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Global Excellence in Public Mental Health: Asia and Australasia Volume II

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Global excellence in public mental health: Asia and australasia volume II

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Effects of traditional Chinese exercises on mental health in individuals with drug rehabilitee: A systematic review and meta-analysis

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Purpose: The intent of this systematic review and meta-analysis was to examine the effects of Traditional Chinese Exercise (TCE) on mental health and drug cravings in drug rehabilitees.

Methods: Six electronic databases (PubMed, Web of Science, MEDLINE, CINAHL, PsycArticles, and CNKI) were searched to identify the potential literature from inception to March 2022. The controlled studies with a pro-posttest design that investigated the effects of TCE on mental health (depression, anxiety, drug craving, and sleep quality) were included. The effect sizes were calculated using the random-effect models with a 95% confidence interval. The Physiotherapy Evidence Database (PEDro) scale was employed to evaluate study quality.

Results: A total of 10 studies (740 participants, mean age 35 years old) were included in this study. The pooled results showed that TCE produced significant improvements in depression (SMD = 0.65, 95% CI 0.29 to 1.02, $p < 0.01$), anxiety (SMD = 0.98, 95% CI 0.44 to 1.53, $p < 0.01$), and drug craving (SMD = 0.87, 95% CI 0.54 to 1.21, $p < 0.01$) compared to the control group. The subgroup analysis results showed that TCE resulted in significant improvements in depression compared to active intervention (SMD = 0.33, 95% CI 0.07 to 0.60) or passive intervention (SMD = 1.07, 95% CI 0.40 to 1.74). A significant improvement in depression was observed in both male and female drug rehabilitee ($p < 0.05$). Moreover, Tai Chi (SMD = 0.69, 95% CI 0.19 to 1.18) or Qigong (SMD = 0.49, 95% CI 0.24 to 0.74) exercise, 3–4 times per week (SMD = 1.06, 95% CI 0.39 to 1.74) or ≥5 times (SMD = 0.39, 95% CI 0.12 to 0.66), >45 min (SMD = 0.62, 95% CI 0.09 to 1.15) or ≤45 min (SMD = 0.68, 95% CI 0.10 to 1.27), and for a duration of 12 weeks (SMD = 0.84, 95% CI 0.15 to 1.54) produced significant improvement in depression.

Conclusion: This current study suggests that TCE (Tai Chi, Qigong) may have benefits in alleviating depression, anxiety, and drug cravings in drug rehabilitees. Further studies are required to verify our results through the implementation of well-designed experimental protocols.

KEYWORDS

Tai Chi, Qigong, depression, anxiety, drug addiction

Introduction

Drug addiction (also known as substance use disorder) is a progressive and elapsing mental illness that causes individuals to lose control of substance abuse despite its associated detrimental (life-threatening) effects (1). Specifically, drug addiction has been widely accepted as being associated with significant changes in brain structure and function, resulting in the desensitization of drugs increasing dosage is needed to help drug users produce the same effect (1). The global prevalence of illicit drug use has reached 5.2% in 2015 (2). This number has increased in some countries/regions; for example, authoritative data have indicated that roughly 15.3% of US citizens have been diagnosed with drug addiction or dependence (3, 4). Similarly, in another country, Australia, this number (illicit drug use) has reached 13% among individuals aged 14 and greater (5). Compared with these above-mentioned countries, Yunan has been widely recognized as one of the provinces most affected by drug abuse in China and its estimated prevalence (registered data of illicit drug users) was almost 1% in spite of the standardized punishment policy (6).

The detrimental consequences of this mental illness are linked to a greater susceptibility of being affected by HIV/AIDS and hepatitis C, a high crime rate, and the development of other co-existing chronic illnesses, such as cardiovascular disease (7). In addition, mental health problems (anxiety, depression, and insomnia) are commonly reported among drug users (8). This comorbidity of mental illnesses contributes to a reduced quality of life, disability, and premature death (9, 10). Economic consequences of drug abuse involve immeasurable harm to public health and safety worldwide, with a global cost of about USD 35 billion per year (11). These financial burdens, to a large extent, have challenged the healthcare system in countries of different economic levels. Direct costs and hospitalization are not affordable for families with drug users, especially in developing and economically disadvantaged countries and regions. Taken together, drug users should receive greater attention from the research community and clinicians.

Pharmacological treatments for drug users have mainly focused on specific receptors within the dopaminergic system, glutamate system, and trace amine system, and they can target the addiction-related systems in the brain to reduce the level of withdrawal and other symptoms (1, 12). Of note, a drug's side effects on the physical and psychological health of users should be pointed out as well. To this end, non-pharmacological treatments have been developed, such as cognitive-behavioral therapy, contingency management, residential rehabilitation based therapies, and repetitive transcranial magnetic stimulation (13). Besides these approaches, exercise as a cost-effective treatment has been increasingly used to alleviate symptoms related to drug addiction (14, 15). A previous review published in 2014 has reported the beneficial effects of physical exercise for drug users (16). With an increasing number of studies on this topic in the last 10 years, an updated review is urgently needed. In addition, this meta-analysis did not focus on a unique exercise modality alone - traditional mindful exercise. Traditional Chinese exercises (TCEs) include Tai Chi and Qigong, which have attracted an increasing number of scholars investigating their benefits on populations (e.g., reducing one's risk of falls and improving mental health). TCE is characterized by slow movements, a deep breathing technique, and meditation training and these unique elements can help drug users alleviate negative emotions caused by withdrawal. Ultimately, the exercises assist one in achieving symptomatic management and obtaining a better quality of life. Indeed, earlier studies have suggested that TCE contributes to decreasing the symptoms of depression and anxiety in adults with or without diseases, such as healthy adults (17) and adults with major depressive disorder (18) or chronic obstructive pulmonary disease (19). Furthermore, individuals who practice TCE might be able to improve their wellbeing (20).

Although previous studies have investigated the beneficial effects of TCE on mental health in different populations, few systematic review studies have investigated the effects of TCE on mental health in subjects suffering from substance use disorders (21, 22). Additionally, two studies reported contradictory results. One study found that Tai Chi had a significant effect in reducing depression (21), while another study found the opposite (22). Moreover, the inclusion criteria of both reviews were not very strict. For example, the participants in Zhang et al.'s study included drug users and alcohol abusers. Different types of intervention (e.g., Qigong + medication) were included in the experimental group (21). Moreover, the quality of included studies was low because of the nature of non-randomized controlled studies. For example, the review study of Liu et al. included one randomized controlled study and six non-randomized controlled studies (22). It also did not investigate the effects of the dose of intervention on mental health in drug rehabilitee due to the limited number of included studies.

Therefore, based on the limited information of these systematic reviews, an updated meta-analysis on these unique exercise modalities should receive greater attention, and the results could be used to help clinicians treat symptoms and drug users if the exercises are practiced on a regular basis.

Methods

Search strategy

We searched for publications in six electronic databases (PubMed, Web of Science, MEDLINE, CINAHL, PsycArticles, and CNKI) from their inception until March 2022. The following terms were combined to retrieve potential studies: (1) "Tai Chi" OR "Taijiquan" OR "Qigong" OR "Baduanjin" OR "Wuqingxi" OR "Dao Yin"; (2) "Amphetamine" OR "Cocaine" OR "Heroin"

OR "Morphine" OR "Methadone" OR "Cannabis" OR "Drug Abuse" OR "Drug Dependence" OR "Substance Abuse"; (3) "depression" OR "anxiety" OR "sleep*" OR "drug craving". In addition, manually search for bibliographies and systematic review studies were performed to identify relevant studies. The current meta-analysis study was followed by the PRISMA (Preferred Repointing Items for Systematic Reviews and Meta-Analyses) (23).

Inclusion and exclusion criteria

Studies were included if they met the following criteria: (i) participants had a drug addiction; (ii) participants only practiced Tai Chi, Qigong, or other types of TCE intervention in the experimental group, and did not use TCE interventions in the control group; (iii) the study reported at least one outcome measurement (i.e., depression, anxiety, and sleep). (v) the study was published in English or Chinese. The exclusion criteria were: (i) other types of studies (e.g., animal or *in vitro* studies, abstracts, case reports, reviews); (ii) the control group included Tai Chi or Qigong exercise; (iii) the intervention duration was not no less than 8 weeks; (iv) there was insufficient information to calculate the effect size of the outcome measurement.

Data extraction and quality assessment

Two authors independently assessed the eligible studies by screening the titles, abstracts, and full texts. A mutual communication was conducted when two authors had disagreements on inclusion or exclusion criteria. The included articles were analyzed following the predesignated structure: author, year of publication, characteristics of subjects, sample size, sex, age, intervention protocol (frequency, time, type, duration, and intensity), outcome measurements (depression, anxiety, drug craving and sleep).

The quality of included studies was evaluated using the Physiotherapy Evidence Database (PEDro) scale (24) by two independent reviewers. This PEDro scale is a systematic tool with adequate content to assess the study quality that includes 11 items, of which Item 1 is not involved in calculating the total scores. The total scores ranged from 0 to 10. The study quality was classified as excellent (9–10 points), good (6–8 points), fair (4–5 points), and poor (<4 points) (24).

Statistical analysis

Comprehensive Meta-Analysis software v3 software (Biostat, NJ) was employed for data analyses in this meta-analysis study. The standardized mean difference (SMD) was expressed as the effect size (ES), with a corresponding 95% confidence interval (CI) and p value (25). The SMD of each study was calculated by comparing the mean change from pre- to post-intervention in the experimental and control groups. The pooled ESs were determined using a randomized effect model and shown in a forest plot, and a positive ES value expressed a positive effect of TCE. The ES was commonly defined by three layers: small (0.2–0.49), moderate (0.50–0.79), and large (≥0.8) (26). Meanwhile, the I^2 statistic test was used to examine heterogeneity across studies. $I^2 < 25\%$, $I^2 < 50\%$, and $I^2 < 70\%$ were considered as low heterogeneity, moderate heterogeneity and high heterogeneity, respectively (27). Publication bias was examined using the funnel plot and Egger's test, and it was not included if the number of included studies was less than 10. Sensitivity analysis was conducted to assess the stability of the results by excluding one study each time. Furthermore, subgroup analysis was performed to explore sources of heterogeneity by the dose of exercise: exercise type - Tai Chi and Qigong; exercise frequency - 1 to 2 times, 3 to 4 times, and more than 5 times per week; exercise duration- 12 weeks, 13–23 weeks, and 24 weeks or more; exercise session time – 30 to 45 min, and more than 45 min (28). The control group was divided into active group (i.e., recreation activity) and passive group (i.e., no treatment). The significance level was set at $p < 0.05$.

Results

Search results

The PRISMA flowchart (Figure 1) presents the study selection in the meta-analysis study. A total of 1,003 studies were retrieved from the database. After removing duplicates ($n = 108$), 895 studies were reviewed and 25 studies remained. Subsequently, 15 studies were excluded based on the reasons shown in the flowchart. Finally, 10 studies (29–38) were selected for inclusion in this meta-analysis.

Study characteristics

Table 1 presents the characteristics of the included studies. These studies were mainly conducted in China, with a total of 740 participants. Three studies were published in the English language (35, 36, 38). The mean age of participants was 35 years old. For TCE intervention, 8 studies used Tai Chi and 2 studies used Qigong exercise. The exercise session of the included studies ranged from 30 min to 80 min, the exercise frequency was 2 to 7 times per week, and the exercise intervention lasted between 12 and 24 weeks. With respect to outcomes, depression, anxiety, drug cravings, and sleep were measured in 10 studies (29–38), 8 studies (29–34, 37, 38), 3 studies (34, 35, 38), and 3 studies (32, 36, 37), respectively. Additionally, with regard

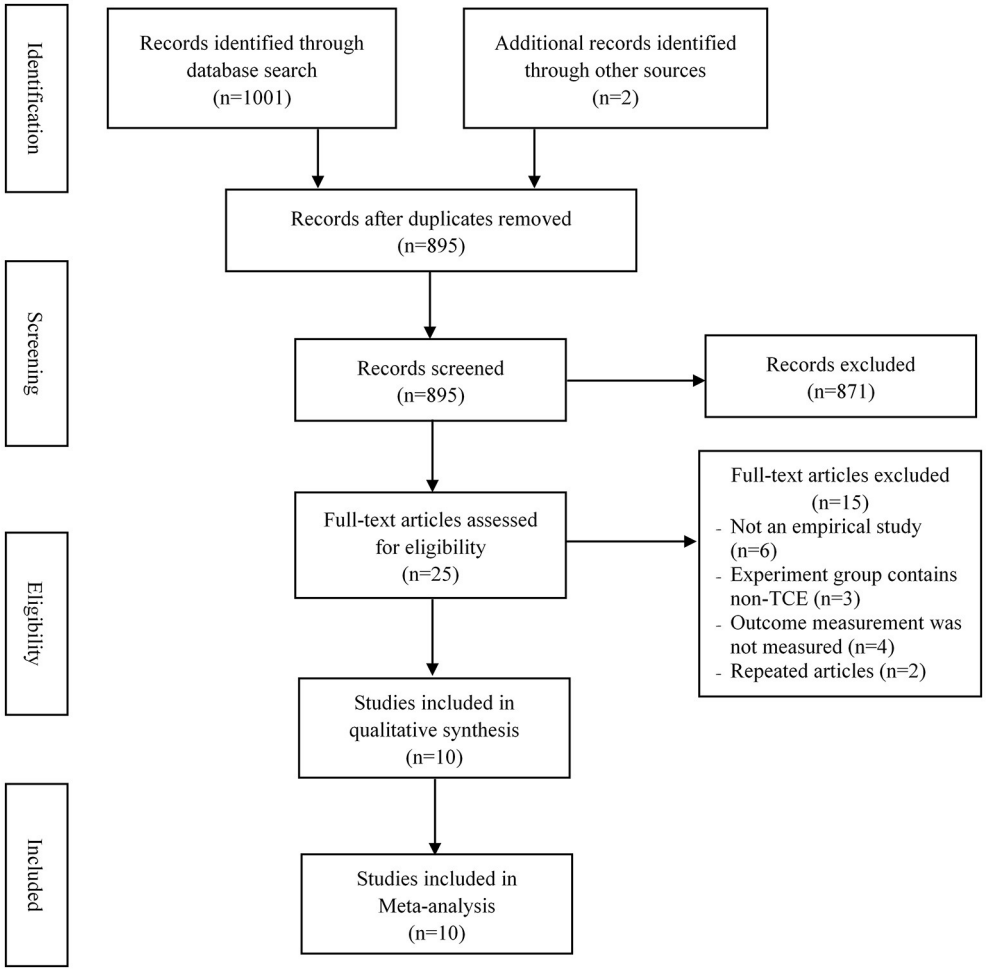

FIGURE 1
The flowchart of the study selection process.

to outcome measurements, depression was measured using the self-rating depression scale (SDS) by Zung, the Baker self-rating depression scale (BDI), and the Hamilton Rating Scale for Depression (HRSD); anxiety was measured using the self-rating anxiety scale (SAS) by Zung; drug cravings were measured using the desire for speed questionnaire by Wang (39); and the Pittsburgh Sleep Quality Index (PSQI) was used to measure sleep quality.

The study quality assessment was used the PEDro scale (Table 2). The study quality scores ranged from 5 to 8 points, indicating that the included studies were considered as fair and had good methodological qualities. Only three studies used a blinding method to measure the outcomes (32, 36, 38).

Synthesized results

Depression was measured using SDS and BDI in the included studies. The pooled result from 10 studies (29–38) indicated that TCE had a positive effect on reducing depression compared to the control group (SMD = 0.65, 95% CI 0.29 to 1.02, $I^2 = 81.8\%$, $p < 0.01$) using a random-effects model (Figure 2). Publication bias was determined using the Egger's test (Egger's regression incept = 0.95, $p > 0.05$) and funnel plot (Figure 3). Furthermore, sensitivity analysis by removing one study at a time examined the sources of heterogeneity. The result revealed that the exclusion of any one study from the analysis did not influence the overall findings (Figure 4). Additionally, excluding two studies (30, 32) that produced smaller effect sizes

TABLE 1 Characteristics of the included studies.

References	Mean age (years) Sample size	Gender	Time/Frequency/ Duration	Interventions		Instrument/ Outcomes	Findings
				Experiment (Details)	Control		
Sui (33)	30 E = 28; C = 30	Male	60min/3times/week 16 weeks	Qigong	No treatment	SDS/depression SAS/anxiety	The Qigong exercise had a significant effect in reducing the depression and anxiety symptoms compared to the control group.
Li et al. (35)	30 E = 17; C = 16	Female	80min/2times/week 24 weeks	Tai Chi	Recreation activity	HRSD/depression HWS/drug craving	There were no significant differences in depression and drug craving between Tai Chi and control groups.
Geng et al. (29)	36 E = 30; C = 27	Female	45min/5tims/week 12 weeks	Tai Chi	Recreation activity	SDS/depression SAS/anxiety	The Tai Chi exercise had a significant effect in reducing the depression and anxiety symptoms compared to the control group.
Zhang and Zhu (38)	40 E = 38; C = 34	Male	50min/5times/week 24 weeks	Tai Chi	Recreation activity	BDI/depression SAS/anxiety DSQ/drug craving	The Tai Chi exercise had a significant effect in reducing the depression, anxiety and drug craving symptoms compared to the control group.
Wang (34)	38 E = 24; C = 25	Female	30min/6times/week 12 weeks	Tai Chi	Recreation activity	SDS/depression SAS/anxiety DSQ/drug craving	The Tai Chi exercise had a significant effect in reducing the depression, anxiety and drug craving symptoms compared to the control group.
Zhao (32)	39 E = 35; C = 37	Male	70min/3times/week 12 week	Tai Chi	No treatment	SDS/depression SAS/anxiety PSQI/sleep quality	The Tai Chi exercise had a significant effect in reducing the depression, anxiety and improving sleep quality compared to the control group.
Zheng (31)	36.5 E = 25; C = 27	Male	60min/5times/week 12 weeks	Tai Chi	Recreation activity	SDS/depression SAS/anxiety	The Tai Chi exercise had a significant effect in reducing the depression and anxiety symptoms compared to the control group.
Zhu et al. (36)	36 E = 42; C = 38	Female	60min/3-5times/week 24 weeks	Tai Chi	Recreation activity	SDS/depression PSQI/sleep quality	The Tai Chi exercise had a significant effect in reducing the depression and improving sleep quality compared to the control group.
Fu et al. (37)	28 E = 100; C = 100	Female	30min/7times/week 20 weeks	Qigong	No treatment	SDS/depression SAS/anxiety PSQI/sleep quality	The Qigong exercise had a significant effect in reducing the depression, anxiety and improving sleep quality compared to the control group.
Zhu (30)	30 E = 50; C = 50	Male	60min/3tims/week 15 weeks	Tai Chi	No treatment	SDS/depression SAS/anxiety	The Tai Chi exercise had a significant effect in reducing the depression and anxiety symptoms compared to the control group.

BDI, Baker self-rating depression scale; C, Control group; DSQ, Desire for speed questionnaire; E, Experimental group; HRSD, Hamilton Rating Scale for Depression; HWS, Rating Scale of Heroin Withdrawal Symptoms; SAS, Self-rating anxiety; SDS, Self-rating depression; PSQI, Pittsburgh Sleep Quality Index.

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TABLE 2 Methodological quality of the included studies.

References	Score	Methodological quality	PEDro item number										
			1	2	3	4	5	6	7	8	9	10	11
Sui (33)	5	Fair	1	1	1	1				1		1	1
Li et al. (35)	5	Fair	1	1		1			1			1	1
Geng et al. (29)	5	Fair	1	1		1				1		1	1
Zhang and Zhu (38)	7	Good	1	1	1	1			1	1		1	1
Wang (34)	6	Good	1	1		1				1	1	1	1
Zhao (32)	8	Good	1	1	1	1		1	1	1		1	1
Zheng (31)	6	Good	1	1	1	1				1		1	1
Zhu et al. (36)	7	Good	1	1	1	1			1	1		1	1
Fu et al. (37)	6	Good	1	1		1				1	1	1	1
Zhu (30)	5	Fair	1	1		1				1		1	1

Studies were classified as having excellent (9–10), good (6–8), fair (4–5), or poor (<4).
The PEDro scale involves (1) eligibility criteria; (2) random allocation; (3) concealed allocation; (4) similarity at baseline on key measures; (5) participant blinding; (6) instructor blinding; (7) assessor blinding; (8) more than 85% retention rate of at least one outcome; (9) intention-to-treat analysis; (10) between-group statistical comparison for at least one outcome; (11) point estimates and measures of variability provided for at least one outcome.

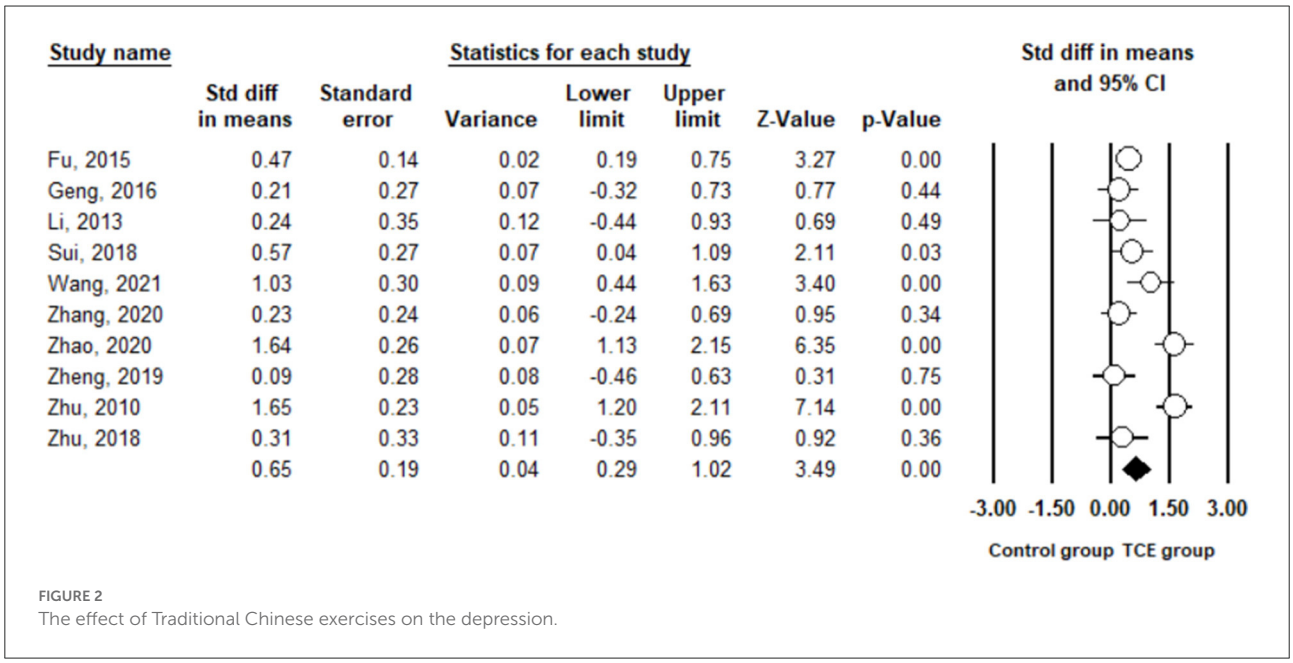

FIGURE 2
The effect of Traditional Chinese exercises on the depression.

to in the overall estimate did not change the result (SMD = 0.40, 95% CI 0.22 to 0.58, $I^2 = 7.7\%$, $p < 0.01$).

In the subgroup analysis (Table 3), when comparing active intervention (SMD = 0.33, 95% CI 0.07 to 0.60) with passive intervention (SMD = 1.07, 95% CI 0.40 to 1.74), significant improvements in depression were found in TCE. In particular, there was a greater magnitude of improvement in depression due to TCE compared to passive intervention. There was no significant difference in terms of sex. In other words, TCE showed a significant improvement for depression in both males (SMD = 0.84, 95% CI 0.16 to 1.52) and females (SMD = 0.46, 95% CI 0.21 to 0.71). With regard to the dose of exercise, significant differences in effect sizes in terms of exercise type (Q = 0.48, p = 0.49), exercise frequency (Q = 3.72, p = 0.16), exercise duration (Q = 3.20, p = 0.20), and exercise session time (Q = 0.03, p = 0.87) were not observed between categorical variables. However, practicing TCE for 3–4 times (SMD = 1.06, 95% CI 0.39 to 1.74) or 5 times or more (SMD = 0.39, 95% CI 0.12 to 0.66) per week showed a significant improvement in depression compared to 1–2 times (SMD = 0.24, 95% CI −0.44 to 0.93) per week. Practicing TCE for 12 weeks (SMD = 0.84, 95% CI 0.15 to 1.54) showed a significant improvement for depression compared to 13–23 weeks (SMD = 0.76, 95% CI −0.004 to

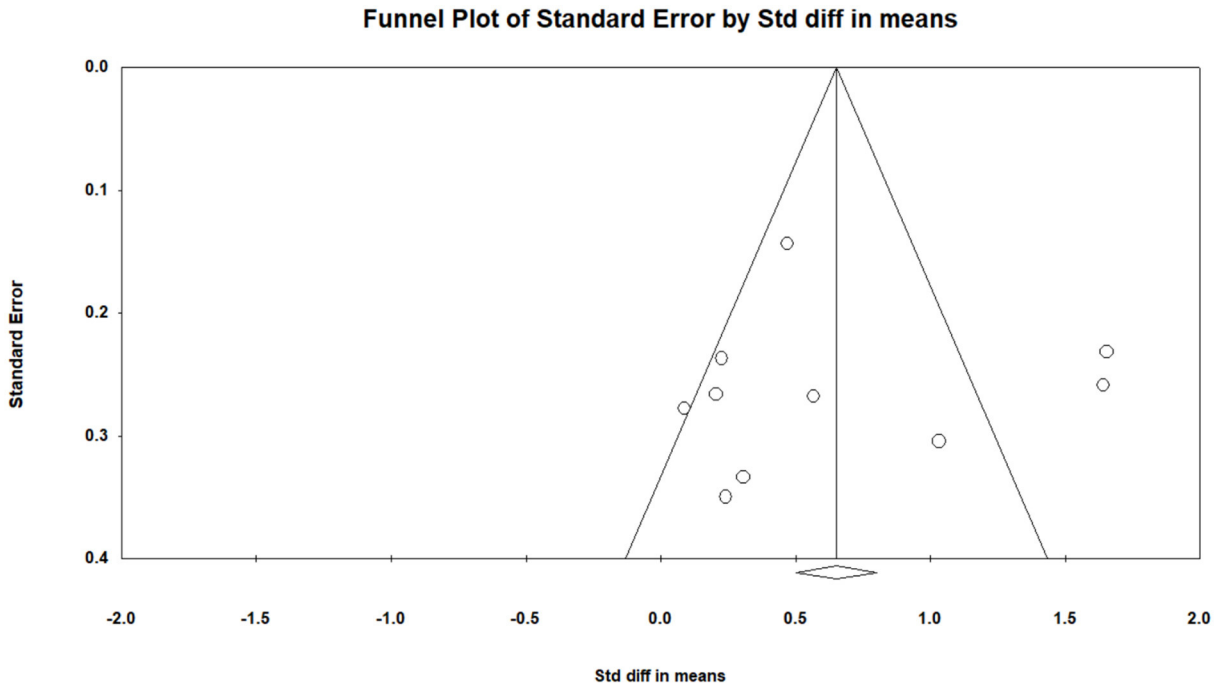

FIGURE 3
The funnel plot for publication bias in depression.

Study name	Point	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Fu, 2015	0.67	0.22	0.05	0.24	1.11	3.02	0.00
Zhu, 2018	0.69	0.20	0.04	0.29	1.08	3.40	0.00
Geng, 2016	0.70	0.20	0.04	0.31	1.10	3.48	0.00
Li, 2013	0.69	0.20	0.04	0.30	1.08	3.45	0.00
Sui, 2018	0.66	0.21	0.04	0.25	1.07	3.18	0.00
Wang, 2021	0.61	0.20	0.04	0.22	1.01	3.03	0.00
Zhang, 2020	0.70	0.20	0.04	0.30	1.10	3.45	0.00
Zhao, 2020	0.54	0.17	0.03	0.21	0.88	3.15	0.00
Zheng, 2019	0.71	0.20	0.04	0.33	1.10	3.61	0.00
Zhu, 2010	0.53	0.16	0.03	0.22	0.85	3.32	0.00
	0.65	0.19	0.04	0.29	1.02	3.49	0.00

FIGURE 4
Leave one out sensitivity analysis for depression.

1.53) and 24 weeks or more (SMD = 0.25, 95% CI −0.08 to 0.58).

Anxiety was measured using the SAS in the included studies. The pooled result from eight studies (29–34, 37, 38) showed that TCE contributed to a significant reduction in anxiety compared to the control group (SMD = 0.98, 95% CI 0.44 to 1.53, I^2 = 90.4%, $p < 0.01$) using a random-effects model (Figure 5). Furthermore, sensitivity analysis by removing one study at a time examined the sources of heterogeneity. The result revealed that the exclusion of any one study from the analysis did not

TABLE 3 Subgroup analysis for TCE versus control group on depression.

Categorical moderator	Level	No. of studies/ comparisons	SMD	95% Confidence interval	I^2, %	Test for between-group hoterogeneity		
						Q-value	df(*Q*)	*p*-value
Study design moderators								
Control type	Active	6	0.33	0.07 to 0.60	24.2 %	4.02	1	0.04
	Passive	4	1.07	0.40 to 1.74	89.8%			
Sex	Male	5	0.84	0.16 to 1.52	89.2%	1.08	1	0.30
	Female	5	0.46	0.21 to 0.71	21.2%			
Exercise moderators								
Exercise type	TC	8	0.69	0.19 to 1.18	85.0%	0.48	1	0.49
	Qigong	2	0.49	0.24 to 0.74	0%			
Frequency	1–2	1	0.24	−0.44 to 0.93	0%			
	3–4	4	1.06	0.39 to 1.74	84.6%	3.72	2	0.16
	≥5	5	0.39	0.12 to 0.66	42.1%			
Exercise duration	12 weeks	4	0.84	0.15 to 1.54	85.6%			
	13–23 weeks	3	0.76	−0.004 to 1.53	89.5%	3.20	2	0.20
	≥24 weeks	3	0.25	−0.08 to 0.58	0%			
Exercise session time	≤45	5	0.68	0.10 to 1.27	82.8%	0.03	1	0.87
	>45	5	0.62	0.09 to 1.15	84.6%			

SMD, standardized mean difference; df, degree of freedom.

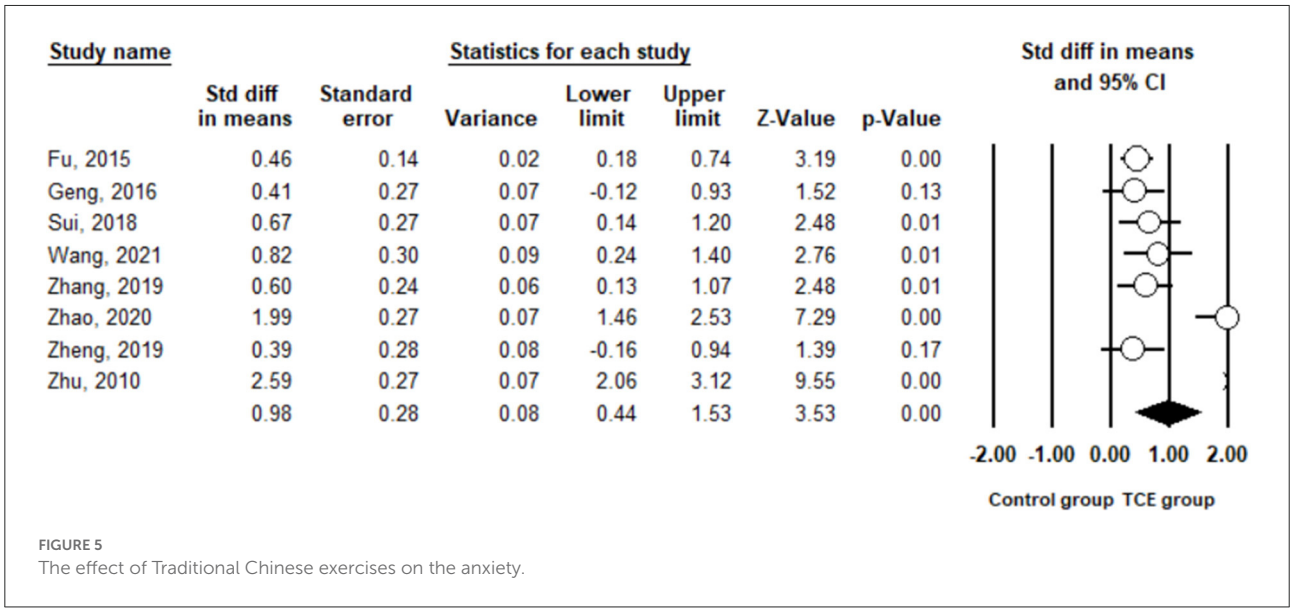

FIGURE 5
The effect of Traditional Chinese exercises on the anxiety.

influence the overall findings (Figure 6). Additionally, excluding two studies (30, 32) that produced smaller effect sizes on the overall estimate did not change the positive result (SMD = 0.52, 95% CI 0.34 to 0.71, $I^2 = 0\%$, $p < 0.01$).

Drug cravings were measured in the term of psychological cravings in the three included studies (34, 35, 38). The pooled results indicated a significant reduction in DSD in the TCE group (SMD = 0.87, 95% CI 0.54 to 1.21, $I^2 = 0\%$, $p < 0.01$) when using a random-effects model (Figure 7).

Sleep quality was measured using the PSQI in the three included studies (32, 36, 37). The pooled results indicated that there was no significant difference in terms of an improvement in the PSQI between the TCE and control groups (SMD = 0.72, 95% CI −0.17 to 1.60, $I^2 = 90.7\%$, $p < 0.01$) using a random-effects model (Figure 8).

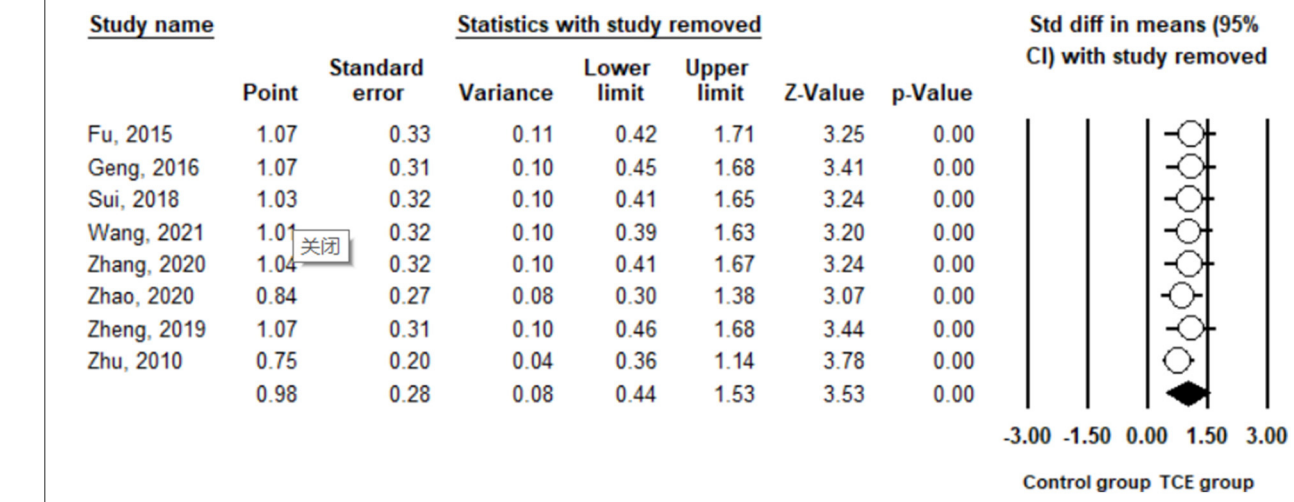

FIGURE 6
Leave one out sensitivity analysis for anxiety.

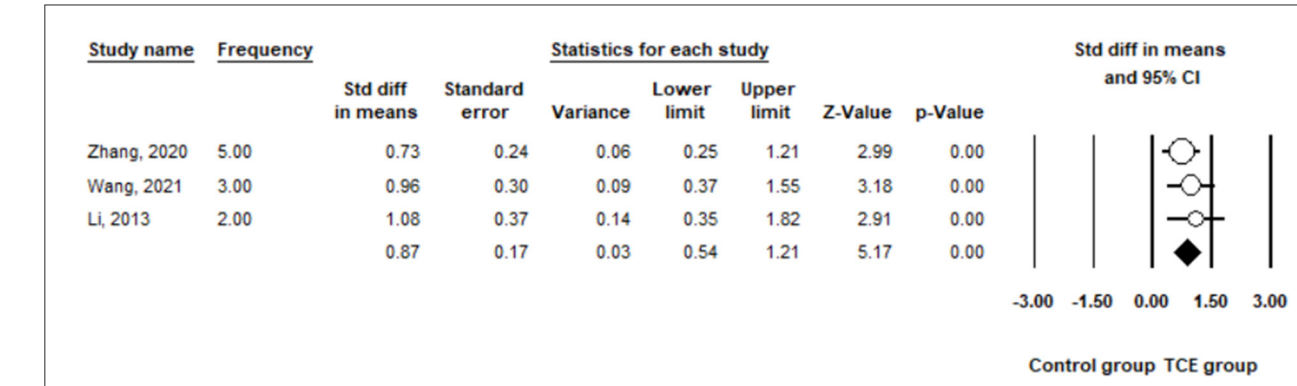

FIGURE 7
The effect of Traditional Chinese exercises on the drug cravings.

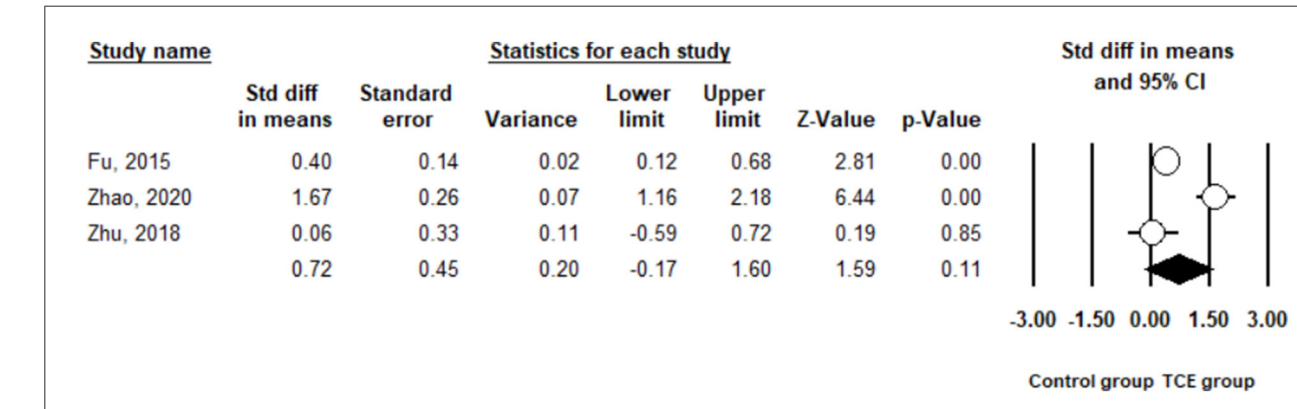

FIGURE 8
The effect of Traditional Chinese exercises on the sleep quality.

Discussion

The health benefits of TCE are increasingly being accepted by citizens and being used to manage mental health problems in drug rehabilitees. This systematic review and meta-analysis aimed to assess the existing studies about TCE (Tai Chi, Qigong) and mental health (depression, anxiety, and drug craving) among drug rehabilitee. The findings showed that TCE might be effective in reducing depression, anxiety and drug cravings among drug rehabilitees.

In this current study, some significant heterogeneities were observed in outcomes of depression and anxiety among the included studies, respectively. A sensitivity analysis was performed to examine the heterogeneity, accordingly. Zhao (32) and Zhu (30) reported larger effect sizes in favor of TCE. However, significant positive results were found after excluding these two studies, showing that TCE had significant effects in terms of reducing depression and anxiety in drug rehabilitees.

Exercise has been assumed to have beneficial effects on health outcomes in adults at different ages. The accumulation of exercise produces a series of positive statuses, reducing the mental health disorders (e.g., depression, anxiety, stress) of practitioners. In our study, the meta-analytic results found that TCE could significantly reduce depression and anxiety symptoms in drug rehabilitees. The ESs for depression (ES = 0.65) and anxiety (ES = 0.98) were moderate and larger, respectively. This implies that TCE has an effect on promoting people's mental health, assisting drug rehabilitees to reduce depression and anxiety symptoms. Our findings were consistent with previous studies (21, 40), which also found that mind-body exercises (e.g., Tai Chi, Yoga) could effectively relieve depression and anxiety symptoms of substance abuse users. Furthermore, according to the subgroup analysis of the present study, drug rehabilitees showed significant decreases in depression and anxiety symptoms after practicing Tai Chi and Qigong exercises. These findings were inconsistent with a previous meta-analysis study (22), which reported no significant effects in favor of Tai Chi exercises. Compared to the number of included studies (n = 3) in the previous study, our study enhanced the statistical power by including a greater number of studies (n = 8). Moreover, the studies included in our systematic review were randomized controlled trials, providing a more reliable result. Additionally, for the other doses of exercise, drug rehabilitee showed a significant decrease in depression after practicing TCE for 30 to 80 min, 3 times or more per week, for 12 weeks. This TCE exercise prescription is consistent with the WHO guidelines, which recommend that adults should perform more than 30 min of exercise at least 3 times per week. However, future research is needed to explore whether long-term TCE (more than 12 weeks) has a positive effect on depression in comparison with non-significant effect observed in our review study.

No previous review study has explored the role of sex on TCE and depression. Our subgroup analysis result also did not show a significant difference in male and female adults, and drug rehabilitees of both sexes could reduce their depression symptom by practicing TCE. The reason for this result is still unknown. It is likely that TCE like other exercise provided comprehensive benefits to mental health. Moreover, the different movements (e.g., meditation, breathing, and slow movements) of TCE could help people focus on the sensation of breathing, biofeedback, and immersive exercise. Thereby, both male and female practitioners strengthened their ability to promote relaxation and decrease depression episodes (41). Therefore, TCE can reduce depression symptom in male and female drug rehabilitees.

With respect to drug craving, previous studies have revealed that exercise has benefits in terms of reducing drug cravings in drug rehabilitee (34, 38). These results are in line with our finding, showing a significant decline in drug cravings with a larger effect (ES = 0.82) in favor of TCE in drug rehabilitees. In fact, long-term drug rehabilitees have a particularly strong dependence on drugs, which may be due to the decrease in dopamine secretion from the brain. Drug users can only take drugs to improve the unhappiness caused by a lack of dopamine, thus increasing their drug cravings. Moreover, in terms of the remarkable finding of the present study, it is likely that TCE contributes to a decrease in drug cravings by acting on other mediating factors, such as improved cognitive function. The key point of motivation for drug rehabilitees may be cravings, but some cognitive functions, such as memory and impulse control, may assist drug users in resisting these addictive impulses or cravings (42). A previous study indicated that engagement in exercise might enhance practitioners' self-cognitive ability to suppress drug cravings (43). Therefore, we believe that drug rehabilitee can reduce drug cravings after practicing TCE.

In addition, drug rehabilitees have an increased risk of sleep disorders and escape this ailment through drug abuse (44, 45). However, few experimental studies have examined the role of TCE in sleep disorders among drug rehabilitees. In our study, three eligible studies were included in the current meta-analysis, and they showed that TCE did not have a benefit of improving sleep quality among drug rehabilitees. This finding is inconsistent with previous studies that investigated the effect of TCE on sleep in people with or without diseases (46, 47). The results suggest a significant improvement in sleep quality in favor of TCE. The reason why TCE is able to assist in relieving sleep disorders is that TCE requires gentle and rhythmic movements; when practitioners perform TCE, the parasympathetic tone can be increased to regulate the nerve center and improve sleep quality. Moreover, TCE can bring pleasure to the body and mind of the practitioner and thereby reduce sleep disorders (48). However, the reason for the lack of a significant effect of TCE found in our study is that it is likely that our study focused on drug rehabilitees and a small number

of studies were included compared with the population in the previous study. Thus, further research is needed to examine this finding.

There are several limitations that need to be acknowledged in this study. First, the participants included in the current study are mainly from China, where TCE is a popular exercise among people of different ages. This implies that more research needs to be completed that includes different ethnic groups in the future. Second, a limited number of studies were included and the studies were mainly conducted in China, which may cause a publication bias. Third, the heterogeneity across studies was relatively high due to the diversity of the study methodologies, such as different durations of intervention, different modalities of intervention, and different outcome measurements or test methods. Four, it is not known how long the TCE effect lasts after the intervention is discontinued, as the original study did not provide additional data to examine the results of the follow-up.

Conclusion

The present systematic review and meta-analysis provides evidence that suggests that there are beneficial effects of TCE (Tai Chi, Qigong) in terms of relieving depression, anxiety, and drug cravings in drug rehabilitees. Further studies are warranted to verify our results by implementing well-designed experimental protocols.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Author contributions

YZ and SL: conceptualization and methodology. YZ: data curation and analysis and writing—original draft preparation. SL: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Prevalence and correlates of suicide attempts in Chinese individuals with borderline personality disorder

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Background: To date, few empirical studies have examined the clinical characteristics of suicide attempts (SA) in individuals with borderline personality disorder (BPD) in China.

Aims: To examine the prevalence and factors associated with SA in Chinese individuals with BPD.

Methods: In this cross-sectional study, 84 patients with BPD were recruited from a large public psychiatric hospital in Wuhan, China, between 2013 and 2015. Trained experienced psychiatrists interviewed participants to collect clinical data, including demographics, axis I and axis II diagnoses of mental disorders according to the DSM-IV-TR, number of hospitalizations, and history of SA. An interview outline was used to identify the existence of lifetime SA. In addition, the Beck Depression Inventory-II, Buss & Perry Aggression Questionnaire, Child Trauma Questionnaire-Short Form, and Beck Hopelessness Scale were administered to assess respondents' depressive symptoms, aggression, childhood traumatic experiences, and hopelessness.

Results: Fifty-two (61.9%) patients reported attempting suicide during their lifetime. Univariate logistic regression analysis screened 7 factors associated with SA in individuals with BPD into Multiple logistic regression analysis: female sex, unemployment, major depressive disorder (MDD), hostility, self-aggression, depressive symptoms, and emotional neglect. Multiple logistic regression analysis identified 3 significant and independent correlates of SA: MDD [odds ratio (OR) = 26.773, 95% confidence interval (CI) = 3.914–183.132, P = 0.001], hostility (OR = 1.073, CI = 1.019–1.130, P = 0.007), and self-aggression (OR = 1.056, CI = 0.998–1.119, P = 0.060).

Conclusion: Chinese individuals with BPD have a high risk of suicide. Correlates of SA in this population differ to some extent from those in Western

populations as reported in the literature. Paying attention to MDD and some types of aggression in Chinese individuals with BPD may help identify their risk of suicide. Future large-sample cohort study may improve the limitations of this study and further confirm the point of view above.

KEYWORDS

borderline personality disorder, suicide attempt, prevalence, factors, clinical characteristics

Introduction

The main characteristics of borderline personality disorder (BPD) include a pervasive pattern of emotion dysregulation, inconsistent identity, and disturbed interpersonal function, as indicated by five (or more) of the following: fear of abandonment, unstable relationships, unstable self-image, impulsivity, recurrent suicide/self-harm, mood instability, feelings of emptiness, inappropriate anger, dissociation/transient paranoid ideation (1). BPD is the most common personality disorder in both clinical and non-clinical settings in Western countries, with a prevalence of approximately 10–25% (2, 3) and 0.7–5.9% (4–6) in clinical and non-clinical populations, respectively. In China, a multicenter study reported that the prevalence of BPD reached 9.9% in psychiatric treatment settings (7). BPD is a serious personality disorder that can cause severe social function impairments, and it is associated with a high risk of suicide. It has been documented that approximately 50–75% of patients with BPD have attempted suicide (8, 9); in addition, each of these patients has attempted suicide more than three times during their lifetime (10). Repetitive suicidal behaviors in patients with BPD are sometimes misinterpreted as merely a form of threat or manipulation in clinical practice. However, since suicide attempts (SA) lead to a greater risk of completed suicide than expected (11), it is a significant clinical concern in patients with BPD.

Several factors were probably associated with SA in patients with BPD, such as comorbidities of other mental disorders, personality traits, childhood abuse, some demographic characteristics, and other factors; however, studies have shown inconsistent results to some extent (10, 12–20). Many studies on BPD indicated that there were significant associations between SAs and affective disorders, especially depressive disorders (10, 14, 17). However, few found that a comorbid diagnosis of major depression had only a short-term effect or little effect on suicide risk in patients with BPD (18, 19). One study even suggested further that risk factors for SA include state depression (e.g., depressed symptoms), but not comorbid affective disorder (18). Similarly, substance abuse is common among suicide attempters with BPD (13, 14); however, some studies have found no associations between substance abuse and SA in these patients (18, 20). Another possible associated factor is the personality traits of patients with BPD, such as aggression, anger, hostility, and impulsivity (10, 12, 13, 15, 17, 19); but negative results have also been reported (20). Moreover, childhood abuse, especially sexual abuse, was considered correlated with SA in patients with BPD (15, 16). Low socioeconomic status, age, hospitalization, and poor psychosocial functioning have also been classified as risk factors for SA in patients with BPD (16, 19, 20).

As mentioned above, the data for clinical characteristics of suicidal behaviors in individuals with BPD are mainly derived from Western countries, and there are still some inconsistent findings. In China, to the best of our knowledge, few empirical studies have been conducted to examine the clinical epidemiology of SA in patients with BPD in China. From the few research data in China (7), it can be inferred that the number of Chinese patients in with BPD may be huge, and the suicidal behavior of this population is a clinical problem that cannot be ignored. Considering the clinical importance of suicide prevention and management of suicidal risk in patients with BPD, we investigated the prevalence and correlates of SA in patients with BPD from a large public psychiatric hospital in central China.

Materials and methods

Participants

Participants were selected from patients treated at Wuhan Mental Health Center over a period of 2 years from 2013 to 2015. This center is the largest public psychiatric specialty hospital in Wuhan, central China, with over 1,000 inpatient beds. Patients with confirmed clinical diagnosis of BPD, according to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) (21), aged between 18 and 60 years, and received treatments at the hospital during the study period were consecutively invited to join the study.

Patients with severe physical diseases, including neurological diseases, such as epilepsy, were excluded. Two experienced psychiatrists assessed their eligibility and invited eligible patients to participate in the study.

Assessment

Trained investigators interviewed patients in a standardized manner, aiming to collect demographic information (sex, age, educational background, occupation, and marital status), axis I diagnoses of DSM-IV-TR, number of hospitalizations, and the outcome of this study, lifetime SA. An interview outline was used to identify the existence of lifetime SA, which mainly included four questions: (1) Have you ever self-injured or suicided, such as taking medicine or cutting your wrists? (2) How many times? (3) What specific methods were used? (4) How much did you want to die while doing these things? If the patient answered yes to question 1 and was able to describe in detail at least one suicidal behavior with thoughts of death, SA was present; Otherwise, SA was absent.

All participants completed 4 validated Chinese self-rating scales: Buss and Perry Aggression Questionnaire (BP-AQ) (22), Beck Depression Inventory-II (BDI-II) (23), Child Trauma Questionnaire-Short Form (CTQ-SF) (24), and Beck Hopelessness Scale (BHS) (25). BP-AQ was used to assess personality characteristic of aggression. It consisted of 30 items, with five subscales: physical aggression, anger, verbal aggression, hostility, and self-aggression. The CTQ-SF was used to assess childhood abuse and consisted of 28 items in five subscales: emotional abuse, sexual abuse, physical abuse, physical neglect, and emotional neglect. BDI-II and BHS were used to rate the levels of depressive symptoms and hopelessness, respectively.

Statistics

Descriptive statistics and univariate and multivariate logistic regression analyses were performed. In the univariate logistic regression analysis, the presence or absence of SA was considered as the outcome variable, while the above demographic, psychosocial, and clinical variables were considered as the independent variables. Significant factors identified in the univariate analysis were included into the multivariate logistic regression analysis. Forward stepwise regression based on maximum likelihood estimation was used to identify independent factors associated with SA in patients with BPD. The 95% confidence intervals (CIs) and odds ratios (ORs) were used to quantify the association between the factors and SA. The statistical significance level was set at two-sided $P < 0.05$. All analyses were performed using IBM SPSS 20.0 (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

Results

Characteristics of included patients

During the study period, a total of 355 patients with BPD met the inclusion and exclusion criteria, of which 84 patients agreed to participate in the study and completed the questionnaires, and all questionnaires were qualified for the analysis. Among the 84 patients with BPD, the age ranged from 18 to 38 years (mean age, 24.6 ± 5.5 years), and 52 (61.9%) had attempted suicide before the interview. Other clinical characteristics and demographic data are shown in Table 1.

Results of the logistic regression analysis on the factors associated with suicide attempts in borderline personality disorder patients

The univariate logistic regression analysis (Table 2) revealed that there were 7 factors associated with SA in patients with BPD, namely female sex, unemployment, major depressive disorder (MDD), hostility, self-aggression, depressive symptoms, and emotional neglect.

The final model of multivariate logistic regression analysis (Table 3) identified three correlates significantly and independently associated with SA in BPD patients: MDD

TABLE 1 Characteristics of Chinese borderline personality disorder (BPD) patients (N = 84).

Characteristics	N (%)
Gender	
Male	22 (26.2)
Female	62 (73.8)
Education level	
Junior college below	32 (38.1)
Junior college or above	52 (61.9)
Occupation	
Unemployed	23 (27.4)
Student	33 (39.3)
Others	28 (33.3)
Marital status	
Unmarried	75 (89.3)
Married	5 (6.0)
Others (divorced, widowed or remarried)	4 (4.7)
Number of hospitalizations	
0 (outpatient)	5 (6.0)
1	10 (11.9)
2 or above	69 (82.1)
DSM-IV-TR[a] axis I diagnosis	
Major depressive disorder (MDD)	57 (67.9)
Bipolar disorder	8 (9.5)
Other or unspecified psychotic disorders	5 (6.0)
Post-traumatic stress disorder	4 (4.7)
No diagnosis	10 (11.9)

[a]Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision.

TABLE 2 Results of the univariate logistic regression analysis on the factors correlated with suicide attempt (SA) in BPD patients.

Factors	B	S.E.	Wald χ^2	*P*	OR (95%CI)
Female (vs. male)	1.216	0.546	4.955	0.026	3.375 (1.156, 9.850)
Age	−0.019	0.044	0.174	0.677	0.982 (0.900, 1.071)
Junior college below (vs. Junior college or above)	−0.734	0.516	2.020	0.155	0.480 (0.174, 1.321)
Unemployed (vs. student and other occupations)	1.232	0.624	3.894	0.048	3.429 (1.008, 11.658)
Married (vs. other marital status)	−20.846	20096.485	0.000	0.999	0.000
Number of hospitalizations (<2 vs. ≥2)	−21.357	8987.429	0.000	0.998	0.000
MDD (vs. other axis I diagnosis)	3.219	0.671	23.025	<0.001	25 (6.713, 93.099)
Physical aggression	0.024	0.015	2.487	0.115	1.024 (0.994, 1.055)
Anger	0.022	0.012	3.504	0.061	1.022 (0.999, 1.046)
Verbal aggression	−0.001	0.012	0.012	0.912	0.999 (0.975, 1.023)
Hostility	0.055	0.017	10.356	0.001	1.057 (1.022, 1.093)
Self-aggression	0.081	0.021	15.404	<0.001	1.085 (1.041, 1.129)
Depressive symptoms	0.059	0.025	5.675	0.017	1.061 (1.011, 1.114)
Hopelessness	0.060	0.050	1.455	0.228	1.062 (0.963, 1.171)
Emotional abuse	0.098	0.060	2.647	0.104	1.103 (0.980, 1.242)
Sexual abuse	0.188	0.110	2.940	0.086	1.207 (0.973, 1.497)
Physical abuse	0.064	0.109	0.348	0.555	1.066 (0.862, 1.320)
Physical neglect	0.162	0.108	2.251	0.134	1.176 (0.952, 1.453)
Emotional neglect	0.317	0.101	9.842	0.002	1.373 (1.126, 1.674)

(OR = 26.773, CI = 3.914–183.132, *P* = 0.001), hostility (OR = 1.073, CI = 1.019–1.130, *P* = 0.007), and self-aggression (OR = 1.056, CI = 0.998–1.119, *P* = 0.060).

Discussion

To the best of our knowledge, this is the first study to examine SA and its associated factors in individuals with BPD in China. The results showed that the lifetime prevalence of SA in Chinese patients with BPD was 61.9%, which is consistent with the high rate reported in Western countries (8, 9). The significant correlates of SA in this patient population were MDD and self-aggression, partly replicating the findings from Western studies (10, 12–15, 17, 19). Meanwhile, it was preliminarily speculated from other inconsistent results that some of the differences might be related to different cultures and regions.

MDD, as a typical and severe type of depressive disorder, has been associated with SA in patients with BPD, which was also found in our study (10, 14, 17). Compared with depressive state and temporary psychological symptoms, MDD refers to more profound and persistent mood problems, and patients may eventually assume that suicide is the only way to end their painful lives. This accords with the characteristics of repeated SAs in patients with BPD. They tend not to present only occasionally suicidal impulses or depressive state. Understandably, the correlations of current depressive and hopeless symptoms to SA in this patient population were not found in this study, although previous studies had the opposite results (10, 18). In addition, no association between comorbidities of other mental disorders and SA in patients with BPD was found in this study, which may be partly due to the small number of cases with comorbidities of other mental disorders. Although this is inconsistent with some Western studies (13, 14), it supports the findings of a large sample study in Shanghai, another China city: depressive disorder is the most common axis I disorder in BPD clinical samples, while substance abuse is rare (26). The DSM-IV includes substance abuse in the diagnostic criteria for BPD as one of the self-damaging impulsive behaviors, but many drugs are tightly controlled in China, which greatly limits their availability.

TABLE 3 Results of the multivariate logistic regression analysis on the factors correlated with SA in BPD patients.

Factors	B	S.E.	Wald χ^2	*P*	OR (95%CI)
MDD (vs. other axis I diagnosis)	3.287	0.981	11.228	0.001	26.773 (3.914, 183.132)
Hostility	0.071	0.026	7.239	0.007	1.073 (1.019, 1.130)
Self-aggression	0.055	0.029	3.534	0.060	1.056 (0.998, 1.119)

Furthermore, aggression, especially hostility and self-aggression, are also significant correlates of SA in patients with BPD, partly replicating the findings of previous studies (10, 12, 13, 15, 17). From the psychopathology of BPD, the hate for important objects caused by severe psychological trauma in the early years and the symbiotic relationship with those objects leads to frequent no-boundary dissatisfaction and violence against others and oneself, and the extreme result is suicide. Specifically, most items of hostility involved the defense mechanism of projection, a paranoid belief that the outside world is bad, while refusing to acknowledge inner bad feelings. More importantly, self-aggression subscale was all about intentional or unintentional self-harm or self-punishment, which was conceptually related to SA. Therefore, this factor was still retained as a correlate of SA in this study, although its significance was borderline. In contrast, impulsiveness, another personality trait of BPD, was not

included in this study on the basis of the possibility of overlap between aggression and impulsiveness (27, 28), and aggression might be more relevant to suicide in patients with BPD (10, 13).

The effect of childhood abuse was not shown in this study, and even sexual abuse, considered by some studies to be the strongest predictor of SA in patients with BPD (15, 16), was not found to be associated. Talking about sex is more of a taboo in Eastern cultures than in Western ones, and this is also true among people with mental disorders (29, 30), which may mask the role sexual abuse plays in such patients. However, why other types of abuse were not associated with SA requires further clarification. In addition, patients' ages and number of hospitalizations were also not associated with SA in this study, which was not consistent with the results of some other BPD studies (16, 20). Most patients were young (under 38 years), which is in line with a significant decline in the prevalence of patients with BPD over 40 years (31), and most patients were repeatedly hospitalized, which is consistent with some studies (32, 33). This may be explained by repeated hospitalizations as a way to escape from daily life, while symptoms of the personality disorder tend to ease with age. Therefore, it may result in failure to distinguish differences in SA among patients of different ages and hospitalizations in this study.

This study had some limitations. First, the participants were clinical patients from a psychiatric hospital in a city in central China, and the sample size was relatively small, which suggested that the findings should be explained with considerable caution. Second, the cross-sectional nature of the study did not permit an examination of causality. Third, as this was a preliminary study, research tools require improving, and certain data require further collection and analysis, such as using a structured interview to improve the detection rate of BPD, comparing it with the results of a new dimension system in the diagnosis for personality disorders (DSM-5 or ICD-11), and investigating the family history of suicide, psychosocial functioning, frequency of SA and other factors. Future research, conducting a relatively large cohort study to compare suicide risk among patients at different time points, use improved diagnostic tools, collect more clinical variables, and collect patient data in community populations as controls, should address most of the limitations of this study.

Conclusion

The high prevalence of SA in Chinese individuals with BPD suggests a significant risk of suicide in this population in China. The suicidal behavior of Chinese patients with BPD is more likely to accompany with MDD and personality characteristics of hostility and self-aggression, but is not related to substance abuse, childhood sexual abuse and other factors as reported by Western studies. Paying attention to MDD and some types of aggression in Chinese individuals with BPD may help identify their risk of suicide. However, given the small sample size, the results should be interpreted with caution. Future large-sample cohort studies incorporating community population sampling and optimizing research tools may further refine the limitations of this study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board of the Wuhan Health and Family Planning Commission [approval number (2013)9, 5/12/2013]. The patients/participants provided their written informed consent to participate in this study.

Author contributions

FY and JT contributed to the conceptualization. JZ and S-FZ investigated patients and conducted project administration. B-LZ analyzed and interpreted the data. FY and S-FZ wrote the draft of the manuscript. B-LZ, JZ, and JT revised and edited the manuscript. FY acquired funding. B-LZ and JT provided supervision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The association between physical performance and subjective wellbeing in Chinese older adults: A cross-sectional study

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Purpose: This study aimed to investigate the association between physical performance and subjective wellbeing among Chinese older adults.

Methods: Data on the Chinese population were gathered from the Study on Global Aging and Adult Health Survey (SAGE). This survey used a stratified multistage cluster sample design based on geographical location and economic status. Chinese older adults aged 65 years old or above from eight provinces (Guangdong, Hubei, Jilin, Shaanxi, Shandong, Shanghai, Yunnan, and Zhejiang) were included in this cross-sectional study. Physical performance was measured using relative handgrip strength and normal gait speed. Subjective wellbeing was measured using quality-of-life (QOL), happiness, and mood through interviews with participants. Logistic regressions were used to examine the associations between physical performance and each of the three wellbeing variables (QOL, happiness, and mood).

Results: Data of 5,421 Chinese older adults (mean age: 72.93 ± 5.89 years old, 47.1% men) were analyzed. In this sample, individuals with a higher level of relative handgrip strength (rHGS) had better mood compared to those with a lower level of rHGS ($p < 0.05$), and persons with lower gait speed had poorer QOL, happiness, and mood compared to those with faster gait speed ($p < 0.05$).

Conclusion: Our findings suggest that a higher level of relative handgrip strength predicted better mood and lower gait speed predicted poor QOL, happiness, and mood in Chinese older adults.

KEYWORDS

handgrip strength, gait, wellbeing, Chinese older adults, quality of life

Introduction

China has the fastest-growing aging population worldwide. With longer life expectancy and reduced fertility rates, 366 million Chinese people will be aged 65 years old or over by 2050 (1). Such significant changes have not only produced multiple challenges for many countries globally and economically but also place substantial pressures on almost every household. Furthermore, managing this rapidly growing

number of older adults is more challenging for China as it is a developing country with one of the largest populations in the world and has a relatively limited healthcare system to care for its aging population compared with western developed countries and more developed regions (2). Many studies have shown that the greatest proportion of chronic illnesses occurs among older adults, and this has been accepted as a universal problem that requires special attention (1, 3).

Normal aging is closely linked to reduced subjective wellbeing (defined as physically and mentally subjective perceptions about daily activities) (4, 5). For example, reduced QOL, unhappiness, and mood dysfunction (measured by using a self-reported questionnaire) are commonly reported health issues resulting from aging. In contrast, individuals with better moods have a lower risk of disabilities, fewer symptoms, and fewer complaints of pain in later life (6). Thus, those with high levels of subjective wellbeing tend to have healthier lives than people with low levels of subjective wellbeing. To effectively improve subjective wellbeing, it is crucial to identify protective factors that can help older adults to live well.

Existing evidence indicates that physical activity is associated with physical and psychological wellbeing in older individuals. For example, regularly engaging in physical activity is significantly associated with better physical function (7), decreased severe mental health, and improved subjective wellbeing in older people (8, 9). Review studies have supported the beneficial effects of engagement in physical activity on the different aspects of psychological wellbeing among the older population (10–12). However, the association between physical function and psychological wellbeing has not been established, and physical function may be crucial for promoting psychological wellbeing in older people (13).

Physical function is the ability to carry out the basic, instrumental activities of daily life (13). In recent years, a substantial number of studies have focused on the physical performance of older adults as they face natural functional decline and sought to determine whether physical measures (e.g., handgrip strength and gait speed) are independent predictors of multiple health-related issues (14–16). For example, regardless of gender, aged individuals with low relative handgrip strength (rHGS) were reported to have reduced QOL (17, 18), a greater degree of depressive symptoms (19), and a lower level of self-perceived happiness (20).

In addition, compared with rHGS, gait speed as an essential component of physical function should receive greater attention, especially in establishing a link between the indicators of functional performance and subjective wellbeing in older adults. Moreover, declined gait speed may negatively influence QOL by accelerating dependency on others to carry out daily activities, increasing the risk of disabilities and hospitalization (21–23), and affecting wellbeing. For example, experiencing negative emotions (e.g., anxiety and depression) is closely associated with declines in physical function (e.g., gait speed) in western populations (24–26). Feldman et al. found that individuals with slower gait speed likely have anxiety symptoms (27). Accordingly, preserving a high gait speed can enhance mental health and wellbeing among senior adults (28, 29).

Collectively, the psychological health benefits of maintaining effective physical function have been widely studied in western countries. However, the link between physical function and subjective wellbeing is less well understood. Only one study investigated the association between physical function and wellbeing in low- and middle-income countries, reporting that higher levels of physical function were associated with better wellbeing in adults (16). However, it is unclear whether the link exists among Chinese seniors. Therefore, this study aimed to investigate the associations between physical performance and subjective wellbeing in Chinese over 65 years of age. It is hoped that the results will help health professionals and clinicians to better design behavioral intervention programs for older adults to maintain better wellbeing as they age.

Methods

Participants

Data from a cross-sectional survey by the SAGE (https://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/sage) was used to investigate the association between gait speed, rHGS, and subjective wellbeing in Chinese older adults. This survey used a stratified multistage cluster sample design based on geographical location and economic status. It is a nationally representative sample of populations from eight Chinese provinces (Guangdong, Hubei, Jilin, Shaanxi, Shandong, Shanghai, Yunnan, and Zhejiang). A total of 5,421 individuals aged 65 years or older were included in the current study after excluding individuals with incomplete data. The entire data collection approach has been described in a previous study (30). The participants completed the interview questionnaires under the guidance of the interviewers. The survey response rate was 93%. This study complies with the Declaration of Helsinki and was granted ethical approval by the Chinese ethics research review board at Peking University. All participants agreed to the experimental conditions and signed an informed consent form.

Handgrip strength

To measure isometric rHGS with a handhold Smedley's dynamometer (Scandidact, Denmark), the participants were seated in a comfortable chair with their feet flat on the ground. They were asked to keep the shoulder of the tested arm in an adducted and neutrally rotated position with the elbow flexed at 90 degrees. Furthermore, during the assessment, the participants were instructed to maintain a neutral wrist position (thumb facing upward). We asked participants to squeeze their hands

as hard as they could for 3 s to gain the maximal handgrip strength of each hand (left hand and right hand). All participants conducted the tests two times taking each side in turn. The average sum of the best results achieved with each hand was deemed to be the overall handgrip strength. The value of rHGS was calculated by dividing handgrip strength by body mass index (BMI) as described in a previous study (31).

Gait speed

To assess gait speed with a timer, the participants were asked to walk at a normal speed over a 4-m flat area. Walk time was recorded using a stopwatch, and the gait speed was calculated by dividing the distance by the walk time for participants who did not have disabling conditions. The relative gait speed was expressed using the gait speed divided by height (in meters) as described in a previous study (32).

TABLE 1 Sample characteristics.

Variables		*n*	Mean ± SD/%
Age		5,421	72.93 ± 5.89
Gender	Male	2,553	47.1
	Female	2,868	52.9
Education (years)	0	862	15.9
	1–6	1,556	28.7
	7–12	509	9.4
	>12	314	5.8
	Missing	2,180	40.2
Setting	Rural	2,442	45.0
	Urban	2,979	55.0
Alcohol consumption	Yes	1,443	26.6
	No	3,759	69.3
	Missing	219	4.1
Smoking	Never	3,567	65.8
	Current	1,168	21.5
	Past	464	8.6
	Missing	222	4.1
Number of chronic diseases	0	1,926	35.5
	1–2	2,601	48.0
	≥3	572	10.6
	Missing	322	5.9
Handgrip strength (kg)		4,809	23.0 ± 11.3
	Missing	612	
Gait speed(s)		4,826	4.98 ± 1.8
	Missing	595	
Quality of life	Good	1,782	32.9
	Poor	3,350	61.8
	Missing	289	5.3
Happiness	Yes	2,981	55.0
	No	2,135	39.4
	Missing	305	5.6
Mood	Good	877	16.2
	Poor	4,304	79.4
	Missing	240	4.4

Subjective wellbeing

The SAGE questionnaire on subjective wellbeing includes 10 items based on the World Mental Health Survey. All questions were translated into Chinese. Previous researchers have suggested that wellbeing studies should include several variables to provide a comprehensive understanding of mental health (33) and capture the attitudes and opinions of participants with minimum bias (34). Therefore, in this study, subjective wellbeing was measured using three common question items, in line with a recent study (35): (1) QOL was tested using the item: *How would you rate your overall QOL?;* the response options were: *very good, good, moderate, bad, and very poor.* The responses were recoded as dichotomous QOL variables, of which, a rating of *very good* and *good* was classified as *good QOL*; a rating of *very poor, poor,* or *moderate* was classified as *poor QOL.* (2) Happiness was tested using the item: *Taking all things together, how would you say you are these days?*; the response options were: *very happy,*" *happy, neither happy nor unhappy, unhappy*, and *very unhappy*. The responses were recoded as dichotomous happiness variables, of which, a rating of *very happy* and *happy* was classified as *good*; a rating of *very unhappy, unhappy,* or *neither happy nor unhappy* was classified as *unhappy*. (3) Mood was tested using the item: *Are you usually in a better mood or a worse mood than most others? Or are you about the same?;* the response options were: *better, the same,* and *worse*. These responses were recoded as dichotomous mood variables, of which, a rating of *better* was classified as *good mood*; a rating of *the same* or *worse* was classified as *poor mood.* The same method of categorizing the responses to subjective wellbeing items was used as that used in the previous study (35).

Control variables

The control variables were age, sex, years of education, setting (rural or urban), smoking status, alcohol consumption, number of chronic diseases (e.g., arthritis, stroke, and diabetes) (36), and BMI. Years of education were classified as 0 (less than primary school), 1–6 (completed primary school), 7–12 (completed secondary school or high-school equivalent), and >12 (completed college or post-graduate degree). Smoking status was classified as currently smoking, ex-smoker, and never smoked. Alcohol consumption was self-reported based on alcohol consumed in the last month. The number of chronic diseases was calculated by adding up the number of self-reported

TABLE 2 The association between physical performance and wellbeing estimated by logistic regression models.

	Quality of life				Happiness				Mood			
	p	OR	95%CI		*p*	OR	95%CI		*p*	OR	95%CI	
Age	0.00	1.03	1.01	1.05	0.003	1.03	1.01	1.04	0.11	1.02	1.00	1.04
Sex	0.98	1.00	0.80	1.24	0.77	1.03	0.83	1.29	0.71	1.05	0.81	1.35
Education (years)												
0	Reference	Reference	Reference									
1–6	0.11	1.18	0.96	1.45	0.83	1.02	0.84	1.25	0.46	1.10	0.86	1.40
7–12	0.00	1.88	1.43	2.47	0.20	1.21	0.91	1.60	0.01	1.49	1.09	2.05
>12	0.00	2.24	1.61	3.10	0.26	1.22	0.87	1.71	0.001	1.91	1.32	2.75
Handgrip strength												
Low	Reference	Reference	Reference									
Moderate	0.10	0.83	0.66	1.02	0.051	0.81	0.64	1.00	0.004	1.48	1.13	1.94
High	0.39	0.90	0.71	1.14	0.61	1.07	0.84	1.36	0.01	1.46	1.09	1.95
Gait speed												
Low	0.002	0.71	0.57	0.88	0.00	0.62	0.50	0.77	0.003	0.69	0.54	0.88
Moderate	0.07	0.82	0.66	1.02	0.09	0.83	0.66	1.03	0.06	0.80	0.63	1.01
High	Reference	Reference	Reference									

OR, odds ratio; CI, confidence interval.
The adjusted model included age, sex, education years, setting, alcohol consumption, smoking, number of chronic diseases, and body mass index (BMI).

diagnosed diseases. The BMI was calculated by dividing weight (in kilograms) by height^2 (in meters).

Statistical analysis

The statistical analyses were conducted using Stata 15.0 (Stata Corp LP, College Station, Texas). The level of statistical significance was set at $p < 0.05$. The descriptive characteristics were summarized and presented as mean and standard deviations (SDs), totals, and percentages. To examine the association between rHGS and the dependent variables, a binary logistic regression model was used. We then examined the relationships among rHGS, QOL, happiness, and mood using binary logistic regression after controlling for the impacts of the control variables, respectively. The results were presented as an odds ratio (*OR*) with a 95% confidence interval (*CI*).

Results

The analytical sample consisted of 5,421 adults aged 65 years old or above (Table 1). In this sample, the mean age was 72.93 ± 5.89 years, 47.1% were male participants, 15.9% of participants had no educational experience, and 55% of participants were living in urban areas. The proportions of current smokers and those who consumed alcohol were 69.3 and 26.6%, respectively. The proportion of those who were disease-free was 35.5%. The mean handgrip strength and gait speed were 23.0 ± 11.3 kg and 4.98 ± 1.8 s, respectively. The proportions of those with good QOL, happiness, and good mood were 32.9, 55.0, and 16.2%, respectively.

Table 2 shows the bivariate association between physical performance (rHGS and gait speed) and wellbeing (QOL, happiness, and mood) in the participants. Individuals with the highest tertile of rHGS ($OR = 1.46$, $p = 0.01$) and moderate rHGS ($OR = 1.48$, $p = 0.004$) had good moods compared to those with the lowest tertile of rHGS. With respect to the gait speed, individuals with the lowest tertile of gait speed had lower QOL ($OR = 0.71$, $p = 0.002$), more unhappiness ($OR = 0.62$, $p < 0.01$), and bad mood ($OR = 0.69$, $p = 0.003$) compared to those with the highest tertile of gait speed.

Discussion

This cross-sectional study examined the association between physical performance and subjective wellbeing among Chinese seniors. The findings suggested that a higher level of rHGS was significantly associated with better mood through controlling for the covariates (e.g., age and years of education); the lower gait speed was significantly associated with poor wellbeing in terms of QOL, happiness, and mood.

Handgrip strength is a proxy measurement for overall strength, predicting many health outcomes. In this study, older adults with a higher level of rHGS had a significantly better mood. This finding is in accordance with previous works (37, 38). An association between HGS and mood was investigated by Laredo-Aguilera et al. (39). This association may be attributed to the fact that a higher HGS represented complete physical

function, which is the most essential requirement for performing daily activities with ease. Thereby, the person with higher rHGS can finish all daily activities that they can, and get in a better mood (39). Even so, there was no significant association between rHGS and QOL and happiness. These findings were inconsistent with other studies (40, 41). Relatedly, Garatachea et al. investigated whether physical function was related to subjective wellbeing in Spanish seniors (13) and found that HGS was significantly correlated with QOL. Moreover, positive relationships between HGS and QOL and happiness were observed in rural Chinese populations (15). These inconsistent results may be due to the differences in measuring instruments and measurement methods. In the current study, participants carried out the HGS testing in a sitting posture, keeping the shoulder of the tested arm in an adducted and neutrally rotated position with the elbow flexed at 90 degrees, whereas in (38), participants were in a standing posture with fully extended their arm, forming an angle of 30 degrees to their trunk. Further studies could verify this association between HGS and wellbeing in Chinese older adults.

Gait speed is a valid and reliable measure for assessing and monitoring physical function and psychological health status (42). The findings of the current study suggested that older adults with lower gait speeds were more likely to report poor wellbeing in QOL, happiness, and mood. Although many factors can influence wellbeing, previous studies have suggested a close association between gait speed and wellbeing, which concurs with the results of the present study (43–45). Kim et al. investigated the relationship between gait pattern and emotional state by utilizing virtual reality technology (46). They reported that a slower gait speed was significantly linked to poor emotional states (a lack of happiness and good mood) in healthy adults. In contrast, a faster gait speed was correlated with higher health-related QOL scores (44). Moreover, gait pattern is controlled by psychomotor skills, which are easily influenced by negative emotions or poor wellbeing (e.g., depression and unhappiness) (46). Thus, it is likely that a slower gait speed can predict poor wellbeing. These results help to explain our findings that Chinese older adults with slower gait speeds had significantly poorer subjective wellbeing.

Given the rapidly increasing older population and the risk of disease and mental health problems, identifying effective interventions is particularly important. The current study's findings suggest that improving physical function (e.g., gait speed and rHGS) may benefit subjective wellbeing, at least in Chinese seniors. In the meantime, the results also imply that engagement in physical activity is an effective way to improve physical function and psychological wellbeing. Furthermore, clinicians should be aware of the association between physical function and subjective wellbeing and encourage older patients to adopt healthy lifestyles to improve their wellbeing. Further studies should explore the mechanisms that link physical function and subjective wellbeing.

Despite its merits, the present study is subjected to several limitations. First, the study's design was not intended to determine causality: whether physical performance was the causative reason for poor wellbeing in this sample. Second, the self-reported measures used to assess wellbeing as well as the other variables only indicate the subjects' mental health condition at a single point time across their entire life trajectory. Third, the sample size of each dependent variable may have restricted statistical power and affected the accuracy of the relationship between physical performance and wellbeing.

Conclusion

The results of this cross-sectional study provided evidence of the association between physical performance and subjective wellbeing among Chinese older adults, suggesting that a higher level of rHGS was associated with better mood, and lower gait speed was associated with poor wellbeing in QOL, happiness, and mood.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Chinese Ethics Research Review Board. The patients/participants provided their written informed consent to participate in this study.

Author contributions

HX and SL: conceptualization and methodology. HX: data curation and analysis and writing the original draft preparation. SL: writing—review and editing. Both authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Prevalence of prolonged grief disorder and its symptoms in Chinese parents who lost their only child: A systematic review and meta-analysis

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Background: Parents who lost their only child and cannot have a second child ("*Shidu*") have been a large population in China. Prolonged grief disorder (PGD) in *Shidu* parents is of clinical and public health concern but the reported PGD prevalence varies widely. To facilitate the planning of grief counseling services, this meta-analysis estimated prevalence of PGD and its symptoms and identified subgroups at elevated risk for PGD.

Methods: We searched English and Chinese literature databases to identify cross-sectional surveys reporting prevalence of PGD or PGD symptoms in Chinese *Shidu* parents. The Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data ("JBI") was used to assess risk of bias of included studies.

Results: Seven studies with a total of 2,794 *Shidu* parents were included and their JBI scores ranged from five to eight. The pooled prevalence of PGD and PGD symptoms was 20.9% and 75.0%, respectively. Greater risk of PGD was observed in mothers [vs. fathers, OR (odds ratio) = 1.89, $P = 0.001$] and in parents with religious beliefs (vs. without religious beliefs, OR = 1.65, $P = 0.040$). More severe PGD symptoms were presented in parents whose only child died from accidents [vs. illness, MD (mean difference) = 3.99, $P < 0.001$]. Deceased children of PGD parents were older than those of non-PGD parents (MD = 1.64, $P = 0.035$) and PGD parents had a shorter duration since the loss than non-PGD parents (MD = −3.26, $P = 0.013$).

Conclusions: PGD is prevalent among *Shidu* parents. Grief counseling services for *Shidu* parents would be more effective if they target those who are mothers and have religious beliefs and those whose children died from accidents, lost children are older, and loss occurs more recently.

KEYWORDS

prolonged grief disorder, *Shidu* parents, prevalence, meta-analysis, China

Introduction

In China, the one-child policy in the past four decades has created tens of millions of one-child families (1). The estimated number of one-child families in China still reached 250 million in 2020 despite the abolition of the one-child policy in 2015 (2). The one-child policy, while it effectively slows the population growth, still produces a large number of couples who lost their only child due to various reasons. In China, "*Shidu* parents" are an official term used to describe couples who lost their only child and cannot have a second child because the mothers have passed the reproductive age (i.e., 50 years and above) or the couples are not willing to adopt children (3). According to Chinese demographers, the number of *Shidu* parents had been 1 million in 2018 and, due to population growth and aging, there will be up to 8 million *Shidu* parents by 2030 in China (4–6).

Grief is a normal emotional reaction following the death of a close friend or family member, however, some bereaved individuals may be overwhelmed and develop prolonged grief disorder (PGD), which is characterized by intense and persistent feelings of grief that are substantially prolonged beyond culturally normed expectations and causes clinically significant distress or impairment in social, occupational, or other important domains of functioning (7). In empirical studies with mixed samples of bereaved persons such as those who lost their parents, spouses, children, and other relatives, prevalence rates of PGD are 1.8–13.9% in China with the most severe PGD symptoms being observed in Chinese persons who lost their children and 9.8% in a meta-analysis of worldwide prevalence studies with higher prevalence of PGD being observed in persons who lost their siblings in western countries (8–10).

In the context of Chinese culture, death of the only child is particularly devastating for the *Shidu* parents because the tradition of loyalty and filial piety emphasizes that "no offspring is the worst one of the three acts that a person is not filial to his/her ancestors" and the parents are likely to feel discrimination and perceive stigma for failure to continue the family line (11, 12). On the other hand, because of the tradition of "bringing up children to support parents in their old age", the loss of the only child means the loss of the primary home care provider for elderly parents or parents when they get old, in particular for the rural parents (13, 14). As a result, traumatic experiences of Chinese *Shidu* parents may be complicated by these negative psycho-socio-cultural factors, which may further magnify the risk of PGD in this vulnerable subpopulation. Accurately gauging the prevalence of PGD in *Shidu* parents and identifying subgroups at high risk for PGD are essential for the mental health planning and policy-making for *Shidu* parents.

In China, a few empirical studies have investigated the prevalence of PGD in *Shidu* parents, but these studies reported a wide range of prevalence estimates (i.e., 9.5–35.3% for PGD and 28.9–95.7% for PGD symptoms) (15–18) and inconsistent findings on the high-risk subgroups of PGD according to parents' socio-demographic and bereavement-related characteristics. For example, Wang found comparable prevalence of PGD between *Shidu* mothers and fathers (10.3% vs. 8.5%, $P = 0.500$) but Zhang and colleagues found significantly higher prevalence of PGD in *Shidu* mothers than fathers (27.8% vs. 13.6%, $P = 0.041$) (15, 19); Zhang found significantly less severe PGD symptoms in *Shidu* parents who lost boys than those who lost girls ($P = 0.006$) but Wang found similar PGD symptom severity between *Shidu* parents who lost boys and those who lost girls ($P = 0.846$) (15, 20). One of the potentially important reasons for the above controversy is the small sample sizes of available studies, which may result in unstable estimates of prevalence and findings on high-risk subgroups of PGD. To facilitate the development of preventive strategies for PGD and the delivery of grief counseling services, it is necessary to perform a systematical review and meta-analysis to provide accurate estimates of the prevalence of PGD and PGD symptoms in Chinese *Shidu* parents.

Methods

This systematic review and meta-analysis was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Supplementary materials: Appendix 1). The first and second authors in dependently performed the literature search, assessed the eligibility of retrieved studies, extracted data from included studies, and evaluated the risk of bias (RoB) of included studies. Any disagreements were resolved by the corresponding author.

Literature retrieval

We conducted a literature search in both Chinese and English bibliographic databases from their inception to 7 September, 2022: China National Knowledge Infrastructure, Wanfang data, SinoMed, VIP Information, PubMed, Embase, and PsycInfo. The search terms were as follows: (*Shidu** OR "only child" OR bereave* OR "family planning") AND (grief OR mourning OR sorrow) (Supplementary materials: Appendix 2). Reference lists of the included studies were also searched manually to identify additional studies.

Inclusion and exclusion criteria

Cross-sectional studies that reported the prevalence of PGD or PGD symptoms in Chinese parents who suffered the loss of their only child and had no a second child were eligible for this study. The presence of PGD or PGD symptoms was assessed by using validated instruments such as the 13-item Prolonged Grief Disorder (PG-13) and Inventory of Complicated Grief. Studies

that did not directly provide a prevalence estimate of PGD or PGD symptoms but provided other data that could be used to calculate prevalence estimates were also included. If two or more publications from the same sample were available, only those with the most complete data were included. Studies focusing on loss other than the death of the only child were excluded.

Data extraction

Variables extracted from included studies were first author, publication year, study site, survey date, sampling method, sample size, mean age of the study sample, percentage of females in the study sample, prevalence of PGD or PGD symptoms, and assessment of PGD or PGD symptoms. Because some of our included studies presented and compared PGD prevalence rates and scores of PGD symptoms [as measured by the 11 PGD symptom items of the PG-13 ("PG-11 score")] between subgroups according to some socio-demographic and bereavement-related factors, we also extracted these comparative data to ascertain subgroups at elevated risk for PGD and having more severe PGD symptoms [i.e., means and standard deviations (SDs) of PG-11 scores and numbers of subjects by fathers and mothers, respectively]. These factors included age, sex, marital status, and religious beliefs of parents and age, sex, causes of death, and duration since the death of the decreased.

RoB assessment of included studies

We used the Joanna Briggs Institute Critical Appraisal Checklist for Studies Reporting Prevalence Data ("JBI checklist" hereafter) to assess the level of RoB of included studies (21). The JBI checklist has nine items that are designed to assess three methodology domains of an individual study: sample representativeness (sample frame, sampling method, sample size, description of participants and setting), statistics (sample coverage of the data analysis, statistical analysis, response rate), and accuracy of the outcome assessment (validity of the instrument for assessing the outcome, standardization and reliability of the instrument for assessing outcome) (22, 23). Each item has four answer options (yes, no, unclear, not applicable) and one point is allocated for a "yes" response, which yields a "0–9" total RoB score for a study with a higher score denoting lower RoB.

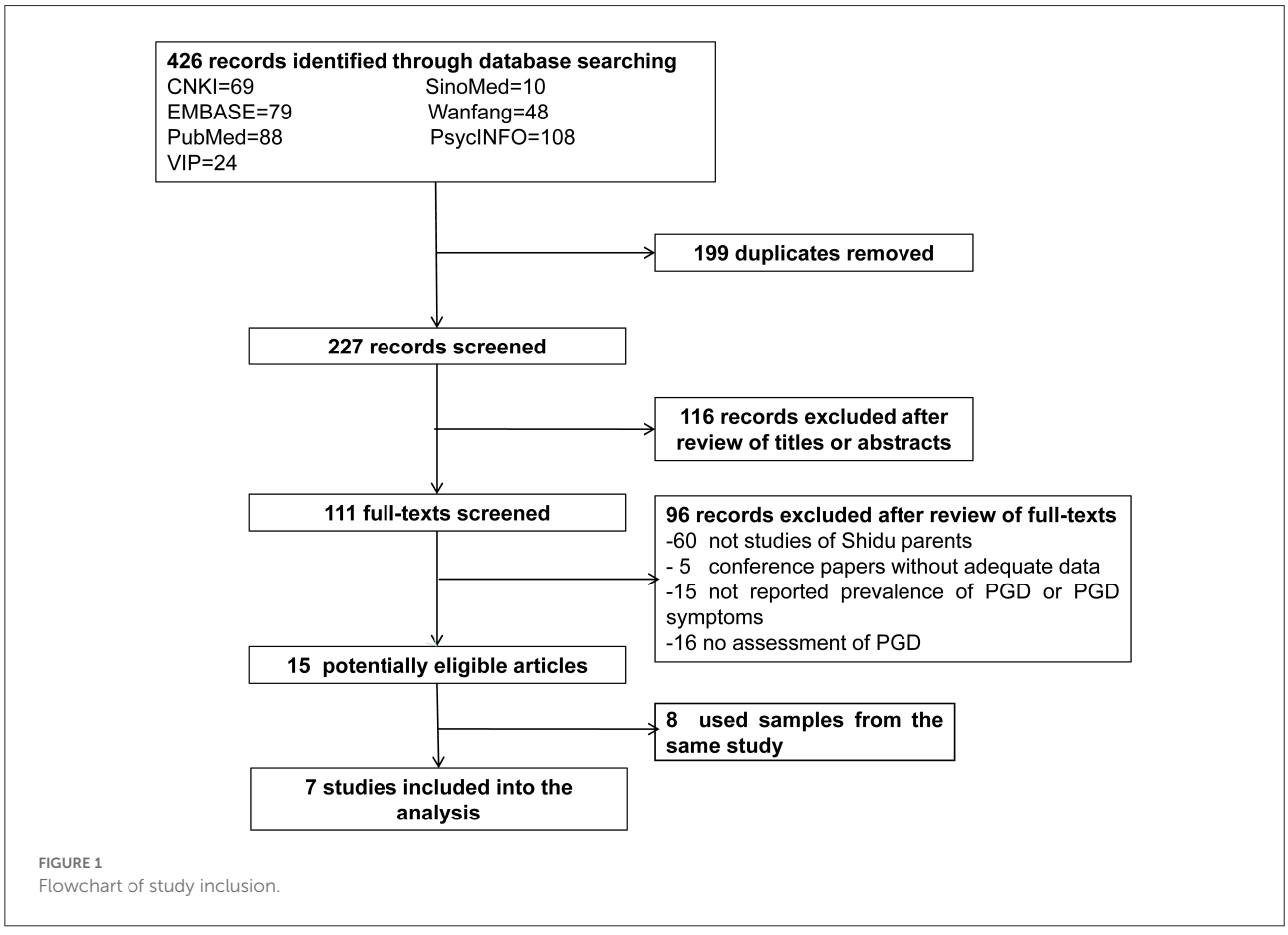

FIGURE 1
Flowchart of study inclusion.

Statistical analysis

Prevalence data were synthesized by using the "metaprop" module of R, version 4.2.0, which adopted the one-step generalized linear mixed models with the logit link function (23). We used I2 statistic to test statistical heterogeneity between studies. When I2 >50%, a random-effects model was used to calculate the combined estimate of prevalence; otherwise, a fixed-effects model was adopted. We used subgroup analysis to explore the source of heterogeneity in the prevalence estimates. Publication bias was assessed by funnel plots and Begg's test. Two-sided $P < 0.05$ was set as statistically significant.

With regard to the meta-analysis of comparative data, we used the "metabin" and "metacont" modules of R, version 4.2.0, for dichotomous and continuous outcomes, and the corresponding effect size measures were odds ratios (ORs) and mean differences (MDs), respectively.

Results

Finally, seven studies with a total of 2,794 *Shidu* parents were included: one focused on PGD symptoms only (18), five focused on PGD only (15, 16, 24–26), and one focused on both PGD and PGD symptoms (19). The flowchart of study inclusion and detailed characteristics of included studies are shown in Figure 1 and Table 1, respectively. Four studies assessed the presence of PGD by using the PG-13 based on the Prigerson et al. (27) diagnostic criteria while two assessed the presence of PGD by using a self-developed scale based on the International Classification of Diseases 11th Revision (ICD-11) (15, 16, 19, 24–26).

The JBI checklist scores of the seven included studies ranged from five to eight (Table 1). No study was rated nine. The two most common methodological problems of included studies were unstandardized way of outcome measurement ($n = 4$) and inappropriate sampling method ($n = 3$) (Supplementary materials: Appendix 3).

The synthesized prevalence of PGD and its symptoms were 20.9% (95% CI: 13.8–30.3%) and 75.0% (95% CI: 14.9–98.1%), respectively (Figure 2). Subgroup analyses identified four factors as statistically significant sources of heterogeneity in the prevalence rates of PGD across included studies (Table 2): % of mothers in the survey sample, sampling method, diagnostic criteria of PGD, and JBI checklist score. Specifically, significantly higher prevalence of PGD was observed in studies with a percentage of mothers >60% than those with a percentage of mothers ≤60% (30.9% vs. 14.0%, $P = 0.001$), in studies adopted convenience sampling than those adopted probability sampling (30.5% vs. 13.4%, $P < 0.001$), in studies diagnosed PGD with ICD-11 than those diagnosed PGD with Prigerson et al. 2009 criteria (34.9% vs. 15.7%, $P < 0.001$), and in studies with JBI scores of "7-8" than those with a JBI score of "5" (32.9% vs. 18.9%, $P = 0.013$).

Begg's test ($z = -1.32$, $P = 0.189$) revealed no statistically significant publication bias across studies included for the meta-analysis of prevalence of PGD (Supplementary materials: Appendix 4).

Results of meta-analyses comparing the PGD prevalence and PGD symptom scores between different subgroups (Supplementary materials: Appendices 5, 6) show that, in comparison to *Shidu* fathers, *Shidu* mothers had higher risk of PGD (OR = 1.89, $P = 0.001$) and more severe PGD symptoms (MD = 2.60, $P = 0.039$). *Shidu* parents who endorsed religious beliefs were more likely to have PGD than those who did not have religious beliefs (OR = 1.65, $P = 0.040$). Risk of PGD (OR = 1.01, $P = 0.937$) and severity of PGD symptoms (MD = −0.85, $P = 0.524$) did not differ significantly between parents who lost boys and girls. Parents whose only child died from accidents had statistically more severe PGD symptoms than those whose only child died from illness (MD = 3.99, $P < 0.001$).

Results of meta-analyses comparing age of the deceased and years since the death of the deceased (Supplementary materials: Appendix 7) show that the deceased children's age was significantly older in PGD than non-PGD parents (MD = 1.64, $P = 0.035$) and the duration since the loss of the PGD parents was significantly shorter than non-PGD parents (MD = −3.26, $P = 0.013$).

Discussion

This study used available meta-analyzable data from the literature to estimate the prevalence of PGD and its symptoms and identify subgroups that are at elevated risk of PGD and have more severe PGD symptoms among Chinese *Shidu* parents. We found that as high as 75.0% of the *Shidu* parents had PGD symptoms and 20.9% of the *Shidu* parents met the diagnostic criteria for PGD. Greater risk of PGD was observed in *Shidu* mothers (vs. fathers) and in parents with religious beliefs (vs. without religious beliefs). More severe PGD symptoms were observed in *Shidu* mothers (vs. fathers) and parents whose only child died from accidents (vs. illness). In addition, PGD parents' deceased children were more likely to be older than those of non-PGD parents and PGD parents had a shorter duration since the loss of the only child than non-PGD parents.

The 75.0% prevalence of PGD symptoms in Chinese *Shidu* parents is much higher than the 13.9–35.0% prevalence of PGD symptoms in the general Chinese population who experienced the loss of family members (28). The 20.9% prevalence of PGD in *Shidu* parents is also higher than the 1.8–13.9% prevalence of PGD in Chinese bereaved adults and the 9.8% worldwide prevalence of GPD in bereaved adults (8–10). In western countries, couples who lose their only child and have

TABLE 1 Characteristics of included studies.

Study	Reference	Survey site	Survey period	Number of survey completers	Sampling method	Response rate (%)	Numbers of men and women	Mean age of the sample (years)	Instrument	Survey method	Diagnostic criteria of prolonged grief disorder (PGD)	Number of subjects with PGD (%)	JBI checklist score*
Xu et al. (2014)	(18)	Dujiangyan	October 2010—March 2011	116	Cluster sampling	53.7	0/116	39.4	Inventory of Complicated Grief (ICG)	Self-report	ICG>25	PGD symptoms: 111 (95.7)	6
Zhang & Jia et al. (2019)	(24)	Beijing, Zhengzhou, Haerbin, Chongqing, Baotou	June -December 2017	466	Convenience sampling	93.8	212/254	60.2	Prolonged Grief Disorder-13 (PG-13)	Self-report	Prigerson et al. (27)	109 (23.4)	7
Wang et al. (2020)	(15)	5 urban districts in Shenyang	March -September 2017	483	Two-stage cluster sampling	81.2	201/282	61.98	PG-13	Self-report	Prigerson et al. (27)	46 (9.5)	7
Zhang et al. 2020	(19)	1 district in Shanghai	September 2015 - January 2017	149	Stratified random sampling	96.1	59/90	62.3	PG-13	In-person interview	Prigerson et al. (27) PG-11>36	33 (22.2) PGD symptoms: 43 (28.9)	8
Zhou et al. 2020	(16)	24 cities from 8 provinces and 3 municipalities	April 2017 - May 2018	1,030	Convenience sampling	97.7	381/643	59.9	ICD-11 diagnostic algorithm, constructed based on existing scales	Online and in-person interview	ICD-11	366 (35.5)	8
Ma et al. 2022	(26)	20 communities in Sujiatun district in Shenyang	November 2019—February 2020.	240	Two-stage cluster sampling	87.3	113/127	62.9	PG-13	Self-report	Prigerson et al. (27)	28 (11.7)	8
Xu et al. 2022	(25)	Yanji and Haerbin	December 2019—January 2020	310	Convenience sampling	Not reported	92/218	61.71 ± 5.48	ICD-11 diagnostic algorithm, constructed based on existing scales	Self-report	ICD-11	102 (32.9)	5

*The joanna briggs institute critical appraisal checklist for studies reporting prevalence data.

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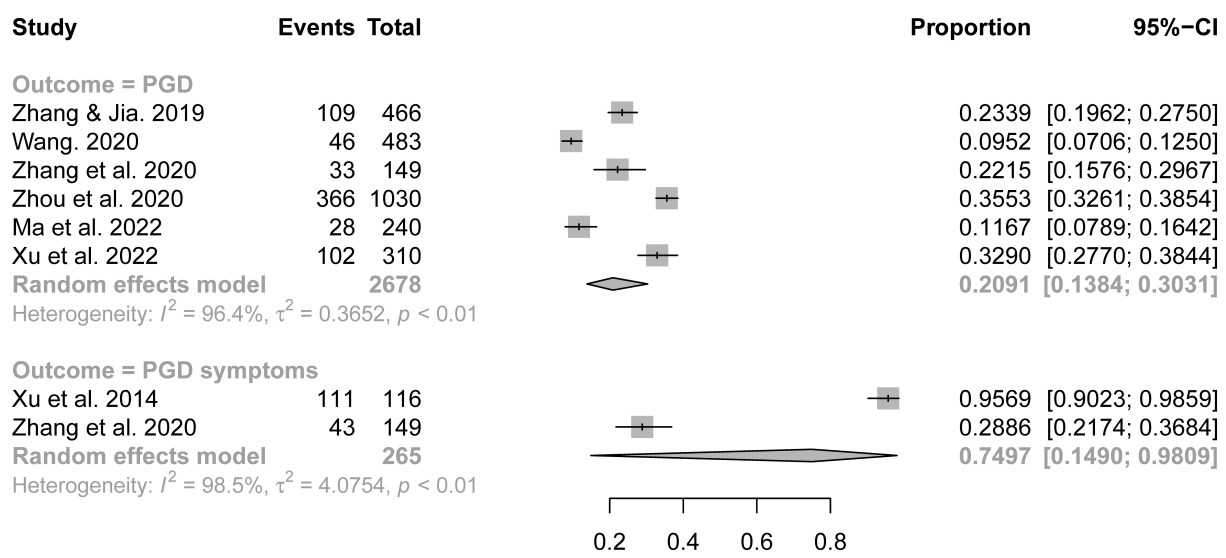

FIGURE 2
Forest plot of prevalence of prolonged grief disorder and its symptoms.

no remaining children are at significantly higher risk of grief than those with one or more surviving children and the grief in these parents is more likely to be chronic and long-lasting (29, 30). In the Chinese society, the loss of the only-child does not only mean "no descendant" and "will die without the care of natural sons/daughters at the bedside" for *Shidu* parents, but also is associated with a variety of challenges including the economic difficulties, the collapse of the family structure, and the loss of joy and hope (31). The high prevalence of PGD symptoms and PGD in our meta-analysis confirms the elevated risk of PGD in Chinese *Shidu* parents.

The higher prevalence of PGD and greater severities of PGD symptoms in bereaved mothers than fathers are quite consistent in the literature (32–34). Our meta-analysis replicated the gender differences in grieving in the population of Chinese *Shidu* parents. There are several explanations for the gender differences in the experiences, expression, and symptom development of grief. For example, bereaved mothers are more likely to share their feelings of grief with others, which helps them process and work through their grief; however, due to men's social roles as "providers and protectors", bereaved fathers tend to move past the loss to make their lives move forward instead of talking about the loss (33–36). As a supporting case in point, findings from a longitudinal study has suggested that prolonged grief in men is more likely to be an acute and decreasing reaction, whereas in women it is more likely to be a delayed and accumulating grief action (37). In the context of China's tradition of "Men's work centers around outside while women's work centers around the home", mothers are more involved in the children's care than fathers (38, 39). We speculate that the higher prevalence of PGD and more severe PGD symptoms in *Shidu* mothers may be due to their much more efforts made for and much more time spent on the care of the only child, which goes for nothing after the loss. This "mother predominance" phenomenon of PGD is further supported by higher PGD prevalence in studies with female-predominant samples (>60% vs. ≤60%) in the subgroup analysis (Table 2).

In western countries, religious beliefs are often associated with lower risk of mental health problems including grief (40, 41). Nevertheless, in China, the world's most atheistic country, believing in religion is a rare phenomenon and many Chinese people become religious believers for the purpose of seeking help from the religion after they suffer from emotional problems and other difficulties (42, 43). The elevated risk of PGD in *Shidu* parents with religious beliefs in our study might be ascribed to their help-seeking behaviors from the religion, that is, religious beliefs might be the result of PGD. Because the included cross-sectional studies cannot provide evidence on the chronological order of religious beliefs and PGD, longitudinal data are needed to further clarify the causal PGD-religion relationship. In this study, death from accidents (vs. illness) was associated with more PGD symptoms in *Shidu* parents. This finding is similar to the significant association between the unexpected death and higher level of grief in bereaved individuals in western countries, since the sudden and unexpected loss damages parents' sense of parenthood and other layers of social identity and destroys the parents' feeling of safety and security (29, 44, 45).

"White-haired parents' attendance of the funeral of the black-haired young children" is the most painful tragedy in traditional Chinese culture (46). Because older adult children are usually have stable jobs and family lives but younger adult children are often in early stage of the career before their

TABLE 2 Subgroup analyses of meta-analysis of prevalence of Prolonged Grief Disorder (PGD) according to study-level factors.

Study-level factor	Number of studies	Number of *Shidu* parents	Number of parents with PGD	Heterogeneity, I2 (%)	Pooled prevalence (95% CI), %	Q	*P*
% of mothers in the study sample*							
≤60%	3	1,189	183	94.5	14.0 (8.7, 21.9)		
>60%	3	1,489	501	80.5	30.9 (24.9, 37.6)	10.29	0.001
Mean age (years) of study sample							
≤61	2	1,496	475	95.4	29.3 (21.6, 38.5)		
>61	4	1,182	209	95.9	17.3 (10.2, 27.9)	3.29	0.070
Sampling method							
Convenience	3	1,806	577	90.7	30.5 (24.7, 37.0)		
Probability	3	872	107	87.6	13.4 (8.7, 20.0)	13.2	<0.001
Way of instrument administration							
Self-administration	4	1,259	257	96.0	17.7 (10.4, 28.4)		
Interview	2	1,179	399	90.1	29.4 (20.8, 39.7)	2.82	0.093
Diagnostic criteria of PGD							
Prigerson et al. (27)	4	1,338	216	92.4	15.7(10.5, 22.8)		
ICD-11	2	1,340	468	0.0	34.9 (32.4, 37.5)	71.51	<0.001
JBI checklist score**							
7–8	5	2,368	582	97.0	18.9 (12.0, 28.5)		
5	1	310	102	Not applicable	32.9 (27.7, 38.4)	6.140	0.013

*The two subgroups were generated by median split of the % of mothers in the study sample of included studies.
**The joanna briggs institute critical appraisal checklist for studies reporting prevalence data.

deaths, the death of older adult children takes away more things than younger adult children, including parents' efforts in bringing up the children. This might explain the older age of the decreased children in *Shidu* parents with PGD. Similarly, in the Netherlands, Wijngaards-de Meij and colleagues reported the positive association between deceased child' age and severe grief reactions in bereaved couples following the death of their children [29), which might be attributed to older deceased children's parents' more times and efforts put into rearing children and lower potential for producing future offspring. In prior studies of grief in bereaved persons in both Asian and western countries, there is a negative association between time since loss and the level of grief (29, 34, 36, 47). Our finding on the shorter duration since the loss in PGD than non-PGD *Shidu* parents is consistent with the universal phenomenon around the world, that is, grief symptoms become milder over time.

The finding on the comparable prevalence of PGD and similar levels of PGD symptoms between *Shidu* parents of boys and girls is not expected, because the traditional Chinese culture prefers sons to daughters (48). Although the loss of the only boy means the discontinuation of the family line, the intimate relationship is generally closer for parents-daughters than parents-boys in China (49), possibly resulting in the similar PGD risk and similar levels of PGD symptoms between parents who lost boys and girls.

This study has several limitations. First, the number of eligible studies for this meta-analysis is small, in particular studies of PGD symptoms. Second, none of the included studies were completely free from risk of bias. Because subgroup analyses reveal that studies with convenience sampling and low JBI checklist scores tended to report higher prevalence of PGD (Table 2), we may have overestimated the true prevalence of PGD in Chinese *Shidu* parents. Third, the higher prevalence of PGD in studies with ICD-11 than those with Prigerson et al. 2009 criteria in the subgroup analysis (Table 2) suggests that the true prevalence of PGD may be underestimated if the ICD-11 was adopted by all included studies. Fourth, these included studies provided few data on the mental health services utilization of *Shidu* parents, which are important for the planning for the grief counseling services for this vulnerable population. More studies that recruit representative samples of Chinese *Shidu* parents and diagnose PGD according to international standardized diagnostic criteria such as ICD-11 and DSM-V are warranted.

In China, the grief counseling services are still in their early stage of development. The limited grief counseling service resources are mainly concentrated in the limited number of palliative care hospitals and departments of palliative care in general hospitals. The other challenges to the grief counseling service system include inadequate professionals engaged in grief counseling, lack of standardized training and supervision of

these professionals, lack of community-based screening and referral system for PGD individuals, and concerns on the quality of counseling services provided (50). Given the large number of *Shidu* parents in China and the 75.0% PGD symptoms prevalence and the 20.9% PGD prevalence in this population, the level of potentially unmet need for grief counseling services is very high. Our study highlights the urgent needs for strengthening the grief counseling services for this population. Possible public health strategies may consider the establishment of the primary care-based two-way referral system for *Shidu* parents with PGD, the training and supervision of community health and social workers to help them acquire the basic capacity to screen for and manage PGD, the provision of outreach services by mental health workers and clinical psychologists from hospitals, the integration of counseling services into the community services, and professional-sponsored organization of *Shidu* parents to provide the avenue for group therapy.

The grief counseling services for *Shidu* parents may include psychosocial support to improve psychological well–being, periodical screening for PGD and other mental health problems, and psychiatric referral and treatment when necessary. Further, these services for *Shidu* parents would be more effective if they target those who are mothers and have religious beliefs and those whose only child died from accidents, lost children are older, and loss occurs more recently.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

B-LZ: design of the study, interpretation of data for the study, revising the paper critically for important intellectual content, and final approval of the version to be submitted. M-DY: acquisition and analysis of data for the study, drafting the paper, revising the paper for important intellectual content, and interpretation of data for the study. Z-QW: acquisition and analysis of data for the study, drafting the paper, and interpretation of data for the study. LF: acquisition and analysis of data for the study, drafting the paper, and revising the paper for important intellectual content. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.1016160/full#supplementary-material

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Anxiety symptoms in older Chinese adults in primary care settings: Prevalence and correlates

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Background: Integrating mental health services into primary care is a potentially cost-effective way to decrease the treatment gap for anxiety in older adults but data on the epidemiology of anxiety symptoms in older Chinese adults in primary care settings have been very limited. This study investigated the prevalence and correlates of anxiety symptoms in Chinese older primary care patients.

Methods: A total of 753 older primary care patients (≥65 years) were consecutively recruited from 13 primary care clinics in Wuhan, China, and interviewed with the validated Chinese version of the short form of the Geriatric Anxiety Inventory (GAI-SF).

Results: The prevalence of anxiety symptoms (GAI-SF ≥ 3) in older primary care patients was 21.1%. Statistically significant correlates of anxiety symptoms were female sex (vs. male, OR = 1.85, $P = 0.002$), poor economic status (vs. good, OR = 2.31, $P = 0.013$), fair and poor family relationship (vs. good, OR = 1.85, $P = 0.006$), hypertension (OR = 2.01, $P < 0.001$), chronic gastric ulcer (OR = 6.82, $P < 0.001$), and Parkinson's disease (OR = 7.83, $P = 0.031$).

Conclusions: Anxiety symptoms are prevalent among older adults attending primary care clinics. Efforts for preventing or reducing anxiety symptoms in older primary care patients may be more useful to target those who are women, have poor financial status, don't have a good family relationship, suffer from hypertension, have chronic gastric ulcer, and suffer from Parkinson's disease.

KEYWORDS

older adults, primary care, anxiety symptoms, cross-sectional survey, China

Introduction

Anxiety symptoms and disorders are common among the elderly population and have been associated with increased risk of comorbidity with depression (1), major medical conditions (1, 2), cognitive impairment (1), poor quality of life (1), delayed recovery from illnesses (1, 2), severe disability (3), and mortality in older adults (1–3). In China, results from a meta-analysis of population-based studies show that as high as 22.1 and 6.8% of the older adults suffer from anxiety symptoms

and disorders, respectively (4). Nevertheless, late-life anxiety is often underdiagnosed, misdiagnosed, and inappropriately treated in both community and clinical settings and its treatment gap is very large in both China and worldwide (5–9). Compared to the prevailing research focus on late-life depression and cognitive disorders, empirical clinical studies on prevalence, clinical characteristics, treatment, and management of anxiety in older adults are very limited (2, 10–13).

Given the wide availability and convenient accessibility of primary care services in communities and older adults' preferences for seeking treatment in primary care settings in China (14–16), integrating mental health services into primary care is a potentially cost-effective way to decrease the treatment gap for anxiety and other common mental health problems in older adults (17–19). To facilitate the planning and provision of old age mental health services, a detailed knowledge about the clinical epidemiology of late-life anxiety in Chinese primary care settings is urgently warranted. To our knowledge, in mainland China, only two studies have examined anxiety symptoms in older patients at urban primary care clinics in Shanghai, China (one in 2016 and the other in 2017) (20, 21). Both studies used the Generalized Anxiety Disorder 7-item (GAD-7) scale to assess the presence of anxiety symptoms in convenience samples of older primary care attenders and found that prevalence rates of anxiety symptoms were 13.5 and 17.2%, respectively. Factors significantly associated with anxiety symptoms in older primary care patients included younger age, female sex, educational attainment of senior middle school (vs. junior), physical deterioration, major medical conditions, physical inactivity, high economic burden due to medical care spending, inadequate family support, and inadequate peer support.

However, since GAD-7 scale is developed to screen for GAD only (22), strictly speaking, findings from the two studies only denote epidemiological characteristics of GAD symptoms in older adults receiving primary care. In fact, detecting anxiety symptoms in older adults is particularly challenging because, in comparison to young and middle-aged adults, older adults have different symptom presentations of anxiety (i.e., fear of being a burden on their families), they are more likely to minimize or deny their own anxiety symptoms, and their anxiety symptoms are more likely to be confused with somatic symptoms and cognitive impairment (23–25). Therefore, importantly, because of the unique clinical features of anxiety in later life (1, 6), the assessment results of anxiety symptoms by using a generic anxiety scale such as GAD-7, which is not specific to the elderly population, are potentially problematic. Further, another significant limitation of the above-mentioned studies is their poor sample representativeness because no rural older primary care patients were included and the participants were recruited conveniently. So the epidemiological characteristics of late-life anxiety symptoms in the elderly primary care population in China remain unknown. In addition, there is evidence that prevalence of anxiety symptoms differs across major medical conditions (26) but the two prior studies only reported the significant associations between anxiety symptoms and physical deterioration and major medical conditions, so it remains unknown which major medical condition contributes to the risk of anxiety symptoms in older adults who visit primary care physicians (PCPs) for their physical conditions.

In western countries, the recognition and management of anxiety and other common mental problems among older adults presenting to primary care are also of great clinical concern but the clinical characteristics of anxiety still have not been well-characterized (27, 28). There have been many studies investigating the prevalence of anxiety in elderly primary care attenders in Spain, United States, and other western countries, and rates of anxiety symptoms and disorders were reported to be 15.7–26.9% and 6.3–22.3%, respectively (29–37). However, because anxiety was not the primary outcome of interest of these available studies, only two reported significant correlates of anxiety symptoms, including female sex, marital status of "unmarried," living alone, life stress events, and medical comorbidity (33, 35). Similar to the above-reviewed studies in mainland China, no detailed information on the association of anxiety symptoms with a specific medical comorbidity was provided. Further, these available studies used a variety of instruments to assess anxiety symptoms, including Goldberg Anxiety and Depression Scale, Hospital Anxiety and Depression Scale, the State-Trait Anxiety Inventory, and GAD-7 scale (33–36), but none of which used instruments that were specific to late-life anxiety.

To fill these knowledge gaps, this study investigated the prevalence and correlates of anxiety symptoms in older adults receiving primary care in Wuhan, the largest municipality in central China with a population of more than 10 million (38), with a particular focus on association between anxiety symptoms and a specific type of major medical condition. Like many other large municipalities in China, the population in Wuhan is aging rapidly in recent years and it had become an aged society since 2018 (39). The rapid aging has posed significant challenges to the healthcare system in Wuhan, including the mental healthcare for its elderly population. To help address the unmet mental health needs of the elderly population in Wuhan and other major municipalities in primary care settings, a first necessary step is to examine the epidemiological characteristics mental health problems among older adults receiving primary care.

Methods

Sampling and participants

Between October 2015 and November 2016, a large-scale multi-center cross-sectional survey was conducted in seven urban and six rural primary care clinics in Wuhan, China (14, 17, 40, 41). The purpose of this survey was to

investigate the clinical epidemiology of a variety of mental health problems in older primary care patients, including depression, anxiety, suicidal ideation, and quality of life. The current study focused on anxiety symptoms of the primary care patients. Details of the sampling have been described in published articles (14, 17, 40, 41). We consecutively included patients who were 65 years old or older, saw PCPs in the 13 selected primary care clinics during the survey period, and were willing to join the study. We excluded patients who cannot complete the interview due to very severe physical illnesses, too severe cognitive impairment, and psychotic symptoms.

In our pilot study, the prevalence of anxiety symptoms was 30%. Accordingly, we set parameters for the sample size estimation as below: the 30% prevalence, a 0.08 confidence interval (CI) width, a two-sided 0.05 type I error rate, and an 80% response rate. The required minimum sample size was estimated to be 660 by using the formula for sample size estimation for cross-sectional studies (42).

Prior to the formal study, the survey protocol was approved by the Institutional Review Board of Wuhan Mental Health Center (approval number: WMHC-IRB-S065). All participants and their guardians (if necessary) provided informed consent before the interview.

Instruments and procedures

All participants were interviewed by 26 PCPs with a questionnaire that was specifically developed for this survey. Interviewees were older adults and their caregivers (when present). The 26 PCPs had been trained and were deemed to be qualified to administer the questionnaire. Before the main study, a pilot study with a convenient sample of 50 older primary healthcare patients was carried out to test the feasibility of the intended procedures and the questionnaire. The survey questionnaire was revised and finalized after the pilot study.

The candidate correlates to be examined included sociodemographics, life style, and major medical conditions. Sociodemographic factors in the questionnaire were sex, age, education level, marital status, self-rated economic status, type of main jobs held by older adults during their young and middle-aged years (mental vs. physical labor), urban and rural residence place, living alone, and self-rated relationship with family members (17).

Lifestyle factors included currently smoking and habit of regular physical exercise (43, 44). A checklist was used to assess the presence of 12 major medical conditions: hypertension, diabetes, heart disease, stroke and other cerebrovascular diseases, chronic obstructive pulmonary disease (COPD), cancer, tuberculosis, chronic gastric ulcer, Parkinson's disease, anemia, hepatitis cirrhosis, and arthritis (14). Diagnoses of major medical conditions were made through interviews, physical examinations, chart review, and completion of laboratory, radiology, and other tests (when necessary).

The primary outcome, anxiety symptoms, was assessed with the Chinese version of the short form of Geriatric Anxiety Inventory (GAI-SF), which is an elderly-specific scale for assessing the severity of anxiety symptoms within the past week and has five questions with a yes-no response format (45, 46). Compared to generic anxiety scales, the GAI-SF has several strengths: minimal somatic symptoms to enable the distinction of psychiatric symptoms from physical illnesses, relative brevity to reduce respondent burden, a binary and single direction response format to decrease the cognitive load of respondents, and simple wording of the questions (46–48). The total GAI-SF scores range between zero and five, with three and above denoting clinically significant anxiety symptoms in China (45). The sensitivity and specificity of the Chinese GAI-SF cut-off score of three or greater for screening for ICD-10 anxiety disorders in older patients from a general hospital were 80.4 and 75.0%, respectively (45). In this study, the Cronbach's alpha coefficient of the Chinese GAI-SF was 0.855, suggesting good internal consistency.

Statistical analysis

Prevalence rates of anxiety symptoms among the total sample and subgroups according to sociodemographics, lifestyle, and major medical conditions were calculated. Chi-square test was used to compare rates between/across subgroups. Multiple binary logistic regression with a forward stepwise entry of all significant factors in the Chi-square test was used to identify correlates of anxiety symptoms. Odds ratios (ORs) and their 95% confidence intervals (95% CIs) were used to quantify associations between factors and anxiety symptoms. Nagelkerke R Square (R^2) was calculated as the indicator for goodness-of-fit of the logistic regression model and its robustness was tested by using Hosmer-Lemeshow's goodness-of-fit test (H-L test) (49). A non–statistically significant result on H-L test indicates that the model is well calibrated, so the fit is good. The statistical significance level was set at two-sided $P < 0.05$. SPSS software version 14.0 package (SPSS Inc., Chicago, IL, USA) was used for all analyses.

Results

Sample characteristics

Altogether, we invited 791 older primary care patients to participate in the study and 753 agreed and completed the survey questionnaire (response rate: 95.2%). The mean age of the study sample was 72.8 years (standard deviation = 6.0, range = 65–97) and 404 (53.7%) were females. Characteristics of the

survey sample and prevalence rates of anxiety symptoms among different subgroups are shown in Table 1.

Prevalence of anxiety symptoms

In total, 159 older adults were screened positive for anxiety symptoms and the corresponding 1-week prevalence of anxiety symptoms was 21.1%. Women had statistically significant higher rates of anxiety symptoms than men (25.5 vs. 16.0%, $P = 0.002$). Similar rates of anxiety symptoms were found between urban and rural older adults (21.3 vs. 20.9%, $P = 0.879$).

Correlates of anxiety symptoms

Results from Chi-square test (Table 1) display that significantly higher rates of anxiety symptoms were observed in women (vs. men), in illiterate participants (vs. primary school or middle school and above), in participants with poor financial status (vs. good or fair), in participants who engaged in physical labor (vs. mental labor) before the older adulthood, in participants with fair and poor family relationship (vs. good), in participants with hypertension, in participants with heart disease, in participants with stroke and other cerebrovascular diseases, in participants with chronic gastric ulcer, and in participants with Parkinson's disease.

In multiple logistic regression analysis, six significant correlates of anxiety symptoms were identified (Table 2): Female sex (vs. male, OR = 1.85, $P = 0.002$), poor economic status (vs. good, OR = 2.31, $P = 0.013$), fair and poor family relationship (vs. good, OR = 1.85, $P = 0.006$), hypertension (OR = 2.01, $P < 0.001$), chronic gastric ulcer (OR = 6.82, $P < 0.001$), and Parkinson's disease (OR = 7.83, $P = 0.031$). The results of H-L test show that the multiple logistic regression model fitted the data well ($R^2 = 0.122$, $\chi^2 = 11.800$, $P = 0.107$).

Discussion

To the best of our knowledge, this is the first study in China that examines the epidemiological characteristics of anxiety symptoms in both urban and rural older primary care patients by using an anxiety scale specific to elderly population, GAI-SF. The main findings of this study are the 21.1% prevalence of anxiety symptoms in older adults receiving primary care and six correlates of anxiety symptoms in this patient population: female sex, poor economic status, fair and poor family relationship, hypertension, chronic gastric ulcer, and Parkinson's disease.

In a community-based survey in Beijing, China, Tang and Wang used GAI to assess the presence of anxiety symptoms in older adults and found that 7.4% of them suffered from anxiety symptoms (50). Compared to this prevalence estimate in community-dwelling older adults, we found a much higher prevalence of anxiety symptoms in older primary care patients. The 21.1% prevalence of anxiety symptoms in older adults in primary care settings is similar to the 22.1% prevalence of anxiety symptoms in older adults in communities from the above-mentioned meta-analysis (4). Nevertheless, we argue that this does not indicate a similar risk of anxiety symptoms in older adults between primary care settings and communities, because all the included studies of this meta-analysis used generic anxiety scales to screen for anxiety symptoms, which tends to overestimate the prevalence of anxiety symptoms in older adults (23, 24, 51).

The high risk of anxiety symptoms in Chinese older primary care attenders may be primarily explained by their prevailing physical health problems, because many major medical conditions (i.e., hypertension, diabetes, and COPD) have been associated with anxiety symptoms and disorders (52, 53). Further, the under-recognition and under-treatment of late-life anxiety in primary care settings, particularly in Chinese primary care settings (5–9, 54), would prolong the duration of the anxiety and result in persistently high level of anxiety in Chinese older primary care patients.

Our findings on the significant associations of anxiety symptoms with female sex and poor financial status are consistent with elevated risk of anxiety symptoms in older women and socioeconomically disadvantageous older adults in earlier studies (55–57). Because family members are a significant source of social support for older Chinese adults and family support plays an important role in the mental well-being of older Chinese adults (58–60), our finding on the significantly higher risk of anxiety symptoms in older adults without a good family relationship is expected. In general, rural older adults are more likely to develop anxiety symptoms than urban older adults because of their lower socioeconomic status and the inadequate health service resources in rural regions (4). However, we found similar risk of anxiety symptoms between urban and rural older adults in this study, which is not in line with prior studies (20, 21, 33, 36). Perhaps, some stronger factors (i.e., major medical conditions) may mask or affect the effect of residence place on the risk of anxiety in older primary care patients.

Accumulating evidence has shown that hypertension and peptic ulcers are psychosomatic diseases and there are reciprocal relationships between hypertension and peptic ulcers and mental health problems such as anxiety (61–64). In addition, anxiety, as a stress response, can also be resulted from some major medical conditions if they persist long enough to become chronic stressors (65). In line with these earlier studies, hypertension and chronic gastric ulcer were significantly associated with anxiety symptoms in older primary care patients. It has been well-recognized that anxiety is a common psychiatric comorbidity in Parkinson's disease and the comorbidity between anxiety and Parkinson's disease can be explained by their shared neuropathophysiology such as the loss of adrenergic and

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TABLE 1 Characteristics of the sample of older adults in primary care settings and prevalence rates of anxiety symptoms by sample characteristics.

Characteristics		No. of older adults	No. of older adults with anxiety symptoms	Prevalence (%)	χ^2	*P*
Sex	Male	349	56	16.0	10.037	0.002
	Female	404	103	25.5		
Age (years)	65–74	488	106	21.7	0.305	0.580
	75+	265	53	20.0		
Education	Illiterate	174	50	28.7	8.131	0.017
	Primary school	216	43	19.9		
	Middle school and above	363	66	18.2		
Marital status	Married	526	114	21.7	0.326	0.568
	Others*	227	45	19.8		
Self-rated financial status	Good	132	26	19.7	10.080	0.006
	Fair	533	103	19.3		
	Poor	88	30	34.1		
Main occupation before older adulthood	Mental labor	220	35	15.9	5.058	0.025
	Manual labor	533	124	23.3		
Residence place	Urban	408	87	21.3	0.023	0.879
	Rural	345	72	20.9		
Living alone	No	670	146	21.8	1.665	0.197
	Yes	83	13	15.7		
Self-rated family relationship	Good	594	114	19.2	6.249	0.012
	Fair and poor**	159	45	28.3		
Currently smoking	No	633	140	22.1	2.391	0.122
	Yes	120	19	15.8		
Regular physical excise	No	319	73	22.9	1.039	0.308
	Yes	434	86	19.8		
Hypertension	No	387	63	16.3	11.181	0.001
	Yes	366	96	26.2		
Diabetes	No	638	128	20.1	2.780	0.095
	Yes	115	31	27.0		
Heart disease	No	675	135	20.0	4.868	0.027
	Yes	78	24	30.8		
Stroke and other cerebrovascular diseases	No	689	136	19.7	9.225	0.002
	Yes	64	23	35.9		
Chronic obstructive pulmonary disease	No	709	149	21.0	0.073	0.787
	Yes	44	10	22.7		
Cancer	No	748	158	21.1	0.004	0.951
	Yes	5	1	20.0		
Tuberculosis	No	751	159	21.2	0.537	0.464
	Yes	2	0	0.0		
Chronic gastric ulcer	No	728	145	19.9	18.892	<0.001
	Yes	25	14	56.0		
Parkinson's disease	No	748	156	20.9	4.569	0.033
	Yes	5	3	60.0		
Anemia	No	745	156	20.9	1.303	0.254
	Yes	8	3	37.5		
Hepatitis cirrhosis	No	751	158	21.0	1.004	0.316
	Yes	2	1	50.0		
Arthritis	No	697	143	20.5	2.019	0.155
	Yes	56	16	28.6		

* *"Others" included never married, separated, divorced, widowed, cohabitating, and remarried.*

** *Because of the very small numbers of the category of "poor" relationship ($n < 10$), "poor" and "fair" were merged into one category.*

TABLE 2 Correlates of anxiety symptoms in older adults in primary care settings.

Factor	Risk level	Reference level	Coefficient	Standard error	χ^2	*P*	OR(95%CI)
Sex	Female	Male	0.616	0.195	10.004	0.002	1.85 (1.26, 2.71)
Self-rated economic status	Poor	Good	0.837	0.338	6.151	0.013	2.31 (1.19, 4.48)
Self-rated family relationship	Fair and poor*	Good	0.615	0.222	7.665	0.006	1.85 (1.20, 2.86)
Hypertension	Yes	No	0.700	0.194	13.042	<0.001	2.01 (1.38, 2.95)
Chronic gastric ulcer	Yes	No	1.920	0.433	19.699	<0.001	6.82 (2.92, 15.94)
Parkinson's disease	Yes	No	2.057	0.956	4.633	0.031	7.83 (1.20, 50.95)

Because of the very small numbers of the category of "poor" relationship ($n < 10$), "poor" and "fair" were merged into one category.

serotonergic neurons (66, 67). As a result, Parkinson's disease was found to be a significant correlate of anxiety symptoms in this study.

This study has a few limitations. First, because of the cross-sectional assessment of anxiety symptoms and associated factors, the current study cannot ascertain the causal relationships between identified correlates and anxiety symptoms. Second, additionally assessing the presence of anxiety disorders according to DSM-IV or other diagnostic criteria would increase the clinical relevance of the study findings but we did collect data on this mental health outcome. Third, we did not investigate the mental health help-seeking behaviors of older adults with anxiety symptoms, which can inform the mental health policy-making and planning in primary care settings. Fourth, our sample of older primary care attenders was recruited from primary care clinics of a large city in central China. Older patients of primary care clinics in other cities were not included, potentially limiting the generalizability of our findings. Fifth, some other factors associated with anxiety in older adults, such as personality and stressful life event, were not measured in this study. Finally, because our study was conducted before the COVID-19 pandemic and the pandemic has had a long-term and far-reaching negative impact on the mental health of older adults (19, 68), studies during the pandemic and post-pandemic periods are warranted to further examine the influence of the pandemic on the risk of anxiety and its associated factors in older primary care attenders.

In conclusion, anxiety symptoms are prevalent among older adults receiving primary care in China. Given the many negative outcomes associated with anxiety, it is necessary to integrate mental health services into the routine primary care services. To achieve the goal of early detection and timely treatment, health services for older primary care patients need to include periodic assessment of anxiety symptoms, psychosocial support to improve the mental well-being, and, if necessary, psychiatric referral and treatment. Efforts for preventing or reducing anxiety symptoms in older primary care patients may be more useful to target those who are women, have poor financial status, don't have a good family relationship, suffer from hypertension, have chronic gastric ulcer, and suffer from Parkinson's disease.

Our findings on some correlates of anxiety symptoms are clinically relevant because family relationship, hypertension, chronic gastric ulcer, and Parkinson's disease are potentially modifiable or treatable. The significant associations of anxiety symptoms with these social and medical problems further indicate the clinical needs for collaborative multidisciplinary management services for reducing the burden of anxiety in older primary care patients, which should integrate social work outreach services to promote family relationship, mental health services to relive anxiety symptoms, and primary care services to manage hypertension, chronic gastric ulcer, and Parkinson's disease.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board of Wuhan Mental Health Center. The patients/participants provided their written informed consent to participate in this study.

Author contributions

QX: acquisition and analysis of data for the study, drafting the paper, and interpretation of data for the study. QX and Y-MX: design and acquisition of data for the study. B-LZ: drafting the paper, revising the paper for important intellectual content, and interpretation of data for the study. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Group-based trajectory and predictors of anxiety and depression among Chinese breast cancer patients

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Background: The aim of the current study is to investigate the change in anxiety and depression amongst Chinese breast cancer patients and to identify causal associations between baseline variables and the trajectory of anxiety and depression within this identified group.

Methods: This is a longitudinal prospective study. Three hundred women with breast cancer were recruited. Patient's depression and anxiety were repeatedly measured by PHQ-9 and GAD-7 at baseline, 6, 12, and 18 months after discharge. The SAS 9.4 PROC Traj procedure was used to examine the group-based trajectory of these recruited patients. Linear mixed models (LMM) were utilized to examine anxiety/depression changes over time, accounting for relevant baseline demographic and clinical factors.

Results: About 26.3% of the participants reported none or very mild anxiety over time, 60.7% reported stable low-level anxiety, and the remaining 13.0% showed significantly decreasing trend in GAD total scores. Meanwhile, 10.7% of the participants reported none or very mild depressive symptoms over time, 66.0% reported stable PHQ total scores throughout the research period, and 23.3% were classified as the "high level-decreasing group". Patients reported significantly higher anxiety and depression scores in the first three assessments. Participants with no or mild life stress along with a positive personality tended to report lower anxiety and depression scores over time.

Conclusion: Most of the breast cancer patients reported stable low-level anxiety and depression 18 months after discharge. Early assessment of optimism and stress levels among cancer patients might help identify people at risk of experiencing long-term anxiety and depression.

KEYWORDS

anxiety, breast cancer, depression, longitudinal, predictor, trajectory

Introduction

Anxiety and depression have great influence on people's wellbeing, functioning, and productivity (1). A recent meta-analysis showed that the prevalence of anxiety amongst breast cancer patients could reach 41.9% (2). Another study reported that 45% of the women with breast cancer had severe levels of state anxiety at the time of cancer diagnosis (3). A prospective, multicenter cohort of 401 consecutive patients with newly diagnosed, advanced cancer showed that the incidence of anxiety was 36% during the COVID-19 pandemic (4). Those women who were married, non-religious, with higher monthly income, feelings of uncertainty and emotional stress were more likely to report anxiety than their counterparts (5). Anxiety significantly influences a patient's physiological and psychological functioning, treatment compliance and quality of life, and are significantly associated with cancer recurrence and all-cause mortality (6).

Depression is also common in people with physical illnesses. It is often under-estimated and under-treated amongst the cancer population (7). It has been reported that around 32.2% of the breast cancer patients experience depression after cancer diagnosis (8). Risk factors for depression among breast cancer patients include a previous history of major depressive disorder (MDD), loneliness, a higher number of comorbid conditions, financial difficulties, increased symptomatic burden, altered body image, alteration of femininity, sexuality as well as attractiveness (1, 9, 10). Additionally, breast cancer survivors with persistent breast pain are more likely to report higher levels of depressive symptoms (11, 12). Depression may influence the course of the disease and compliance, and is significantly associated with poor quality of life in cancer patients (7).

Comorbidity of anxiety and depression is common among breast cancer patients during treatment and survivorship (1). Sun et al., found that about 32.93% of the cancer patients experienced anxiety, and 38.55% reported depressive symptoms after diagnosis (1). Burgess et al., found that ∼50% of the cancer survivors with early breast cancer diagnosis suffered from anxiety, depression, or both in the first year after diagnosis; the anxiety/depression rate dropped to 25% in the second year, and only 15% of the cancer survivors reported anxiety or depression in their fifth year after diagnosis (13). Boyes et al. investigated the prevalence and short-term trajectories of anxiety and depression in the first year after diagnosis, and found that 22 and 21% of the cancer patients reported anxiety 6 and 12 months after cancer diagnosis, and 13% reported depression at both timepoints (14).

Identifying and managing anxiety and depression amongst the cancer population is of great importance (6). Until now, there is an increasing body of research into cancer patient's anxiety and depression in China, however, information about the time course of anxiety and depression is limited because most previous studies have used cross-sectional research designs, with few of them concentrating on the patient's trajectory of anxiety and depression over long-term treatment and into survivorship. Among the few previously mentioned longitudinal studies; most span over a time period from soon after diagnosis to up to 1-year post-treatment. In this study, we aim to investigate the changes in anxiety and depression over a time frame of 18 months after discharge of this aforementioned group. Two research questions will be investigated: (1) what is the trajectory of anxiety and depressive symptoms in Chinese breast cancer patients? and (2) what are the predictors of change in anxiety and depression?

Methods

Study design and participants

This is a longitudinal prospective study consisting of 4 assessments at baseline (time of discharge), 6, 12, and 18 months after discharge. All breast cancer patients were consecutively recruited from January to December 2019 at Southern Medical University Nanfang Hospital and Guangdong Provincial People's Hospital. Participants were eligible if they were an adult; had a clear diagnosis of breast cancer; and were able to read, write and understand Chinese. Patients were excluded if they were under age; had obvious cognitive impairments; or receiving palliative treatment. This study's protocol was approved by Nanfang Hospital Ethics Committee (Ref no: NFEC-2018-038), and Guangdong Provincial People's Hospital Ethics Committee [Ref no: 2018295H(R1)]. Written informed consent was obtained from all participants on the day of recruitment. Participants were assured that their participation was voluntary, and that their information would be kept confidential. All participants were contacted by telephone or WeChat (a social communication application in China) by a research staff, to give their ratings again at follow-ups.

Instruments

Personal information sheet

A specific set of questions were designed to collect information about patient's age, marital status, educational background, employment, monthly income, life stress level, physical comorbidities, family cancer history and personality tendency. Patient's life stress level was assessed using a self-designed question: what is your current stress level? Four responses were provided; namely: none, mild, moderate and high level. In addition, patient' personality

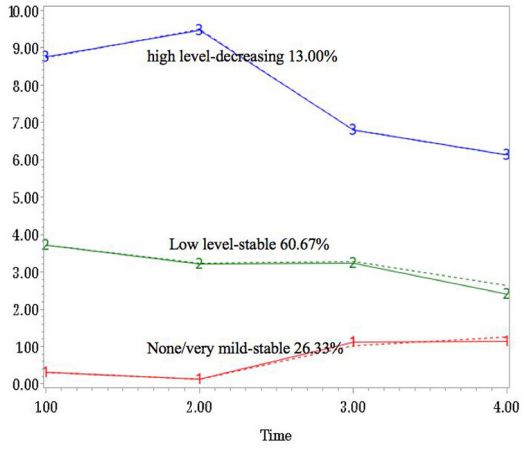

FIGURE 1
Group-based trajectories for the anxiety changes over time.

tendency was measured by a single question derived from the Chinese version Personality Traits Questionnaire (15): what do you think is your dominant personality trait (Positive or Negative)?

Patient health questionnaire

The PHQ-9 is a self-report measure of 9 items used to assess depressive symptoms. Each item is rated between 0 and 3. Total PHQ-9 scores range from 0 to 27. A sum score of 5 or more suggests the presence of depressive symptoms (16). The Chinese PHQ-9 has good psychometric properties, with Cronbach's alpha of 0.89 (17).

Generalized anxiety disorder

The GAD-7 is a self-report measure of 7 items used to evaluate anxiety symptoms. Each item is rated from 0 and 3, with total scores ranging from 0 to 21. A sum GAD-7 score of 5 or more indicates the presence of anxiety symptoms (18). The Chinese GAD-7 has satisfactory psychometrics (19).

Data analysis

All the statistical analyses were conducted with SAS version 9.4 (SAS Institute Inc., Cary. NC), and SPSS version 21.0 (SPSS Inc., Chicago, IL, USA). The SAS 9.4 PROC Traj procedure was used to investigate the group-based trajectory modeling and identify subgroups of patients who had similar trajectories on GAD and PHQ total scores over time. Censored normal (CNORM) model with cubic trajectory for each group was used for modeling the conditional distribution of GAD and PHQ scores. The model fit was assessed with Bayesian Information Criterion (BIC), and log Bayes factor [2loge(B10)≈2(ΔBIC)]. As recommended, the log Bayes factor of larger than 10 indicated a strong evidence of model fit (20).

To test the different distributions of baseline demographic and clinical variables among different trajectory groups, chi-square tests or Fisher's exact tests were performed. Furthermore, multinomial logistic regression analysis was conducted to explore the relationships between demographic and clinical characteristics and trajectory groups whilst adjusting for covariates. Additionally, the effects of baseline demographic and clinical variables on the changes of anxiety and depression (dependent variable) were examined *via* Generalized Linear Mixed Model by Restricted Maximum Likelihood (REML); with the fixed effects of time, age, marital status, education, employment, income, comorbidities, family history, current life stress, and personality, and random effects of subjects. The *post-hoc* comparisons of estimated marginal means of anxiety and depression scores over time were estimated with Bonferroni method. A two-side P-value < 0.05 was considered statistically significant.

Results

Patient characteristics

The mean age of participants was 44.94 years (SD = 9.79). At baseline, 144 (48.0%) of the participants reported depression, and 101 (33.7%) of the women reported anxiety. The mean score of PHQ decreased from 5.00 (SD = 4.26) at baseline (T1), to 4.21 (SD = 4.23) at 6-month follow-up (T2), 4.16 (SD = 3.33) at 12-month assessment (T3), and 3.24 (SD = 2.61) at 18-month follow-up endpoint (T4). Similarly, patients' anxiety level dropped from 3.50 (SD = 3.77) at baseline, to 3.26 (SD = 3.80) at T2, 3.15 (SD = 2.82) at T3, and 2.61 (SD = 2.77) at endpoint. The prevalence of anxiety and depression gradually decreased from 33.7 and 48.0% at baseline, 31.7 and 37.3% at T2, 22.3 and 26.9% at T3, to 13.9 and 14.6% at T4.

Group-based trajectories and group comparisons

For both anxiety and depression, three-group trajectory models were estimated from the latent class growth modeling of SAS PROC Traj. The trajectories were labeled as: "none/very mild-stable group," "low level-stable group," and "high level-decreasing group" according to the significant difference of linear effect from 0, and the sign of coefficient (Figures 1, 2). For anxiety symptoms, 79 (26.3%) of the participants reported none or very mild anxiety over time,

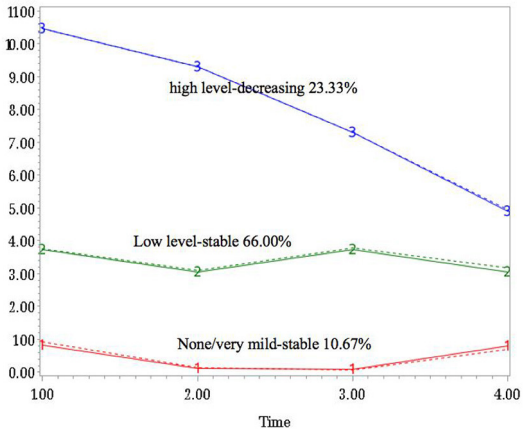

FIGURE 2
Group-based trajectories for the depression changes over time.

182 (60.7%) reported stable low-level anxiety, and the remaining 39 (13.0%) showed apparent decreasing trend throughout the 18-month period. Similarly, 32 (10.7%) of the participants reported none or very mild depressive symptoms over time, 198 (66.0%) exhibited stable PHQ total scores throughout the research period, and 70 (23.3%) of the participants were in the "high level-decreasing trajectory group".

Chi-square tests showed that participant's monthly income ($X^2 = 13.156$, $P = 0.041$), life stress ($X^2 = 15.300$, $P = 0.018$) and personality ($X^2 = 28.478$, $P < 0.001$) were significantly differently distributed among the three anxiety groups. Also, participant's physical comorbidities ($X^2 = 9.989$, $P = 0.007$), life stress ($X^2 = 18.865$, $P = 0.004$) and personality ($X^2 = 16.511$, $P < 0.001$) were significantly differently distributed among three depression groups. Other sociodemographic and clinical variables had no significant associations with anxiety/depression trajectory groups (Table 1).

Multinomial logistic regression revealed that, compared with the "none/very mild-stable anxiety group", baseline life stress and negative personality were positively associated with low level-stable anxiety group (OR = 1.69, 95% CI = 1.18–2.43, $P = 0.004$, and OR = 7.24, 95% CI = 1.59–32.78, $P = 0.010$, respectively) and high-level decreasing anxiety group (OR = 1.85, 95% CI = 1.12–3.07, $P = 0.017$, and OR = 24.91, 95% CI = 4.94–125.61, $P < 0.001$, respectively) after adjusting for covariates. Similarly, compared to the high-level decreasing depression group, patients in the low level depression group were less likely to report severe life stress (OR = 0.654, 95% CI = 0.467–0.916, $P = 0.013$) and negative personality (OR = 0.448, 95% CI = 0.219–0.915, $P = 0.028$). Patients in none/very mild depression group were also less likely to suffer from high life stress compared to the high-level group (OR = 0.469, 95% CI = 0.282–0.872, $P = 0.015$).

Associations of baseline variables on the trajectory changes in linear mixed models

The linear mixed models showed that time ($F = 7.728$, $P < 0.001$; and $F = 20.098$, $P < 0.001$), life stress level ($F = 6.588$, $P < 0.001$; and $F = 5.731$, P=0.001), and personality ($F = 23.305$, $P < 0.001$; and $F = 21.883$, $P < 0.001$) significantly affected both anxiety and depression. Specifically, Bonferroni-corrected post-hoc tests revealed that patients reported significantly higher anxiety score at baseline (T1, estimate = 0.918, 95% CI: 0.452–1.384, $P < 0.001$), the 2nd (T2, estimate = 0.681, 95% CI: 0.261–1.101, $P = 0.002$), and 3rd measurements (T3, estimate = 0.571, 95% CI: 0.304–0.839, $P < 0.001$), than at the endpoint assessment (T4). Compared with those with high levels of life stress, patients who had no stress [estimate = −1.789, 95% CI: −2.824 – (−0.754), $P = 0.001$] or mild stress [estimate = −1.802, 95% CI: −2.748 – (−0.856), $P < 0.001$] would perform at a significantly lower anxiety level. Also, patients who had a positive personality would exhibit significantly less anxiety symptoms than their counterparts [estimate = −1.821, 95% CI: −2.563 – (−1.078), $P < 0.001$] (Table 2). Similar results were found in patient's depression trajectory. Patients reported significantly higher depression scores at the time of the first three assessments than at the fourth measurements (P all < 0.001). Participants with no ($P = 0.001$) or mild life stress ($P = 0.003$) would also then report lower depression scores than those with high stress level. In addition, patients who had positive personality tended to report lower depression scores compared to their counterparts ($P < 0.001$) (Table 3).

Discussion

The prevalence of anxiety and depression in women with breast cancer was found to be 33.7 and 48.0% at discharge, and 13.9 and 14.6% at 18-month assessment. Our findings were in line with Burgess's study which reported that the prevalence of anxiety and depression amongst women with breast cancer declined from 48 to 15% from the first year of diagnosis to the fifth year after diagnosis (13). Cancer diagnosis and its treatment could be conceptualized as traumatic events and lead to long-term psychological disturbances (21). Previous studies reported that about 30% of patients suffer from anxiety or depression for almost 1 year after diagnosis (22–24), and the prevalence estimates of persistent depression range from 12 to 25% among adult cancer patients (13, 25). Another study found that even 20

TABLE 1 Demographic and clinical characteristics of participants among different trajectory groups ($N = 300$).

Variable	Total	Anxiety					Depression				
	N (%)	Group 1	Group 2	Group 3	X^2/Z	*P*	Group 1	Group 2	Group 3	X^2/Z	*P*
Age											
Below 39 years	93 (31.0)	22 (27.8)	58 (31.9)	13 (33.3)	1.942	0.746	10 (31.3)	60 (30.3)	23 (32.9)	5.530	0.237
40–59 years	176 (58.7)	51 (64.6)	104 (57.1)	21 (53.8)			20 (62.5)	121 (61.1)	35 (50.0)		
60 and above	31 (10.3)	6 (7.6)	20 (11.0)	5 (12.8)			2 (6.3)	17 (8.6)	12 (17.1)		
Marital status											
Single	19 (6.3)	3 (3.8)	15 (8.2)	1 (2.6)	9.033	0.172	1 (3.1)	15 (7.6)	3 (4.3)	6.716	0.348
Married	259 (86.3)	71 (89.9)	154 (84.6)	34 (87.2)			27 (84.4)	171(86.4)	61 (87.1)		
Divorced	17 (5.7)	2 (2.5)	12 (6.6)	3 (7.7)			2 (6.3)	11 (5.6)	4 (5.7)		
Widowed	5 (1.7)	3 (3.8)	1 (0.5)	1 (2.6)			2 (6.3)	1 (0.5)	2 (2.9)		
Education											
Primary and middle school	124 (41.3)	24 (30.4)	80 (44.0)	20 (51.3)	6.096	0.192	9 (28.1)	80 (40.4)	35 (50.0)	5.812	0.214
High school	108 (36.0)	33 (41.8)	63 (34.6)	12 (30.8)			12 (37.5)	75 (37.9)	21 (30.0)		
Undergraduate and above	68 (22.7)	22 (27.8)	39 (21.4)	7 (17.9)			11 (34.4)	43 (21.7)	14 (20.0)		
Employment											
Full time	146 (48.7)	47 (59.5)	82 (45.1)	17 (43.6)	9.147	0.165	19 (59.4)	98 (49.5)	29 (41.4)	3.740	0.712
Part time	26 (8.7)	2 (2.5)	20 (11.0)	4 (10.3)			2 (6.3)	18 (9.1)	6 (8.6)		
Unemployment	80 (26.6)	17 (21.5)	53 (29.1)	10 (25.6)			8 (25.0)	50 (25.3)	22 (31.4)		
Retired	48 (16.0)	13 (16.5)	27 (14.8)	8 (20.5)			3 (9.4)	32 (16.2)	13 (18.6)		
Monthly income											
<3,000 RMB	116 (38.7)	23 (29.1)	79 (43.4)	14 (35.9)	13.156	**0.041**	9 (28.1)	73 (36.9)	34 (48.6)	9.171	0.164
3,000–5,000 RMB	79 (26.3)	19 (24.1)	47 (25.8)	13 (33.3)			9 (28.1)	51 (25.8)	19 (27.1)		
5,000–10,000 RMB	68 (22.7)	27 (34.2)	31 (17.0)	10 (25.6)			10 (31.3)	44 (22.2)	14 (20.0)		
More than 10,000 RMB	37 (12.3)	10 (12.7)	25 (13.7)	2 (5.1)			4 (12.5)	30 (15.2)	3 (4.3)		
Chemotherapy											
Yes	260 (86.7)	71 (89.9)	155 (85.2)	34 (87.2)	1.067	0.587	30 (93.8)	167 (84.3)	63 (90.0)	2.987	0.225
No	40(13.3)	8 (10.1)	27 (14.8)	5 (12.8)			2 (6.3)	31 (15.7)	7 (10.0)		
Physical comorbidities											
Yes	230 (76.7)	67 (84.8)	137 (75.3)	26 (76.7)	5.306	0.070	27 (84.4)	159(80.3)	44 (62.9)	9.989	**0.007**
No	70 (23.3)	12 (15.2)	45 (24.7)	13 (33.3)			5 (15.6)	39 (19.7)	26 (37.1)		
Family cancer history											
Yes	57 (19.0)	11 (13.9)	35 (19.2)	11 (28.2)	3.476	0.176	5 (15.6)	37 (18.7)	15 (21.4)	0.581	0.772
No	243 (81.0)	68 (86.1)	147 (80.8)	28 (71.8)			27 (84.4)	161(81.3)	55 (78.6)		
Life stress											
None	78 (26.0)	28 (35.4)	42 (23.1)	8 (20.5)	15.300	**0.018**	13 (40.6)	54 (27.3)	11 (15.7)	18.865	**0.004**
Mild	115 (38.3)	36 (45.6)	67 (36.8)	12 (30.8)			11 (34.4)	84 (42.4)	20 (28.6)		
Moderate	69 (23.0)	11 (13.9)	45 (24.7)	13 (33.3)			5 (15.6)	39 (19.7)	25 (35.7)		
High	38 (12.7)	4 (5.1)	28 (15.4)	6 (15.4)			3 (9.4)	21 (10.6)	14 (20.0)		
Personality											
Positive	251 (83.7)	77 (97.5)	151 (83.0)	23 (59.0)	28.478	**<0.001**	32(100.0)	170(85.9)	49 (70.0)	16.511	**<0.001**
Negative	49 (16.3)	2 (2.5)	31 (17.0)	16 (41.0)			0 (0.0)	28 (14.1)	21 (30.0)		

1 US Dollar ≈ 6.3 RMB. Group 1: none/mild-stable; Group 2: low level-stable; Group 3: High level-decreasing. Bold values means statistically significant.

years after diagnosis, 5% of breast cancer survivors still suffer from psychological distress (26).

In this study, 60.7 and 66.0% of the women reported stable low-level anxiety and depression throughout the 18-month period after treatment. Meanwhile, 13.0 and 23.3% showed a decreasing trend in anxiety and depression. Our research findings are partially consistent with past evidence indicating that the levels of cancer patient's anxiety and depression usually

TABLE 2 Associations between baseline variables on the changes of anxiety in linear mixed models.

Parameters	Comparisons	Estimates	P value	95% CIs	
				Lower	Upper
Age (years)	Below 39 years	0.986	0.872	−1.108	1.305
	40–59 years	−0.501	0.353	−1.563	0.560
	60 and above	Ref	–	–	–
Marital status	Single	1.571	0.201	−0.840	3.983
	Married	1.928	0.075	−0.195	4.052
	Divorced	2.102	0.084	−0.284	4.489
	Widowed	Ref	–	–	–
Education	Primary and middle school	0.173	0.664	−0.611	0.957
	High school	0.630	0.087	−0.092	1.353
	Undergraduate and above	Ref	–	–	–
Employment	Full time	−0.515	0.292	−1.476	0.446
	Part time	0.420	0.501	−0.807	1.647
	Unemployment	−0.770	0.155	−1.832	0.293
	Retired	Ref	–	–	–
Monthly income	<3,000 RMB	0.448	0.433	−0.676	1.572
	3,000–5,000 RMB	0.215	0.660	−0.746	1.177
	5,000–10,000 RMB	0.362	0.442	−0.564	1.288
	More than 10,000 RMB	Ref	–	–	–
Chemotherapy	Yes	0.125	0.763	−0.689	0.939
	No	Ref	–	–	–
Physical comorbidities	Yes	−0.424	0.204	−1.079	0.232
	No	Ref	–	–	–
Family cancer history	Yes	0.249	0.485	−0.453	0.951
	No	Ref	–	–	–
Life stress	None	−1.789	**0.001**	−2.824	−0.754
	Mild	−1.802	**<0.001**	−2.748	−0.856
	Moderate	−0.648	0.180	−1.598	0.301
	High	Ref	–	–	–
Personality	Positive	−1.821	**<0.001**	−2.563	−1.078
	Negative	Ref	–	–	–
Timepoint	1	0.918	**<0.001**	0.452	1.384
	2	0.681	**0.002**	0.261	1.101
	3	0.571	**<0.001**	0.304	0.839
	4	Ref	–	–	–

Bold: statistically significant; 1 US dollar ≈ 6.3 RMB.

TABLE 3 Associations between baseline variables on the changes of depression in linear mixed models.

Parameters	Comparisons	Estimates	P value	95% CIs	
				Lower	Upper
Age (years)	Below 39 years	0.831	0.190	−0.415	2.077
	40–59 years	0.387	0.487	−0.710	1.485
	60 and above	Ref	–	–	–
Marital status	Single	0.650	0.604	−1.815	3.115
	Married	0.838	0.448	−1.332	3.008
	Divorced	1.234	0.321	−1.210	3.677
	Widowed	Ref	–	–	–
Education	Primary and middle school	0.008	0.984	−0.800	0.816
	High school	0.196	0.602	−0.543	0.935
	Undergraduate and above	Ref	–	–	–
Employment	Full time	−0.620	0.221	−1.615	0.375
	Part time	−0.271	0.674	−1.540	0.998
	Unemployment	−0.756	0.176	−1.852	0.340
	Retired	Ref	–	–	–
Monthly income	<3,000 RMB	0.749	0.206	−0.413	1.912
	3,000–5,000 RMB	0.457	0.362	−0.529	1.444
	5,000–10,000 RMB	0.481	0.319	−0.467	1.429
	More than 10,000 RMB	Ref	–	–	–
Chemotherapy	Yes	0.066	0.877	−0.769	0.901
	No	Ref	–	–	–
Physical comorbidities	Yes	−0.571	0.096	−1.243	0.101
	No	Ref	–	–	–
Family cancer history	Yes	0.479	0.192	−0.242	1.200
	No	Ref	–	–	–
Life stress	None	−1.787	**0.001**	−2.847	−0.727
	Mild	−1.457	**0.003**	−2.430	−0.484
	Moderate	−0.404	0.415	−1.379	0.570
	High	Ref	–	–	–
Personality	Positive	−1.820	**<0.001**	−2.585	−1.054
	Negative	Ref	–	–	–
Timepoint	1	1.747	**<0.001**	1.264	2.231
	2	0.964	**<0.001**	0.512	1.416
	3	0.922	**<0.001**	0.579	1.264
	4	Ref	–	–	–

Bold: statistically significant; 1 US dollar ≈ 6.3 RMB.

gradually decrease or remain stable. For example, Saboonchi et al. investigated the trajectories of anxiety in 725 breast cancer survivors over a 2-year follow-up, and successfully identified four different trajectories (i.e., High Stable, High Decrease, Mild Decrease and Low Decrease) (27). Ng et al. also found that there is significant reduction in patient's anxiety level

at 6 and 12 months as compared to baseline (28), while Kristin et al. reported that the anxiety level in 236 post-surgery breast cancer patients remained unchanged after 1 year (29). As for depression, Avis et al., evaluated the trajectories of depressive symptoms following breast cancer diagnosis and found that most breast cancer patients could be classified as having very low (3.8%) or low (47.3%) depressive symptoms at all of the timepoints, while 11.3% of the patients had initially high scores that declined over 24 months after diagnosis (30). Another longitudinal study also found that there was significant reduction in depressive symptoms over the 14-month follow-up period (31). However, in a 1-year prospective study, depression was found to be relatively low and did not change significantly at both 6 and 12 months timepoint (28).

In line with previous publications, in this study, participants with none or mild life stress tended to report lower anxiety and depression scores over time. According to previous evidence, stressful life events predispose cancer patients in developing anxiety, depression and other emotional disturbances (13, 32, 33). One possible reason is that stressful events waste patients' psychological energy and exhaust their coping resources that would otherwise be used to deal with their psychological problems (34). The relationship between stress and internalizing psychopathologies has been strongly established (35). Past studies indicated that stressful life events predict depressive episodes and are significantly associated with anxiety amongst different populations (35). Compared to their counterparts, depressed or anxious individuals tend to exhibit helplessness behaviors toward stressors; therefore, interventions such as stress control psycho-educational program might help in reducing a patient's psychological distress (36).

Another possible reason why some patients tend to have better adjustment than others is their personality trait. Researchers have suggested that personality is one of the most significant factors when coping with life-threatening illness, and optimism may be a key factor in understanding why some people experience long-term anxiety and depression (37). There are a number of studies indicating that the level of optimism is negatively correlated with anxiety and depression (38). Compared to pessimists, optimists tend to report better psychological resilience (e.g., better problem-solving coping), wellbeing, and health-related quality of life (21). A recent similar study indicated that lower level of optimism at the time of breast cancer diagnosis significantly predicted the development of both anxiety and depression 5 years after diagnosis. Prince et al. examined the association between neuroticism/extraversion and first-onset anxiety and depressive disorders and found that high neuroticism is either a significant risk factor, or a marker of risk, for anxiety and depressive disorders (39). Results also suggested that individuals who reported lower levels of trait positive emotionality were more likely to have a chronic course of depression (40). One possible reason why optimism influences long-term psychological distress is that it affects the way cancer patients cope with the diagnosis, treatment, progression, and other serious events (21). Therefore, early assessment of optimism levels among cancer patients might help to identify women at risk of experiencing long-term anxiety and depression (21).

Several limitations of this study merit consideration. First, it is important to recognize that these results may not apply to all women diagnosed with cancer as only women with breast cancer were included in the current study. Second, several covariates (e.g., job loss, and the experience of psychotherapy) were not investigated, findings should not be generalized without considering the possible effects of these factors. Third, single-item self-report personality measurement may not adequately examine underlying personality features of individuals. Further investigations of personality are warranted as a single item provides weak psychometric information.

Conclusions

Most of the breast cancer patients reported stable low-level anxiety and depression 18 months after discharge. Life stress and personality traits helps predict course trajectories for anxiety and depression. Early assessment of optimism and stress levels among cancer patients might help to identify people at risk of experiencing long-term anxiety and depression.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Nanfang Hospital Research Ethics Committee (Ref no: NFEC-2018-038), and Guangdong Provincial People's Hospital Research Ethics Committee [Ref no: 2018295H(R1)]. The patients/participants provided their written informed consent to participate in this study.

Author contributions

WL, YC, and YY: study design. WL, QZ, YX, HS, YW, WX, and YT: data collection, analysis, and interpretation. WL, QZ, and YX: drafting of the manuscript. SG, YC, and YY: critical revision of the manuscript. All authors: approval of the final version for publication.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Physical activity and mental health in sports university students during the COVID-19 school confinement in Shanghai

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Background: In 2022, Shanghai was seriously affected by the coronavirus disease 2019 (COVID-19) pandemic. The government implemented citywide static management for 2 months, as well as all universities in Shanghai, which changed the normal learning and living style of sports students and led to a decline in physical activity level. As the physical activity has a strong correlation with mental health, this study aimed to investigate the current state of physical activity (PA) and mental health of the students in Shanghai University of Sport. It will try to reveal the correlation between PA and depressive symptoms, anxiety symptoms, fear of COVID-19 and smartphone addiction.

Methods: A cross-sectional survey was conducted on a random sample of 400 students who came from six different majors in May 2022 at the Shanghai University of Sport. Respondents completed the International Physical Activity Questionnaire Short Form (IPAQ-SF), the Chinese version of the 9-item Patient Health Questionnaire (PHQ-9), the Chinese version of the Generalized Anxiety Disorder Scale (GAD-7), the Chinese version of the COVID-19 Fear Scale (FCV- 19S), and the Smartphone Addiction Scale (SAS-SV). Demographics, PA, depressive symptoms, anxiety symptoms, fear of COVID-19, and smartphone addiction were compared. A binary logistic regression model was used for the further analysis.

Results: A total of 376 college students were included in the final analysis. Binary logistics analysis showed that moderate physical activity (MPA) was negatively correlated with depression (OR = 0.95, 95%CI = 0.93–0.98), anxiety (OR = 0.97, 95%CI = 0.95–0.99), fear of COVID 19(OR = 0.99, 95%CI = 0.98–0.99)and smartphone addiction (OR = 0.94, 95%CI = 0.9–0.98) (all $P < 0.05$). Sedentary behavior was positively correlated with smartphone addiction (OR = 1.01, $P < 0.01$, 95%CI = 1.001–1.004).

Conclusion: There was an association between the presence of MPA and depressive symptoms, anxiety symptoms, fear of COVID-19, smartphone addiction, and sedentary behavior associated with smartphone addiction levels. Clarifying the causal relationship between PA and mental health will require further research.

KEYWORDS

COVID-19, confinement, physical activities, mental health, sports university students

Introduction

In late February 2022, a round of SARS-CoV-2 infection broke out in Shanghai. According to the Shanghai Health Commission, as of May 4, 2022, there have been more than 593,336 cumulative cases of SARS-CoV-2 infection, of which 538,450 were asymptomatic, with 503 cumulative deaths (1). COVID-19 spread rapidly on a large scale, leading to strict and comprehensive pandemic control strategies throughout the city for 2 months. The lockdown resulting in closing public places, primary and secondary schools. Universities implemented school closures and residents implemented a policy of quarantine at homes under strict control and isolation-related measures that the epidemic was effectively controlled. However, this dramatic lifestyle change might affect the wellbeing of different age groups (2). According to previous studies, measures including restriction of movement and isolation can lead to varying degrees of increased mental health problems. For instance, the prevalence of major depressive disorder and anxiety disorders during the COVID-19, respectively, reached 27.6 and 25.6%, with much higher prevalence than before the COVID-19 (3). A Canadian study of anxiety and depression symptoms in adults during the COVID-19 also found that the proportion of respondents with high to very high levels of anxiety increased from 5 to 20%, and the number of respondents reporting high levels of depression increased from 4 to 10% (4). Not only that, confinement and lockdown also tended to cause problems such as insufficient physical activities, increased sedentary behavior, excessive use of electronics, and increased fear of COVID-19 infection (5–8). Moreover, the increase of these undesirable behaviors and mental health problems may further aggravate the symptoms of depression and anxiety in the epidemic. It may seriously affect people's mental health (9–11).

As a group in society vulnerable to mental health disorders and sudden changes, the mental health of college students during the pandemic has attracted widespread attention (12). Sun et al. investigated the mental health of 1912 Chinese college students during the pandemic. They found that 46.55 and 34.73% of college students had symptoms of depression and anxiety, respectively (13). Lockdown and quarantine have led to a decrease in personal physical activity and an increase in sedentary, game-obsessed, and college students' excessive use of electronic devices. Huang et al. found in a survey of 10,357 medical college students that the rate of smartphone addiction was as high as 59.42%, accompanied by sedentary, reduced PA, and poor mental health (10). A study from Spain found that physical activities among college students during the lockdown period of COVID-19 decreased by 29.5 and 18.3% for moderate-intensity and high-intensity PA, respectively. However, the sedentary time increased by 52.7% compared to the period before the pandemic (14). It leads to cognitive impairment, depression negative emotions and other mental health problems. Therefore, it becomes very relevant about how to effectively solve college students' mental health problems during the pandemic.

With the rise of evidence-based research on the relationship between physical activities and mental health, PA showed the association with the rise of general wellbeing and enhanced perception of quality of life and mood, and could significantly alleviate anxiety and depressive symptoms (15, 16). The evidence of a significant and positive association between PA and mental health was also successively and strongly confirmed in COVID-19 pandemic (17–19). A review of previous studies implied that many studies have been conducted to investigate the PA and mental health aspects of general college students during the pandemic (13, 20–22). however, few studies have been conducted on the relationship between PA and mental health of students at sports universities. Students from sports universities belong to a special group, these students usually have better physical quality and habit of participating in sports, and their PA level is higher than that of students from ordinary universities. Some of them take courses that get involved in theoretical and practical aspects of different sports, and they have mastered certain methods of physical exercise and the ability to design training contents (23). Beyond that, some studies found that there is a significant difference in the social adaptability psychological quality between sports college students and non-sports college students, in which sports college students could cope with various stimulis and influences exerted on them by others or the external environment and have greater acceptance and carrying capacity stronger stress coping power (24), Hence, whether such populations were able to engage in regular physical activities during the COVID-19 confinement and whether they had the same mental health problems faced by the average college student should be further explored.

During this outbreak, for positive response to the epidemic prevention policy, Shanghai University of Sport implemented the most strict control measures. In addition to the epidemic control and security personnel, students could not leave the dorms without a special reason. The university was responsible for providing daily meals and deliver to every dorm, so as to reduce the personnel flow and contact, which could minimize the risk of transmission. The strict lockdown limited students' activities to their rooms. They could not process normal travel and exercise, which led to a sharp reduction in physical activity and the possibility of psychological problems that were often seen in mental health studies during the pandemic, such as depression, anxiety, excessive use of electronic products and fear of COVID-19. Therefore, whether the physical education students can process regular physical activities in a limited space and whether they have to face the same mental health problems as the ordinary university students need to be further explored. As a result, the purpose of this study was to conduct a questionnaire survey on undergraduate students at the Shanghai University of Sport during the lockdown period of the pandemic in 2022, in hope of better understanding the current situation

of PA and mental health of the students and the association between different physical activity levels and mental health. It will provide basic data reference for sports colleges and universities to carry out health education, PA advice and psychological guidance for college students during the special epidemic period and the post-epidemic period.

Methods

Respondent recruitment

In this study, a cross-sectional questionnaire survey of current undergraduate students with confinement was conducted at the Shanghai University of Sport from May 5 to 15, 2022, 4 weeks after strict and comprehensive pandemic control strategies for the whole area. The Shanghai University of Sport is the earliest sports university created after the founding of China, with a variety of disciplines and majors within it, and its Kinesiology program is one of the best sports majors in the country, with many students from athletes having high PA levels and exercise habits. With the consent of the university, this study randomly selected 400 students from six different majors from the 2019 to 2021 grades of Shanghai University of Sport. The selection criteria included: (a) undergraduate students; (b) Not volunteering or working for the university during the pandemic. Compared to graduate students, undergraduate students reported higher rates of emotions and behaviors related to poor mental health (25, 26). While volunteers or staff were required to complete tasks assigned by the university every day, such as meals delivery and nucleic acid testing, etc., which were not suitable for this study.

To guarantee the validity of questionnaires and ensure that respondents were able to understand the content of the questionnaires (detailed instructions are included in the measurement), the study was conducted through the students' teacher in charge who specifically administered and interpreted the questionnaires with an initial sample size of 400 students. After excluding respondents with incomplete and missing data, the information from 376 college students was finally valid.

Procedure

Considering the safety issues during the pandemic, all respondents completed the questionnaires *via* the WeChat "Questionnaire Star" survey platform with descriptions of the survey instructions. The questionnaires included physical activity scales, depressive symptoms, anxiety symptoms, smartphone addiction, and the fear of COVID-19 scale, as well as some sociodemographic information. The respondents' guardians have been informed about the survey through the respondents' counselors prior to data collection. Subsequently, informed consent forms were sent to the respondents and their parents. After obtaining their consent, the survey was started. The purpose of this study was explained to all respondents and it was emphasized that all data collected would be analyzed in an aggregated manner and that personal information would be kept strictly confidential. This study was based on the Declaration of Helsinki and it was approved by the Ethics Review Committee of Shanghai University of Sport.

Measurements

Exposure

Physical activity

Daily PA time and sitting time were self-reported using the International Physical Activity Questionnaire Short Form (IPAQ-SF), which was developed as a surveillance instrument to measure multiple domains of PA (27, 28). The IPAQ-SF is considered a reliable instrument to assay the total amount of PA obtained in the 15–65 years people (28). The IPAQ-SF required respondents to report the frequency and duration of each PA (vigorous-intensity activities, moderate-intensity activities, and walking), as well as the duration of daily sitting during the last 7 days. The Chinese version of the IPAQ-SF has been confirmed adequately reliable and valid in previous studies (27).

Outcomes

Anxiety symptoms

Anxiety symptoms were measured using the Chinese version of the Generalized Anxiety Disorder scale (GAD-7) (29). Each item has four response options with scores ranging from 0 to 3 (0 = Not at all to 3 = Nearly every day). Each respondent could obtain a total score that ranged from 0 to 21, with a higher score indicating more severe anxiety symptoms. Total scores of 5, 10, 15, and 20 were identified as mild, moderate, moderately severe, and severe anxiety, respectively. Thus, with the cut-off point set at 5, respondents were categorized into two groups: no anxiety symptoms (GAD-7 score <5) and anxiety symptoms (GAD-7 score ≥ 5). The Chinese version of GAD-7 has been widely used and well-validated in multiple studies (29), In this study, the Cronbach alpha coefficient of the GAD-7 scale = 0.895 and the correlation coefficients of the GAD-7 and PHQ-9 were 0.751 and 0.934, respectively, with acceptable reliability and convergent validity (30).

Depressive symptoms

The Chinese version of the 9-item Patient Health Questionnaire (PHQ-9) was applied to measure the severity of depressive symptoms (31). A total score ranged from 0 to 27 (higher points indicating more severe depressive symptoms), with each item that could earn 0–3 points (0 = Not at all to 3 = Nearly every day). Total scores of 5, 10, 15, and 20 were

identified as mild, moderate, moderately severe, and severe depressive symptoms, respectively (31). Thus, a total score of 5 was set as a cut-off point to categorize respondents into two groups: no depressive symptoms (PHQ-9 score <5) and depressive symptoms (PHQ-9 score ≥ 5). The Chinese version of PHQ-9 has been widely used and well-validated in Chinese adolescents (32), which would be further supported by this study. The Chinese version of the PHQ-9 has been extensively used and validated among Chinese adolescents. The overall reliability coefficients Cronbach s α and McDonald's ω of this scale in this study were 0.824 and 0.86, respectively, and the correlation coefficient between PHQ-9 and GAD-7 was 0.751, implying that its reliability and convergent validity were good (33).

COVID-19-related fear

COVID-fear was measured *via* the Chinese version of the Fear of COVID-19 Scale (FCV-19S) (34, 35). It consisted of seven items, with each item that can be responded to on a five-point Likert scale (strongly disagree=1 to strongly agree = 5), with higher scores indicating a greater COVID-fear level. The scale was widely used in several countries, and a systematic review with the evidence from 16 papers including 21 countries and 16 language versions of the FCV-19S found that the different language versions of the FCV-19S were a powerful and valid tool for assessing fear of COVID-19 and did not differ significantly by age and gender (36). Beyond that, the psychometric properties of the FCV-19S have been confirmed in the Chinese population, and some scholars examined the applicability of the FCV-19S in 2,445 Chinese students, and the findings manifested good reliability (reliability and index) where item separation reliability = 1.00, item separation index = 18.44, person separation reliability = 0.88, and person separation index = 2.77. The validity of the FCV-19S was also favorable. The validity of the FCV-19S was also ideal, The mean significant correlation values for FCV-19SC and depression, anxiety, and stress were $|r|$ = 0.467, 0.482, and 0.469, respectively (37). Thus, the FCV-19S-C was shown to be a valid measure of Chinese students' fear of COVID-19. The internal consistency of this study was good, with a Cronbach s alpha coefficient of 0.86, and its construction and criterion validity remained the acceptable limits (38).

Smartphone addiction

The Smartphone Addiction Scale short version (SAS-SV) was adopted to measure the extent of smartphone addiction (39, 40). The scale contains 10 items related to smartphone addiction, with a score of 1 to 6 on a scale of "strongly disagree" to "strongly agree" (6 levels). The higher the total score, the higher the degree of smartphone addiction, using ≥33 (females) and ≥31 (males) as their classification criteria for smartphone addiction. A 2019 study showed that the SAS-SV scale was a valid scale for assessing excessive smartphone use among children and adolescents in Hong Kong, and its results indicated that the scale had good convergent validity and the CFA confirmed that the model had acceptable goodness of fit (comparative fit index = 0.96, Tucker Lewis index = 0.95, root mean square error of approximation = 0.06) (41). The scale had good reliability in this study (α = 0.81; ω = 0.78) (42).

Statistical analyses

Data analysis was performed *via* SPSS 26.0 software. The basic conditions of college students who attended the questionnaire survey were depicted. Then, the descriptive data were expressed as the mean and standard deviation (SD) of continuous variables, and logistic regression equations were used to analyze the association and strength between physical activity and mental health of sports university students with different degrees of physical activity as independent variables, depression, anxiety, fear of COVID-19, and smartphone addiction as dependent variables, respectively, controlling for confounding factors gender, grade, major, family residence, whether they were only children, parents' educational level, and family economic status, and so on, so as to delve into the association and strength between physical activities and mental health of students at sports universities. The test level α = 0.05.

Results

In this study, a total of 376 questionnaires from students that were around 20 years old (20 ± 1.3) in Shanghai University of Sport were valid, including 144 (38.3%) male students and 232 (61.7%) female students. According to the result, the average scores of long sedentary time (M = 497.4, SD = 524.9), depression (M = 6.7, SD = 5.1), smartphone addiction (M = 34.1, SD = 9.2) were above the normal range. The mean value of anxiety (M = 4.5, SD = 4.4) was kept in the normal range. The average scores in fear of COVID-19 was 2.2 ± 0.8. The daily mean time to perform low to moderate intensity PA was 5.5 (SD = 20.1) min, 12.7 (SD = 23.4) min, and 12 (SD = 21.9) min, respectively, as detailed in Table 1.

Binary logistic regression analysis showed that moderate-intensity physical activities was negatively associated with depression (OR = 0.95, 95% CI = 0.93–0.98), anxiety (OR = 0.97, 95% CI = 0.95–0.99), COVID-19 (OR = 0.99, 95% CI = 0.98–0.99) fear and smartphone addiction (OR = 0.94, 95% CI = 0.9–0.98) were negatively associated (all *P*-values < 0.05), and sedentary behavior was positively associated with smartphone addiction (OR = 1.01, $P < 0.01$, 95% CI = 1.001–1.004), after adjusting the model to control for statistically significant characteristic variables such as grade, whether the child was an only child, parental literacy, and family economic status. The results did not change significantly, as detailed in Table 2.

TABLE 1 Participants' characteristics.

Variables	Mean or *n* (%)	SD
Sex		
Male	144 (38.3)	
Female	232 (61.7)	
Age (year)	20	1.3
Height (cm)	170.2	12.3
Weight (kg)	64.7	17.3
SED	497.4	524.9
LPA	5.5	20.1
MPA	12.7	23.4
VPA	12.0	21.9
Covid-19 fear	2.2	0.8
Smartphone addiction	34.1	9.2
Depression symptoms	6.7	5.1
Anxiety symptoms	4.5	4.4

LPA, low physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; SED, sedentary behavior.

Discussion

Upholding data from a sample of college students at the Shanghai University of Sport during the confinement period of Shanghai from May 5 to May 15, 2022, the purpose of this study was to determine the relationship between PA and depressive symptoms, anxiety symptoms, COVID-19 fear, and smartphone addiction. It was found that MPA was negatively associated with depressive symptoms, anxiety symptoms, smartphone addiction, COVID-19 fear, and a positive association between sedentary and smartphone addiction. Possible explanations for these results were discussed below.

Shanghai has implemented a series of strict and comprehensive pandemic control strategies to reduce the transmission and infection rate of COVID-19 in 2022. With the purpose of making sure the gathering and contact of people, the university arranged three meals per day by building, time and area during the control period, with uniform delivery to the door of the dormitory, and all school students could not leave the dormitory under the control of the strict policy. The adoption of such a closed management policy may lead to higher levels of depression, anxiety, and stress and lower levels of subjective wellbeing among school students (43). In this context, this study found that students' MPA was negatively associated with depressive symptoms, this result could be supported by previous studies conducted by Herbert which validated the effectiveness of exercise in preventing and reducing depressive symptoms at university students populations, that exercise interventions comprising aerobic exercises of low- to moderate intensity may work best to improve mental health

TABLE 2 Associations between LPA, MPA, VPA, and SED with fear of COVID-19, smartphone addition, depressive symptoms and anxiety symptoms.

Variables	Fear of COVID-19				Smartphone addiction				Depressive symptoms				Anxiety symptoms			
	β	*P*	OR	95%CI	β	*P*	OR	95%CI	β	*P*	OR	95%CI	β	*P*	OR	95%CI
LPA	0.002	0.414	1.002	0.998 1.006	0.025	0.303	1.025	0.978 1.075	0.003	0.822	0.997	0.972 1.023	0.001	0.9	1.001	0.979 1.025
MPA	−0.005	0.009**	0.995	0.991 0.999	−0.064	0.006**	0.938	0.895 0.982	−0.049	0.000***	0.952	0.929 0.976	−0.03	0.009**	0.971	0.949 0.993
VPA	0.003	0.268	1.003	0.998 1.007	−0.024	0.36	0.976	0.927 1.028	0.011	0.419	1.012	0.984 1.04	0.014	0.264	1.014	0.989 1.04
SED	0.000	0.448	1	1 1	0.002	0.01*	1.002	1.001 1.004	0.001	0.147	1.001	1 1.002	0.001	0.055	1.001	1 1.002

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$; LPA, low physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; SED, sedentary behavior; CI, confidence interval; OR, odds ratio.

among university students after a few weeks of intervention (44). and the role of moderate-to-vigorous physical activity (MVPA) in alleviating depressive symptoms has also been widely recognized (45–47).

A study showed that during the pandemic, people who regularly engaged in MVPA were 12–32% less likely to experience symptoms of depression. A single 20–60 min session of physical activities 1–5 times per week had the significant positive effect on depression (48) while high-frequency exercise (3–5 times per week) interventions were more effective in alleviating depression symptoms than low frequency (1 time per week) (49). Compared with previous findings, this study realized no significant difference between the effects of low- and high-intensity physical activity on depressive symptoms, and moderate-intensity physical activities were effective in alleviating depression. Some scholars have used restricted cubic spline model analysis to identify an approximate "U" shaped dose-effect relationship between weekly MVPA time, total physical activities and the risk of developing depressive symptoms. With the increase of weekly MVPA time and total physical actibity, the risk of developing depressive symptoms showed a tendency to decrease then increase (50). It could be seen that exercise intensity and total physical activities should be maintained at an appropriate intensity and level for alleviating and preventing the occurrence of depressive symptoms (51); another important reason may be that it was difficult to perform strenuous physical activities during the closure control period due to the policy of preventing from leaving home and the lack of corresponding exercise equipment for college students in physical education (17), and moderate-intensity exercises, such as jumping gymnastics, self-weight strength training and other moderate-intensity physical activities are commonly chosen by students and have produced good alleviating effects on depression.

In this study, MPA was also negatively associated with anxiety symptoms, a result was consistent with a large body of research and showed that physical activities had a positive effect on improving mood and wellbeing, reducing anxiety and promoting mental health (52). From the neurobiological mechanism hypothesis, PA enhanced mental health and alleviated anxiety symptoms by changing the structural and functional organization of the brain (53) while the behavioral mechanism hypothesis suggested that physical activities improved self-regulation and coping skills, thus helping people to stay mentally active effectively (54). Physical activities of appropriate intensity and frequency could release psychological tension and increase mental stability (55). In 2020, the World Health Organization gave more specific recommendations that for adults aged 18–64 years, at least 150 min of moderate-intensity aerobic exercise or at least 75 min of high-intensity aerobic exercise per week may reduce the risk of anxiety (56). Promoting mental health by maintaining and improving PA levels have already became a critical and highly effective measure with effects comparable to those of medication and psychotherapy, and it is widely recognized (56–58).

Prolonged lockdown and removal from the constraints of the normal group environment may be accompanied by changes in various behavioral habits of college students, including the frequency of smartphone use. Smartphone addiction is a new type of behavioral addiction in which individuals use smartphones excessively and have no control over the behavior, resulting in impaired social functioning and bringing about psychological and behavioral problems (59). In this study, the average score of smartphone addiction for the sample as a whole was 34 (over 33 for female students and over 31 for male students as having symptoms of smartphone addiction), implying that most students are in a state of smartphone addiction during the epidemic control period, just like students who came from general universities, and that smartphone addiction might affect physical activities during the day (60, 61). This study found that students engaging in moderate-intensity PA were negatively associated with smartphone addiction, and sedentary behavior were positively linked with smartphone addiction. A study last year has the similar results, in which smartphone addicted college students resulted in the increased sedentary time and decreased physical activity time compared to the pre-COVID-19 outbreak. It meant that long sedentary time and low moderate physical activity time were positively associated with smartphone addiction among college students (10). Also, a 2020 US study also showed that during the early restriction period of COVID-19, a reduction in PA and increased time spent using smartphone screens led to poorer mental health outcomes (62), the longer the sedentary time was, the poorer mental health and wellbeing would be (9). This study validated previous studies in some respects that performing moderate-intensity PA can reduce the level of smartphone addiction, and that sedentary behavior is a risk factor for smartphone addiction. Therefore, it can be suggested that reducing sedentary behaviors and maintaining moderate to high PA levels during self-quarantine of the COVID-19 pandemic should be an important measure to avoid smartphone addiction and promote physical and mental health among college students.

Furthermore, this study found a negative correlation between MPA and fear on the COVID-19, which is also consistent with previous studies that found a negative correlation between fear scores and physical activity levels on the COVID-19 (higher fear was associated with lower physical activity levels), with each increase in scale score decreasing the odds of engaging in strenuous physical activity 3% (63). Engaging in moderate-intensity physical activities contributes to and alleviates fear of COVID-19 and can be explained by theories of stress and maladaptive coping as well as health behavior theories because COVID-19 global spread exceeds an individual's psychosocial resources (e.g., social support; self-regulatory skills) and exacerbates an individual's fear of

COVID-19 and thus may be reduced by using maladaptive coping strategies to respond, thereby reducing time spent participating in physical activities.

In interpreting the results of the above study, some limitations of this study were noted. First of all, this study made use of a cross-sectional study design, which only allowed for correlational analysis and did not allow for causal inference, and it was more difficult to collect questionnaires and had a smaller sample size during the school closure period of the pandemic. Future studies should be able to consider larger sample sizes and use longitudinal designs and randomized controlled trials to help establish causal relationships between physical activities, depression, anxiety symptoms, smartphone addiction, and fear of COVID-19. Another limitation of this study was the self-reported nature of the data, which was heavily influenced by potential recall bias and current subjective mood. For example, people who have experienced poor mental health problems may be more inclined to participate in research because they find the topic more relevant. This may lead to an overestimation of depressive and anxiety symptoms. Future studies should use more objective measures. Furthermore, the mechanisms associated with why only moderate-intensity PA can be a significant influence on depression, anxiety symptoms, smartphone addiction, and fear of COVID-19 factors in this study remained an open question for future research.

Despite these limitations, our findings still have clinical and policy implications. First of all, university psychology counselors could further evaluate the psychological problems of the students based on the result of the investigation, in order to implement effective intervention, which will help students to alleviate mental health problems in the lockdown. In addition, moderate intensity exercise seems to be a better choice in the relatively small space. The students could choose to do some self-weight strength training, jumping gymnastics, rope skipping and other moderate-intensity physical activities (64). It is recommended to have exercises for 20 min a day, adjust life schedule and reduce sedentary behaviors, so as to alleviate mental health problems caused by the epidemic lockdown.

Conclusion

There was a significant association between moderate-intensity physical activities and depression, anxiety, fear of COVID-19, and smartphone addiction, and a significant association between sedentary behavior and smartphone addiction among sports college students during the lockdown. The findings again demonstrated that physical activities and reduction of sedentary behavior could contribute to the mental health of college students, but further longitudinal studies should be needed to elucidate the causal relationship between moderate-intensity physical activities and mental health among sports college students. This study suggested that during the pandemic, current college students in closure management should be encouraged to overcome difficulties such as space limitations, actively engage in moderate-intensity physical activity, and reduce sedentary behaviors, which are beneficial for alleviating mental health problems, such as depression, anxiety symptoms, fear of COVID-19, and smartphone addiction.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Review Committee of Shanghai University of Sport. The patients/participants provided their written informed consent to participate in this study.

Author contributions

YW: conceptualization, methodology, investigation, data curation, and writing—original draft. YL: validation, supervision, formal analysis, writing—reviewing and editing, and funding acquisition. Both authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Association between vigorous physical activity and life satisfaction in adolescents

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Purpose: The association between overall physical activity (PA) and life satisfaction has been confirmed in adolescents. However, the associations between different forms of PA at various intensities and life satisfaction are under-studied. This study aimed to explore the association between vigorous PA (VPA) and life satisfaction, and whether the associations vary by gender and age.

Methods: Using data from the Health Behavior in School-aged Children (HSBC) investigation, the research samples of 11- to 15-year-old adolescents were included for further. The information on VPA was collected *via* two self-reported questions, including frequency per week and hours per week. Life satisfaction was assessed by a ladder of 0–10 scores, with being higher indicating better life satisfaction. Logistic models were carried out to analyse the association between VPA and life satisfaction among adolescents, and results were presented with odd ratio (OR) and associated 95% confidence interval.

Results: Among the 214,080 (49.2% male) adolescents studied, both boy and girl participants reporting higher frequency of VPA per week were more likely to be associated with higher life satisfaction (e.g., in boys, VPA for every day: OR = 1.054; in girls: VPA for every day: OR = 1.047). More hours of VPA was also associated with better life satisfaction in adolescents (in overall sample, 7 h or more: OR = 1.178).

Conclusions: In conclusion, this research provided evidence on the roles of VPA on life satisfaction among adolescents aged 11–15. Considering life satisfaction is regarded as an indicator of adolescents' psychological health development, our study supports and extends the evidence for the importance of VPA in adolescence.

KEYWORDS

vigorous physical activity, adolescence, life satisfaction, health, HSBC

Introduction

Mental health educators and professionals are concerned about adolescents' well-being promotion (1–3). A lot of constructs related well-being are proposed, and it is widely recognized that fostering an understanding of life satisfaction is important to goal achievement (4, 5). Life satisfaction is an overall and cognitive appraisal of individuals'

life (6, 7). Life satisfaction is a crucial component of positive psychology, which can be defined as a subjective sensitivity of the multiple life aspects in people (8–10). Life satisfaction involves a cognitive assessment in humans' whole character of life (11), which also includes self-satisfaction, family satisfaction, as well as school satisfaction (12). Better life satisfaction is linked with improved health outcomes (13). Besides, life satisfaction has also been regarded as being related to future externalizing, internalizing behaviors and peer victimization experiences in previous studies (14, 15). Life satisfaction is also a predictor of health-related quality of life (16), behavioral problems (17) (i.e., violence (18)) and psychological problems (i.e., depressive disorders (19), suicidal ideation (20)) in adolescents. Empirical evidence indicated that a decline in life satisfaction in adolescents (21–24).

Owing to the significance and practical implications, improving life satisfaction is of great importance. According to the empirical evidence, physical activity (PA) has been regarded as an optative strategy to boost children's and adolescents' mental (25) and physical health (26, 27). Recently, there is evidence showing that higher PA levels are related to children's and adolescents' life satisfaction (10, 28). In general, PA and life satisfaction's positive relationship has been reported in several previous studies (29–32). For example, PA was positively related with life satisfaction in US middle school children (29). Besides, one cross-sectional research that investigated 4,758 adolescents in South Carolina revealed that life satisfaction was favorably associated with PA, and gender and ethnicity had effect on this association (30). Another study of 1,002 Chinese middle school students also supported the positive association, and adolescents who participated in more PA had a higher life satisfaction (31). Besides, results from the CASPIAN-IV study demonstrated that PA may be a better way to achieve optimal life satisfaction than reducing screen time among children and adolescents (33, 34).

Although the associations between overall PA and life satisfaction have been established, some research gaps remain, that needs to be addressed by future research. The first one is that little is known about the different forms of PA and life satisfaction. As we implied above, one evident research gap is rare evidence concerning VPA and life satisfaction. If researchers can verify the association between VPA and life satisfaction in adolescents, it would be more beneficial to promote wellbeing in this population subgroup. Second, previous studies mostly focused on adolescents from single country. This lack of evidence from multiple countries would limit research findings generalization, as evidence based on more countries or regions can be applied widely for adolescents' health promotion. For example, one recent study highlighted a positive association between frequency of VPA and life satisfaction Italian Adolescents (35). Unclearly, it cannot be judged whether VPA or specific PAs have a positive influence on life satisfaction in other countries.

Thus, this study aims to explore the associations between VPA and life satisfaction in adolescents using a multiple-country data. This study hypotheses that high participationsof VPA would be associated with higher life satisfaction in adolescents.

Methods

Study design and participants

With the public data from the Health Behavior School-aged Children (HBSC) survey, we conducted this cross-sectional research and studied it in accordance with the international HBSC protocol. HBSC is considered a multinational collaborative WHO research that gathers health behavior data every 4 years from a nationally typical sample of 11–13–15 ages' adolescents, where "school classes" will be considered the main sampling unit. Systematic bunch sampling applies the population's eventuality proportional to obtain a nationally typical sample. The samples' class teachers were told and asked to transmit each student an information sheet that included some basic information about the research, which was expected to be provided to their parents or guardians (27). An opt-out form will be signed and returned only in the event of refusal to participate. Study participants were invited to take in this survey voluntarily. A formal consent from study participants was obtained prior to data collection.

Data required were collected in an anonymous manner and standard safeguards to ensure confidentiality. A well-trained teacher granted a normal and self-made questionnaire to students. According to the survey in 2013/2014, the reaction rate of school/class and student level in most areas exceeded 85%.

Measures

Vigorous physical activity (independent variables)

VPA was surveyed by the two terms in below. The first item was "In your spare time, how many opportunities do you have to exercise until you're out of breath or sweaty?" The answers maybe *every day, 4–6 times/week, 2–3 times/week, once a week, once a month even less, and never*. The second item was "Outside school hours, how many hours per week do you typically exercise during spare time to get breathless or sweaty? "The answers maybe *zero, ∼0.5 h, ∼1 h, about 2–3 h, about 4–6 h, about 7 h even more*.

Life satisfaction (outcome)

Life satisfaction was assessed based on the ladder life scale (36). The participants were asked to tick the box. The ladder numbers correspond to 0–10 from bottom to top, with 10 at the

top representing the best life, and 0 at the bottom representing the worst life. Which class do you think you are in now? 10 is the best life, 0 is the worst, previous research has shown that even a single life satisfaction survey can be very accurate, very valid, credible. The scores are also high and are basically the same as multiple measures of life satisfaction. (37–39).

Covariates

Sociodemographic factors included sex (boy or girl), age (11, 13 and 15 years), alcohol use last 30 days (On how many days have you drunk alcohol?), socioeconomic status (family well off), smoking (in the last 30 days, on how many days have you smoked cigarettes?), watching television/, playing computer games and body mass index (BMI). Family well off was assessed by a question, that was "How well of do you think your family is?". BMI was estimated by self-reported height and weight. The reason of above covariates were chosen is that they were included in previous studies on physical activity and mental health in children and adolescents (40). According to the previous studies, these controlling variables (e.g., drinking alcohol, family well off, smoking, watching tv/DVD/video, playing computer games, vigorous physical activity and BMI) were highly linked with life satisfaction (41–44). In addition, socioeconomic status is also associated with life satisfaction (35).

Statistical process

All the statistical analysis was performed using the SPSS 25.0. Prior to final analysis, some procedures have been made. Study participants provided valid cases of variables of interest of this study were targeted for further analysis. Missing cases of variables of interest were deal with completed case analysis, as the proportion of missing case was under 8% of total sample. Descriptive analysis was used to report sample characteristics. Categorical data are shown as numbers and percentages, while continuous data are displayed as the mean and standard deviation. The Kolmogorov–Smirnov test and normal probability plot were applied to test the assumption of normality of continuous variables (i.e., BMI and life satisfaction). To assess the associations between VPA and life satisfaction, Generalized Linear Models were used as this model is highly compatible with the different kinds of distributions of the studied variables. Three models were established, the first one was the associations between VPA and life satisfaction in the overall sample while controlling for all the covariates. The second model concerned with the associations between VPA and life satisfaction by sex while controlling for all the covariates except for sex. The third model concerned with the association between VPA and life satisfaction by age while controlling for all the covariates except for age. In all the models, "*none*" (hours of VPA per week) and "*never*" (frequency of VPA per week) were treated as reference group. Odd ratio (OR) with 95% confidence interval (CI) was presented. The statistical significance was set up as $p < 0.05$.

TABLE 1 Association between vigorous physical activity and life satisfaction.

	Overall			
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.050**	**1.041**	**1.059**
4-6 times a week	0.000	**1.025**	**1.016**	**1.034**
2-3 times a week	0.000	**1.016**	**1.007**	**1.024**
Once a week	0.767	1.001	0.993	1.010
Once a month	0.984	1.000	0.990	1.010
Less than once a month	0.001	0.983	0.974	0.993
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	REF			
Half an hour	0.003	**1.070**	**1.023**	**1.119**
1 hour	0.000	**1.098**	**1.050**	**1.148**
2-3 hours	0.000	**1.144**	**1.094**	**1.197**
4-6 hours	0.000	**1.145**	**1.091**	**1.202**
7 hours or more	0.000	**1.178**	**1.120**	**1.239**

OR, odd ratio; CI, confidence interval; REF, reference group.
Bold fonts denote statistical significance.
Models controlled for sex, age, family socioeconomic status, smoking, alcohol use, television viewing time, computer games time, computer use time, body mass index.

Results

Supplementary Table S1 presents several characteristics of the sample adopted in this study. The sample consisted of 105,414 boys and 108,666 girls, accounting for 49.2 and 50.8% of the total sample, respectively. Besides, the largest proportion of adolescents in the entire sample, 34.6%, were 13 years old, while adolescents aged 11 and 15 years old occupied 32.2 and 33.1% separately, in the study. In addition, among all adolescents those who never smoked or had not consumed alcohol in the past 30 days made up most of the sample. However, they generally spent half an hour per day playing computer games on weekdays but spent 2 h or less a day on weekends basically. Finally, the average body mass index (BMI) of adolescents reached 19.6, and their life satisfaction level on average was about 8. Information on study participants by country can be found in Supplementary Table S2.

As shown in Table 1, for the whole sample, the highest likelihood of reporting high life satisfaction was observed among participants who exercised more than once a week (Every day: OR = 1.050; 95% CI: 1.041–1.059; 4-6 times a week: OR = 1.025; 95% CI: 1.016–1.034; 2-3 times a week: OR = 1.016; 95% CI: 1.007, 1.024). On the contrary, in general, the possibilities of reporting better life satisfaction were significantly higher in the participants with more hours spent for VPA.

Moreover, Table 2 illustrates the relationship between VPA and life satisfaction of the participants by gender. VPA was related to higher life satisfaction in both boys (OR = 1.054; 95%

TABLE 2 Association between vigorous physical activity and life satisfaction by gender.

Boy				
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.054**	**1.041**	**1.067**
4–6 times a week	0.000	**1.031**	**1.019**	**1.044**
2–3 times a week	0.000	**1.014**	**1.002**	**1.026**
Once a week	0.07	1.002	0.990	1.015
Once a month	0.07	0.995	0.980	1.011
Less than once a month	0.08	0.992	0.977	1.006
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	REF			
Half an hour	0.770	1.010	0.944	1.081
1 h	0.036	**1.073**	**1.005**	**1.146**
2–3 h	0.000	**1.154**	**1.082**	**1.231**
4–6 h	0.000	**1.147**	**1.071**	**1.228**
7 h or more	0.000	**1.188**	**1.108**	**1.273**
Girl				
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.047**	**1.034**	**1.059**
4–6 times a week	0.000	**1.018**	**1.006**	**1.030**
2–3 times a week	0.000	**1.017**	**1.005**	**1.029**
Once a week	0.10	1.000	0.988	1.012
Once a month	0.07	1.003	0.989	1.017
Less than once a month	0.06	0.981	0.968	0.993
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	Ref			
Half an hour	0.001	**1.106**	**1.042**	**1.175**
1 h	0.000	**1.118**	**1.052**	**1.187**
2–3 h	0.000	**1.130**	**1.062**	**1.202**
4–6 h	0.000	**1.141**	**1.066**	**1.222**
7 h or more	0.001	**1.333**	**1.051**	**1.221**

OR, odd ratio; CI, confidence interval; REF, reference group.
Bold fonts denote statistical significance.
Models controlled for age, family socioeconomic status, smoking, alcohol use, television viewing time, computer games time, computer use time, body mass index.

CI: 1.041, 1.067), and girls (OR = 1.047; 95% CI: 1.034, 1.059). Similarly, VPA more than twice a week was associated with higher life satisfaction in both boys and girls as well. Meanwhile, life satisfaction was reported to be higher as the hours of VPA a week increased.

Results for the relationship between VPA and life satisfaction by age are illustrated in Table 3. In general, adolescents aged 13 and 15 years old who had VPA more frequently per week appeared more likely to report high life satisfaction. In terms of VPA hours per week, adolescents aged 13 or 15 years who engaged in more tended to report higher life satisfaction. Conversely, adolescents aged 11 years, especially for those engaging in VPA every day (OR = 1.335; 95% CI: 1.200–1.485) or those with more than 7 h a week for VPA (OR =

TABLE 3 Association between vigorous physical activity and life satisfaction by age group.

11 years				
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.335**	**1.200**	**1.485**
4–6 times a week	0.023	1.132	1.017	1.26
2–3 times a week	0.593	1.029	0.927	1.143
Once a week	0.098	0.91	0.814	1.017
Once a month	0.300	0.926	0.8	1.071
Less than once a month	0.021	0.857	0.752	0.977
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	REF			
Half an hour	0.943	0.997	0.914	1.087
1 h	0.052	1.088	0.999	1.185
2–3 h	0.087	1.078	0.989	1.174
4–6 h	0.259	1.055	0.961	1.158
7 h or more	0.023	**1.122**	**1.016**	**1.238**
13 years				
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.600**	**1.447**	**1.769**
4–6 times a week	0.000	**1.305**	**1.182**	**1.442**
2–3 times a week	0.000	**1.216**	**1.103**	**1.341**
Once a week	0.256	1.06	0.959	1.172
Once a month	0.662	1.027	0.911	1.158
Less than once a month	0.806	0.986	0.882	1.103
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	Ref			
Half an hour	0.006	**1.119**	**1.033**	**1.211**
1 h	0.001	**1.143**	**1.057**	**1.236**
2–3 h	0.000	**1.223**	**1.131**	**1.323**
4–6 h	0.000	**1.244**	**1.144**	**1.354**
7 h or more	0.000	**1.316**	**1.206**	**1.437**
15 years				
Frequency	***p***	**OR**	**95%CI**	
Every day	0.000	**1.758**	**1.605**	**1.927**
4–6 times a week	0.000	**1.426**	**1.301**	**1.562**
2–3 times a week	0.000	**1.261**	**1.153**	**1.379**
Once a week	0.000	**1.181**	**1.077**	**1.295**
Once a month	0.004	**1.166**	**1.051**	**1.295**
Less than once a month	0.495	0.967	0.878	1.065
Never	REF			
Hours a week	***p***	**OR**	**95%CI**	
None	Ref			
Half an hour	0.131	1.056	0.984	1.135
1 h	0.228	1.044	0.973	1.121
2–3 h	0.000	**1.153**	**1.074**	**1.238**
4–6 h	0.000	**1.166**	**1.08**	**1.259**
7 h or more	0.000	**1.168**	**1.079**	**1.265**

OR, odd ratio; CI, confidence interval; REF, reference group.
Bold fonts denote statistical significance.
Models controlled for sex, family socioeconomic status, smoking, alcohol use, television viewing time, computer games time, computer use time, body mass index.

1.222; 95% CI: 1.016–1.238) were more likely to report higher life satisfaction.

Discussion

This study aimed to explore the associations between frequency and duration of VPA and life satisfaction in adolescents aged 11–15 years. The results generally suggested a relationship between a higher frequency of VPA and higher levels of life satisfaction in adolescents regardless of gender differences. Farren et al. (45) discovered that VPA presented a negative relationship with depression symptoms in adolescents. The authors, based on their results, recommended indirectly improving the quality of life and mental health of adolescents by increasing VPA. In addition, Hrafnkelsdottir et al. found that adolescents in Iceland who undertook more frequent VPA together with decreased screen time were less likely to report mental health problems. One research carried out by Bélair et al. (46) concluded that low levels of VPA were related to depression symptoms, based on the evidence from the sample of Canadian adolescents. This indicated that more frequent VPA should contribute to lower depression levels in adolescents, resulting in better life satisfaction. Additionally, the study carried out by Costigan et al. (47) further emphasized the role played by frequent VPA in improving life satisfaction in adolescents, recommending VPA for adolescents three times a week. For this regard, Oberste et al. (48) suggested that MPA or VPA played an essential role in treating mental health in adolescents. One of the most prevalent explanations for this finding is that PA prevents underlying mental health problems such as depression, anxiety, lower self-esteem, and suicidal tendencies, therefore increasing life satisfaction levels in youth (49).

Adolescents with more hours spent in VPA outside of school hours were less likely to report higher scores of life satisfaction, especially in those with none, half an hour and 1 h a week for VPA. These findings are consistent with the positive associations between VPA and adolescents' better life satisfaction in several previous studies (50–52). The positive association may be interpreted by Graham et al. (1) increased physical health (i.e., Cardiometabolic fitness (53), functional capacity (54)). Besides, another explanation might be the effects of physical activity on psychological problems, such as anxiety, depressive symptoms (55). These benefits that adolescents obtain from physical activity might increase their satisfaction with life. Data from one HBSC study revealed that VPA was a stronger predictor of life satisfaction than MVPA in adolescents, especially for boys, which implied that the promotion of VPA might be an efficient way to foster life satisfaction among adolescents (51). Thus, not participating in PA not only has an impact on current life satisfaction but also is associated with dissatisfaction during adulthood (30). Although socioeconomic status was not the aim of this study, it has been regarded as a confounding factor.

As implied by the results, there was a age difference in the association between VPA and life satisfaction. This finding is consistent with the results presented by GarciaGarcia et al. (56) that VPA of children and adolescents aged 11 did not play a significant role in the health-related quality of life (HRQoL) and less maturity groups' correlation. Other researchers have reached different outcomes which mainly on the VPA duration and life satisfaction's correlation among adolescents' subgroups by age. On one hand, Olofsson et al. (57) suggested a negative association between VPA and HRQoL as well as life satisfaction in adolescents. Nevertheless, it should be noted that the adolescents participating in the study were treated for isolated congenital valvular aortic stenosis, which means that the results achieved by the scholars might be distinct among healthy adolescents. On the other hand, other researchers have discovered a positive connection between the duration of VPA and life satisfaction levels among adolescents. According to Cao et al. (58), the study carried out among teenagers aged 11–16 indicated that frequent VPA of sufficient time should be a protective factor for depression among the participants including boys and girls from junior high schools, which means that sufficient VPA was positively associated with more life satisfaction among adolescents. Besides, although Urchaga et al. (59) did not specify the connection between VPA and life satisfaction for the 12–16-year-old adolescents in the sample, they recommended in their study that school-age adolescents should conduct VPA for 60 min at a time.

Study strengths and limitations

The main strengths are standardized and validated data collection procedures, based on the international HBSC study, and the use of a large and representative sample to investigate the association between VPA and life satisfaction in adolescents. Some inherent limitations should be acknowledged within this study's participants, measure and design. First, because the design of the study is cross-sectional, no causal conclusion could be drawn from the current study; it is impossible to make sure the orientation of independence and outcomes' connection. Second, the self-reported measures are taken in the study to collect variable data, and they are subject to the social desirability of participants and the recall bias. Due to the limitations, it is suggested that future research focus on the generation of strong proof. Although there are some mentioned restrictions, but the research also has advantages.

Conclusion

In conclusion, this cross-sectional study suggested that more frequent VPA might associated with better life satisfaction among adolescents. however, this association between may be

influence by age of adolescents and this research finding needs further confirmation. Generally, with the purpose of achieving higher life satisfaction among adolescents, VPA with higher frequency and longer duration is recommended. The practical implication of this study is to encourage the future research may be paid specific attention on the association VPA related to life satisfaction, which would be conducive to well-being promotion in adolescents.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary materials, further inquiries can be directed to the corresponding authors.

Ethics statement

All data were anonymized and publicly available; therefore no ethical approval was required. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

BF: writing—original draft. KX and PZ: formal analysis. BF, KX, and PZ: writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.944620/full#supplementary-material

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Clinical insomnia among elderly primary care attenders in Wuhan, China: A multicenter cross-sectional epidemiological study

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Background and objectives: Integrating sleep health into primary care is a promising approach to narrow the treatment gap for insomnia in older adults but data regarding the epidemiological characteristics of insomnia among elderly primary care attenders (EPCAs) are very limited. This study examined the prevalence and correlates of clinical insomnia among Chinese EPCAs.

Methods: By using two-stage consecutive sampling method, a total of 757 EPCAs were recruited from seven urban and six rural primary care centers in Wuhan, China. The Insomnia Severity Index (ISI) and the Geriatric Depression Scale (15 item version) were administered to assess insomnia severity and depressive symptoms, respectively.

Results: The two-week prevalence of clinical insomnia (ISI score $\geq$ 15) was 28.9%. Significant correlates of clinical insomnia were: female sex (vs. male, OR = 2.13, $P < 0.001$), fair and poor family relationship (vs. good, OR = 1.59, $P = 0.028$), hypertension (OR = 1.67, $P = 0.004$), heart disease (OR = 1.73, $P = 0.048$), arthritis (OR = 2.72, $P = 0.001$), and depressive symptoms (OR = 4.53, $P < 0.001$).

Conclusion: The high prevalence of clinical insomnia among Chinese EPCAs suggests a high level of sleep health need in older patients in China's primary care settings. Considering the many negative outcomes associated with insomnia, it is necessary to integrate sleep health into primary care in China.

KEYWORDS

insomnia, elderly, primary care, epidemiology, China

Introduction

While insomnia is prevalent among the general population, in particular among the elderly population, it is often under-recognized, under-diagnosed, and under-treated (1–4). For example, in a recently published population-based survey in Hebei, China, as high as 9.4 and 21.9% of the residents aged 18–59 years and 60 years and older suffered from insomnia symptoms, respectively, as defined by a cut-off score of seven or greater on the Athens Insomnia Scale (AIS) (5). However, the corresponding rates of visiting a doctor for sleep problems in the past year among individuals with insomnia of the two age-groups were as low as 5.5 and 6.8%, respectively (6). In an international survey across four high-income countries (France, Italy, Japan, and the USA), overall, 15.8% of the adults with a history of insomnia had consulted a physician about their sleep problems, 10.6% of those who consulted physicians were prescribed a drug for the sleep problems, and 6.2% of those who were prescribed drugs were still taking these drugs at the time of this survey (7). Taken together, these data suggest the high level of unmet needs in insomnia management in both the adult and elderly population in China and other countries in the world.

Given the wide availability and easy accessibility of primary care services in most countries in the world (8, 9), primary care physicians (PCPs) are in a unique position to detect older adults with sleep problems and initiate treatment at an early stage when it may be more cost-effective. In the case of China, because of its limited mental health service resources and their unequal distribution between urban and rural regions, and older adults' preference for seeking health services at primary care settings, particularly rural older adults, integrating sleep health into primary care has been a very promising approach to narrow the treatment gap for insomnia and other common mental health problems in older adults (10–13). To facilitate the planning and provision of sleep healthcare services in primary care settings, it is necessary to have the knowledge on the epidemiological characteristics of insomnia among elderly primary care attenders (EPCAs) in China.

In comparison to the numerous studies on insomnia in community-dwelling older adults (4, 14, 15), studies examining insomnia in EPCAs have been very limited. To date, three studies have investigated the prevalence and correlates of insomnia in older adults attending primary care, of which only one was conducted in China (16–18). By using DSM-III-R, Hohagen and colleagues assessed the presence of insomnia in a sample of 330 older patients from the offices of five general practitioners in Mannheim, Germany, and found a 23% prevalence of insomnia and its three significant correlates in older general practice patients: female sex, depression, and organic brain syndrome (16). In Kerala, India, Dahale and colleagues used the Insomnia Severity Index (ISI) to examine insomnia in 1,574 EPCAs from 71 primary care centers and found that 11.8% of the EPCAs suffered from clinical insomnia (17). Factors associated with insomnia in EPCAs in this study included older age, female sex, chronic medical illness, common mental disorders, and greater disability (17). In an urban primary care center in Shanghai, China, Xu and colleagues used the Pittsburgh Sleep Quality Index (PSQI) to screen for insomnia in a volunteer sample of 90 EPCAs and found the insomnia prevalence was 53.9%; however, this study did not analyze correlates of insomnia (18). Limitations of the only available study in China include the convenient sampling, the small sample size, and no inclusion of rural EPCAs. Further, although PSQI is often used to screen for insomnia with reasonable accuracy, it has been criticized for lack of specificity and its problematic factor construct and, strictly speaking, it is only suitable for the discrimination between "good" and "poor" sleepers, not individuals with and without insomnia (19–23). Therefore, the epidemiology of insomnia in Chinese EPCAs remains largely unknown.

To fill the above knowledge gaps, the current study was set out to investigate the prevalence and correlates of clinical insomnia in EPCAs from both urban and rural primary care centers in Wuhan, the largest city with more than 10 million residents in central China (24, 25).

Methods

Participants and sampling

Between October 2015 and November 2016, we conducted a large-scale cross-sectional survey among 791 EPCAs in seven urban and six rural primary care centers in Wuhan, China (8, 10, 26, 27). The outcomes of interest of this study included quality of life, common mental health problems, psychosocial problems, and insomnia. The present study focused on insomnia. Participants were recruited *via* two-stage cluster consecutive sampling. In brief, the first stage purposively selected 13 primary care centers from the 13 districts (seven urban and six rural) in Wuhan, one center each district, which were located in or nearest to the most populous area of the district. The second stage consecutively invited older patients who were 65 years old or over and seeking treatment at these primary care centers during the survey period of this study to participate. Patients who refused to participate and were not able to complete the survey due to severe physical illnesses and cognitive impairment and psychotic symptoms were excluded.

Before the fieldwork of this survey, the study protocol was approved by the Institutional Review Board of Wuhan Mental Health Center. All participants provided written informed consent before the interview.

Questionnaire and procedures

The survey instrument was a questionnaire, which was specifically developed for this study and was administered by

trained PCPs of the selected primary care centers in a face-to-face interview format.

Socio-demographic variables in the questionnaire were age, sex, education, marital status, self-rated financial status (good, fair, poor), residence place, living arrangement (alone or with others), and self-rated relationship with family members (good, fair, poor).

Lifestyle factors included smoking and physical exercise. Current smokers were those who were currently smoking at least one cigarette per day on at least 5 days per week (10). Respondents participating in physical exercise regularly were those having the habit of physical exercise (27).

A checklist was used to ascertain the presence of six chronic medical conditions: hypertension, diabetes mellitus, heart disease, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), and arthritis.

The validated Chinese Geriatric Depression Scale, 15-item version (GDS-15), was used to assess depressive symptoms (28–30). The total score of the GDS-15 is the sum of the 15 items, with a possible range of 0–15 and a cut-off score of five or more indicating clinically significant depressive symptoms in China (31).

We used the validated Chinese ISI to evaluate insomnia in the past 2 weeks, which is developed according to the DSM-IV diagnostic criteria for insomnia and consists of seven items scoring from "0 = none" to "4 = very severe" (32, 33). The ISI total score ranges from zero to 28, with ≥ 15 being considered as clinical insomnia (23, 34).

Statistical analysis

Prevalence of clinical insomnia was calculated. Chi-square test was used to compare rates of insomnia between/across subgroups according to characteristics such as sex and education levels. Binary logistic regression analysis with the forward selection (Wald) method was used to examine the independent correlates of insomnia. Statistically significant variables from the Chi-square test were included into the multiple logistic regression model. Odds Ratios (ORs) and their 95% confidence intervals (CIs) were used to quantify the associations between insomnia and correlates. The statistical significance level was set at $P < 0.05$ (two-sided). SPSS software version 15.0 package (SPSS Inc., Chicago, IL, USA) was used for all analyses.

Results

In total, 757 EPCAs completed the survey questionnaire. The mean age of the study participants was 72.78 years (standard deviation = 5.99, range = 65–97) and 407 (53.8%) were women. Characteristics of the study sample and prevalence rates of clinical insomnia by variables are shown in Table 1.

In total, 219 elderly patients (28.9%) had clinical insomnia (ISI score ≥ 15) during the past 2 weeks.

Results from Chi-square test (Table 1) display that significantly higher rates of clinical insomnia were observed in women (vs. men), in illiterate patients (vs. middle school and above), in patients with poor financial status (vs. good), in patients having poor and fair family relationship (vs. good), in patients suffering from hypertension, in patients suffering from heart disease, in patients suffering from COPD, in patients suffering from arthritis, and in patients having depressive symptoms ($P \leq 0.032$).

Six significant correlates of clinical insomnia were identified (Table 2): female sex (vs. male, OR = 2.13, $P < 0.001$), fair and poor family relationship (vs. good, OR = 1.59, $P = 0.028$), hypertension (OR = 1.67, $P = 0.004$), heart disease (OR = 1.73, $P = 0.048$), arthritis (OR = 2.72, $P = 0.001$), and depressive symptoms (OR = 4.53, $P < 0.001$).

Discussion

To the best of our knowledge, this is the first study in China that examined the epidemiological characteristics of insomnia in older adults attending primary care centers. The main findings are the 28.9% prevalence of clinical insomnia in EPCAs and six correlates of insomnia in this patient population: female sex, fair and poor family relationship, hypertension, heart disease, arthritis, and depressive symptoms.

In population-based studies using ISI and the same definition of clinical insomnia, the prevalence rates of clinical insomnia in rural community-residing older adults and older adults during the COVID-19 pandemic in China were 19.2 and 15.6%, respectively (22, 35). Compared to these prevalence estimates in the elderly population, we found a much higher prevalence of clinical insomnia in Chinese EPCAs. The 28.9% prevalence of insomnia in Chinese EPCAs is also much higher than the 11.8% prevalence of insomnia in India EPCAs (17). Because both older age and major medical conditions are major risk factors for insomnia in population-based studies (5, 35, 36), the elevated risk of insomnia in Chinese EPCAs might be primarily due to the older age and poor physical health of this older and physically ill population. In addition, we speculated that the very low treatment rate of insomnia in the elderly population in China might partly explain the high risk of insomnia in EPCAs (6).

In line with previous studies (15–17, 35, 37), we found the greater risk of insomnia in EPCAs who were women, had fair and poor family relationship, and were depressed. The higher prevalence of insomnia in females may be ascribed to their more vulnerability to negative socioeconomic factors and stressful life events in comparison to males (38). Further, women are more likely to develop common mental health problems, including depression and anxiety, which could result in elevated risk

TABLE 1 Characteristics of the sample of elderly primary care attenders and prevalence rates of clinical insomnia by sample characteristics.

Characteristics		No. of older adults	No. of older adults with insomnia symptoms	Prevalence (%)	χ^2	*P*
Sex	Male	350	74	21.1	19.199	<0.001
	Female	407	145	35.6		
Age (years)	65–74	490	146	29.8	0.507	0.477
	75+	267	73	27.3		
Education	Illiterate	177	67	37.9	14.457	0.001
	Primary school	216	69	31.9		
	Middle school and above	364	83	22.8		
Marital status	Married	529	149	28.2	0.498	0.480
	Others*	228	70	30.7		
Self-rated financial status	Good	133	30	22.6	8.808	0.012
	Fair	536	153	28.5		
	Poor	88	36	40.9		
Residence place	Urban	409	112	27.4	1.034	0.309
	Rural	348	107	30.7		
Living alone	No	673	195	29.0	0.006	0.939
	Yes	84	24	28.6		
Self-rated family relationship	Good	596	158	26.5	7.981	0.005
	Fair and poor**	161	61	37.9		
Currently smoking	No	637	190	29.8	1.574	0.210
	Yes	120	29	24.2		
Habit of physical excise	No	319	90	28.2	0.138	0.710
	Yes	438	129	29.5		
Hypertension	No	390	92	23.6	11.158	0.001
	Yes	367	127	34.6		
Diabetes	No	642	179	27.9	2.259	0.133
	Yes	115	40	34.8		
Heart disease	No	678	186	27.4	7.075	0.008
	Yes	79	33	41.8		
Stroke and other cerebrovascular diseases	No	693	199	28.7	0.183	0.669
	Yes	64	20	31.3		
Chronic obstructive pulmonary disease	No	713	200	28.1	4.615	0.032
	Yes	44	19	43.2		
Arthritis	No	700	190	27.1	14.441	<0.001
	Yes	57	29	50.9		
Depressive symptoms	No	522	98	18.8	84.355	<0.001
	Yes	235	121	51.5		

*"Others" included never married, separated, divorced, widowed, cohabitating, and remarried.
**Because of the very small numbers of the category of "poor" relationship ($n < 10$), "poor" and "fair" were merged into one category.

of insomnia in women (37). The close relationship between depression and insomnia has been consistently reported in various populations including the EPCAs (16, 17, 35, 39). The reciprocal relationship between depression and insomnia might be explained by their shared pathophysiological pathways, including gut microbiome composition, genetic overlap, and neurotransmitter system in the brain (40). The traditional Chinese culture values filial piety and family harmony, which are significant determinants of mental wellbeing in older Chinese adults (41, 42). Because Confucianism is deeply rooted in values, beliefs, and attitudes of older Chinese adults (43), the significant association of insomnia with fair and poor family relationship, an indicator of family disharmony, is expected.

The etiology of insomnia is multifactorial and involves various social, mental, and physical factors (15). In the literature, medical conditions linked with insomnia include cancer, heart

TABLE 2 Correlates of clinical insomnia in elderly primary care attenders.

Factor	Risk level	Reference level	Coefficient	Standard error	χ^2	*P*	OR (95%CI)
Sex	Female	Male	0.757	0.183	17.154	<0.001	2.13 (1.49,3.05)
Self-rated family relationship	Fair and poor*	Good	0.462	0.211	4.809	0.028	1.59 (1.05,2.40)
Hypertension	Yes	No	0.512	0.180	8.073	0.004	1.67 (1.17,2.38)
Heart disease	Yes	No	0.548	0.277	3.924	0.048	1.73 (1.01,2.98)
Arthritis	Yes	No	1.001	0.310	10.440	0.001	2.72 (1.48,4.99)
Depressive symptoms	Yes	No	1.512	0.182	69.056	<0.001	4.53 (3.17,6.48)

*Because of the very small numbers of the category of "poor" relationship (n<10), "poor" and "fair" were merged into one category.

disease, high blood pressure, diabetes, arthritis, chronic pain, and gastrointestinal problems (44–46). Our findings on the significant associations of insomnia with hypertension, heart disease, and arthritis are consistent with prior studies. The physical discomfort, pain, and feelings of depression and stress caused by major medical conditions may explain the elevated risk of insomnia in EPCAs with hypertension, heart disease, and arthritis.

This study has a few limitations. First, this is a cross-sectional study, so the causality between identified correlates and insomnia cannot be inferred in EPCAs. Longitudinal data are warranted to answer this clinical question. Second, we did not assess the recognition and treatment of insomnia in EPCAs by PCPs and older patients' attitudes toward sleep health services provided in general practice, which are important for the planning of sleep health services in Chinese primary care centers. Third, some factors associated with insomnia such as social support, chronic pain, and environmental noise were not measured in this study.

In conclusion, nearly 30% of the Chinese EPCAs suffer from clinical insomnia, suggesting a high level of sleep health need in older patients in China's primary care settings. Considering the many negative outcomes associated with insomnia and the inadequate mental health service resources in China (25), it is necessary to integrate sleep health into primary care. Sleep health services for Chinese EPCAs need to include periodic screening for insomnia, expanded psychosocial supports, effective management of major medical conditions and depression, and, when necessary, referral to psychiatrists and sleep specialists. Further, services for EPCAs would be more effective if they targeted those who are women, have fair and poor family relationship, suffer from several chronic medical conditions such as hypertension and arthritis, and are depressed.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Institutional Review Board of Wuhan Mental Health Center (approval number WMHC-IRB-S065). The patients/participants provided their written informed consent to participate in this study.

Author contributions

B-LZ: acquisition and analysis of data for the study, drafting the article, and interpretation of data for the study. H-JL and Y-MX: design and acquisition of data for the study. X-FJ and B-LZ: drafting the article, revising the article for important intellectual content, and interpretation of data for the study. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Vigorous physical activity and self-rated health during adolescence: A cross-sectional survey

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Background: Despite the positive relationship between self-rated health and general physical activity, very little research has touched upon the relationship between self-rated health and vigorous physical activity. Such research will help to promote self-rated health among adolescents by addressing the close relationship between self-rated health and the components of physical activity.

Purpose: In this study, the relationship between self-rated health and vigorous physical activity among Chinese adolescents were analyzed.

Methods: The current study was based on a collaborative survey conducted by the WHO in several nations, and the data generated by Health Behavior in School-aged Children every 4 years on health behavior were adopted. The school class was taken as a basic unit for sampling. Cluster sampling was performed systematically, and the possibility was proportional to the population. The sampling was conducted to collect typical cases. The class teachers were informed of the sampling activities, and they were to collect data on the students by distributing the questionnaires.

Results: The research included 116,828 respondents from 36 countries. Among them, 51.82% were girls and 48.18% were boys. A total of 98.54% of the respondents considered their health status as fair or above when completing the questionnaire, while 1.46% believed that their health status was poor. Moreover, more than 86% of the respondents participated in vigorous exercise more than weekly, and better self-health ratings were found among respondents who exercised more than weekly (once a week: OR = 1.95, CI: 1.86–2.04; two or three times a week: OR = 1.69, CIL: 1.63–1.76; four or six times a week: OR = 1.30, CI: 1.25–1.35). Certain respondents reported better results for self-rated health (4–6 h every week: OR = 1.36, CI: 1.30–1.43; 2 or 3 h every week: OR = 1.48, CI: 1.42–1.55; 1 h every week: OR = 1.64, CI: 1.57–1.72).

Conclusion: In this study, empirical evidence is provided for the relationship between self-rated health and vigorous physical activity among adolescents. From the results, it can be observed that there is a positive relationship between self-rated health and vigorous physical activity among adolescents.

KEYWORDS

vigorous physical activity, self-rated health, adolescence, HBSC, survey

Introduction

Self-rated health (SRH) has been identified as a standard measure for evaluating perceived health status in public health surveys (1). SRH refers to one's perception of one's overall health status, physical health and mental health (2, 3). SRH is usually measured by using a five- or four-point Likert Scale, which can indicate one's perceived health status (2). According to the World Health Organization (WHO), SRH is more important than traditional morbidity and mortality in evaluating health outcomes in adolescents (4–7). SRH consists of several components, such as general physical functioning, psychological health and health behaviors (8). In numerous previous studies, SRH has been proved to be an important indicator of several health outcomes, including body fatness (9), mental health (10, 11), morbidity (12) and mortality (13, 14). Accordingly, a high prevalence of poor SRH has been well-documented in previous studies (15–17). For example, a population-based survey indicated that 11% of participants rated their health as poor and a decline in SRH with age was found among adolescents residing in urban areas (15). In another large sample survey, 20.9% of Iranian adolescents rated their SRH as poor (17). However, data from a longitudinal cohort study demonstrated that a generally high (%) SRH was reported in Swedish adolescents, especially in boys (18). Furthermore, gender differences in SRH were also found in the previous studies, where boys reported higher SRH than girls (15, 18). By contrast, one Chinese cross-sectional study revealed that the gender differences in SRH were not significant among Chinese adolescents (19). In addition, data from the Health Behavior in School-aged Children (HBSC) survey indicated that more adolescents reported higher SRH and boys rated their health as better than girls.

The positive association between health-related behaviors such as physical activity (PA) and health outcomes has been well-documented in previous studies (20–23). PA is an important predictor of self-perceived health in adolescents (24). Thus, results from a review study showed that most of the included cross-sectional studies reveal that high PA is associated with better SRH in adolescents (8, 25). Furthermore, only four studies did not report a significant association between physical activity and SRH in children and adolescents, which can be explained by the limitations of the studies' designs (8). In addition, a dose-response association between PA and SRH was reported in this review, which indicated that higher PA is linked with higher SRH (8). For example, data from one cross-sectional study indicated that, compared with adolescents recognized to be physically inactive, those adolescents who participated in PA every day were over 11-times more likely to rate their perceived health as "good or excellent" (OR: 11.5; 95% CI: 2.0–65.8) (26). Similarly, one Canadian study also revealed that more physically active adolescents were more likely to report "very good or excellent" SRH than their inactive peers (11). A longitudinal study also reported similar findings (3, 27). For instance, a prospective study (with 4 years of follow-up) revealed that adolescents with insufficient PA tended to rate their perceived health as "poor" (3, 28).

There are an increasing number of researchers showing that an increase in PA from moderate to vigorous plays a critical role in preventing non-communicable diseases (NCDs), such as type II diabetes, cardiovascular disease, obesity and some cancers (29–31). Despite the positive associations between overall PA and SRH, few studies have focused on the relationship between vigorous PA (VPA) and SRH. Identifying strong associations between different types of PA and SRH could be beneficial for the promotion of intense PA in adolescents. Therefore, the present study aimed to explore the association between VPA and SRH in adolescents using public data.

Methods

Study participants and design

For the implementation of "Health Behavior in School-aged Children" (HBSC), a cross-sectional study was conducted and relevant research was performed according to the international HBSC protocol (32). This was a collaborative survey by the WHO that was conducted across different nations, and data on health behavior were collected using the HBSC regularly, that is, every 4 years. The samples are representative of adolescents aged between 11 and 15 years in the nation. The class at the school was considered a basic sampling unit. The cluster sampling was systematic, and the probability was proportional to the population. The sampling was performed to obtain samples that were representative of the nation. The teachers of the classes to be sampled were informed, and they collected information on the students by sending them information sheets. There was

a brief introduction to the survey on the information sheets, and the students gave the sheets to their guardians or parents. If students refused to take the survey, then they were required to sign opt-forms and give them back. The data were collected anonymously, and standard measures were also taken to protect the students' private information. The teachers responsible for the survey were well-trained, and they sent a self-compiled, anonymous and standard questionnaire to the respondents. The specific information on the protocol, the theoretical framework and the purpose of the international research are described elsewhere (33, 34). Based on the survey performed in 2013 and 2014, the feedback rate was 85% and above in most of the schools and classes and among most of the students (35). The data were collected randomly, and the respondents were representative of the nation; there were 108,666 girls and 105,414 boys.

Measures

Vigorous physical activity (independent variables)

To measure VPA, the two questions below were asked. The first one was "how often did you do a workout by which you sweat or get out of breath after class?" The answers included never, less than once a month, once a month, once a week, 2 to 3 times a week, 4 to 6 times a week and every day. The second one was "how long did you spend on a workout after class by which you sweat or get out of breath?" The answers included about 7 h or more, about 4 to 6 h, about 2 to 3 h, about 1 h, about half an hour and none. The reliability and validity of the questions were tested several times and determined to be good, as described elsewhere (36, 37).

Self-rated health

Self-rated health was assessed using a Likert response scale, with a single question — "Would you say your health is…?"— and a four-point response scale was used including the categories excellent, good, fair and poor. SRH is a standardized indicator that has frequently been used in various areas of health research (38, 39).

Covariates

Information on the study participants' sex, age and country were included as covariates, in line with previously published studies (40, 41). These variables were adjusted for further statistical analysis.

Statistical analysis

Statistical Package Social Science (SPSS) version 23.0 was used for all the statistical analyses in this study. Descriptive analysis was used to report the sample characteristics; percentages and means with standard deviations are used to describe categorical and continuous variables. An ordinal regression model within a generalized linear model was used to establish the association between independence and outcome. After excluding missing cases of variables included in this study, 116,828 samples were included for final analysis. Parameters on model fit and diagnosis were also reported. The significance of the statistical test was set up as $p < 0.05$.

Results

Table 1 presents the sample characteristics of this study. According to Table 1, 116,828 participants from 36 countries were involved in this research, of which 48.18% were boys and 51.82% were girls. In terms of age composition, adolescents aged 15 made up the largest proportion of the whole sample, at 37.10%. This was closely followed by the group of adolescents aged 13, which accounted for 35.08%, while adolescents aged 11 comprised the smallest proportion of the sample, at 27.83%. Table 2 depicts the participants' results regarding their SRH and the frequency and duration of VPA per week.

As shown in Table 2, 98.54% of the adolescents in the study gave a fair or above rating for their health, while only 1.46% of the adolescents rated their health as poor. In addition, more than 86% of the adolescents engaged in vigorous exercise at least once a week. Meanwhile, 13.46% of the adolescents had conducted vigorous exercise no more than once a month, while 4.94% had never carried out VPA. Furthermore, over 90% of the adolescents did at least half an hour of VPA per week, with the majority choosing to exercise for 2–3 h a week.

Table 3 reveals the relationship between the frequency and duration of VPA and SRH among adolescents. Generally, worse SRH was observed among participants who participated in less VPA in terms of both frequency and hours (once a week: OR = 1.95, CI: 1.86–2.04; 2–3 times a week: OR = 1.69, CI: 1.63–1.76; 4–6 times a week: OR = 1.30, CI: 1.25–1.35). In addition, less vigorously active adolescents were more likely to report worse SRH (4–6 h per week: OR = 1.36, CI: 1.30–1.43; 2–3 h per week: OR = 1.48, CI: 1.42–1.55; 1 h per week: OR = 1.64, CI: 1.57–1.72) compared with those reporting 7 h or more. The results for the covariates included in the model were also shown in Table 3.

Discussion

The main aim of the present study was to analyse the association between VPA and SRH in adolescents, using public data based on a large sample size from the HBSC survey in 42 European countries. This study mainly that after controlling for some significant covariates, there was a significant association

TABLE 1 Sample characteristics of this study.

	Proportion
Country	
Albania	3.12%
Armenia	1.25%
Austria	2.12%
Belgium (Flemish)	2.73%
Bulgaria	2.91%
Canada	6.50%
Switzerland	4.44%
Czech Republic	3.48%
Germany	3.40%
Denmark	2.41%
Estonia	2.65%
England	1.49%
Spain	4.22%
France	3.37%
Greece	2.97%
Croatia	3.14%
Hungary	2.65%
Ireland	0.72%
Israel	1.04%
Iceland	6.24%
Italy	2.65%
Luxembourg	1.73%
Latvia	4.02%
Republic of Moldova	3.82%
Makedonski denar	1.21%
Malta	0.88%
Netherlands	2.56%
Norway	0.28%
Poland	3.23%
Portugal	3.60%
Romania	1.67%
Russian Federation	2.94%
Scotland	1.26%
Sweden	4.38%
Slovenia	3.42%
Wales	1.48%
Sex	
Boy	48.18%
Girl	51.82%
Age category	
11	27.83%
13	35.08%
15	37.10%

TABLE 2 Descriptive results for outcome and independents.

	Proportion
Self-rated health	
Excellent	36.36%
Good	50.80%
Fair	11.39%
Poor	1.46%
Vigorous physical activity frequency	
Every day	17.94%
4–6 times a week	25.12%
2–3 times a week	30.08%
Once a week	13.39%
Once a month	3.83%
Less than once a month	4.69%
Never	4.94%
Vigorous physical activity hours a week	
7 h and more	11.38%
4–6 h	15.27%
2–3 h	26.40%
1 h	22.80%
Half an hour	14.76%
None	9.38%

between VPA and SRH in adolescents. More specifically, more participations in VPA and more durations of VPA were both two potential contributors to adolescents' SRH. More analysis is displayed below.

The current study indicated that adolescents who reported higher levels of VPA were more likely to rate better perceptions of health. This research finding was consistent with the previous studies. Another study (42) investigated the relationship between VPA and SRH. Similarly, another study found a positive correlation between more participation in PA at higher intensity, further demonstrating the roles of VPA on SRH outcomes in adolescents. Collectively, the current study, alongside previous studies, provides new insights into the current limited knowledge of VPA and health promotion research.

Some underlying mechanisms can be used in this study for a better understanding of the roles of VPA on SRH in adolescents. A recent meta-analytical study found that VPA would contribute to physical health outcomes (43), including lower risks of adiposity and cardiovascular diseases. This review suggests that adolescents participating in more VPA are likely to be healthier than those participating in less VPA, making those with higher VPA report better SRH. In addition to physical health outcomes, emerging evidence has suggested that participating in more VPA can to some extent promote mental health and well-being (44, 45). Similar to explaining the roles of VPA on physical health indicators, owing to contributions of VPA to mental health, it is also available that adolescents who reported VPA to display better mental health, then rating better perceived overall health. Although speculative, it is reasonable to assume the positive roles of VPA

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TABLE 3 Results for the associations between vigorous physical activity and self-rated health.

	OR	95% CI		*p*-value
Frequency (ref = Every day)				
4–6 times a week	1.30	1.25	1.35	0.000
2–3 times a week	1.69	1.63	1.76	0.000
Once a week	1.95	1.86	2.04	0.000
Once a month	2.14	2.00	2.29	0.000
Less than once a month	2.29	2.15	2.45	0.000
Never	2.08	1.94	2.24	0.000
Hours (ref = 7 h or more)				
4–6 h	1.36	1.30	1.43	0.000
2–3 h	1.48	1.42	1.55	0.000
1 h	1.64	1.57	1.72	0.000
Half an hour	1.72	1.63	1.81	0.000
None	1.62	1.52	1.73	0.000
Sex (ref = girls)				
Boys	1.43	1.40	1.46	0.000
Age (ref = 11 years)				
15 years	1.74	1.69	1.79	0.000
13 years	1.41	1.37	1.45	0.000
Country	1.01	1.009	1.01	0.000

OR, odd ratio; CI, confidence interval; ref, reference group.

in the promotion of healthy adolescents, the actual underlying mechanism explaining the association between VPA and SRH should be further clarified.

This study also suggested that adolescents reported participating less in VPA. In comparison to those in a national study, 43.06% of the adolescents reported that they participated in VPA four or more times a week, and this prevalence is similar to that of their European counterparts (ranging from 37% to 57%) (46). Compared with that in another cross-sectional study, however, the prevalence of frequent (four or more times a week) VPA in the present study was lower than that in Icelandic adolescents (64.3%) (47). In addition, 86.54% of the adolescents in the present study participated in VPA more than once a week, which is in line with a previous study (48). In the aforementioned study, 84% of American adolescents engaged in VPA more than once a week (48). Owing to the health benefits of VPA, it should be considered to increase VPA in adolescents.

Compared with previous studies, the current study focused on VPA rather than moderate to vigorous physical activity, which can add new evidence to the literature. To our knowledge, previous studies primarily laid sufficient research interest and attention on MVPA and SRH, while very few studies collected information on VPA in insolation. Our study, based on a large sample size, provides new insights into, advancing the knowledge on the associations between PA at different intensities and health outcomes in adolescents. Considering our preliminary evidence in our study, regarding VPA and SRH, it helps strengthen the current PA guidelines to include more recommendations on PA at a higher intensity. However, the research findings in the present study were based on self-reported measures, which are subject to measurement errors. Thus, research findings concerning the association between VPA and SRH may be potentially influenced. Future studies are promising to use more advanced measures to estimate the associations between VPA and SRH in adolescents.

Implications

Although the results of the present study cannot provide causal evidence, the positive relationship implies that VPA might be an important contributor to SRH in adolescents. Given the findings from the present study, there is a potential to promote SRH by increasing VPA in adolescents. Future interventional studies should explore how to increase VPA levels in adolescents.

Study limitation

Several limitations of the present study should be noted. First, the data included in the analysis were from a cross-sectional study, which might not provide a causal explanation for the association between VPA and self-rated health in adolescents. The second limitation is the use of self-administrated measurements, which may have contributed to the overestimation of VPA and self-rated health in adolescents.

Conclusion

This study provides empirical evidence for the association between VPA and self-rated health in adolescents and indicates that VPA is positively associated with self-rated health in adolescents. For efficient health promotion in adolescents, it would be better to encourage adolescents to participate in more VPA.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

All data were anonymized and publicly available; therefore no ethical approval was required. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

YW and JW: writing—original draft. JW and GC: formal analysis. YW, JW, GC, and WS: writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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The effects of forest therapy on public mental health and circular economy: A policy support model in Japan

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Background: Forest therapy has gained popularity in Japan and even other nations/regions due to its health benefits. In addition, forest therapy has contributed to the development of circular economy and industrial upgrading. Japanese successful practice can serve as a model for other countries in the Asia-Pacific region. To this end, the aim of this study was to determine whether forest therapy can improve the whole well-being of the participants and has a positive effect on the development of circular economy in the region.

Methods: Both empirical and inductive research methods were used; empirical approach was conducted to perform comparative analysis of regional data that was retrieved from the research project of Japanese Forestry Agency in 2015. Specifically, the efficacy of forest therapy on physical (blood glucose, blood pressure, body weight) and mental (sleep quality e.g.,) health outcomes among 815 participants was investigated. Regional data are from the statistics of Iiyama City from 1990 to 2005. After the concept of forest therapy became popular in the late 1990s, this element had a great positive impact on the economic benefits of Ishiyama City and other major forest scenic areas. We summarize and analyze a series of policies made by relevant departments of the Japanese government in the years from 2019 to 2021 to promote forest therapy and related circular industry development.

Results: Significant (pre-to-post participation) changes in physical measure was observed. Firstly, mean weight of those overweight participants decreased across three different time points (pre-test/enrollment = 79.7 kg, 3-month participation = 77.2, and 6-month participation = 76.8 kg), while overall mean weight of the participants decreased to 61, 60.5, and 60.4 kg, respectively. Secondly, Participant with normal weight showed a decrease on mean HbA1C (from 6.09 to 6.06) at Week 24, while overweight participants demonstrated a slight change 6.03–6.01 after 6 months the average HOMA-IR for overweight participants decreased from 3.5 to 2.5 at Week 24, while participants with normal weight demonstrated a decrease from 2.2 to 1.7 at Week 24. Forest Therapy has emerged in Japan since Mid-1990s and has attracted a large number of tourists all over the world due to its unique health benefits.

Conclusion: Forest therapy in Japan has positive effects on whole well-being of Japanese residents and it has helped public mental health promotion and economic growth. Under the guidance and support of government policies, it can promote the development of circular economy and industrial transformation and set a model of Japanese forest therapy development for other countries in the Asia-Pacific region.

KEYWORDS

public mental health, Circular economy, Forest therapy, MBPS, policy support, Japan

Introduction

The gap between global environmental degradation and rising health expectations

With rapid economic growth over half century, the ecological environment has been severely damaged due to excessive use of natural resources and excessive emissions of carbon dioxide. Such environmental change has not only resulted in physical and mental health issues but also affected global sustainable development. Specifically, living environment becomes worse as the economic development continues, which is not the ideal way of life (1). Deterioration of ecological environment is one of the greatest challenges for humanity as the temperature of the earth's surface continues to rise (2). If developed economies do not lead the world on a sustainable development path, human health will continue to suffer from environmental pollution (3). As the earth's environment has become irreversibly worse than before the industrial era, the generations between the 1960s and 2020s will be more exposed to the effects of extreme climate events, and their living environment will be significantly worse (4). This means that modern people are more prone to the decline of immunity resulting frum environmental problems, making human health problems more serious (5, 6). The pace of modern society is fast, and people generally feel that life is too stressful, which can easily lead to the deterioration of people's health (7). The approach to this problem must be pluralistic as health goals and biobased-economy development paths can only be considered in conjunction with better public policy (8).

From late 2019, human health issues (like depression, anxiety, sleep problem, increased sedentary behavior, and physical inactivity) are much more complicated than ever due to the COVID-19 pandemic (9–14). People's health has been affected by various social pressures, which have been exacerbated by the pandemic that has been ravaging the world for 3 years (15–20). The pandemic does not only dealt a fatal blow to human beings physically (20–23), but also caused great economic and mental pressure due to the prolonged lockdown (24–29). Only in the first year of the COVID-19 pandemic, global prevalence of anxiety and depression increased by a massive 25%, according to a scientific brief released by the World Health Organization (WHO) (30). The unprecedented stress has been caused by the social isolation resulting from the pandemic (31–33). All age groups with health and clinical conditions reported different levels of mental health issues because of the pandemic (34–41). Even if some people are allowed to travel, they must endure long quarantines at their destination hotels. These restraints have had a serious negative impact on people's health (42).

Japanese forest therapy as a classic mindfulness-based practices

Regular engagement in physical activity is an important way to maintain well-being (43–47). Within an umbrella of physical activity, mindfulness-based Practices (MBPs) as traditional Eastern approaches have a greater emphasis on coordinative slow movement and deep breathing technique in line with meditative state (48–51). Such unique (easy-to-learn and safe) features have attracted significant number of practitioners (including those with chronic illness) (52–57) because its positive effects on relieving stress-related negative emotion and rehabilitative outcomes. MBPs play an increasingly important role in health and circular economy promotion, especially in a policy environment where people are under pressure to reduce carbon emissions.

Forest therapy in Japan is at the forefront of MBPs as a natural health treatment (58). Japan's vision of the effects of mindfulness is not limited to a single aspect. Forest therapy is an important way to bring together mindful exercise, mental health, and forest circular economy, as the idea of circular development has a very good historical and policy foundation in Japan, and it integrates comprehensive cognition of medicine, health science, economics, and public policy (59). The aim of this study was to analyze the reason how Japan makes forest therapy and the circular economy promote each other from the perspective of public policy and study the way how Japan combines the forest resources and the MBPs, encourages people to live in harmony

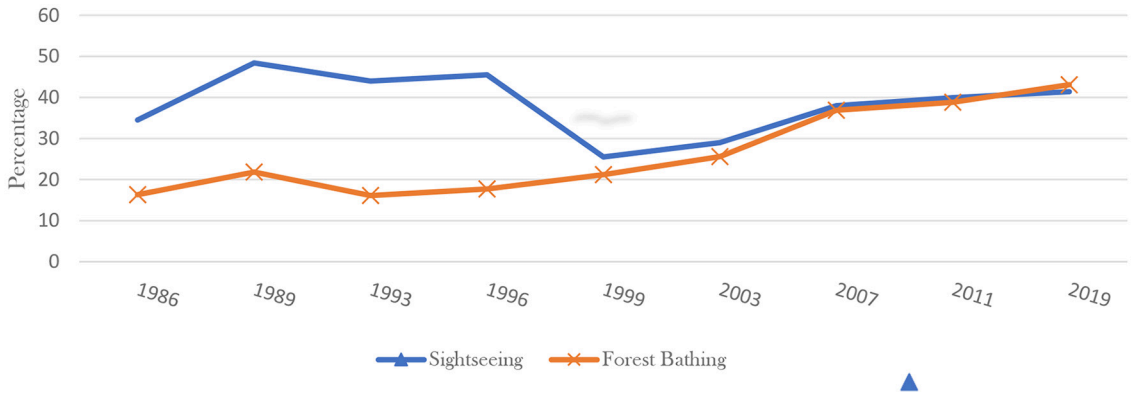

FIGURE 1
Forest bathing accounts for the percentage of people who go to the forest.

with nature, better improving national health level (60). As the idea of ESG (Environmental, Social and Governance factors to evaluate companies and countries on how far advanced they are with sustainability) gradually prevails in the global development, the Japanese government firmly increases the investment and protection of forest resources through various policies, which has laid a good policy foundation for encouraging people to go into the forest and carry out MBPs treatment. Especially in the post-COVID-19 era, Japanese governments at all levels have reached a strong consensus on the coordinated development trend of forest therapy industry and circular economy in the face of great challenges posed by long COVID syndrome.

Japan focuses on the multiple functions of forest resources

Japan's forest coverage is 68.5 percent, and its forest service industry policy is also quite comprehensive and detailed. Japan attaches great importance to the dual benefits of forest industry for people's health, well-being and the circular economy of the society and has set up forest therapy bases throughout the country since 1997 (61, 62). These specific projects are undertaken by local governments, medical groups, tourism bases and other groups. Many local governments would take forest resources into account when they launch regional development policies (63). Forest resources will play an even greater role in economic and health recovery in the post-pandemic period, especially after the novel Coronavirus impact and the mental health problems caused by the prolonged lockdown.

Forest therapy encourages enterprises and local governments to maintain and use forest resources under good planning. In the use of forest resources at the same time, a large number of people will be directed to the forest, and then the forest function and economic development combined, which is more in line with the concept of circular development in Japan. It is obvious that the market mechanism will not spontaneously adjust to this goal. The government needs to use policy tools to guide local governments and enterprises to see the advantages of combining the dual functions of forest resources for health care and circular economy. Such a development philosophy would reduce the destruction of forest resources by local governments and curb their urge to develop polluting industries (64). In recent years, forest therapy and its estimated preventive effect are attracting more and more attention (65). Facing the great pressure of carbon neutrality, the world should seriously consider the positive effects of circular economy on human beings (66). Japanese forest therapy is going global as many other countries start to accept the MBPs effectiveness of the forest therapy (67). In the era of global bio economy, major economies have developed many financial products related to sustainable development (68, 69). Japan's forest health industry and circular economy model are worthy of reference by the international financial community to better play the role of ESG in sustainable development.

Materials and analysis

Forest therapy as an MBPs way for national health promotion

Japan has the longest life expectancy in the world and is also a country rich in forest resources. In mindfulness therapy, one of the main contents is to regulate mental state and reduce mental stress through meditation. From the perspective of the relationship between Japanese traditional culture and mindfulness meditation, mindfulness refers to spiritual baptism, which means that one can get spiritual sublimation. When conducting forest bathing, many activities can also be defined as MBPs and become part of forest therapy. From the perspective of participants, MBPs plays a regulating role in all aspects of the practice of forest therapy participants, by releasing the mental

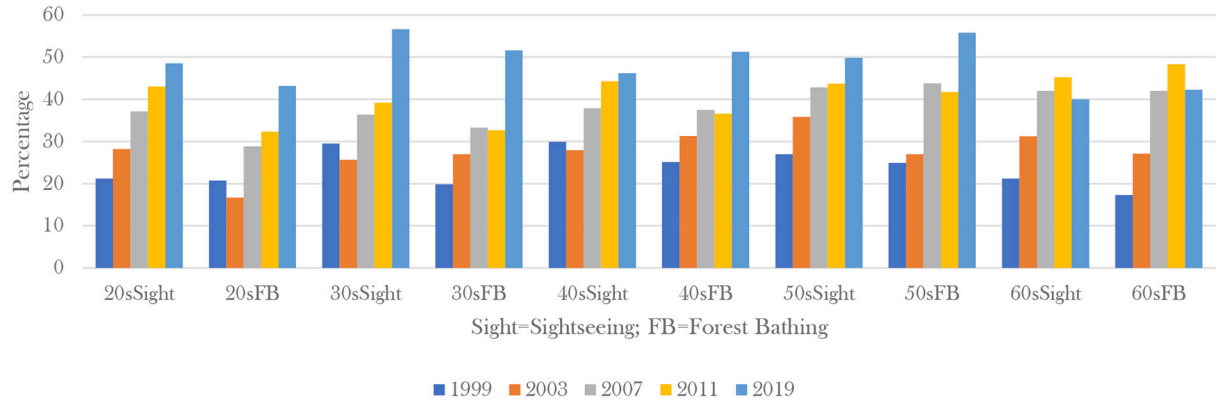

FIGURE 2
Comparison of the share of visitors in forests with sightseeing and forest bathing. *In Japan, forest bathing is not only for the purpose of medical care, but also closely combined with tourism. Japan has one of the highest population densities in the world. For many Japanese people, the forest is one of the main places to release the pressure of life and adjust their emotions, so the activity of forest bathing is often with the purpose of leisure play (73).

pressure and anxiety of participants, transfer their attention, reduce the psychological burden caused by the body and mind, so as to make their actions more natural and healthier (70). The Japanese place great emphasis on improving their health by exercising in the forest (71, 72). A continuing survey of the Cabinet Office, Government of Japan from 1986 released around every 3 or 4 years has revealed Japanese people's enthusiasm for forest bathing. The data indicates that Forest Bathing therapy as the purpose of visitors in forests has always ranked second (Figure 1) and even turned to get the first position in 2019. The upward trend that people go to forests for enjoying forest bathing has continued since the early 1990s.

The relationship between forest therapy and people's pursuit of health is even more evident when we compare specific data on visitors of different age groups. We can tell people under 40s year-level are more interested in sightseeing in forests while the purpose of forest bathing therapy of people over 40 almost surpassed the youth generations (Figure 2) in all surveys (73). Young people have no health pressure, so sightseeing is the primary purpose of visiting the forest. The fact that people over 40 years of age chose forest bathing as their first choice for forest activities shows the impact of forest therapy on health. Different from the Western view of life and death, East Asian cultural traditions place special emphasis on health, longevity and harmony between nature and human-being. Especially in Japan, a country that attaches great importance to the harmonious coexistence between nature and human-being, many elderly people see forest therapy as a way to bring them closer to nature and maintain physical and mental health. Evidence has shown that forest therapy can indeed keep the body functioning in balance, so forest therapy has been recognized and accepted by more and more Japanese people, especially the elderly (61).

TABLE 1 Health condition of all participants in SLS program in 2016.

Basic physical condition of 815 participants in 2016 SLS

Health index	Category		Male		Female
Obesity	BMI (kg/m^2)	58.6	76%	35.3	41.60%
	Waistline (cm)	71.8		30.2	
Blood pressure	Systolic (mmHg)	38.6	46.70%	30.2	33.90%
	Diastolic (mmHg)	35.1		13.5	
Blood lipid	HDL-C (mg/dl)	9.8	76.30%	2.4	71.80%
	LDL-C (mg/dl)	61.4		67.3	
Blood glucose	FPG (mg/dl)	48.8	85.10%	29	84.90%
	HbAlc (%) (NGSP)	78.2		80.8	

Data Source: Ministry of health, labor and welfare of Japan.

Data analysis of specific case-group from Japanese national forest therapy bases

Ministry of Health, Labor, and Welfare (MHLW) and Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan have jointly launched a forest therapy program, names as Smart Life Stay (SLS) from 2016, which aims to help improve health of the people who have higher blood glucose through forest bathing therapy. According to the data from MHLW, there are more than 11 million people whose HbA1c value is higher than 6%, 6.8 million's HbA1c value is higher than 6.5% and 2.7 million confirmed diabetics cases in Japan. The Japanese government set up 23 pilot forest therapy bases mainly in Honshu Island and Kyushu Island. The program typically consists of several consecutive days of forest therapy trips, during which visitors are instructed in specific diet management, exercise management and forest bathing activities. Physical data were

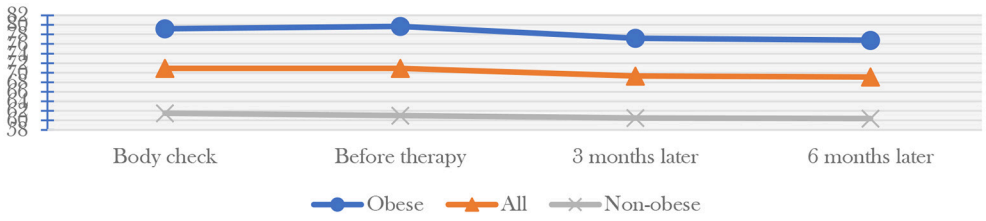

FIGURE 3
Weight Effect on participants after the forest therapy activity.

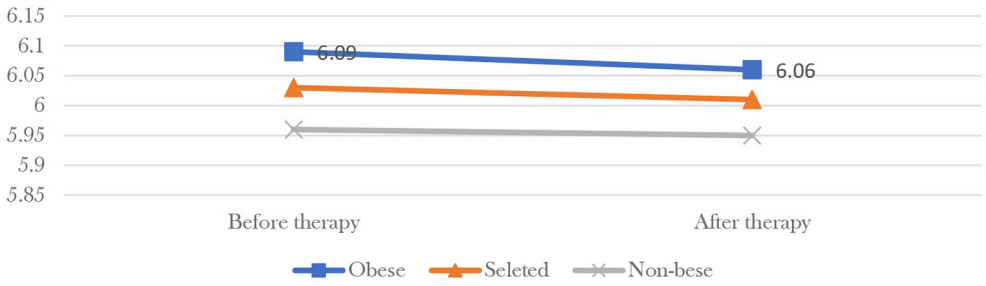

FIGURE 4
HbA1c value change of selected participants at four pilot bases. * HbA1c is a term commonly used in relation to diabetes. The term HbA1c refers to glycated hemoglobin. HbA1c is a product of glucose bound to hemoglobin in red blood cells. To a certain extent, the higher the blood glucose, the longer the duration, the higher the value, which can reflect the average blood glucose level in the past 2–3 months and has been used as the gold standard to evaluate the long-term blood glucose control in clinical practice. The normal reference value of the standard HbA1c detection method is 4–6%. Generally, diabetes requires HbA1c value below 7%, and >7% means an increased risk of diabetic complications. It develops when hemoglobin, a protein within red blood cells that carries oxygen throughout the body, joins with glucose in the blood, becoming "glycated". In Japan, 6% proposed by the Japanese Diabetes Society in 2013 is generally used as the baseline point of treatment, and the goal is to keep the blood glucose value below 6% when people with diabetes receive relevant treatment. When the blood glucose level is between 6 and 7%, it means that attention should be paid to whether there are complications during treatment. When the blood glucose level is between 7 and 8%, it means that the condition of diabetes has become more serious.

compared before and after the program, and two more tests were conducted at 3 and 6 months after the program ended to confirm the effects of forest therapy on the health of the visitors. In addition, participants were also compared with many random non-participants.

MHLW released the data of total 815 participants of the program in 2015 (Table 1), including 570 males between 50 and 55 years old and 245 females between 55 and 59. It was clear that most of the participants had health problems, particularly regarding hyperlipidemia and hyperglycemia, most of them had problems. 76% percent of the male participants were obese. The participants' weight fell (Figure 3) from the two medical examinations 3 and 6 months after the treatment. Obese people lost the most weight, from 79.7 to 77.2 kg after 3 months and 76.8 kg after 6 months on average. The corresponding figures for all participants on average are 70.9, 69.3, and 69.1 kg, for non-obese participants are, respectively 61, 60.5, and 60.4 kg. More than 98% of the participants were satisfied with the program's activities finally.

Considering that 85 percent of all participants had hyperglycemia, the government used data from 195 randomly selected participants at four pilot bases (Figure 4) to show that the HbA1c (form of hemoglobin that is chemically linked to glucose) value of obese participants dropped from 6.09 before participation to 6.06, 6 months later, the non-obese from 5.96 to 5.95, and the overall mean from 6.03 to 6.01. The government also selected 118 participants from Aichi Prefecture to compare the change of HOMA-IR (important indicator of insulin resistance) value before and after the therapy (Figure 5), found the value of obese participants dropped from 3.5 before participation to 2.5, 6 months later, the non-obese from 1.3 to 1.2, and the overall mean from 2.2 to 1.7. Finally, data from all participants were compared with a randomly selected control group of non-participants and the effect was found to be significant.

Case of Iiyama city, Nagano prefecture

Policy support for forest therapy bases requires the efforts of local governments. For the forest base to operate for a long time and benefit residents and tourists, it must obtain the policy support from all aspects of the government. Two cities in Nagano

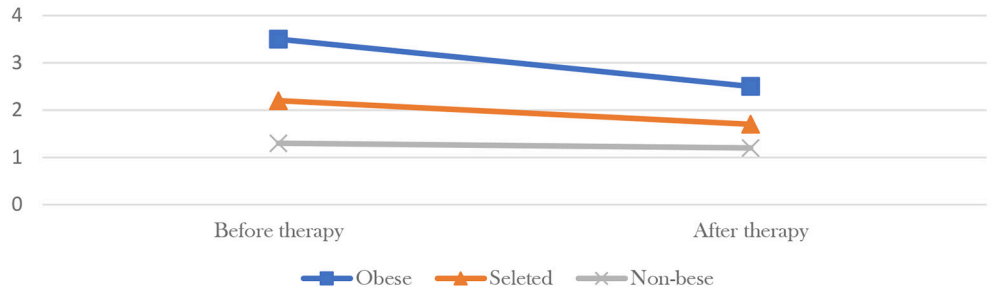

FIGURE 5
HOMA-IR change of selected participants in Aichi Prefecture pilot base.

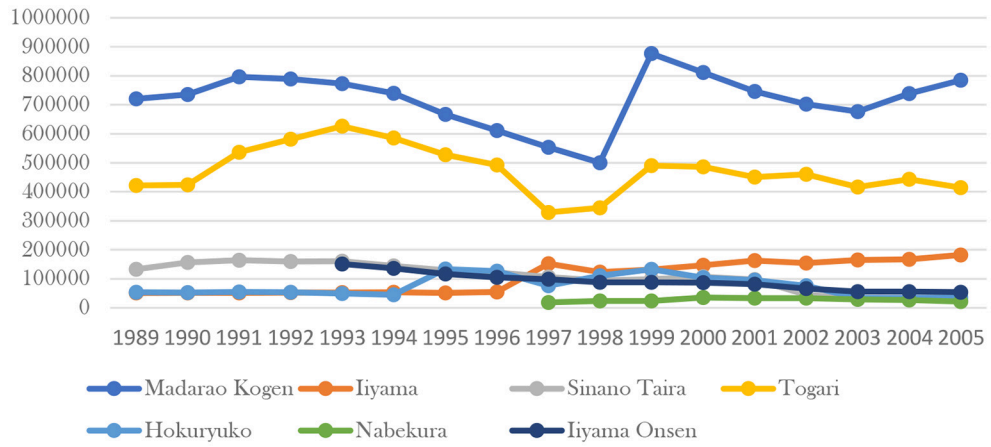

FIGURE 6
Comparison of tourist data of scenic spots in Iiyama city.

prefecture, Iiyama and Saku, have been designated as forest therapy areas (74). Located in the northern part of Nagano Prefecture and backed by the Madarao Plateau, Iiyama city is rich in natural resources such as forests, lakes, and hot springs, and has been a good health resort since ancient times. Especially after the emergence of the concept of forest bathing, as one of the major cities in Japan close to forests and mountains, many tourists come to the city for forest therapy every year. The number of tourists is increasing year by year, and the forest service industry is booming, which opens a new path for tourism and circular economy in Iiyama city. Compared to the other cities, the forest area of Iiyama city is vast, providing visitors with good forest trails for healthy exercise and relaxation.

Iiyama is an excellent sample city to test the effectiveness of forest therapy policy support. Some areas of the city are forest bathing pilot bases, while others are not. In Nagano Prefecture, Iiyama and Saku are the only two designated cities as forest therapy area. Iiyama city has seven main areas for tourists, including Madarao Kogen, Hokuryuko, Nabekura, Iiyama, Sinano Taira, Iiyama Onsen, Togari. From 1997, Iiyama and Madarao have been designated as forest bathing base under Iiyama city government's policy guideline. The tourist data (Figure 6) from 1989 to 2005 in these areas show Madarao Kogen and Iiyama have apparently seen an increase in tourist numbers since the new policy was introduced in 1997, and the trend has continued into the 21st century. In other areas the trend is in the opposite direction. If we observe the data (Figure 7) of same level as Iiyama city in the whole Nagano Prefecture, only Iiyama city, Saku city and Ueda city had obvious upward trend in tourists after 1997. Iiyama and Saku are the only two designated forest therapy cities in Nagano and the reason why Ueda also got a surge in tourist after 2002 was that the city of Ueda had built up more brand-new resorts since 2000.

Policy agenda

Faced with the increasing pressure of work and life and the serious mental problems, the Japanese society increasingly calls for attaching importance to forest and health, and the original concept of forest bath has received further attention

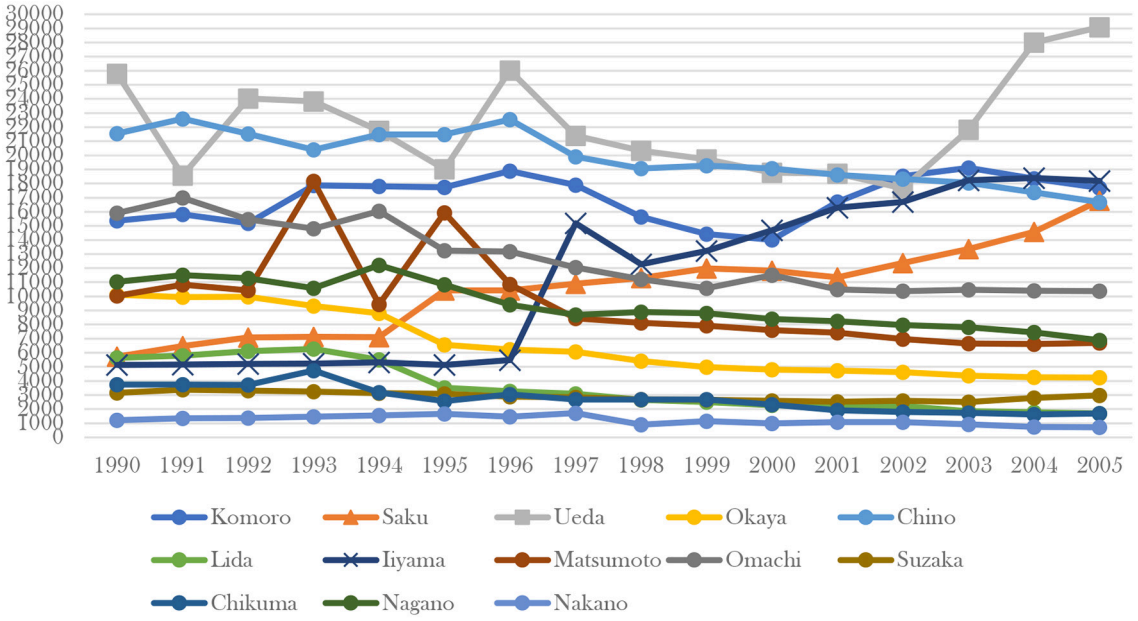

FIGURE 7
Comparison of tourist data of cities in Iiyama city.

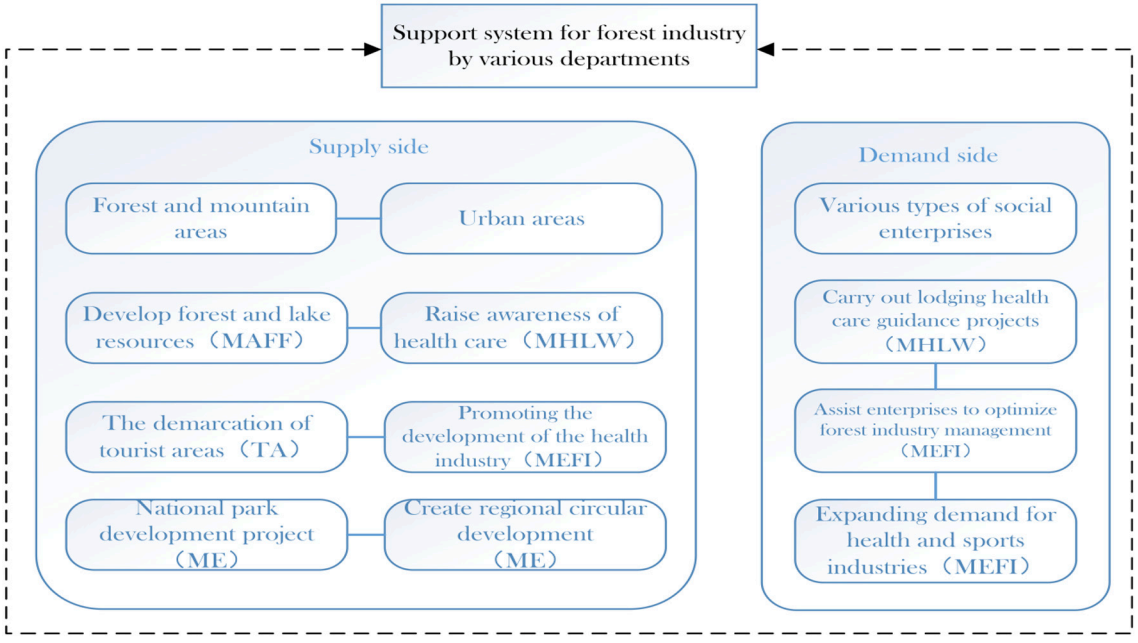

FIGURE 8
Japanese government's policy process on forest service resource integration.

and promotion (75). To promote industrial transformation and resource integration, realize the coexistence of natural resources and social development, and form a good economic cycle model, the Japanese government began to integrate the original concept of forest bath into the forest therapy industry, to promote the development of forest service industry. Since 2019, the Japanese government established the forest service review committee, led by the Forestry Agency, combined the main government departments to make joint industry associated support policy and the construction of the administrative system, hope to be able

to further rational development of forest resources, in the health care and natural protection, and achieve a balance between social and economic development (76).

In the industrial support system, the Japanese government starts from the supply side and the demand side (Figure 8) to integrate the forest service resources. On the supply side, the Ministry of Agriculture, Forestry and Fisheries (MAFF), which is responsible for the management of natural resources including forests and lakes, plays a leading role in promoting prominent areas with rich forest and lake resources and building designated bases for forest therapy. The Tourism Agency (TA) and the Small and Medium Enterprise Agency (SMEA) play an important role in the forest service industry, which is closely related to tourism and the revitalization of local economies. Health care is also an important part of the forest service industry. The Ministry of Health, Labor, and Welfare (MHLW) is responsible for the construction and cooperative development of related health care facilities, and the Ministry of Economy, Trade, and Industry (MEFI) further promotes the development of health care industry on this basis. The Ministry of Environment (ME) is also an indispensable part of the support system, as green and circular is one of the important characteristics of forest service. From the perspective of sustainable social and economic development, the Ministry of Health, Labor and the Ministry of Economy, Trade and Industry have integrated forest service with health care industry, responding to the concerns of The Japanese society on the theme of nature and health and striving to form a green circular economy in which forest service plays an important role.

Results and discussion

The health and economic effects of forest mindfulness therapy

From the perspective of the relationship between Japanese traditional culture and mindfulness meditation, mindfulness refers to spiritual baptism, which means that one can get spiritual sublimation. When conducting forest bathing, many activities can also be defined as MBPs and become part of forest therapy. From the perspective of participants, MBPs plays a regulating role in all aspects of the practice of forest therapy participants, by releasing the mental pressure and anxiety of participants, transfer their attention, reduce the psychological burden caused by the body and mind, so as to make their actions more natural and healthier (70).

Mindfulness therapy has many effects on human health. The first is diet management. According to the health survey data of the Ministry of Health, Labor and Welfare, many Japanese people have formed abnormal eating habits due to the mental stress of years of work, which affects the normal operation of the digestive system. Forest therapy can put participants in a less stressful surroundings, lower blood pressure, and encourage participants to self-correct their eating habits to prevent digestive diseases (77). Secondly, forest therapy is a process of "combination of static and dynamic". In addition to meditation, jogging, climbing, and other exercises are also carried out in the forest environment. Compared with the urban environment and drug dependence, the exercise efficiency can be improved better, that is, the frequency of oxygen inhalation and cardiopulmonary exercise are more regular under the same exercise intensity (78). With a sound policy base and widespread support at the national and local levels, forest mindfulness therapy in Japan has achieved multiple effects in promoting health and a circular economy. From the observation group data released by MHLW in 2015 from national forest therapy bases, most participants, especially obese group, got health returns. Their weight, blood pressure, blood lipid, and blood glucose levels have gone down significantly 3 months after they finish the forest bathing project and even after 6 months all the values still have a minor falling. Data from a sample of people whose blood glucose levels were measured showed that forest bathing had a significant effect on the health of obese people.

From the local tourism economic data, the positive effect of forest therapy base policy is also obvious. In Nagano Prefecture, Iiyama and Saku are the only cities with forest therapy policies, and the number of tourists in these two cities has continued to increase since the introduction of the forest therapy base policy. In Iiyama city, there are totally ten tourist resorts. Iiyama and Madarao are the only designated forest therapy bases, and the number of tourists has skyrocketed in these two places since the introduction of the forest therapy base policy in 1997, while the number of tourists in other places has been declining year after year.

The close cooperation of relevant policy departments of the Japanese government has provided a good environment for the development of the mindfulness movement. The government departments of economy, environment and health have cooperated and issued some policies, which play a key role in the cultivation of local forest therapy bases. This virtuous policy cycle among the government, the base and the public is of great benefit to the development of the Mindfulness-based Practices movement in Japan. Meanwhile, the MBPs also promotes the health of Japanese citizens and the circular economy of the country.

Policy support related to local development and circular economy

Japanese society attaches importance to the concept of forest and health, and the Japanese government also believes that industrial innovation should be carried out to build green circular development (79). Through consistent policy support and guidance from the central and local governments, forest therapy in Japan has promoted the multi-functional use of forest resources and the development of tourism (80). On the one hand, this greatly reduces the pressure brought by

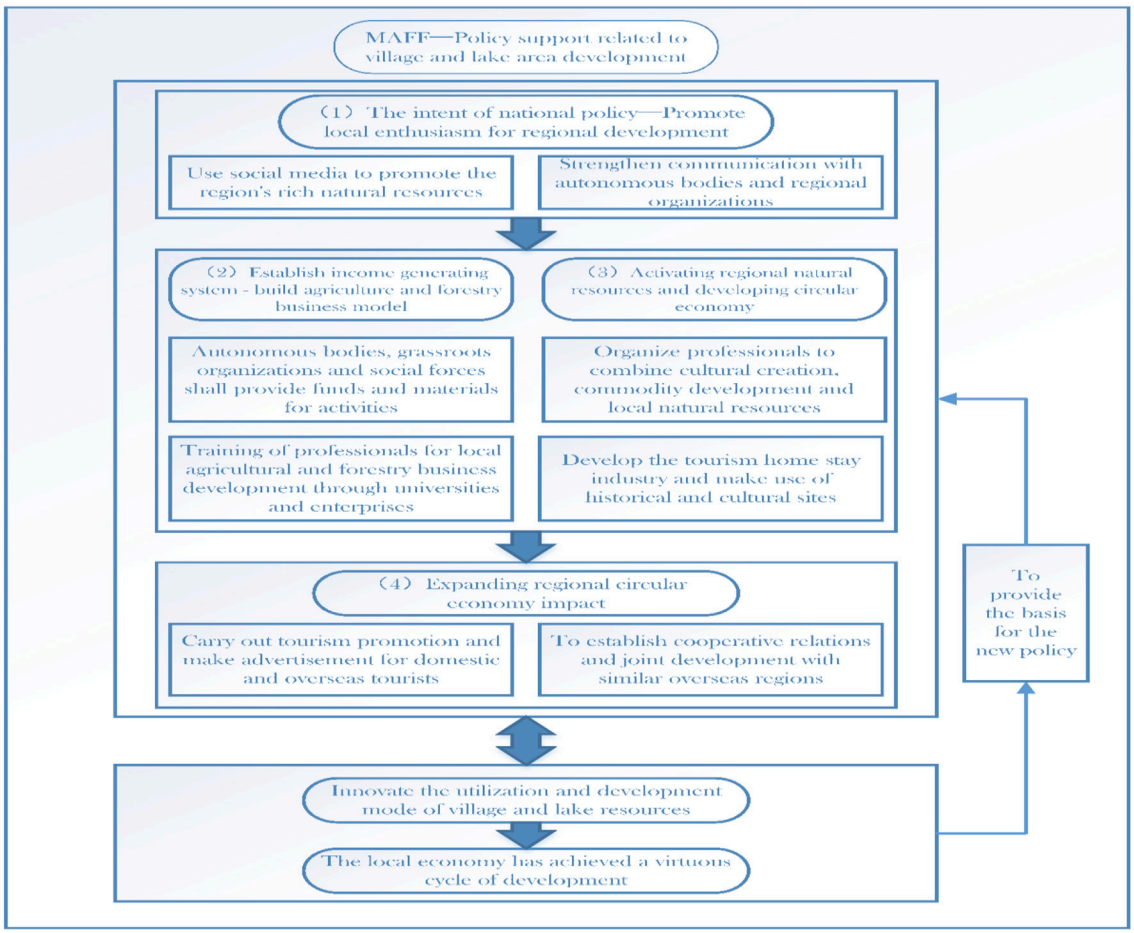

FIGURE 9
The ministry of agriculture, forestry and fisheries' leading role in the development planning of forest services.

carbon emissions to local development, and at the same time improves the completeness of the industrial chain in the circular economy model (81). Local economic development will ultimately help enterprises and residents better protect forest resources and the natural environment. The core issue for policy authorities is to constantly evaluate the effectiveness of policies to determine when appropriate policy adjustments should be made and to balance development across different regions (82). In addition, the health sector and the economic management sector have different criteria for evaluating the effectiveness of a policy. Since the objectives of promoting public health and local economic development involve cross-border collaboration between multiple government departments, continuous political and policy support from the central government level is essential.

As the most important manager of forest resources, The Ministry of Agriculture, Forestry and Fisheries plays a leading role (Figure 9) in the development planning of forest services. The policy intention of the forest service development plan led by the MAFF is to promote the enthusiasm of local governments and enterprises for the development of forest resources. The entire policy process is based on the principle of resource sharing, focusing on the use of social media to promote forest resources, and strengthening collaboration among autonomous bodies, local organizations, and enterprises. Local autonomous bodies, grassroots organizations, and social forces, including enterprises and voluntary groups, work together to provide material support for the development of forest services, cultivate relevant professionals through universities and enterprises for the development of local agriculture and forestry businesses, and form an internal circular operation model that can ensure the industry generates income.

Government should guide, not dominate, or intervene in the market

The core of the forest service industry is to upgrade the traditional tourism, forestry, health care and other industries under the standard of Green, Healthy and Sustainable and

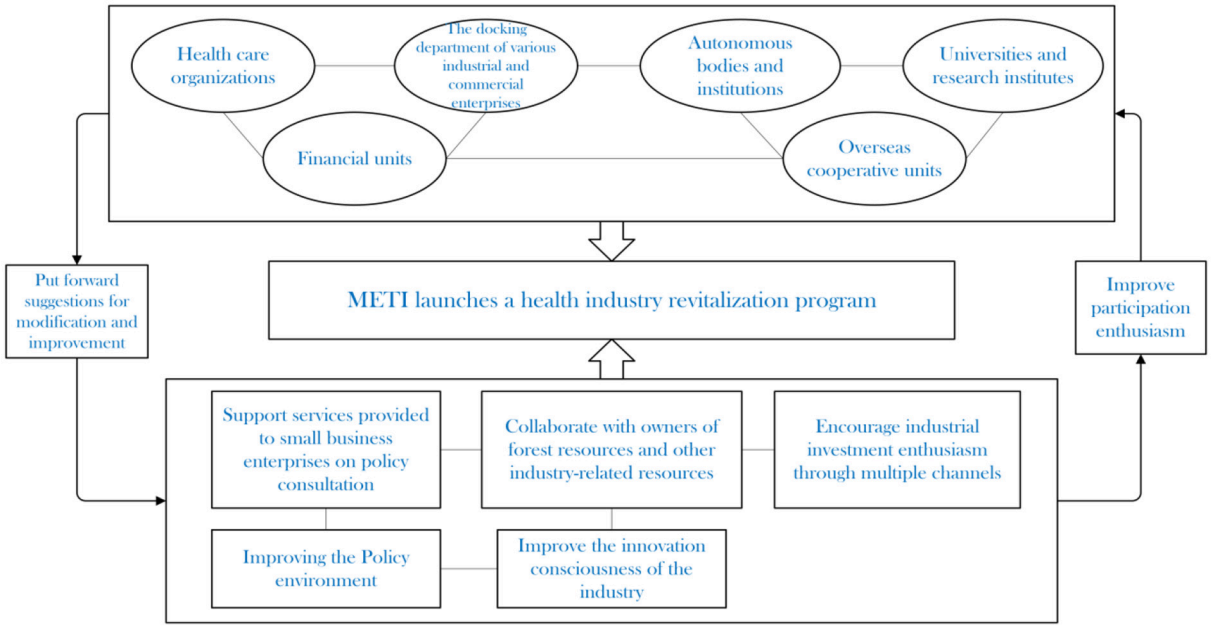

FIGURE 10
Policy support on health industry revitalization program.

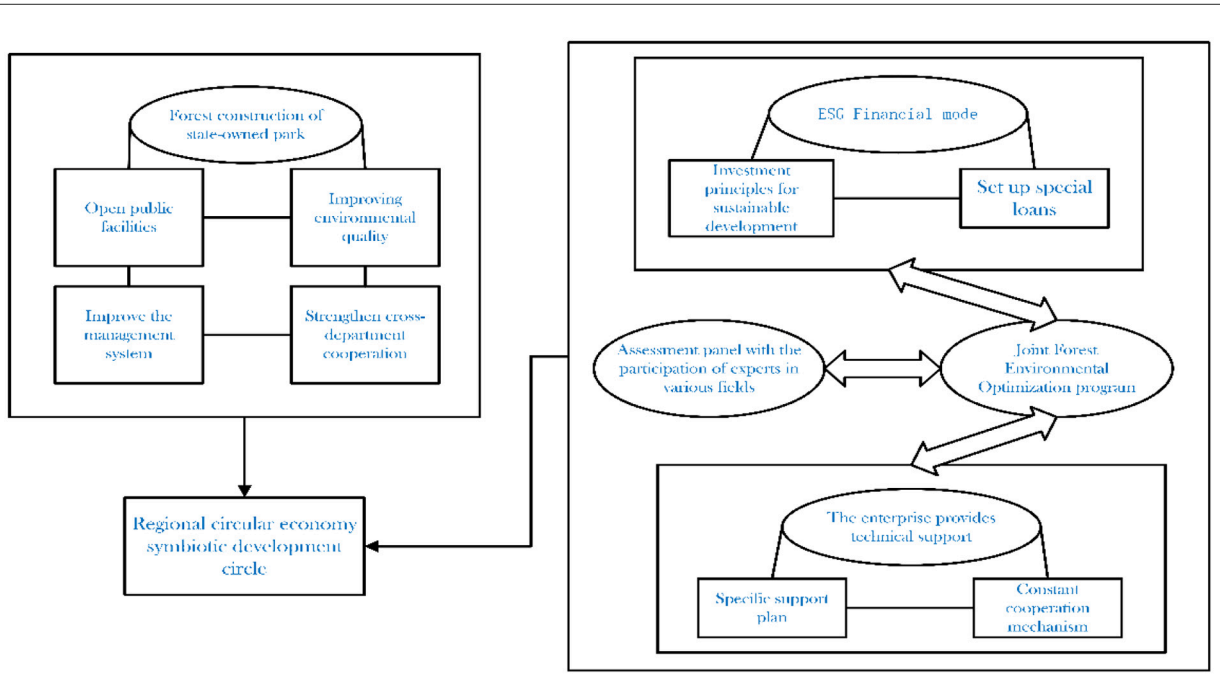

FIGURE 11
Forest services industry development in a policy collaborative environment.

develop into a comprehensive industry integrating with the forest. The Ministry of Economy, Trade and Industry is focusing on the comprehensive health industry (Figure 10) in supporting the forest service industry. METI first establishes platform for collecting opinions from various parties. As a role of supply side, it needs to improve the management

system for forest service industry, optimize the investment environment and market rules, and guide industry innovation. METI provides support services to small business enterprises in business scope, policy consultation and other aspects, and cooperates with other industry-related resource owners to promote industrial investment enthusiasm through multiple channels. While introducing plans for development guidance, the leading position of enterprises in the market is respected and excessive government interference is avoided.

Policy suggestion

Place the forest services industry in a policy collaborative environment

In the process of developing forest resources, it is necessary to always coordinate with environmental protection and avoid the development path of first developing and then protecting (83). The government should open more public facilities (Figure 11) related to forests to create better activity spaces to attract tourists and more precisely separate tourist areas from forest reserves. In addition to promoting the integration of state-owned forest parks into the forest service industry, the government should call on experts from various fields to participate in the evaluation of the plan and guide local autonomous bodies to jointly propose the forest environment optimization plan, which is the basis of the circular economy. The new financial model ESG, which combines environmentally sustainable development with social responsibility, will provide special green loans to enterprises engaged in forest service industry, set corresponding loan issuing standards, and require enterprises to fulfill their commitments in forest environmental protection (84). The government should encourage enterprises to formulate technical plans to support forest environmental optimization, provide technical support, establish constant cooperation mechanism, promote the participation of various subjects, and improve the efficiency of forest environmental optimization.

Forest therapy mindfulness movements go global with good policy support

Low carbon is the main path for the global response to climate. On the one hand, the movement mode of MBPs can alleviate long-term COVID-19 symptoms, and on the other hand, carbon reduction should go global to address climate change (85). Major economies should form a consensus and jointly introduce more and better policies and movement standards to encourage forest service industries worldwide, promote human health and circular economy development. In most developed and developing countries, where forest resources are plentiful, policy priorities should be focused on making forest resources better available to people's health. Scientists from different disciplines can share information, combine exercise science with energy conservation requirements, and jointly come up with more scientific standards for forest mindfulness therapy, to promote harmony between mankind and nature and help people recover more quickly from the pandemic.

Conclusion

Under the background of over-exploitation, environmental degradation and increasing pressure on mental and physical health, how to save resources, develop economy and promote human health without over-dependence on medicines is an extremely important sustainable development policy issue. Japan has achieved great success in this area. Data from Japan suggest that forest therapy mindfulness movements are not only good for physical health but can also benefit local circular economy development when combined with a good policy environment. This should be replicated globally. The focus of public policy should be diversified and coordinated with cutting-edge ESG financial means to achieve the goal.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

SZ: data analysis. JT and YZ: policy analysis. HS: data collection and comparison. ZG: data ananlysis. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Physical activity, sleep quality and life satisfaction in adolescents: A cross-sectional survey study

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Background: Physical activity, sleep is an important component of adolescents' 24-h movement behavior, and life satisfaction predicts adolescent physical and mental health. However, few studies have explored the relationship between the two variables among Chinese high school students. Consequently, this study aimed to explore the relationship between sleep quality and life satisfaction among Chinese high school students.

Methods: This cross-sectional study was conducted in October 2020 in five high schools in Xuchang City, China. High school students from senior 1 to senior 3 were asked to fill up a questionnaire of demographic characteristics and validated screen instructions for sleep quality (Pittsburgh Sleep Quality Index) and life satisfaction (Satisfaction with Life Scale). The multivariate regression model was applied to explore the association between sleep quality and life satisfaction.

Results: A total of 1127 individuals (51.1% males) participated in this survey, and the prevalence of poor sleep quality was 42.3%. The mean score on the Satisfaction with Life Scale was 16.72 ± 5.67, according to the corresponding scoring criteria, with 15–19 being generally dissatisfied. After controlling for demographic variables, the contribution of subjective sleep quality ($\beta = -0.181, p < 0.01$), sleep duration ($\beta = -0.080, p < 0.01$) and daytime dysfunction ($\beta = -0.311, p < 0.01$) to life satisfaction of high school students increased to 23.2%, indicating that subjective sleep quality, sleep duration, and daytime dysfunction were 22.9% predictive of life satisfaction among high school students. And also, physical activity on schooldays and weekend days were associated with better sleep quality and higher life satisfaction ($p < 0.05$).

Conclusions: Among Chinese high school students, the prevalence of sleep problems was high, and the majority of students held moderate life satisfaction. Sleep quality was positively correlated with life satisfaction among Chinese high school students, with better sleep quality resulting in higher life satisfaction among students.

KEYWORDS

sleep quality, life satisfaction, teenagers, cross-sectional studies, mental health

Introduction

Sleep is an important component of the 24-h movement behaviors of adolescents, while poor sleep quality is prevalent among this population (1–6). There has been a significant decline in sleep quality among adolescents (7), while this decline has been exacerbated by the COVID-19 outbreak (8–12). Not only the pandemic, but also physiological, psychological, demographic, geographical, and socioeconomic factors influence the prevalence of sleep quality in adolescents (13–15). Several studies from China proposed that the prevalence of poor sleep quality among high school students ranged from 8.54 to 41.9% (16, 17). Moreover, the prevalence of poor sleep quality was the highest among senior high school students compared to students in primary school, junior high school, and college (18). Studies from Malaysia and Italy reported similar prevalence rates of 24.0 and 18%, respectively (19, 20). However, the prevalence of poor sleep quality among high school students in Spain, Turkey and Sweden is close to or over 60%, with a prevalence of 76% among Swedish girls (21–23). Poor sleep quality among adolescents has become a serious public health problem worldwide, with many negative consequences (24–26). Numerous observational studies showed an association between poorer sleep quality and poorer learning capacity and academic performance (27, 28). Moreover, high school students with poorer sleep quality were more likely to engage in school bullying (29). In terms of addictive behaviors, a large number of studies reported the relationship between poor sleep quality and nicotine dependence, internet addiction, and substance abuse (21, 22, 30, 31). Additionally, poor sleep quality was a risk factor for recurrent aphthous ulcers and primary nocturnal enuresis (32, 33). In terms of mental health, poor sleep quality has been demonstrated as a risk factor for poor mental health conditions, such as depression, anxiety and lower subjective well-being (8, 34–37). Furthermore, several cross-sectional studies reported that high school students with lower sleep quality were more likely to have suicidal ideation and carried out non-suicidal self-injury (34, 38, 39).

Life satisfaction is an individual's general perception of their life situation over a period of time (40). Life satisfaction is an important parameter reflecting an individual's quality of life, and a very important component of psychological well-being (26, 41–44). Previous research has shown that life satisfaction is not only influenced by internalized emotions such as depression and anxiety (45), but also by modifiable lifestyle behaviors (46). Furthermore, among adolescents, life satisfaction predicts their level of mental health and social problem-solving skills (47–49).

Among adolescents, a few studies have explored the relationship between modifiable lifestyle behavior and life satisfaction. Schmiedeberg et al. found that participation in leisure activities (parties, sports, holidays) was positively associated with life satisfaction among German teenagers and adults, while Internet and TV consumption were negatively associated with life satisfaction (50). In another survey of 245 high school students, it was reported that low physical activity and nonparticipation in sports teams were associated with lower life satisfaction, where the number of siblings in the family also has an effect (51). A cross-sectional study from China found that prolonged screen time and lower levels of physical activity were associated with lower life satisfaction among Chinese junior high school students (52). A large random sample longitudinal study of German adolescents and adults (15–41 years old during the observation period) by Schmiedeberg et al. tested the effects of five leisure activities (sports, vacation, meeting friends, internet use, and watching TV) on respondents' life satisfaction and found that some leisure activities (partying, sports, vacation) had a positive effect on life satisfaction, and while Internet and TV consumption had a negative effect on life satisfaction (50). Zullig et al. administered physical activity, life satisfaction, and self-evaluation questionnaires to 245 7th and 8th grade students and found that females who had not exercised vigorously in the past 7 days had significantly lower life satisfaction and those who did not participate in sports teams had satisfaction was lower, and regression analysis showed that physical activity increased life satisfaction among secondary school students, and that secondary school students with more sports participation had higher life satisfaction than those with less sports participation (51). In addition to physical activity and sedentary behavior, two modifiable lifestyle behaviors, previous studies have also explored the relationship between sleep quality and life satisfaction among adolescents. Ness et al. proposed that among 701 Norwegian university students, good sleep quality, long sleep duration, and stability in sleep and wake times were associated with higher life satisfaction (53). While the correlation between greater sleep quality and higher life satisfaction was also found among university students in Malaysia (54). Nevertheless, no studies have investigated the relationship between sleep quality and life satisfaction in this large population of Chinese adolescents. Previous studies have only investigated the relationship between sleep quality and life satisfaction among Chinese university students and older adults (55, 56), whereas studies with a representative sample of Chinese adolescents are scarce.

Therefore, this study will investigate the prevalence of sleep quality and life satisfaction among Chinese high school students during the COVID-19 pandemic period, and explore the relationship between sleep quality and life satisfaction in order to provide a theoretical basis for improving high school students' life satisfaction through improving sleep quality and contributing to their mental health.

Methods

Study design

A cross-sectional design was adopted for this study, which was conducted in October 2020 in Xuchang City, China. Stratified random sampling was utilized to sample students from five high schools in Xuchang City. Demographic information, quality of sleep and satisfaction with life by questionnaire. After calculating the sample size by G power, two classes of students from grades 1–3 were selected in each high school for the survey. This study was conducted by paper-based questionnaires. To ensure the return rate of the questionnaire, it was uniformly explained by the class directors and distributed with the class during the students' lunch break, and students were asked to fill in and return it independently. This study is a cross-sectional study. The sleep quality and life satisfaction of high school students require a two-sided test. A is 0.05. According to the relevant literature, the prevalence of indicators is 13%, and the allowable error d is 0.02. Calculate the sample size according to the following formula. The available sample size is $n = 1087$. A total of 1270 students agreed and participated in this research survey. 1127 valid questionnaires were obtained after excluding invalid questionnaires with missing important information, with a response rate of 88.74%. The design of the present study was in accordance with the Declaration of Helsinki, and signed informed consent was obtained from the participants prior to the start of the study. This study was approved by the Institutional Review Board (IRB) of the Shanghai University of Sport (SUS), and permission to carry out the study was obtained from teachers and principals of participating schools.

Measurement

Sleep quality

The Pittsburgh Sleep Quality Index (PSQI) was utilized in this study to measure the sleep quality of high school students (57). This scale comprises 19 self-reported items and 5 other-reported items. The 18 self-reported items are scored on a total of seven components for sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, subjective sleep quality, use of sleep medication, and daytime function in the past month. The 7 components have their corresponding scoring conventions, which are converted into a corresponding score (0–3) and added together to give a final total score (0–21) for the overall sleep quality, with higher scores indicating poorer sleep quality. The PSQI classifies sleep quality into three categories, with a score of <3 indicating good sleep quality, 3 to 7 indicating moderate sleep quality and >8 indicating poor sleep quality (57). The Chinese version of PSQI has been reported to have acceptable reliability and validity in the Chinese population (58).

Life satisfaction

Life satisfaction in this study was measured using the Satisfaction with Life Scale (SWLS) developed by Diener (59). This scale consists of 5 items on a 7-point Likert scale ranging from 1 for very dissatisfied to 7 for very satisfied. The scores for each item are added up, with higher scores indicating higher life satisfaction. Life satisfaction scores can be divided into seven levels, with 5–9 being very dissatisfied, 10–14 being dissatisfied, 15–19 being generally dissatisfied, 20 being neutral, 21–25 being generally satisfied, 26–30 being satisfied and 31–35 being very satisfied (59). The Chinese version of SWLS has been demonstrated to have acceptable validity and reliability in the Chinese population (60).

Covariates

Sociodemographic characteristics, which consisted of grade (senior 1, senior 2, and senior 3), gender (male, female), residence (urban, rural area), and whether they are an only child (yes or no), were identified as covariates for further analysis.

Statistical analysis

Excel 2016 was utilized for data entry and storage, while all the statistical analysis was performed using SPSS 20.0. The demographic characteristics, sleep quality and life satisfaction were reported using a descriptive approach. One-way ANOVA was used to analyze differences in demographic variables between sleep quality and life satisfaction among high school students, while Person's correlation analysis was used to examine the correlation between sleep quality and life satisfaction. continuous variables were expressed as mean and standard deviation (mean $\pm$ standard deviation), and categorical variables were expressed as numbers (n) and percentages (%). Multiple linear regression analysis was performed to analyze the relationship between sleep quality and life satisfaction, controlling for demographic variables, and statistical significance was established at the $p < 0.05$ level.

Results

Demographic characteristics

A total of 1127 valid questionnaires with a balanced gender distribution were obtained, of which 51.1% were male. There was also a balanced distribution of participants by grade, all between 30 and 40 per cent, with the highest number of students in the senior 1 grade (37.4%). Most of the students lived in rural areas (64.0%) and the majority were the only children (85.0%) in their families (see Table 1).

TABLE 1 Demographic characteristics ($n = 1127$).

	N	%
Gender		
Male	576	51.1
Female	551	48.9
Grade		
Senior 1	421	37.4
Senior 2	355	31.5
Senior 3	351	31.1
Residence		
Urban	406	36.0
Rural area	721	64.0
Whether only child		
Yes	169	15.0
No	958	85.0

TABLE 2 Prevalence of sleep quality and life satisfaction ($n = 1127$).

	N	%
Life satisfaction		
Very dissatisfied	47	4.2
Dissatisfied	114	10.1
Generally dissatisfied	293	26.0
Neutral	492	43.7
Generally satisfied	120	10.6
Satisfied	48	4.3
Very satisfied	13	1.2
Sleep quality		
Good sleep quality	87	7.7
Moderate sleep quality	563	50.0
Poor sleep quality	477	42.3

Prevalence of sleep quality and life satisfaction

Prevalence of sleep quality and life satisfaction among high school students in Table 2. 43.7% of high school students had moderate life satisfaction, followed by participants who were generally dissatisfied (26.0%) and the lowest number of very satisfied (1.2%). In terms of sleep quality, half of the total, had moderate sleep quality (50.0%), followed by those with poor sleep quality (42.3%) and very few with good sleep quality (7.7%).

Association between sleep quality and life satisfaction

In order to examine the relationship between sleep quality and life satisfaction, regression analysis was conducted with life satisfaction as the dependent variable, and gender, grade, residence, and whether only child was treated as independent variables to construct model 1. The independent variables in model 1 were treated as controlled variables, and the sleep quality was treated as the independent variable to construct model 2. The results of regression analysis were clearly presented in Table 3. In Model 1 (Correlation coefficient = 0.083, Coefficient of determination = 0.007, Adjusted coefficient of determination = 0.003), grade ($\beta = -0.075$, $p < 0.05$) was a statistically significant predictor of life satisfaction for high school students, with a contribution of 0.3%. After controlling for demographic variables (Correlation coefficient = 0.489, Coefficient of determination = 0.239, Adjusted coefficient of determination = 0.232), the contribution of subjective sleep quality ($\beta = -0.181$, $p < 0.01$), sleep duration ($\beta = -0.080$, $p < 0.01$) and daytime dysfunction ($\beta = -0.311$, $p < 0.01$) to the life satisfaction of high school students increased to 23.2%, indicating that subjective sleep quality, sleep duration, and daytime dysfunction were 22.9% predictive of life satisfaction among high school students.

Association between physical activity and life satisfaction

In order to examine the relationship between physical activity and life satisfaction, regression analysis was conducted with life satisfaction as the dependent variable, and gender, grade, residence, and whether only child was treated as independent variables to construct model 2. The independent variables in model 2 were treated as controlled variables, and physical activity was treated as the independent variable to construct model 2. The results of regression analysis were clearly presented in Table 4. In model 1, the correlation coefficient, the coefficient of determination, and the adjusted coefficient of determination is 0.083, 0.007, and 0.003, respectively. In model 2, the correlation coefficient, the coefficient of determination, and the adjusted coefficient of determination is 0.217, 0.047, and 0.042, respectively. After controlling for demographic variables, the results suggested that physical activity regardless of weekdays and weekend days were associated with better sleep quality.

Discussion

In our knowledge, this study is the first study with a representative sample to investigate the prevalence and relationship of sleep quality and life satisfaction among Chinese adolescent in high school. This present study found that the

TABLE 3 Regression results of sleep quality and life satisfaction ($n = 1127$).

	Life satisfaction					
	Model 1			Model 2		
	B	SEx	β	B	SEx	β
Gender	− 0.197	0.337	− 0.017	− 0.005	0.302	0.000
Grade	− 0.517	0.204	− 0.075*	− 0.080	0.185	− 0.012
Residence	− 0.103	0.365	− 0.009	− 0.420	0.323	− 0.036
Whether only child	0.480	0.491	0.030	0.277	0.436	0.017
Subjective sleep quality				− 1.297	0.236	− 0.181**
Sleep duration				− 0.596	0.226	− 0.080**
Daytime function				− 2.020	0.191	− 0.311**

R, correlation coefficient; R^2, coefficient of determination; R^2adj, adjusted coefficient of determination; B, unstandardised regression coefficient; Sex, standard error; β, standard regression coefficient; *represents $p < 0.05$; **represents $p < 0.01$.

TABLE 4 Regression results of physical activity and life satisfaction ($n = 1127$).

	Life satisfaction					
	Model 1			Model 2		
	B	SEx	β	B	SEx	β
Gender	− 0.197	0.337	− 0.017	0.141	0.334	0.012
Grade	− 0.517	0.204	− 0.075*	− 0.475	0.200	− 0.069*
Residence	− 0.103	0.365	− 0.009	− 0.037	0.358	− 0.003
Whether only child	0.480	0.491	0.030	0.625	0.489	0.039
Schooldays physical activity				0.392	0.129	0.113**
Weekend days physical activity				0.915	0.303	0.113**

R, correlation coefficient; R^2, coefficient of determination; R^2adj, adjusted coefficient of determination; B, unstandardised regression coefficient; Sex, standard error; β, standard regression coefficient; *represents $p < 0.05$; **represents $p < 0.01$.

prevalence of sleep problems was high among adolescent high school students in China, and that the majority of students held moderate life satisfaction. Sleep quality was positively correlated with life satisfaction among Chinese high school students, with better sleep quality resulting in higher life satisfaction among students. Furthermore, there was a positive association between higher sleep quality and higher life satisfaction, while sleep duration and daytime dysfunction significantly predicted life satisfaction among Chinese high school students.

The prevalence of sleep problems in this study was 42.3%, which is consistent with a meta-analysis on sleep quality among adolescent students in China, which mentioned a 13.9–44.8% detection rate of sleep disorders among college and high school students (61). The quality of sleep of Chinese high school students is influenced by many personal and social factors, such as family relationships, their own experiences, and academic stress (62). Especially in high school, adolescents must face huge changes in adolescence and the enormous pressure of the entrance exam of higher education at the same time, which can easily lead to anxiety, depression, and other psychological problems, and also reduce sleep quality. Furthermore, more high school students had moderate to poor sleep quality than good sleep quality, which is consistent with the founding of the study by Zhao et al. (63). Compared to other studies in the context of the COVID-19 pandemic in China, the prevalence of poorer sleep quality in this study was higher (8, 64). In cross-sectional studies, one possible explanation for the differences in results across studies is cohort effect (65, 66). Moreover, all participants in the present study were high school students, whereas participants in the previous study included both middle school and high school students (8, 64). High school students had poorer sleep quality than middle school students (18, 67), thus differences in sampling may contribute to differences in the prevalence of sleep quality between studies.

The SWLS scores of the adolescents in this study were lower than those of the previous study, which may be due to the difference in the age of the sample size (68). In the previous study, the participants were all undergraduate students from a medical science university (68), while the participants in the present study were all high school students. This group of high school students is under immense pressure to progress to higher education, whereas undergraduates are

not under pressure to progress and have more freedom and time. Although undergraduate medical students also experience high levels of academic stress, it is not possible to analyze this qualitatively or quantitatively in relation to the stress of high school students taking university entrance examinations. Therefore, different ages, different social life circumstances and different academic stress may have contributed to this paradox. The prevalence of dissatisfaction with life in this study is similar to another cross-sectional survey of high school students in China, which may corroborate that different ages, social life circumstances, and academic pressures can influence adolescents' life satisfaction (69). In the context of the COVID-19 pandemic, no study has investigated the prevalence of subjective well-being among Chinese adolescents. Xiao et al. investigated the subjective well-being of Chinese university students and found that mean life satisfaction was 20.51 (70), representing neutrality according to the SWLS scoring scale. The highest percentage of subjective well-being status in the present study was also neutrality, which is similar to the results of previous studies.

In terms of the relationship between sleep quality and life satisfaction, this study found a negative relationship between total sleep quality score and life satisfaction, suggesting that the better the sleep quality, the higher the life satisfaction, which is consistent with existing studies (71). This may be due to the fact that sleep is a basic physiological need of the human body, and good sleep quality can ensure that high school students maintain a better mental state in their daily study and life. At the same time, the influence of physical activity on the life satisfaction of high school students should also be considered [33]. The results show that there is a positive correlation between school day PA, weekend PA and life satisfaction of high school students, adolescents with higher levels of physical activity have higher life satisfaction, and through the consumption of energy and catharsis of emotions during participation in physical activity, not only can improve the physical problems of high school students, but also reduce the generation of bad emotions and enhance the positive perception of life status, thus increasing the life satisfaction of high school students. Students who have good sleep quality are more confident in life and can better enjoy the various pleasures in life, with less negative emotions and more positive emotions leading to increased life satisfaction. The regression results of this study showed that the total score of PSQI was a significant negative predictor of life satisfaction for high school students, which is consistent with existing studies (72, 73). High school students who sleep better will be able to recover and recharge their strength and energy, show more confidence in their daytime life and study, and have a more positive attitude toward life and study, while students who do not sleep well will be depressed, less positive, and less motivated to do things, resulting in less satisfaction in life. In further, lower sleep duration was also a predictor of poorer life satisfaction, which is consistent with the results of previous studies on the same age group (73). Lemola et al. found that short sleep duration (<6 h per day) and long sleep duration (>9 h per day) were associated with lower life satisfaction (73). Therefore, based on the findings of this study, we suggest that schools and families should pay more attention to the sleep of high school students in their daily lives. The causes of reduced life satisfaction come not only from academic stress, but also from a range of sleep problems that do not easily attract attention. Schools need to set a scientific schedule for students' work and rest, not too long or too short. It is important to ensure that high school students get enough sleep or reduce the amount of homework as appropriate, thus to reduce the phenomenon of high school students writing homework after school until midnight or even early in the morning. Students' lunch breaks can also be appropriately increased to ensure the efficiency of their daytime studies, so as to improve the quality of their sleep and thus increase their life satisfaction.

Limitation

Several limitations inevitably exist in this study. First, the inclusion and exclusion criteria for participants were not identified in this study, such as physical or psychological disorders, and these may have introduced bias into the analysis of the results. Second, the measurement of sleep in this study was subjective. Although the Chinese version of the PSQI is reliable in Chinese populations, studies have reported that people are unable to accurately report their duration of sleep (74). This may have over- or underestimated sleep duration in this study, thus introducing bias in the examination of the correlation between sleep and life satisfaction. Third, the present study was cross-sectional designed and this study design was incapable of verifying causal inferences. Consequently, future studies should identify inclusion and exclusion criteria for participants, objectively measure the outcome of sleep quality, and apply longitudinal and retrospective designs to provide more precise evidence. However, this study also has certain strengths in that it expands on related areas of research and can provide some insights into promoting the mental health of this particular group of high school students.

Conclusion

This present study found that, among Chinese high school students, the prevalence of sleep problems was high, and the majority of students held moderate life satisfaction. Furthermore, there was a positive association between better sleep quality and greater life satisfaction, while sleep duration and daytime dysfunction significantly predicted life satisfaction among Chinese high school students. School and family interventions should increase the life satisfaction of high school students by improving the quality of their sleep, thereby promoting physical and mental health.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YC and XH conceived the study and reviewed the first and final versions of the manuscript. YC collected and analyzed data and drafted the manuscript. ZY and YY assisted in revising the manuscript. All authors contributed to the article and agreed to the submitted version of the manuscript.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Participation in community seniors' organizations and mental health among retired adults in urban China: The mediating role of interpersonal needs

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Purpose: This study aimed to investigate the association between participation in community seniors' organizations (CSOs) and mental health among retired adults in urban China, and illustrate the causal mechanism.

Methods: We collected data on participation from a community seniors' organization and mental health survey in Shenzhen City, China, in July 2022. The survey used a two-stage cluster sample design, based on administrative divisions as the primary sampling unit and communities as the second sampling unit, where retired adults were randomly sampled. The inclusion criteria were individuals >60 years old (the mandatory age for retirement in China) or women who retired early at the age of 45 years. We used three multivariable regression models to estimate the effects of participation in CSOs on mental health. Furthermore, we used structural equation models to examine the mediator of acquired interpersonal needs in the association between CSOs participation and mental health.

Results: The study examined the values of CSOs, generated explicitly for older adults and explained how participation in such organizations benefits retired adults' mental health. Mental health is defined in three dimensions: aggregate mental health, positive emotions, and negative emotions. The results show that constituting social networks with like-minded individuals and perceiving interpersonal needs are the two main benefits of CSOs on mental health. The retired individual who participated in CSOs with a higher level of diversity and frequency, joined specific types such as health- and study-related CSOs, could receive more interpersonal needs and were probably mentally healthier. The mediating mechanism of interpersonal needs associated with participation in mental health was significant. Besides, mental health is generally affected by physical health, sleep quality, and socioeconomic status.

Conclusion: This study suggested that CSOs have expanded the social interaction channels of retired adults and affected their mental health by providing basic interpersonal needs such as inclusion, dominance, and affection. Among the types of CSOs, health and study organizations might enhance mental health most effectively, while semi-official organizations have no effect.

KEYWORDS

participation in community seniors' organizations, mental health, positive emotions, negative emotions, social capital, interpersonal needs, retired adults, urban China

Introduction

Mental health issues or distress (e.g., depression, anxiety, and poor sleep quality) (1–6) have been increasingly recognized as one of the most popular public health problems worldwide across different age groups including aging population (7–12). In particular, such mental health problems among older adults have placed a huge burden on society, public health, and the medical system (13–16). Previous studies have indicated that isolation, loneliness, and/or mental distress often occur with a decline in physical and cognitive function in late life (17–20). The authoritative data has indicated that more than 20% of the world population aged 60 years and above suffer from mental disorders (21–23). Among retired adults with chronic disease, 35–40% have mental health comorbidity (24). As the largest segment of the world's retired adult population, Chinese retired adults aged 65 years and above exceeded 164.49 million in 2019 (25). Retirement may increase depressive symptoms in adults, especially in men from lower occupational class backgrounds (26). A previous study has shown that retirement could lead to the 50–75 aged adults being overwhelmed by self-perception of retirement (27). The rate of depression among retired adults is 6–29.4%, and those with physical diseases is 52.1–63.4% in China (28). Thus, mental health in retired adults requires more attention.

Promoting social participation is one of the key proposals of "active aging (29) and other age groups like adolescents (3, 6, 30, 31) and the Chinese government has adopted this policy as one of the important means of achieving successful aging for older adults in 2019. Numerous studies have shown that social participation influences mental health (32–34). Social participation could broaden social interactions and reduce psychological problems caused by changes in life, physical conditions, and social relationships (35). This could reduce the risk of depression (36) and greatly improve mental health. Furthermore, the effect of social participation on mental health in retired adults was significantly higher than that in younger adults. However, most studies have examined the effect of participation in social and leisure activities (37). Few have examined the effect of community seniors' organizations (CSOs) participation. Furthermore, the mechanism linking CSOs participation and mental health remains understudied.

Retired adults often report feelings of social isolation, loneliness, anxiety, or depression because their social roles and ties in social connection networks have significantly changed. Furthermore, a deficient sense of belonging to the new social role and social context leads to negative effects such as a loss of self-fulfillment due to not working and socializing with colleagues (38). China has a collectivist culture, and retired adults often meet to share daily activities in local communities (39–41). Emerging evidence suggests that mental health can be enhanced through participation in CSOs (42). These organizations are common government-financed community social organizations in urban China like Shenzhen City, and may be important in linking social interaction with mental health, considering the high needs of retired adults for social belonging and interpersonal needs. In this study, we applied a social capital theory approach to explore whether CSOs financed by the government can improve retired adults' mental health and the underlying mechanisms among retired adults in urban China.

Literature review

Social capital theory

Social capital theory forms the theoretical bedrock for analyzing the effect of CSOs participation on the mental health of retired adults. Social capital first emerged from research by Durkheim in 1980 on the importance of building strong families and local communities. According to Durkheim, social capital is a social relationship formed by an institutionalized network of mutual acquaintances and recognition, and a collection of actual or potential resources that provide benefits and convenience to members (43). Putnam (44) defined social capital as "features of social organizations, such as networks, norms, and trust, which facilitate coordination and cooperation for mutual benefit".

According to Durkheim and Putnam's definitions, social capital has two fundamental features. First, the sources of social capital stem from the structure of social organizations rather than attributes of individuals. Second, social organizations are places where individuals acquire social networks through participation. Generally, a society with high levels of social capital is characterized by high levels of social interaction, trust in others, and reciprocity, resulting in enhanced interactions with others (45).

A CSO is described as a community-level organization that is partly financed by the government, but operated by a non-governmental organization and recognized as social capital in China. First, it was established to pursue a specific purpose: to meet the diverse demands of retired adults, in which retired adults are the main participants. Second, it has the characteristics of a social organization, such as low transaction costs, high organizational recognition, and mutual trust among organizational members (46). These characteristics enable CSOs to have a specific social relationship network, which helps promote the formation of retired adults' participation intention. Third, compared to other community social organizations, CSOs display homogeneity, alignment, and interests of retired adults and can effectively meet retired adults' diverse needs in China's urban community.

Participation in CSOs and mental health

Participation in CSOs can be described as an individual's involvement in organizations for older adults that form social networks and provide opportunities for social interaction among retired adults in a community.

Participation is an important mechanism by which a community-level organization affects the mental health of retire adults. Studies have shown the benefits of social interaction in community-level organizations on mental health. For example, a longitudinal study in Indonesia found that the number of community-level organizations was positively associated with self-reported physical and mental health (47). Some studies have found that the type of participation in community-level organizations (volunteer activities, community events, clubs for the elderly) could bring mental health benefits to retired women irrespective of an individual level relationship (e.g., friendship, communication with family and friends, hobbies) (48). Croezen et al. (34) found that participation in religious organizations offered mental health benefits beyond those offered by participation in other forms of social organization. Broad social interaction and regular collective leisure activities might have beneficial effects on the functional health of retired adults through behavioral and mental pathways (49).

Building on the above studies, we may assume that CSOs have expanded social networks with like-minded people and broadened the social interaction channels of retired individuals in China. This bridges and enhances social inclusion, to enable positive effects on the mental health of retired adults. Furthermore, the diversity, frequency, and quality of participation in CSOs, and types of CSOs help these individuals to understand their mental health.

The mediator role of interpersonal needs in the association between participation in CSOs and mental health

Interpersonal needs refer to the desire for affection/openness, control, and inclusion when individuals get together in a group, which is theorized from social relationships (50). It is common knowledge that humans need to form close affectional ties (51), and social interaction and interpersonal connections provide individuals with a sense of belonging and social identity, and opportunities to participate in activities and projects (52). However, retired adults tend to experience a decline in physical and cognitive function as they age. Social networks may shrink, which may lead to social isolation. Social isolation and inactivity increase the risk of a first episode of major depressive disorder (53). Additionally, retired adults who are socially isolated have a much greater risk of dying than those who are well connected (54). In contrast, retired adults who possess multiple social roles can boost their self-esteem and self-worth (55), which meets their interpersonal needs to some extent. For example, one study indicated that retired adults who participated in volunteer activities perceived themselves to be in good self-rated health and had fewer depressive symptoms and good functional abilities, possibly because volunteering provides them with the opportunity to adopt new social roles that are mentally rewarding (56). These findings indicated that meeting interpersonal needs may be beneficial to the mental health of retired adults. In summary, CSOs provide social interaction and social role-acting opportunities and enhance retired adults' social sense of belonging. Thus, they may promote their mental health by meeting interpersonal needs.

Although previous studies have examined the effect of participation in community-level organizations and interpersonal needs on retired adults' mental health, some research gaps remain. First, existing studies are mainly based on the effect of social interaction. Few studies have directly examined the association between participation in community-level organizations and retired adults' mental health, and underlying mechanisms have not been fully examined. Furthermore, no study has examined the mediation mechanism among participation in community-level organizations, interpersonal needs, and mental health in China. Based on survey data, this study examined the mediating role of interpersonal needs in the relationship between CSOs participation and mental health among retired adults in urban China, which provides an approach reference for China's active aging.

Building on these studies, CSOs provided places of participation and interaction, and offered a sense of belonging where participants could make friends and engage in various activities, which reduces their risk of being gradually left behind by society. Therefore, we hypothesize:

H1: CSO participation has a significant effect on the mental health of retired Chinese adults.

H2: Interpersonal needs mediate the relationship between CSO participation and mental health among retired adults in urban China.

Methods

Participants and sample

The data were sampled using a two-stage cluster sample design and collected directly in Shenzhen, China, in July 2022. In the first stage, five communities were sampled randomly. In the second stage, cluster sampling was used to survey the members and participants of the community seniors university (laoniandaxue)[1] and community seniors care centers (laonianren zhaoliao zhongxin) where trained interviewers conducted interviews. Under the Chinese top-down policy of promoting purchase of service contracting (POSC) from non-profit organizations, community care centers have gradually become the most important activities for retired individuals

1 The Chinese expression of community seniors universities is listed in (laoniandaxue), similarly hereinafter.

to exercise, entertain, make friends, and volunteer services. Therefore, community care centers were used as the final sampling unit to obtain a representative sample. In total, 193 retired adults were surveyed using cluster sampling. Of these, five returned incomplete questionnaires with several missing responses and 188 (97.4%) responded. The participants were 44–76 years old (70.7% women), with a mean age of 62.61 years and SD of 6.28.

Inclusion and exclusion criteria

The inclusion criteria were >60 years or women who retired early at the age of 45 years. The exclusion criteria were <60 years but not retired, inability to understand or complete the questionnaire because of serious disabilities, and lack of informed consent.

Measures

Mental health

We used 5-items from the China Health and Retirement Longitudinal Study Wave 4 (2018) Questionnaire to measure mental health (e.g., "No matter what happens I can adjust my status"; "Feel as happy as when I was young") (57), as shown in Table 1. Responses were based on a 5-point rating scale (1 = "never" to "5 = always)." The scores of the last three questions were reversed, with higher scores indicating higher mental health levels. In this study, Cronbach's alpha for the scale was 0.612.

We used principal component analysis to process 5-items of mental health to acquire a better understanding of the potential internal structure of retired adults' mental health (58). The equation is transformed factor values = (factor + B) × A, A = 99/(factor maximum–factor minimum), and B = (1/A)–factor minimum. After rotating by the maximum variance orthogonal method, two common factors "positive emotions" and "negative emotions" were identified. Thereafter, we converted the standardized factor scores of these two factors into an index ranging from 1 to 100. The second and third independent variables were "Positive emotions" and the third "Negative emotions." As shown in Table 2, the aggregate mental health of the retired sample was 19.4, with a minimum value of 8 and a maximum value of 25. After the "1–100" conversion, the positive and negative emotions were 55.6 and 22.7, respectively.

Participation in CSOs

Participation in CSOs was measured in four dimensions. **The diversity** was assessed by enquiring whether respondents participated in the following six types of groups in their neighborhood: literature and art, sports, healthcare, comprehensive, learning, and public welfare. Responses to each item were binarized (i.e., respondents who participated in the group were coded as 1; if not, they were coded as 0 for each item), and the mean was 2.4. **The frequency** was accessed by enquiring "how many times do you participate in social organization activities per week on average?" The response options were: <1 time, 1–2 times, 3–5 times, 6–7 times, and > 8 times, with assign values of one, two, three, four and five, respectively and the mean was 2.5. **The quality** refers to the theory of interpersonal needs and poses five questions from the three dimensions of belonging needs, domination needs, and emotional needs. The five questions were: (1) "I am a member of a social organization; I belong to this group." (2) "Other members of the social organization can understand me, I agree with me." (3) "I can convince other members to do what I want." (4) "I can maintain a very close personal relationship with other members." (5) "I feel honored when I do something with other members, a great sense of achievement." The responses were never, rarely, sometimes, often, and always, and they were assigned values from 1–5, and thereafter summed up, reflecting the interpersonal needs from participating in CSOs, with an average value of 17.3 and a maximum of 25. **The types** were assessed by classifying the above six types of social organizations into four categories: Hobby-related CSOs, Health-related CSOs, Study-related CSOs, and Semi-official CSOs. Responses to each item were binarized (i.e., respondents who participated in the group were coded as 1; if not, coded as 0 for each item).

Control variables

Based on previous studies' results, this study added the variables: physical health, sleep quality, material wealth, and socioeconomic status as control variables in the regression models, and demographic variables, such as respondent gender, age (natural logarithm), and education level. The descriptive statistical structures of all independent variables were shown in Table 2. The participants were 44–76 years old (70.7% women), with a mean age of 62.61 years and SD of 6.28. We used a single item by Vingilis and Wade to measure **physical health** (59). We used a 5-point Likert scale (1 = very good, 5 = very bad) to measure one item of self-rated physical health status (e.g., "In my opinion, my general health status is…"). The item was reversed on the scale, and total scores ranged from 1 to 5, with higher scores indicating a higher level of physical health. Self-related health is a subjective assessment of health status that has been widely adopted in large-scale surveys, as a well-established predictor of mortality (60). We measured **sleep quality** using a single item by Hicks et al. (61). We used a 5-point Likert scale (1 = very satisfactory, 5 = deeply discontent) to measure one item of subjective sleep quality (e.g., "In my opinion, my general sleep status is…"). The item was reversed on the scale, and total scores ranged from 1–5, with higher scores indicating a higher level of sleep quality. We used six items from the China

TABLE 1 Mental health scale.

	No matter what happens, I can adjust my status	Feel as happy as when I was young	Often feel afraid	Often feel lonely	I often feel that the older I get, the less useful I am
Never (%)	21.74	4.79	52.13	56.38	44.15
Sometimes (%)	18.48	14.89	34.57	30.32	28.72
Often (%)	11.41	20.21	9.57	10.64	15.43
Usually (%)	30.43	38.83	2.66	1.60	8.51
Always (%)	17.93	21.28	1.06	1.06	3.19
Average (1–5)	3.0	3.6	4.3	4.4	4.0

TABLE 2 Description of variables.

Variable code	Variable content	Obs	Mean	Std. dev.	Min	Max
MH	Mental health	188	19.404	3.227	8	25
PE	Positive emotions	188	55.6	22.9	1	100
NE	Negative emotions	188	22.7	16.4	1	100
Gender	Gender (man = 1, women = 2)	188	1.707	0.456	1	2
lnage	Logarithm of age	187	4.131	0.102	3.784	4.331
Edu3_1	Primary school or below	188	0.176	0.381	0	1
Edu3_2	Junior high school, high school, technical secondary school	188	0.489	0.501	0	1
Edu3_3	College degree or above	188	0.335	0.473	0	1
Physical health	Subjective physical health	188	2.293	0.973	1	5
Sleep quality	Sleep quality	186	2.672	0.95	1	5
Material wealth	Material wealth	188	2.25	1.805	0	7
SES	Socioeconomic status	182	4.918	1.997	1	10
Diversity	Diversity of participation	188	2.367	1.547	0	7
Frequency	Frequency	180	2.533	1.15	1	5
Quality	Interpersonal needs	188	17.309	5.704	0	25
Hobby-related CSOs	Hobby-related CSOs	188	0.910	0.729	0	1
Health-related CSOs	Health-related CSOs	188	0.431	0.497	0	1
Study-related CSOs	Study-related CSOs	188	0.463	0.500	0	1
Semi-official CSOs	Semi-official CSOs	188	0.484	0.690	0	1

Health and Retirement Longitudinal Study Wave Questionnaire (57) to measure **material wealth** (e.g., have extra income beyond retirement salary," "have a car"). The average score was 2.3. We used a family social class rating scale to measure **socioeconomic status** and the mean value was 4.9.

Results

Effects of control variables on mental health

As shown in Table 3, we conducted a bivariate correlation analysis to show the relationship between mental health and a set of control variables, including gender, education, material wealth, and socioeconomic status (SES), which were assumed to be causes of variation. Pearson's correlation coefficient, symbolized by a lower case, denotes the direction and strength of the relationship between variables.

Gender

Gender significantly and moderately correlated with mental health and negative emotion. Compared to men, women had significantly higher levels of mental health ($r = 0.201$, $p < 0.05$) and fewer negative emotions ($r = -0.222$, $p < 0.05$). There was no significant difference in positive emotions between men and women.

TABLE 3 Correlation among mental health-related variables and control variables.

	Gender	Education	Material wealth	SES
Mental health	0.201**	0.068	0.194**	0.410***
Positive emotions	0.048	0.062	0.149**	0.152**
Negative emotions	−0.222**	−0.014	−0.126	−0.403***

**$p < 0.05$, ***$p < 0.01$. SES, socio-economic status. The values in the cells are the Pearson's correlation coefficients among variables.

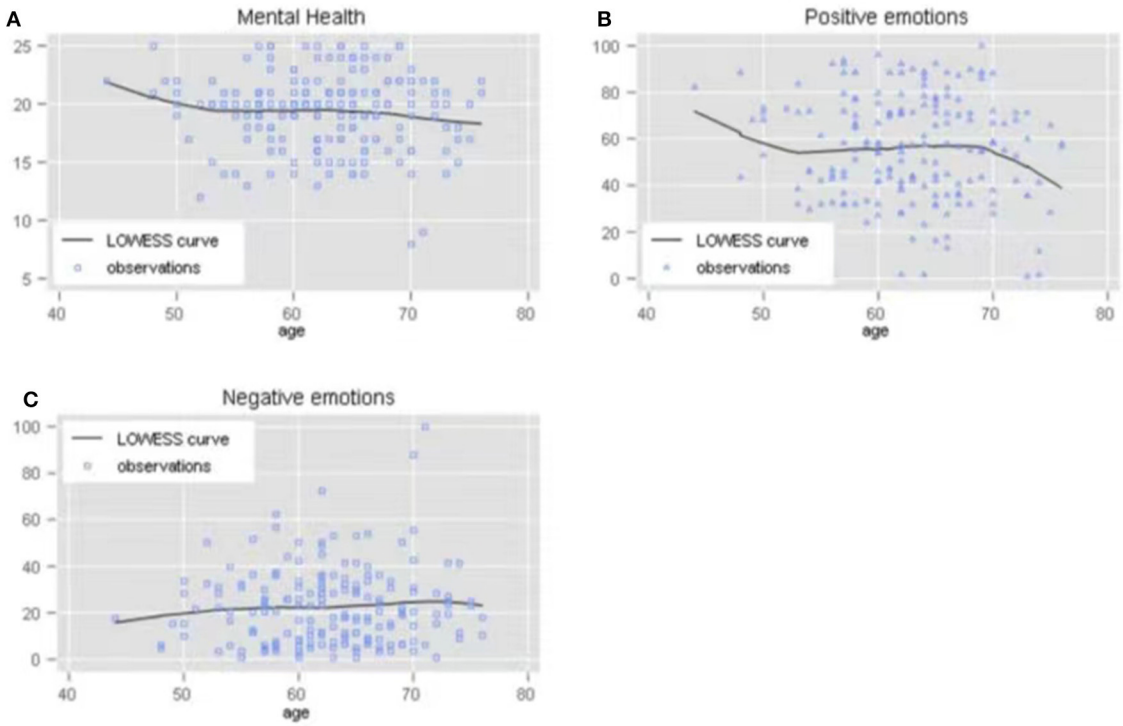

FIGURE 1
(A) The effect of age on mental health. **(B)** The effect of age on positive emotions. **(C)** The effect of age on negative emotions.

Age

As shown in Figure 1, we conducted LOWESS regression analysis to illustrate the association between mental health and age measured in years, denoting a weak non-linear relationship. Compared to respondents <50 years and >70 years old, those aged between 50 and 70 years were more mentally healthy and positively emotional. When combined with the multivariable regression models, age measured in natural logarithm values, was not significant in any of the models.

Education

As shown in Table 3, there was no significant relationship between education level and mental health. The educational levels of retired adults were categorized as "Primary school or below," "Junior high school, high school, technical secondary school," and "College degree or above." There were no significant differences between participants who graduated from primary school and below and those from higher education levels. Education level was not statistically significant in any of the regression models.

Material wealth and socio-economic status

Material wealth describes the objective ability to obtain material conditions, while socioeconomic status shows the subjective perception of social class. As shown in Table 3, material wealth significantly and positively correlated with mental health ($r = 0.194$, $p < 0.05$) and positive emotions ($r = 0.149$, $p < 0.05$). The association between material wealth and negative emotions was not statistically significant. Similarly, socio-economic status significantly and positively correlated

TABLE 4 Correlation among dimensions of participation and mental health.

	Mental health	Positive emotions	Negative emotions
Diversity of participation	0.145*	0.040	−0.141
Frequency of participation	0.274*	0.088	−0.235*
Quality of participation	0.317*	0.161*	−0.272*

*$p < 0.1$. The values in the cells are the Pearson's correlation coefficients among variables.

TABLE 5 Difference in mental health among participants and non-participants in CSOs.

Mean-diff	Hobby-related CSOs	Health-related CSOs	Study-related CSOs	Semi-official CSOs
Mental health	1.549***	0.958**	0.877*	−0.233
Positive emotions	5.105	7.301**	−0.443	−0.939
Negative emotions	−7.004***	−2.248	−4.893**	1.004

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$. The mean-diff values in cells indicate the comparison of means between those who participated in specific CSOs and those who did not.

with mental health ($r = 0.410$, $p < 0.01$) and positive emotions ($r = 0.152$, $p < 0.05$), and negatively with negative emotions ($r = -0.403$, $p < 0.01$). Summarily, the mental health of retired individuals significantly associated with the quantity of material wealth and perception of their socio-economic status.

Physical health and sleep quality

As shown in Table 6, the coefficient of physical health ($\beta = -2.832$, SE = 1.283) implied that negative emotions decreased, on average, by 2.832 for each 1-unit increase in physical health while keeping other variables constant. The effects of sleep quality were also statistically significant on mental health ($\beta = 0.483$, SE = 0.228) and negative emotions ($\beta = -4.592$, SE = 1.161). This signified an increase in mental health by 0.483 and a decrease in negative emotions by 4.592 for each 1-point increase in sleep quality.

In summary, the above analyses show that gender, education level, physical health, sleep quality, material wealth, and socioeconomic status significantly affect the mental health of retired individuals. Among the control variables, female gender, physical health, sleep quality, and socioeconomic status can significantly reduce negative emotions, whereas education level, material wealth, and socioeconomic status could effectively enhance positive emotions. After adding other variables, the effects of sex, physical health, sleep quality, and socioeconomic status on mental health remained statistically significant.

Effects of participation in CSOs on mental health

Participation in CSOs was defined in multiple dimensions: diversity, frequency, quality, and type. We conducted binary correlation analysis to show raw correlations between each dimension of participation and mental health, as shown in Table 4. We adopted regression models to estimate the net effect of each dimension, as shown in Table 6.

Diversity and frequency of participation

Diversity referred to the number of categories of CSOs who participated[2]. The frequency of participation referred to the number of times per week individuals participated in activities organized by CSOs. As shown in Table 4, diversity of participation positively and weakly correlated with mental health ($r = 0.145$, $p < 0.1$). The frequency of participation affected mental health positively and moderately ($r = 0.274$, $p < 0.1$), while negatively affecting negative emotions ($r = -0.235$, $p < 0.1$). As shown in Table 6, the coefficient of frequency ($\beta = 0.481$, SE = 0.215) implied that mental health increased on average by 0.481 for each 1-unit increase in the frequency of participation, while the net effect of diversity of participation on mental health was not statistically significant.

Quality of participation

Quality of participation was defined as the level of basic interpersonal needs, including belonging, dominance, and affection needs individuals acquired in CSOs. This determines the resilience and sustainability of organizations, according to interpersonal theory of behavior. As shown in Table 4, the quality of participation correlated: moderately and positively with mental health ($r = 0.317$, $p < 0.1$), weakly and positively with positive emotions ($r = 0.161$, $p < 0.1$), and moderately and negatively with negative emotions ($r = -0.272$, $p < 0.1$). Furthermore, as shown in Table 6, the net effects of participation quality remained

2 For example, if a respondent participates in five organizations of the same category, it is considered one category, and the value of the diversity variable is recorded as one.

TABLE 6 Results of multivariable regression analysis.

	Model 1 Mental health	Model 2 Positive emotions	Model 3 Negative emotions
Gender	0.901*	0.928	−5.714**
	(0.527)	(4.393)	(2.683)
lnage	−1.353	−13.31	−0.988
	(2.279)	(18.999)	(11.602)
Edu_1	−0.004	−0.89	−2.053
	(0.707)	(5.894)	(3.599)
Edu_2	−0.342	−5.311	−1.288
	(0.502)	(4.183)	(2.554)
Physical health	0.113	−2.987	−2.832**
	(0.252)	(2.101)	(1.283)
Sleep quality	0.483**	−3.205	−4.592***
	(0.228)	(1.901)	(1.161)
Material health	0.125	1.583	−0.023
	(0.131)	(1.096)	(0.669)
SES	0.331***	1.019	−1.667***
	(0.122)	(1.017)	(0.621)
Diversity	−0.585*	−4.638	1.106
	(0.364)	(3.039)	(1.856)
Frequency	0.481**	1.008	−1.645
	(0.215)	(1.797)	(1.097)
Quality	0.158***	0.907**	−0.523**
	(0.047)	(0.393)	(0.24)
Hobby-related CSOs	0.33	7.365	1.488
	(0.674)	(5.615)	(3.429)
Health-related CSOs	1.395**	14.751***	−0.59
	(0.62)	(5.166)	(3.155)
Study-related CSOs	1.164**	5.075	−3.457
	(0.589)	(4.908)	(2.997)
Semi-official CSOs	−0.123	2.212	1.45
	(0.679)	(5.659)	(3.456)
_cons	15.749	102.217	81.959
	(9.835)	(81.99)	(50.068)
Observations	170	170	170
R^2	0.342	0.169	0.361
Adjust R^2	0.278	0.088	0.298
F	6.378***	2.514**	7.323***

*$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
The values in () are standardized errors of coefficients.

statistically significant in the regression models, with coefficients of 0.158 (SE = 0.047), 0.907 (SE = 0.393) and −0.523 (SE = 0.24) in the mental health, positive emotions and negative emotions models, respectively. The results indicated that, on average, mental health and positive emotions increased by 0.158 and 0.907, respectively and decreased by 0.523 for each 1-unit increase in the quality of participation.

Types of participation

Most empirical studies tend to consider CSOs as a unique type of social interaction of retired adults; however, the types of CSOs are discussed to a lesser extent. There were four main types of CSOs in urban China: hobby CSOs such as plaza dancing groups (guangchangwu dui), health CSOs such as community care centers (laonianren zhaoliao zhongxin), study-related CSOs such as community seniors universities

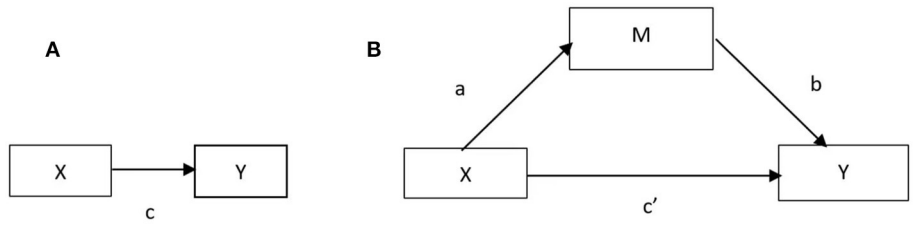

FIGURE 2
(A) Illustration of a direct effect. **(B)** Illustration of a mediation design.

(laonian daxue), and semi-official CSOs referred to as the seniors associations (laonian xiehui).

We conducted T-Test analysis to compare the means of mental health between participants and non-participants, as shown in Table 5. Structural differences appear among several types of CSOs.

Compared to non-participants, the mean difference in mental health for participants was: 1.549 ($p < 0.01$), 0.958 ($p < 0.05$) and 0.877 ($p < 0.1$) for hobby, health- and study-related CSOs. These results indicated that the average mental health of those participants of hobby-, health-, and study-related CSOs were 1.549, 0.958, and 0.877 points higher respectively, than non-participants. The mean difference of positive emotions was 7.301($p < 0.05$) for participants of health CSOs. For negative emotions it was -7.004 ($p < 0.01$) and -4.893 ($p < 0.05$) for participants of hobby- and study-related CSOs.

In the multivariable models shown in Table 6, the effects of participation in the following types of organization were significant: health CSOs in the mental health model ($\beta = 1.395$, SE = 0.62), positive emotions model ($\beta = 14.751$, SE = 5.166), and study-related CSOs ($\beta = 1.164$, SE = 0.589) in the mental health model. Among the various types of CSOs, participation in health CSOs plays the most robust role in improving mental health and positive emotions.

The mediating mechanism of interpersonal needs on mental health

The study further investigated the mediating mechanism of interpersonal needs on mental health acquired from participation in CSOs, testing whether diversity and frequency of participation affected mental health through the mediating role of interpersonal needs. As shown in Figure 2, we conducted two mediation analyses by conducting structural equation modeling to assess the mediating effect of interpersonal needs, using the Sobel test (62), which enhanced the robustness of the Baron and Kenny method (BK). The independent variables were diversity (X_1) and frequency (X_2) of participation, the mediating variable was interpersonal needs (M), the dependent variable was mental health (Y), and the control variables were the remaining variables in Model 1.

In the diversity model, as shown in Figure 3, the effect of X_1 on M, the effect of M on Y, the effect of X_1 on Y without controlling M, and the effect of X_1 on Y controlling M were 0.586, 0.151, 0.88 and -0.129, respectively. The results of the Sobel test, Sobel's $Z = 2.045$, $p < 0.05$, and the results of bootstrap resampling procedures using 170 samples equal to the observations of the sample, unstandardized indirect effect = 0.088, SE < 0.052, $Z = 1.825$, $p < 0.1$, 95% bias-corrected bootstrap CI (0.012, 0.220) excluding a zero value, confirmed that "interpersonal needs" was a mediator between the diversity of participation and mental health of retired adults. Furthermore, the direct effect of X_1 was significant at the 99% confidence level, and indirect effect became insignificant after adding the mediator variable. This result indicated a complete mediation mechanism of interpersonal needs associating diversity of participation with mental health.

In the frequency model, as shown in Figure 4, the effect of X_2 on M, the effect of M on Y, the effect of X_2 on Y without controlling M, and the effect of X_2 on Y controlling M were 0.810, 0.151, 0.122 and 0.419 respectively. The results of the Sobel test, Sobel's $Z = 2.097$, $p < 0.05$, and the results of bootstrap resampling procedures using 170 samples, standardized indirect effect = 0.122, SE = 0.070, $Z = 1.869$, $p < 0.1$, 95% bias-corrected bootstrap CI (0.021, 0.299) excluding a zero value, confirmed that "interpersonal needs" also served as a mediator associating frequency of participation with mental health. Furthermore, the direct and indirect effects of X_2 were both significant after adding the mediator variable, and the ratio of indirect effect to total effect was about 23%. The results showed a partial mediation mechanism of interpersonal needs associating frequency of the participation with mental health.

Discussion

Although there is increasing number of CSOs in urban China with massive urbanization over the last 40 years, the value they generate for public mental health remains implicit. Previous studies have focused on its role in supplying public services and

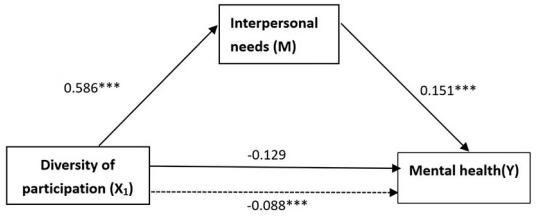

FIGURE 3
The mediation model associating diversity of participation with mental health. Dotted line denotes the original effect of the independent variable excluding the mediator variable.
$^{***}p < 0.01$.

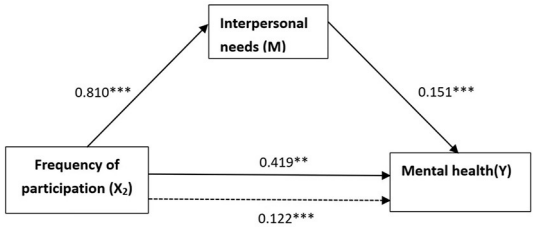

FIGURE 4
The mediation model associating frequency of participation with mental health. Dotted line denotes the original effect of the independent variable excluding the mediator variable.
$^{**}p < 0.05$, $^{***}p < 0.01$.

satisfying physical needs, as the Chinese government has been promoting the purchase of social service contracting policies since 2000, impelled by the new public management reform. However, CSOs also satisfy their psychological needs in an intangible way. This study examined the association between CSOs and mental health and investigated how membership and participation in various CSOs benefited retired adults' mental health.

Effects of participation in CSOs on mental health

This study's first finding was that participation in CSOs benefited mental health by constituting social networks among retired adults in urban China. Some studies indicated that social interaction had a significant impact on retired adults' mental health through sharing social network resources (33, 63). Moreover, social networks could effectively alleviate the negative mental states of anxiety, depression, and interpersonal sensitivity and enable retired adults to maintain a positive mental status and enhance their subjective wellbeing (64). However, social networks among acquaintances such as family and friendship networks were emphasized more in Chinese research because the acquaintance society was a typical feature of Chinese traditional culture, where the networks among strangers were considered weak and incredible. This study confirmed that participation in CSOs could promote the formation of social networks based on variational residence in urban China, thus improving mental health, promoting positive emotions, and alleviating negative emotions in retired adults.

More detailedly, the frequency and quality of participation in CSOs could significantly improve mental health, by 0.481 and 0.158, respectively. The more individuals spent time in CSOs, the more they obtained a sense of belonging, dominance, and affection by participating in CSOs, they were likely to have more mental health. Effects of diversity of participation on mental health was absorbed by the quality of participation as the complete mediator effects were confirmed in the diversity SEM. Analysis of positive and negative emotions showed that the quality of participation in CSOs could significantly promote positive emotions and alleviate negative emotions among retired adults.

Effects of types of participation in various CSOs were also examined, and the findings differed from research in other countries. Health CSOs, particularly community care centers that supply physical therapy services and health care, and Study-related CSOs, mainly as community seniors universities exclusive for older adults, can satisfy psychological needs and promote mental health, while religion organizations were discussed and emphasized in other studies. Compared to non-participants, those who participated in health and study-related CSOs had higher scores on mental health by 1.395 and 1.164, respectively. Analysis still indicated that membership of health CSOs could exert significant effects on the positive and negative emotions of retired adults. It was worth pointing out that there was no significant difference between participants and non-participants of semi-official CSOs which were mainly organized and financed by the municipal government in mental health.

Mediating effects of interpersonal needs

The mediating mechanism of interpersonal needs associated with participation in CSOs' mental health was significant. According to social capital theory, previous studies have focused on resources affiliated with social networks. This study illustrated the causal chain between participation in CSOs and mental health through the mediator of interpersonal needs, which made participation valuable for mental health among retired adults. The psychologist, W. Schutz proposed a three-dimensional interpersonal behavior theory based on interpersonal needs, highlighting that all individuals were eager for three basic needs in the process of interpersonal interaction: inclusion, dominance, and affection. These basic interpersonal needs determined the behaviors that individuals adopted in interpersonal interactions and how

they described, interpreted, and predicted others' behaviors. CSOs provided basic needs in participation and interpersonal interactions, which helped to boost positive emotions, decrease negative emotions, and improve aggregating mental health.

Conclusion

The present study was one of the first studies to explore the mechanisms of CSOs participation affecting the mental health of retired adults. Furthermore, it examined the mediating role of interpersonal needs in the association between CSOs participation and mental health, based on social capital theory. The major empirical findings discussed above verify these hypotheses and advance our knowledge of the association among CSOs, interpersonal needs, and mental health. First, CSOs participation had a significant positive effect on the mental health of retired adults. However, unlike religious organizations which play a strong role in other countries, the effect of health organizations was the strongest in China. Additionally, participation in a semi-official organization did not work, which was surprising. Second, the results highlighted that interpersonal needs mediate the association between CSOs participation and mental health among Chinese retired adults. When retired adults obtained the three dimensions of interpersonal needs: inclusion, dominance, and affection from participation, their mental health would be significantly enhanced. Additionally, the diversity and frequency of participation could facilitate the interpersonal needs of retired adults obtained from CSOs. In conclusion, this study showed that both CSOs participation and interpersonal needs were promoting factors in mental health. This indicated that the design of programs and policies for retired adults should consider meeting their interpersonal needs and involving retired adults in more CSOs participation that focus on promoting active aging. Of note, more high-quality longitudinal studies should be conducted to further substantiate the results of this study.

Data availability statement

The original contributions presented in the study were included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Shenzhen University (PN-202200090). The patients/participants provided their written informed consent to participate in this study.

Author contributions

YL made contribution to research design, theoretical analysis, and paper revision. JLa contributed to original draft preparation, data analysis, design of participation scale, and paper revision. JLi contributed to paper writing and revision. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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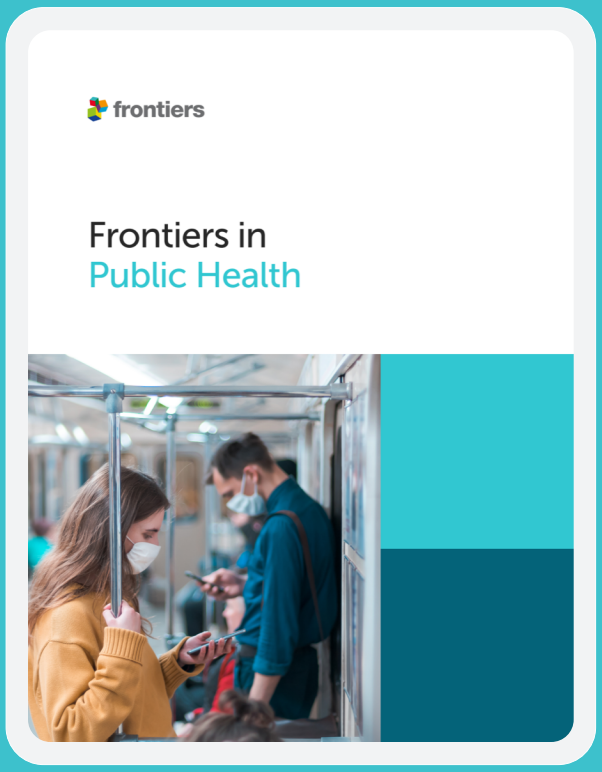

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