuals and the benefits of relevant mental health.

In recent years, PSU intervention studies have grown, especially indicating that cognitive behavioral therapy (CBT) as one of psychological therapies has received a special attention to PSU treatment (for a review, see Kim [14]). CBT involves a comprehensive educational and psychological intervention strategies which can assist problematic smartphone user to recognize their positive thoughts and behaviors. Thereby it enables practitioners to actively apply the strategies learned to change their mobile phone needs, especially in the case of relapse [14]. As an effective approach for treating PSU, CBT has been widely used in practice. There is strong evidence supporting its efficacy for treating PSU college students as compared with wait-list group and no treatment group [15,16]. Furthermore, Lan et al found that 8 weeks of cognitive behavioral intervention (static meditation) significantly reduced smartphone addiction among university students [17].

Generally, more PSU treatment options are encouraged, particularly those culture-specific, low-cost (relative to CBT), and readily-accessible interventions like Qigong. Qigong (Baduanjin), as one type of ME, has been widely accepted as similar to mindfulness-based therapy in regulating one's emotion and fostering purposeful attention by experts [18–20]. Qigong is performed at a slow pace in coordination with anatomic alignment, proprioceptive body awareness, deep breathing exercise, and a meditative state of mind (similar to mindfulness emphasizing noncompetitive, present-moment, and nonjudgmental introspective component) [18,20–22]; According to the traditional Chinese medicine theory, Qigong and mindfulness are considered as dynamic(movement) meditation and static meditation, respectively (Yeung et al. [20]). A growing body of evidence has shown beneficial effects of both meditation forms for a wide range of mental health outcomes in occupational, clinical, and educational settings [23–25]. Recent reviews have moreover documented that ME training lead to significantly decreased symptoms of

depression, anxiety, and stress in participants with mental illness [26–28]. Moreover, Vera and colleagues found that college students who practiced ME exercise were likely to reduce their stress and depression [29]. Other studies showed the similar results-the alleviative effects of ME exercise for stress, anxiety and depression for college students [30,31]. In addition, previous studies have shown beneficial effects of ME exercise on mental health (e.g., stress, anxiety, etc.) among individuals with substance abuse [32,33]. Despite many studies on mental health, there have been no studies investigating the role of ME exercise among college students with PSU.

Based on a plenty of previous studies, ME may be effective in treating PSU among college students who face considerable stress due to academic pressure and in interpersonal relationships and often use smartphone for stress relief and social interaction. To our knowledge, there are currently no studies examining the comparative effects of ME (Qigong) exercise and established psychotherapy (e.g., CBT) in this unique group. Consequently, the present study aimed to examine the effects of ME and cognitive behavioral therapy on levels of addictive smartphone use, anxiety, loneliness and stress among PSU college students. Thus, interventions were expected to help the college students reduce their problematic smartphone usage and maintain a good lifestyle.

2 Methods

2.1 Study Design and Ethics

This study comprised a 12-week randomized controlled trial (RCT) with three armed interventions (ME group, cognitive behavior therapy group, and control group). All assessments were conducted before the start of the exercise program and after the interventions (Week 12). The study protocol was approved by the research team's institutional review board. All participants were assured that their data would be confidential and anonymous and that they could withdraw from the study at any time. All participants provided written informed consent to take part in the study.

2.2 Participants

In a public university of the central China, this research project was advertised via campus poster and social media groups (e.g., Wechat). Initially, 762 college students who had expressed their interest were invited to visit our lab and to complete the Mobile Phone Addiction Index (MPAI) questionnaire which has been accepted as a valid and reliable instrument to identify PSU [7,34]. Based on the preliminary survey, participants were deemed eligible for the study if they met the following criteria: (i) MAPI scores were not less than 40 (out of 85) according to the Leung's assessment scale [7]; (ii) They were able to independently attend the exercise training without any assistive device; (iii) They did not have serious diseases (e.g., cardiovascular disease, cerebrovascular diseases, psychiatric disorders) or a history of alcohol abuse; (iv) They did not participate in any structured exercise (e.g., walking, running, weight training and, etc.) in the past three months; (v) They signed informed consent before beginning the study. Finally, 102 eligible participants were included in this study. An independent statistician who was not involved in this study employed a computerized method to generate random number sequence (1:1:1 ratio) and subsequently placed them into opaque sealed envelopes labeled with participant codes. Eventually, 102 participants were randomly allocated to ME group (n = 34), CBT group (n = 34) or control group (n = 34).

2.3 Experimental and Control Conditions

Participants were instructed to practice ME-Qigong with a certified coach. The ME lasted for 12 weeks with two sessions per week. Each ME session lasted 90 min, comprising 10 min warm-up, 70 min of ME, and 10 min cool down. The standardized ME contained eight structures with beginning and ending postures in each structure. Each movement routine is repeated six times. At the same time, the participants were asked to

follow the instructor's instructions and combine movement with breathing and meditation. The detailed movements were described in previous study [35]. For the CBT group, participants were invited to receive CBT from a certified therapist. The CBT lasted for 12 weeks comprising two sessions a week specifically targeting symptoms related to problematic smartphone use. Each session lasted for about 90 min. According to the previous CBT protocol [36,37], the contents of the CBT were designed: Session 1—an orientation and interaction between therapist and students; Session 2—education about high-risk situations concerning problematic smartphone use; Session 3—focus on eliminating negative behavior and recognizing own feeling states; Sessions 4 and 5—instructed muscle relaxation techniques for managing own feelings, and directed cognitive reconstruction; Sessions 6 and 7—instructed techniques for dealing with relapse of addiction; Sessions 8 and 9—instructed strategies for replacing and overcoming excessive smartphone use; Session 10–design of special goals for modifying individual's own unhealthy lifestyle; Sessions 11 and 12—review of the program learned and application to prevent addiction. Participants in the control group were asked to maintain their normal daily activities.

2.4 Measures

Participants were asked to complete all measurements in baseline (1st week) and post-intervention (12th week). Each measure (questionnaire) was listed as follows:

Problematic smartphone use: This was assessed using the Mobile Phone Addiction Index (Chinese revision) which assesses the risk of smartphone addiction (as previously described by Xiong et al. [38]). There are 17 items comprising four domains assessing the addiction (inability to control cravings, feeling lost, withdrawal, and low productivity). Each item is rated on a 1 to 5 scale. The total range of scores is 17 to 85, and higher scores indicate a higher level of addiction risk.

Anxiety: This was assessed using the Self-Rating Anxiety Scale (SRAS) and was developed by Zung [39]. The 20 items are each rated on a scale from 1 to 4, and a total range of 20 to 80. According to the classification in a previous study [8], the anxiety symptoms are classified as mild anxiety (scoring 50–59), moderate anxiety (60–69), and severe anxiety (≥70).

Loneliness: This was assessed using the ULS-8 Loneliness Scale [40]. The eight items are each rated on a scale from 1 to 4, and a total range from 8 to 32. Higher scores represent a higher level of loneliness.

Stress: This was assessed using the Perceived Stress Scale (PSS-14) and has been widely used in evaluating stress status [41,42]. The 14 items are each rated on a scale from 0 to 4, and a total range from 0 to 56. Higher scores suggest higher levels of stress.

Adverse event: The participants' serious adverse events were assessed by the certified therapist after each intervention.

2.5 Statistical Analysis

G*power was applied for sample size calculation. As a two-way mixed analysis of variance (ANOVA) was used for statistical analysis, main parameters were set to effect size = 0.25, α = 0.05 (two-tailed), power = 0.80. Thus, each group requires at least 27 participants. Given an expected dropout rate of 15%, a final number of at least 93 participants was needed.

The SPSS 25.0 software package (IBM Corporation, Chicago, IL) was utilized for all statistical analyses. Descriptive statistics were used to examine the participants' demographic characteristics at baseline. Of which, categorical variables are expressed as numbers and percentages, and continuous variables are expressed as the means ± standard errors (SEs). A chi-square test was used to compare categorical variables, and one-way ANOVA was used to compare continuous variables between groups at baseline. A two-way mixed ANOVA was used to examine our primary outcome of interest which refers to the *group × time* interaction effect. Post-hoc analysis was performed using Bonferroni tests

when significant main and interaction effects were observed. A statistical significance level was set at *p*-value of less than 0.05.

3 Results

Fig. 1 presents the CONSORT flow diagram of participants' selection and allocation in this study. 762 participants were screened before commencing the RCT, and 102 of the 762 participants met the inclusion criteria. Then 102 participants were randomly allocated to one of the three groups (ME group: n = 34, CBT group: n = 34 and control group: n = 34). Seven participants dropped out during 12-week intervention period due to their conflict of schedule (CBT = 4; ME = 3), which lead to 95 participants (68 males and 27 females; mean age: 19.23 years) for data analysis (Fig. 1). Tab. 1 depicts the baseline characteristics of participants among three groups. There were no significant group differences across all variables (all *p*-values >0.05), except the professional course, where there was significant difference in between three groups ($p < 0.05$). No adverse effect related to the intervention was reported.
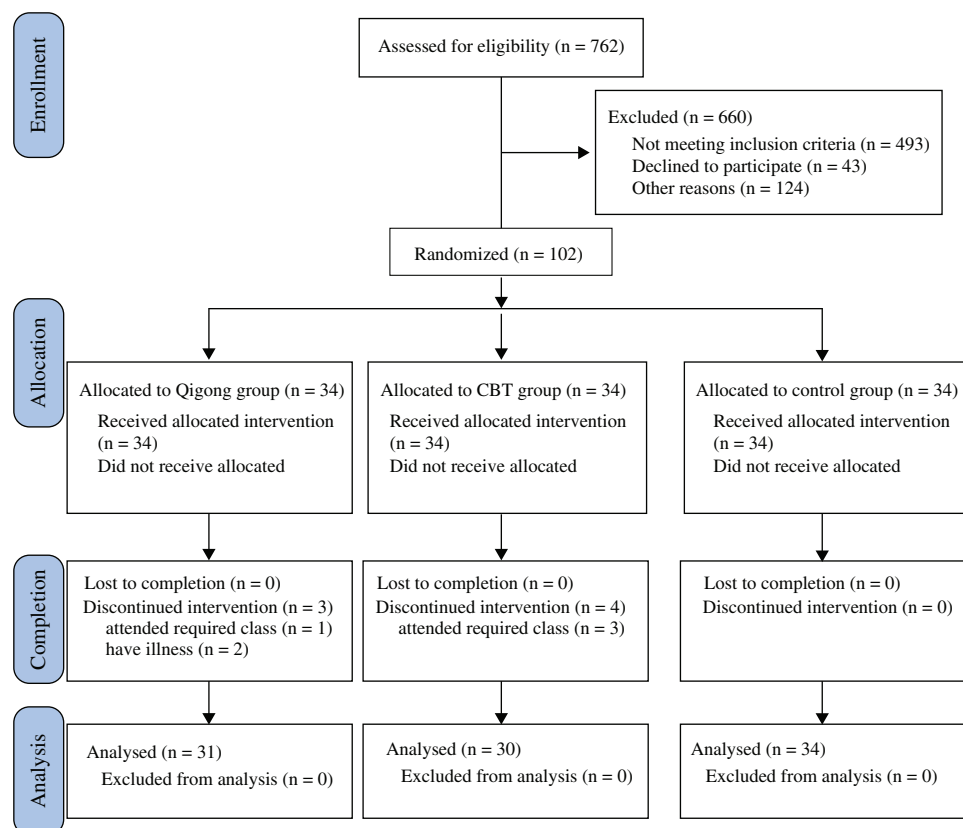

Figure 1: CONSORT flow diagram of participants selection and allocation

Tab. 2 summarizes the comparison scores of assessing problematic smartphone use, loneliness, anxiety, and stress from baseline to post-intervention in the three groups. There were no significant differences on problematic smartphone use, loneliness, anxiety, and stress at baseline among ME, CBT and control group.

A significant *group* × *time* interaction effect ($F(2,58) = 13.604$, $p < 0.001$) was observed for PSU level. Follow-up results indicate that the ME group showed a significantly greater decrease in PSU level than both CBT and control groups ($ps < 0.001$). However, CBT showed marginal significance in decreasing PSU level as compared with control group ($p = 0.07$).

Table 1: Demographic data among three groups

Characteristics	Mind-body exercise (n = 31)	Cognitive behavior therapy (n = 30)	Control (n = 34)	Statistic (df)	p-value
Age (year)	19.21 ± 1.02	18.77 ± 1.29	19.71 ± 1.77	$\chi^2(2) = 1.21$	0.710
Gender				$\chi^2(2) = 0.89$	0.640
Male	24(77.4%)	20(66.7%)	24(70.6%)		
Female	7(22.6%)	10(33.3%)	10(29.4%)		
MPAI	51.13 ± 1.55	48.17 ± 1.12	47.82 ± 1.00	$\chi^2(2) = 36.74$	0.530
Professional course*				$\chi^2(2) = 10.12$	0.006
Natural science	24(77.4%)	22(73.3%)	34(100.0%)		
Social science	7(22.6%)	8(26.7%)	0		
Family				$\chi^2(2) = 0.46$	0.795
Single child	22(71.0%)	19(63.3%)	22(64.7%)		
Siblings	9(29.0%)	11(36.7%)	12(35.3%)		
In a relationship				$\chi^2(2) = 3.15$	0.207
Yes	6(19.4%)	12(40.0%)	11(32.4%)		
No	25(80.6%)	18(60.0%)	23(67.6%)		
Monthly smartphone fee (RMB)				$\chi^2(8) = 10.18$	0.253
<20	1(3.2%)	1(3.3%)	5(14.7%)		
20–50	12(38.7%)	13(43.4%)	14(41.2%)		
51–100	6(19.4%)	9(30.0%)	9(26.5%)		
101–150	3(9.7%)	4(13.3%)	1(2.9%)		
150–200	9(29.0%)	33(10.0%)	5(14.7%)		
Daily Mobile Phone Use				$\chi^2(8) = 13.55$	0.094
3–4	0	3(10.0%)	2(5.9%)		
4–6	1(3.2%)	2(6.7%)	4(11.8%)		
6–8	23(74.2%)	17(56.6%)	19(55.9%)		
8–10	3(9.7%)	8(26.7%)	8(23.5%)		
> 10	4(12.9%)	0	1(2.9%)		
Main Purpose of Cell Phone use				$\chi^2(8) = 11.76$	0.162
Social (chatting)	13(41.9%)	14(46.7%)	16(47.1%)		
Study and work	14(45.2%)	12(40.0%)	16(47.1%)		
Personality	0	3(10.0%)	0		
Entertainment	4(12.9%)	1(3.3%)	1(2.9%)		
Killing time	0	0	1(2.9%)		
Awareness of Harm of Mobile Radiation				$\chi^2(2) = 0.38$	0.829
Yes	26(83.9%)	25(83.3%)	30(88.2%)		
No	5(16.1%)	5(16.7%)	4(11.8%)		

Note: RMB = Chinese Yuan; *, $p < 0.05$.

Table 2: Comparative effects of interventions on addiction and mental health

Outcomes		Mind-body exercise		Cognitive behavior therapy		Control Group		F-value		
		Baseline	Week 12	Baseline	Week 12	Baseline	Week 12	Group	Time	Group × Time
Problematic smartphone use	Mean ± S.E.	51.13 ± 1.55	42.06 ± 1.03	48.23 ± 1.10	39.17 ± 1.00	47.85 ± 1.00	46.65 ± 0.81	28.728**	0.249	13.604**
	Median (P25, P75)	51(44,54)	42(38,45)	48(44,51)	40(34,43)	47(43,51.5)	46(42.75,49)			
Loneliness	Mean ± S.E.	50.10 ± 0.87	40.68 ± 0.51	50.47 ± 0.82	42.87 ± 0.46	48.79 ± 0.99	47.00 ± 1.06	*5.656** *	*105.736** *	*7.455** *
	Median (P25, P75)	51(46,53)	41(40,42)	51.5(47.75,53)	42(41,45)	48(42,53.25)	46(42,51.5)			
Anxiety	Mean ± S.E.	51.29 ± 1.08	45.58 ± 0.92	53.20 ± 0.90	43.07 ± 0.81	54.03 ± 0.91	52.59 ± 0.86	*17.097** *	*48.709** *	*10.265** *
	Median (P25, P75)	53(47,56)	44(42,48)	52(49.75,57)	43(41,46)	53.5(49,57)	52(48,57)			
Stress	Mean ± S.E.	34.22 ± 0.92	29.52 ± 0.77	33.83 ± 1.00	31.17± 0.66	34.50 ± 5.82	32.68 ± 0.87	*1.362*	*24.973** *	*2.455*
	Median (P25, P75)	34(31,38)	31(27,32)	33.5(29,37.25)	31(28,33.5)	34(30.5,37.25)	32(29,36)			

Note: Values are means ± standard errors; *, $p < 0.05$; **, $p < 0.001$.

A significant *group × time interaction (F(2,58) = 7.455, $p < 0.001$)* was observed on loneliness. Follow-up results indicate that the ME group reported significantly reduced loneliness as compared to the control group ($p < 0.001$), whereas there was no significant difference between ME group and CBT group in this respect. In addition, loneliness in both ME group and CBT group was significant lower at post-intervention (Week 12) than at baseline ($p < 0.001$).

A significant g*roup × time* interaction effect (F(2,58) = 10.265, $p < 0.001$) was observed on anxiety. Follow-up results indicate that both the ME group and CBT group reported significantly reduced anxiety as compared to the control group ($p < 0.001$), whereas there was no significant difference on anxiety between ME group and CBT group.

No group × time interaction effect was observed for stress. There was a significant main effect of *time* (F(1,29) = 24.973, $p < 0.001$) reflecting that stress in both the ME and CBT group was significantly decreased from baseline to post-intervention (Week 12).

4 Discussion

The present RCT was to investigate the beneficial effects of 12-week ME exercise and CBT on addiction level and mental health among PSU college students. Findings showed that compared to CG, ME exercise had significant decrease in addiction level, loneliness; both ME exercise and CBT significantly decreased anxiety. And 12-week of ME exercise and CBT significantly decreased stress as compared with their baseline. In terms of PSU level, ME training seems to be superior to CBT, suggesting that culture-specific, low-cost, and readily accessible ME may be useful for overcoming PSU of college students.

PSU has become a serious global health issue. The advanced smartphone provides individuals with entertainment function and social interaction. Thereby it is often found that lots of college students are excessively addicted to charming mobile games [43]. Going one step further than prior studies, the present study adds to the understanding of the effects of ME exercise on decreasing PSU and its associated psychological symptoms (e.g., loneliness, anxiety, and stress). Regarding to the addiction level, there were significant differences between two experimental groups (ME is more beneficial than CBT) and control group, and marginal significant difference was observed between CBT and control group.

This finding is line with previous review study, which supported that mindfulness (as a key component of dynamic Qigong/Baduanjin) training contributed to a greater benefits in treating substance use than CBT and usual care [44]. In addition, the promising results observed in the present study partially align with a previous study of Bowen et al (2014) that indicated that individuals with drug addiction who received mindfulness training or CBT for 6-month had a decrease in drug use, but mindfulness training produced a greater reduction in this outcome as compared to CBT at 12-month follow-up [45]. In our study, ME enhanced participant's attention and social communication each other, participants also can enjoy the dynamic activity during ME practice as compared with CBT. Then problematic smartphone users were able to recognize their true condition and enhance their ability to shift negative behavior to active behavior or intentional state [46]. Moreover, ME may contribute to improve problematic smartphone users' ability to tolerate discomfort associated with craving [14,46]. Therefore, ME had a positive effect on eliminating participants' smartphone addiction.

As the positive association between problematic use level and mental health (i.e., loneliness, anxiety and stress) has been established [46,47]. Regarding to the psychological symptoms, our study found that it is possible to obtain clinically changes in loneliness and anxiety after 12-week of ME or CBT. For these positive effects, a smoothing system may be activated during practicing ME and CBT, which may alleviate students' negative emotions and improve the perception of internal physically sensation [48]. Moreover, ME and CBT had an important effect on reducing stress for PSU college students. It is plausible that ME and CBT may effectively also improve emotion regulation which refers to the ability to manage and change their emotional state e.g., via expressive suppression and cognitive reappraisal [49]. Previous study has indicated that effective emotion regulation may be as an important contributor to PSU prevention [50]. For the problematic smartphone users, they may not have enough capacities to reduce the frequency of smartphone use as lack of emotion regulation of their impulsive behavior [50]. This situation could be reversed by ME, which contributed to improve emotion regulation and brain activity to prevent and treat the addiction [51,52]. Therefore, the findings from the study here were that ME benefited to improving the mental health on loneliness, anxiety, and stress after 12-week interventions as compared to control group, which were in line with previous positive effects of mindfulness training on better emotion regulation [52].

Several limitations exist in the present study. First, the PSU assessment was based on a self-report questionnaire [34], which although is commonly used to identify the risk of smartphone addiction with high reliability, is not a diagnostic tool. Second, small sample size was included to conduct the group comparison, particularly ME *vs*. CBT, and lead to insufficient statistical power, and gender differences in the evaluation were not conducted (because of the small numbers of females). Further study with a larger sample to replicate this study is encouraged along an equal number of male and female participants. Third, self-report scales were used to assess the study variables, and may cause some bias of measures in PSU and relevant mental health. Fourth, this study involved simple pre- and post- assessments, and did not conduct an investigation on the long-term follow-up effects of interventions on PSU and subsequent mental health. It would be interesting to examine whether long-term ME can reduce PSU among college students or other populations in future studies. Fifth, there were several methodological deficiencies. For example, the lack of participants and assessor blinding on treating and testing, which may be confounding factors influencing the results. Further studies were needed to examine these findings with strict experimental standards. Finally, the limitation may be the low cut-off score to be included in the study. It may lead to many participants remaining highly addiction scores after the intervention.

Excitingly, the consequence of our study has to do with cultivating experiences of ME exercise and PSU. ME exercise, as a mind-body exercise, contains eight sections that emphasize breathing, postures and movements to improve physiological and psychological benefits throughout the whole body [53]. The practitioners can achieve self-psychosomatic regulation by practicing the ME exercise. It could be said

that ME exercise can meet the need to alleviate mental health among college students with PSU. Moreover, no side effects occurred during the intervention period, which imply that ME is safe as an intervention by affecting loneness, anxiety and stress for college students with PSU. These findings of current study may offer predictable information for researchers or clinicians to help college students with PSU to manage their smartphone use and psychological health. Therefore, ME exercise is suggested as a strategy to enable college students with PSU to manage their smartphone use in daily life.

5 Conclusion

Overall, the findings of this study suggested that both ME and CBT may be effective in reducing problematic social use and promoting good mental health outcomes (i.e., less loneliness, anxiety, and stress) for college students with problematic smartphone use.

Conflicts of Interest: The authors report no financial or other relationship relevant to the subject of this article.

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