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ORIGINAL RESEARCH

A randomized controlled trial of mindfulness-based Tai Chi Chuan for subthreshold depression adolescents

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Purpose: The incidence of subthreshold depression (StD) in adolescents is growing rapidly, which in turn is known to impair functioning and increase the risk of major depression. It is therefore important to provide effective intervention to prevent the transition from StD to major depression. As a traditional Chinese mind-body exercise, Tai Chi Chuan (TCC) may be an available selection. Researchers have shown the effectiveness of mindfulness-based therapy on depression; however, for the StD youth, there have been no studies to investigate whether mindfulness-based Tai Chi Chuan (MTCC) can be recommended as an effective exercise for improving their psychological state. The aim of present study was to evaluate the effect of MTCC on psychological outcomes of StD adolescents including the depression levels and mindfulness state in a randomized controlled trial (RCT).

Patients and methods: An RCT was carried out. A sample of 64 participants who meet the inclusion criteria agreed to be arranged randomly to either the MTCC group (n=32) or the control group (n=32). Participants of the MTCC group received an 8-week, 2 days per week, 90-minute MTCC intervention for each session. Usual physical curriculum was administered to the participants in the control group. The effectiveness of MTCC training was measured by blinded evaluators through validated scales, which included depressive symptoms, stress, and mindfulness level before and after the intervention.

Results: Significant improvements in psychological health were observed from MTCC groups. After 8-week intervention, superior outcomes were also observed for MTCC when compared with control group for decrease in depression (F=59.482, P<0.001) and stress level (F=59.482, P<0.001) and increase in mindfulness (F=59.482, P<0.001).

Conclusion: The findings of this preliminary study indicated the effects of the MTCC intervention on depression level among StD youngsters. This study provides preliminary evidence that MTCC is suitable for Chinese adolescents and is effective in decreasing depression level.

Keywords: Tai Chi, mindfulness, college students, subthreshold depression

Introduction

Subthreshold depression (StD) has been used to describe symptoms of depression that are clinically relevant, yet not meeting the criteria for full-blown major depressive disorder (MDD).[1] StD was considered as the early stage of MDD and had the predictive effect on major depression.[2,3] Individuals with StD have an OR of >5 for having a first lifetime episode of MDD.[4] Although the symptoms of StD were less severe than those of MDD, they may pose a significant burden on the work and study of the affected individuals, as well as have a significant social and economic impact.[5] Previous studies have suggested that StD is a highly prevalent condition worldwide

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with an estimated rate of 25%.[6] Adolescents are prone to mental disorders because of their immature psychological regulation mechanism.[7] Researchers revealed that the rate of StD among adolescents in China was as high as 36.56%.[6] StD adolescents have no obvious depression symptoms, and are thus easily ignored by their parents and teachers. On the other hand, adolescent rebellion behaviors increased the difficulty of identifying their depressive symptoms. Based on the above-mentioned reasons, StD adolescents show a delayed optimum prophylaxis period, which consequently led to the rising prevalence of major depression in a clinical setting.[8]

StD adolescents suffer from a variety of physical and psychological symptoms such as a significant but not severe somatic reaction or a subjective feeling of discomfort (like gastrointestinal or respiratory discomfort feeling, fatigue, headache, back pain, etc), a prolonged period of negative emotions, pessimism, loss of interest, self-blame, low self-evaluation, lack of attention, decreased learning efficiency, and problems in interpersonal communication. Some of them are prone to neurosis, such as compulsion or hypochondria.[3] StD groups actually experience depression which in turn impairs their social functioning, study, and everyday life; if no timely intervention is done, they are likely to develop depression. A report from Lewinsohn et al showed that subthreshold depressive symptoms predicted future MDD.[9]

Despite its high prevalence and significant social and economic impacts, the effective defense mechanism for StD remains unclear in China. Although psychotherapies can be effective, it is not practical to apply to adolescents on a large scale because of traditional concept and healthcare resource limitations.[10] A possible alternative approach to reducing the population burden of StD is improving the usage of school resources and making it available to implementation continuously. In recent years, school-based psychological intervention has been developing and proved to be effective among youth.[11–13] In China, due to the heavy burden of homework and academic pressure, students are left with less spare time to attend other activities, thus school-based psychological intervention model may be more suitable to StD adolescents. As a traditional Chinese mind-body exercise, Tai Chi Chuan (TCC) has been adopted in physical education (PE) in colleges and is increasing in popularity in the West.[14–16] As it comprises mental concentration, physical balance, muscle relaxation, and relaxed breathing, TCC showed great potential for becoming widely integrated into the prevention and rehabilitation of a number of medical and psychological conditions. A growing body of clinical research has begun to evaluate the efficacy of TCC as a therapy for a variety of health issues. Systematic reviews have suggested that practitioners can achieve an efficiency of "body relaxation and mind calm", and TCC may show significant improvement in anxiety, depression, and stress.[17–19] Mindfulness has its conceptual roots in Buddhism, and as a kind of psychotherapy, it has been proved its effectiveness in a clinical setting.[20] Till date, none of the researchers combined TCC with mindfulness skills effectively to investigate their effects on StD population. Furthermore, for StD adolescents, the evidence is unclear as to whether mindfulness-based Tai Chi Chuan (MTCC) can be recommended as an effective school-based exercise for improving psychological well-being. Therefore, high quality, rigorous, prospective, well-controlled randomized trials with appropriate comparison groups and validated outcome measures are needed to further test the effects of MTCC services as an intervention for specific psychological outcomes in college student populations.

The aim of the present study was to evaluate the effect of MTCC on psychological outcomes of StD adolescents including the depression levels and mindfulness state in a randomized controlled trial (RCT). We hypothesized that the school-based MTCC intervention would provide strategies for managing negative emotions, thus resulting in greater decreases in depression levels in Chinese StD adolescents.

Patients and methods

Study design

This study was a randomized controlled design. Participants were equally (1:1) allocated to the MTCC exercise group (intervention group) and the control group using the lottery method by statistics staff who were independent from the study. The participants were blinded to their random assignment until the end of this session. When the trail ends, the control group received related intervention of their own accord. The MTCC exercise will be conducted at the gymnasium of Harbin Medical University as instructed by a qualified coach. The anonymous data were collected by a research assistant who was blinded to the group assignment and independent from the MTCC delivery. The entire study flow is illustrated in Figure 1.

Sample and setting

Participants were recruited from freshman and sophomore in Harbin Medical University. On one hand, WHO defines adolescents as those in the age range from 10 to 19 years; on the other hand, for convenience, college school students attend PE course in each semester for the first 2 years. The sample size estimation in this RCT was calculated by

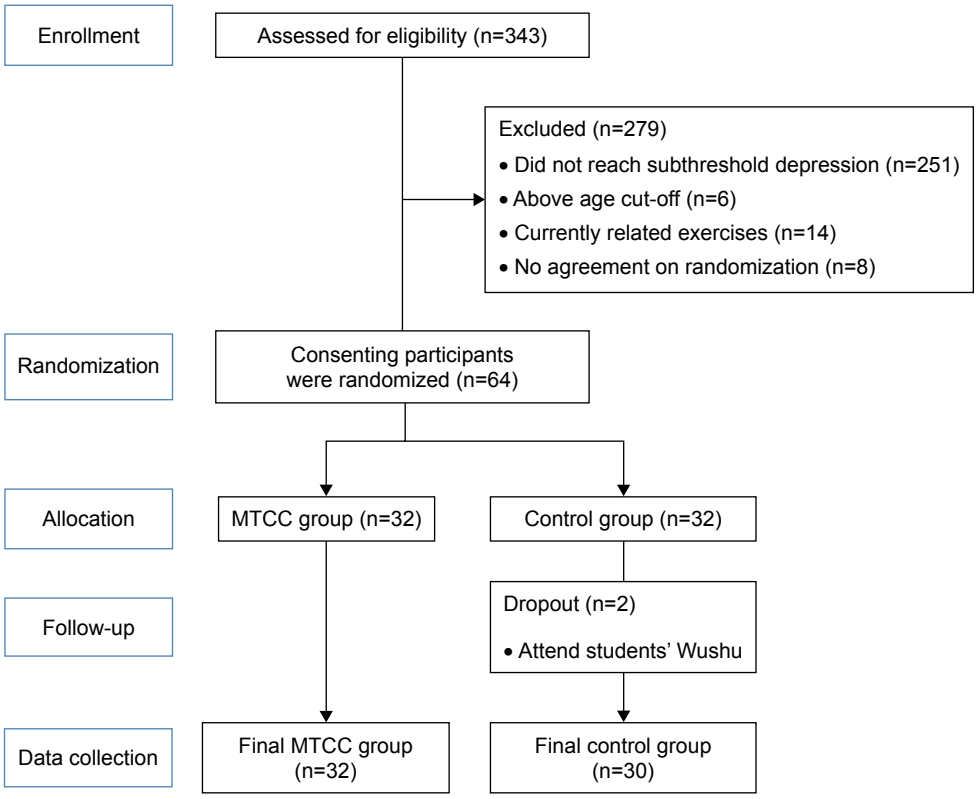

Figure 1 Study flow diagram: enrollment to analysis.
Abbreviation: MTCC, mindfulness-based Tai Chi Chuan.

using the G*POWER version 3.1 program with a power (1–β) of 0.80 in the Student's *t*-test and a significance level of 0.05. Based on the values reported in TCC studies on depression,[21,22] the total sample size was selected as 60. We put up a poster on the campus at the beginning of autumn semester in 2017 to recruit the participants. A total of 343 students agreed to join the study and finally 64 met the inclusion criteria. Considering the possibility that 5%–7% of the students would drop out, we recruited all the 64 participants. Inclusion criteria included: 1) freshman and sophomore aged 16–19 years; 2) had subthreshold symptoms of depression (defined by nine-item Patient Health Questionnaire depression scale [PHQ-9] as 2–4 symptoms of depression experienced more than half of the days or nearly every day for 2 or more weeks, which have affected study, social life, or functioning); and 3) had no other major disabling medical or mental disorder. Participants who had or being participated in a similar intervention were excluded. Patients with major depression or no depression were excluded. All participants provided their written informed consent. The average age of all participants was (18.41±2.01) years, and 41 participants were female. The study was approved by the institutional review board at Harbin Medical University (No 2017-12). The entire trial program is illustrated in Figure 1.

Intervention

The MTCC intervention group

Participants allocated to the MTCC training groups received 8 weeks of MTCC courses. The MTCC training combined mindfulness skills with simplified 24 short-form TCC, and was taught by experienced PE coaches who had been qualified and engaged in the teaching of TCC course for 10 years and got a certification on mindfulness training. Participants were asked to gather at the campus gymnasium where they had PE classes twice per week. Systematic content of PE classes included the basic mindfulness-based TCC, arranged at the first 8 weeks, twice a week, and 90 minutes per session in autumn semester. All 32 participants were disposed in 4×8 formation. Each class included 10 minutes of warm-up (eg, gentle stretches of the neck, chest-expanding, knee movement), 20 minutes of demonstration and explanation, 30 minutes of practice and guidance, and 20 minutes of group imitation training. Each session concentrated on one theme and related practice, more specifically as seen in Box 1.

The control group

Participants allocated to the control group received normal PE classes according to the curriculum. No specific mindful or TCC exercise will be administered in the control group.

Box 1 Details of weekly MTCC exercises

Week 1–1: approaching mindfulness and TCC
Demonstration: mindfulness and related skills; benefits of TCC and mindfulness Practice: cultivate mindfulness exercise (mindfulness-based awareness training) Training: mindfulness-based breathing and walking meditation
Week 1–2: basic theory and introduction of 24 short-form TCC
Demonstration: essentials of TCC; introduction of 24 short-form Practice: TCC shape-up exercise Training: head, neck, shoulder, elbow, chest, back, wrist, spine, hip gestures
Week 2–3: combine mindfulness with TCC
Demonstration: relationship of mindfulness with TCC Practice: no judgment shape-up exercise Training: combining mind and body together
Week 2–4: commencing form and Part the Wild Horse's Mane on Both Side
Demonstration: illustration of two gestures of TCC Practice: commencing form and Part the Wild Horse's Mane on Both Side Training: stand in lines to practice one by one
Week 3–5: White Crane Spreads its Wings and Brush Knee and Twist Step on Both Side Week 3–6: Play Pipa and Repulse Monkey Week 4–7: Grasp the Bird's Tail and Grasp the Bird's Tail Week 4–8: Single Whip and Wave Hands Like Clouds Week 5–9: Single Whip and High Pat on Horse Week 5–10: Kick with Right Heel and Strike Opponent's Ears with Both Fists Week 6–11: Turn and Kick with Left Heel and Snake Creeps Down (left) Week 6–12: Snake Creeps Down (right) and Jade Lady Weaves Shuttles Week 7–13: Needle at Sea Bottom and Flash the Arm Week 7–14: Turn, Deflect Downward, Parry and Punch and Apparent Close up Week 8–15: Cross Hands and Closing Form
Demonstration: illustration of related two gestures of TCC Practice: related gestures practice Training: stand in lines to practice one by one
Week 8–16: Summary
Demonstration: sum up the skills and the core of practice (in the present moment and nonjudgmental TCC) Practice: all the difficulties encountered during previous practice were revealed and solved Training: each participant developed a suitable practice pattern for themselves and related resources and contact methods were provided to facilitate further practice

Abbreviations: MTCC, mindfulness-based Tai Chi Chuan; TCC, Tai Chi Chuan.

To avoid possible overlap (contamination) with components of the MTCC program, the students in the control group who planned to use some related techniques such as meditation and yoga during the intervention period (8 weeks) were excluded. After completion of the study, an equivalent MTCC course was offered to the control group.

Measures

Nine-item patient health questionnaire depression scale

The primary outcome was depression symptom severity assessed with the PHQ-9. The scale is a well validated and widely used measure of depression that assesses the frequency of the nine Criterion A symptoms of a *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition, major depressive episode over the previous 2 weeks. It consists of nine items that are rated on a five-point scale and were scored as never (0) to very often (3), with scores ranging from 0 to 27 and scores of 5, 10, 15, and 20 representing mild, moderate, moderately severe, and severe levels of depression, respectively. The scale has been used in Chinese population revealing good reliability (α=0.89) and validity (r=0.97).[23]

The Chinese version of the Perceived Stress Scale (CPSS)

The scale consists of 14 items that assessed the perception of stress. Each item is rated on a five-point scale and scored as

never (0) to very often (4), with scores ranging from 0 to 56. Higher scores represent the greater perceived level of stress.[24] Scores from 0 to 28 were considered normal, scores from 29 to 42 indicated moderate stress, whereas scores from 43 to 56 indicated severe stress, which required external resources to relieve stress. The CPSS was translated by Yang et al[25] and the internal reliability was 0.76.

Mindful Attention and Awareness Scale (MAAS)

Participants' self-reported mindfulness level was measured with the MAAS.[26] The scale comprises 15 items that assess the most important characteristics of mindfulness. Items are rated on a six-point scale and scored as almost always (1) to almost never (6), with higher scores reflecting greater mindfulness state. The scale has been tested among Chinese college students and revealed good internal consistency reliability (α=0.85) and test–retest reliability (r=0.54).[27]

Procedure

Initial contacts were made by one of the authors of this study with school to get collaboration. After approval of the institutional review board and ethics committees, the sports center posted the posters to recruit interested students, and the inclusion criteria screenings were completed by professional staff. The 8-week MTCC intervention was carried out by a qualified psychologist. All participants in the control group received the related MTCC class after the study period in the next semester. The questionnaires were delivered and collected by two students who were independent of the study. All the participants completed questionnaires at two points. The first time was the initial baseline orientation that the MTCC class started and the second time was the day after the end of 8-week intervention.

Statistical methods

All the collected data were analyzed using IBM SPSS 21.0 (version 21.0; IBM Corp., New York, NY, USA) with bilateral inspection by two dependent assistants. Given that low number of cases were lost to follow-up (3.12%), we deleted the data of the participants who had dropped out of the program (n=2). The continuous variables were assessed by mean with SD or median with range. A series of 2 (condition) by 2 (time) repeated-measures ANOVA was used to directly test the outcomes (PHQ-9, MAAS, and CPSS) between the two groups. The effect sizes for the ANOVAs were measured by partial eta squares (η2), where η2=0.14 represents a large effect size, η2=0.06 a mild effect size, and η2=0.01 a small effect size. The effect sizes for the paired samples t-tests were calculated using Cohen's d, with 0.2 indicating a small effect, 0.5 a medium effect, and 0.8 a large effect.[28,29] A P-value $\leq$0.05 was considered as statistically significant.

Results

Participants' subthreshold depression rate

Students volunteered for this study and among them 92 students met the criteria for StD (2–4 symptoms of PHQ-9). According to previous studies,[30] major depression was defined as having five or more symptoms of depression and no depression category was defined as having fewer than two symptoms or none of them. In our study, the rate of StD was 26.82%.

Efficacy of MTCC on depressive symptoms, stress, and mindfulness level

A series of 2 (condition) by 2 (time) repeated-measures ANOVA were conducted to examine changes across time between the intervention and the comparison conditions on measures of PHQ-9, MAAS, and CPSS. Table 1 reveals descriptive statistics with mean scores of pre–post measures and significance of time and time–group interaction. The results found a significant interaction between time and condition for PHQ-9 (F=59.482, P<0.001, η2=0.498), MAAS (F=37.476, P<0.001, η2=0.384), CPSS (F=17.270, P<0.001, η2=0.224). Furthermore, simple effect analyses were used to figure out how the time and group interaction effects were different (Tables 2 and 3). The categorical outcomes for the PHQ-9 scale are presented in Table 4. After the intervention, the rates of StD and major depression in the MTCC group were lower than those of the control group.

Discussion

To the best of our knowledge, this is the first RCT pilot study to combine mindfulness with TCC to evaluate the school-based intervention on mental health of StD college students. Specifically, the benefits of MTCC on participants have been testified, such as a decrease in the depression and stress levels, and promotion of mindfulness state. At the same time, our study found that the rate of StD was as high as 26.82%, which was in line with previous studies.[31] Influenced by eastern cultural values, most of the subthreshold depressed people are reluctant to seek psychological counseling or clinical psychotherapy, resulting in the development of symptoms and increase in the prevalence of depression in recent years.[32,33] Studies have shown that the incidence of StD among adolescents reached 30%–40%.[34] Teenagers lack mature psychological regulation and control mechanism, which easily leads to emotion imbalances during the period

Table 1 Comparison of two groups on PHQ-9, MAAS, and CPSS

	MTCC M (SD)		Control M (SD)		*F*	*P*-value	$\eta 2$
	Pre	Post	Pre	Post			
PHQ-9	8.66 (2.12)	6.03 (2.18)	8.23 (2.11)	8.10 (2.52)			
Time effect					72.896	<0.001	0.549
Time×group effect					59.482	<0.001	0.498
Group effect					2.280	0.136	0.037
MAAS	52.00 (5.00)	57.69 (4.79)	52.47 (6.36)	52.83 (6.74)			
Time effect					48.518	<0.001	0.447
Time×group effect					37.476	<0.001	0.384
Group effect					2.468	0.121	0.040
CPSS	27.19 (3.86)	24.12 (2.96)	26.90 (3.56)	26.53 (3.37)			
Time effect					28.084	<0.001	0.319
Time×group effect					17.270	<0.001	0.224
Group effect					1.638	0.206	0.027

Abbreviations: MTCC, mindfulness-based Tai Chi Chuan; PHQ-9, nine-item Patient Health Questionnaire; MAAS, Mindful Attention and Awareness Scale; CPSS, Chinese version of the Perceived Stress Scale.

of heavy academic pressure and complex interpersonal relationships.[35] Schools pay more attention to students suffering from depression, while less awareness exists with regard to this condition among StD population in China. Adolescent depression leads to a wide range of mental health problems in adulthood.[36] Strengthening the management of StD adolescents could alleviate the depressive symptoms and reduce the incidence of severe depression, and thus promote their psychosomatic development and academic accomplishments smoothly, improve the ability of social participation, and reduce the financial burden on families and societies.

TCC is an ancient Chinese martial art characterized by slow circular movements, breath regulation, and focused attention.[37] As a kind of oriental concept form of exercise, the core is Yi, Qi, Xing, Shen (Chinese), which is accord with the requirement of human body physiology and psychology, TCC has a very important role in promoting individual physical health.[18] TCC has been adopted in PE classes to promote adolescents' health.[38] The benefits of TCC on physical and psychological health have been reported in numerous studies;[39–41] however, most of them pay attention to various patients or the aged population. Besides, TCC emphasizes meditation in accordance with mindfulness skills that originated from Buddhism in China, which is the core Zen method of primitive Buddhism.[42] Therefore, in this study, we designed an RCT trial to examine the effects of an 8-week

Table 2 Pre–post comparison of independent group on PHQ-9, MAAS, and CPSS

PHQ-9			Effect size (d)	Standard error	*P*-value	95% CI	
						Lower bound	Higher bound
MTCC	Pre	Post	2.625	0.225	<0.001	2.175	3.075
Control	Pre	Post	0.133	0.232	0.568	−0.331	0.598
MAAS			**Effect size**	**Standard error**	***P*-value**	**95% CI**	
						Lower bound	**higher bound**
MTCC	Pre	Post	−5.688	0.605	<0.001	−6.897	−4.478
Control	Pre	Post	−0.367	0.624	0.559	−1.616	0.882
CPSS			**Effect size**	**Standard error**	***P*-value**	**95% CI**	
						Lower bound	**Higher bound**
MTCC	Pre	Post	3.031	0.446	<0.001	2.139	3.923
Control	Pre	Post	0.367	0.461	0.429	−0.555	1.288

Abbreviations: MTCC, mindfulness-based Tai Chi Chuan; PHQ-9, nine-item Patient Health Questionnaire; MAAS, Mindful Attention and Awareness Scale; CPSS, Chinese version of the Perceived Stress Scale.

Table 3 Pre–post comparison of two groups on PHQ-9, MAAS and CPSS

PHQ-9			Effect size	Standard error	*P*-value	95% CI	
						Lower bound	Higher bound
Pre	MTCC	Control	0.423	0.538	0.435	−0.653	1.498
Post	MTCC	Control	−2.069	0.597	0.001	−3.264	−0.874
MAAS			**Effect size**	**Standard error**	***P*-value**	**95% CI**	
						Lower bound	**Higher bound**
Pre	MTCC	Control	−0.467	1.448	0.748	−3.363	2.429
Post	MTCC	Control	4.854	1.477	0.002	1.899	7.809
CPSS			**Effect size**	**Standard error**	***P*-value**	**95% CI**	
						Lower bound	**Higher bound**
Pre	MTCC	Control	0.288	0.944	0.762	−1.600	2.175
Post	MTCC	Control	−2.377	0.805	0.004	−3.987	−0.767

Abbreviations: MTCC, mindfulness-based Tai Chi Chuan; PHQ-9, nine-item Patient Health Questionnaire; MAAS, Mindful Attention and Awareness Scale; CPSS, Chinese version of the Perceived Stress Scale.

Table 4 Depression outcome by groups after intervention (n=62)

	MTCC group (n=32)	Control group (n=30)	Fisher's exact test *P*-value
Categorical outcomes			<0.001
No depression	21 (65.63%)	2 (6.67%)	
Subthreshold depression	11 (34.37%)	27 (90%)	
Major depression	0 (0%)	1 (3.33%)	

Abbreviation: MTCC, mindfulness-based Tai Chi Chuan.

MTCC PE class on StD college students. After intervention, the results revealed that the depressive symptoms and stress levels were decreased when compared with the control group and the effect sizes were large; at the same time, the level of mindfulness in the MTCC group was increased with an effect size of (13.98±9.64) points. MTCC training implied the maintenance of an open attitude which let people to be mindful and have the ability to regulate the metacognitive capability and therefore change the cognitive deviation and increase the positive cognitive reevaluation.[43] In previous studies, researchers have applied relaxation training on university students and produced similar reductions in depressive and anxiety symptoms as a result of more complex cognitive behavioral therapy (CBT).[32,34,44]

Mindfulness skills as the third-wave of CBT has been systematically used in psychotherapy, and related guidelines have been recommended by the National Institute of Clinical Excellence for the treatment of recurrent depression in UK.[45] Among the Chinese teenagers, due to limitation of time and poor compliance with regular psychology consulting, the depression symptoms were ignored and missed intervention. Compared with the traditional drug treatment, MTCC as a class-form intervention was more easily accepted by students and their parents. The results proved the feasibility and availability of this intervention. During practice, participants cultivated a friendly attitude toward themselves, respecting their own abilities without judgment or competition. Personal boundaries such as limits of stability, flexibility, and endurance, as well as habits to cope with these limitations were explored, fostering body awareness. Emotional awareness was developed by consciously observing and accepting arising emotions during MTCC practice (eg, fear of embarrassment, fear of failing, self-criticism, anxiety).

Strengths and limitations

In this research, we effectively combined mindfulness skills with traditional TCC. Considering the feasibility and compliance, we implemented MTCC in the usual PE class form and preliminarily applied to StD adolescents in China. The results showed that MTCC helps participants decrease negative emotions, alleviate symptoms of depression, and cultivate mindfulness. The intervention was convenience and effectiveness that was applied for the first time in China. Although the design was RCT, due to the limitation of time and conditions, this trial was limited by a modest sample size. Future studies should increase the sample size to confirm the effects. What is more, since the curriculum was designed to be applied in college school, the intervention time was 8 weeks and no follow-up period was required; in order to understand the long-term sustainability of the positive effects seen with the MTCC, an extended observation and intervention period was needed. Finally, the MTCC program was administered only in college school while in other settings remains to be tested in future studies.

Conclusion

Results from this RCT showed that MTCC is effective in reducing depression symptom levels in StD adolescents. StD is a psychological condition between health and depression, and if no timely and effectively intervention is done, it is more likely to develop to major depression. It is a feasible, easily disseminated intervention that may help reduce the population disease burden of depression. In the future study, we can develop targeted MTCC intervention pattern according to different populations, improving the well-being of society.

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Data sharing statement

The data and material supporting the results of this article are included within the article and its additional files.

Author contributions

All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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