



# The influence and mechanism of Taichi Chuan on improving mental health in adolescents: The chained mediating effect of meaning in life and psychological resilience

Doudou Yang<sup>a</sup>, Xiaoyan Wang<sup>b,\*</sup>

<sup>a</sup> Guangdong University of Science and Technology, Dongguan, 523668, Guangdong, China

<sup>b</sup> Guangzhou Polytechnic of Sports, Guangzhou, 510650, Guangdong, China

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## ABSTRACT

This study explored the main effect of Taichi Chuan on adolescents' mental health, as well as the heterogeneous influencing factors. Two separate studies were conducted on 722 Chinese adolescents from one secondary school in Guangzhou. We used the method of statistical analysis to analyze the scales designed to assess their Taichi Chuan, meaning in life, psychological resilience and mental health. In Study 1, the practice of Taichi Chuan exhibits a substantial positive impact on mental health ( $\beta = 1.125, p < 0.001$ ). Additionally, meaning in life and psychological resilience have a mediating effect on the relationship between Taichi Chuan and mental health. Intriguingly, both mediators play a chained mediating role in the impact of Taichi Chuan on adolescents' mental health, with an effect size of 0.035 (95%CI: [0.001, 0.045],  $p < 0.01$ ). Study 2 re-evaluated the hypotheses, incorporating age and grade as control variables, and confirmed that Taichi Chuan enhances mental health ( $\beta = 0.257, p < 0.05$ ). A chain mediation effect was observed with meaning in life and psychological resilience as mediators (effect size = 0.106, 95 % CI: [0.025, 0.226],  $p < 0.05$ ). The findings of study 2 were consistent with those of study 1. Embodied cognition theory posits that the integration of internal psychological processes with external bodily dynamics leads to a state of harmony and unity. The conclusions of this study integrate the principles of Taichi Chuan with embodied cognition theory, not only can alleviate the individual distress and family burdens associated with adolescents' mental health, but also promote the integrative development of martial arts education in middle schools.

## 1. Introduction

The adolescent stage, a critical period for cognitive, emotional and personality development, is often accompanied by numerous growth challenges. Escalating academic pressures make adolescents increasingly vulnerable to mental health problems. Data co-released by UNICEF and the World Health Organization in 2021 highlighted that suicide, claiming nearly 46,000 adolescents worldwide annually, ranks among the top five causes of death in individuals aged between 10 and 19 years. It is estimated that over 13 % of these demographic grapples with mental disorders. In affluent nations, nearly one in five adolescents aged 15–24 frequently experience depressive symptoms or fatigue (Hagopian et al., 2019). Adolescents' mental health concerns have evolved into a notable global public health issue, warranting increased attention and preventative efforts. Literatures reflect that physical activity and sports

participation significantly enhance adolescents' mental health and socio-emotional adaptability (Fjolla & Naveen, 2022).

In western contexts, martial arts are commonly perceived as any of numerous combat and self-defense forms (embracing a variety of martial sports or skills). Principally derived from East Asia, these are widely applied as physical exercise (Cynarski & Skowron, 2014). An introductory definition in the Encyclopedia Martial Arts of the World is as follows: "Martial arts are considered to be systems that blend the physical components of combat with strategy, philosophy, tradition, or other features that distinguish them from pure physical reaction (in other words, a technique, armed or unarmed, employed randomly or idiosyncratically would not be considered a martial art) (Green, 2010)." Unarmed varieties include aikido, judo, karate, kung-fu, and taekwon do. However, the humanistic theory of martial arts takes into consideration other dimensions: anthropological, cultural, moral, social and

\* Corresponding author.

E-mail addresses: [800004@gzsport.edu.cn](mailto:800004@gzsport.edu.cn) (D. Yang), [wangxiaoyanj@126.com](mailto:wangxiaoyanj@126.com) (X. Wang).

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pedagogical, psychological and philosophical, religious and health aspects (Cynarski & Skowron, 2014).

Taichi Chuan is a form of mind-body exercise originating from China. Similar to aikido, it prioritizes the synchronization of bodily movement and breath, highlights the significance of the body's internal self-regulation, and with it a wealth of philosophical culture and educational implications. According to divide into "hard" and "soft" martial arts by Vertonghen et al. (2014). Taichi Chuan belong to the soft one. It is formed by combining traditional sports health preservation methods with core ideas rooted in Chinese Confucianism, Daoist theories, Yin-Yang dialectics, and traditional Chinese medical meridian theory (James, 2019). Its features are gentleness, slowness, and stability. As for emblematic of the national ethos, it not only promotes physical and mental vigor but also epitomize the harmony between the internal and external self. The practice of Taichi Chuan requires a harmonious blend of motion and stillness, underscored by the conscious guidance of actions. Emphasizing individual comfort, it modulates the functions of various organs, necessitating concentration and complete relaxation. This promotes stress relief, anxiety reduction, and psychological equilibrium. Specifically, the synchronization of Taichi Chuan's physical maneuvers with breathing cultivates an individual's serene and composed disposition. Additionally, Taichi Chuan prioritizes internal-external congruity, necessitating cognitive engagement in physical activities to ensure balance, correlating with the precepts of embodied cognition theory. This theory suggests that our cognitive functions emanate from the dynamic interplay between the bodily and mental complex and its environmental surroundings, accentuating the indispensable role this interaction plays in cognitive inception (Wallace, 2021).

Previous studies of Taichi Chuan have primarily focused on contributions to cultural dissemination, historical heritage, school education, sports medicine, rehabilitation science and other areas. Existing studies have also demonstrated the significant role of Taichi Chuan in these aspects. The subjects of previous studies are mainly focused on college students and disadvantaged groups, but existing studies haven't delved into adolescents' mental health issues from a quantitative research perspective either. Therefore, this study aims to offer a practical approach to promote their physical and mental well-being by integrating Taichi Chuan with sports psychology to alleviate the mental health issues of adolescents.

## 2. Literature review

Taichi Chuan, a traditional Chinese martial art, is gaining global popularity due to its positive health benefits. Taichi Chuan displays immense potential for development and has been extensively incorporated into both international and domestic research in preventative care and rehabilitation of medical and psychological conditions (Woolacott & Tang, 2020). In an investigation into the effect of Taichi Chuan on primary hypertension, 99 patients suffering from hypertension were randomly assigned to either a control or experimental group in order to monitor the fluctuations in their systolic and diastolic pressures before and after the intervention. After a 12-week period of intervention, Taichi Chuan could improve the blood pressure of patients with hypertension by decreasing the serum Ang II level and increasing the serum NO level (Lin et al., 2021). The practice of Taichi Chuan has a positive impact on the physical activity levels and mental health of low-risk pregnant women. An experiment involved 136 low-risk pregnant women demonstrated notable differences after a 12-week Taichi Chuan intervention program in comparison with regular care. The women underwent the Taichi Chuan program displayed better progress in physical activity levels and exercise self-efficacy, excluding any symptoms of prenatal depression (Ma et al., 2023).

However, there has a few researches showed that Taichi Chuan and Qigong exercises had a potential impact on the ability of healthy to relax, they had an impact on the activation of positive mental states of

people exercising. For health people, they would be preventive exercise, and for people with ailments, effective therapy (Skrzeta et al., 2021). Zeng et al. (2013) investigated martial arts students' motivation and health behaviors in the city of Changshu, the results reflected that motivation factors, practice-times and risk behaviors were administered very well; while hygiene, nutrition and fitness were not administered well and need to be improved. Vertonghen et al. (2014) used a quantitative methodology, the present investigation analyzed mediating factors, including characteristics of the participants, their social background, and type of martial arts & combat sports that might influence the outcomes of martial arts & combat sports involvement among adolescents. The results showed that difference exist in the characteristics and social background of participants depending on the type of martial arts & combat sports being practiced, could make different effects on the mental health of adolescents.

### 2.1. Taichi Chuan and mental health

The theory of embodied cognition posits that physical experiences have a considerable influence on cognitive functionality (Rotella & Richeson, 2015). Participation in physical activities such as Taichi Chuan can significantly shift individuals' perception of their environment, thereby altering their emotions, attitudes, judgments, and thought processes (Jones et al., 2022). Studies have indicated that involvement in Taichi Chuan can enhance self-assurance and elicit positive among adolescents, consequently promoting mental well-being and social inclusion (Ruth et al., 2006). Under the framework of "Healthy China 2030", Li et al. (2023) have shown that Taichi Chuan practice can aid in quelling negative emotions among adolescents and encourage a balanced mental state.

The Taichi Chuan practice, which harmonizes internal and external aspects, thereby aligning body and spirit, refreshes the psyche and improves physical health. It can be inferred that adolescents can achieve enhanced physical fitness and mental regulation through active engagement in Taichi Chuan. This is particularly beneficial for adolescents facing anxiety, as the training provides a potent means to refocus their attention and relieve physical exhaustion. Regular Taichi Chuan practice can also fortify neuron cell function in the adolescents' brains, improve cognitive functions and flexibility, increase neuron connections, thereby improving mental health and preventing cognitive disorders. Based on these premises, Hypothesis 1 is proposed in this study: Taichi Chuan can positively influence adolescents' mental health.

### 2.2. Chained mediating effect of meaning in life and psychological resilience

Mental health can be bolstered through two protective mechanisms: meaning in life and psychological resilience (Pinar et al., 2018). Meaning in life is an individual's understanding and acknowledgment of the significance of their existence, which includes setting and achieving life goals, tasks, and missions, and embraces two dimensions—the pursuit and possession of meaning (Steger et al., 2006). Conversely, psychological resilience, also known as psychological elasticity or recovery, encapsulates an individuals' inherent abilities or characteristics that aid in managing stress, overcoming setbacks, and dealing with trauma (Daniel et al., 2016). Previous researches from sports exercise perspectives demonstrates a significant positive correlation between an individuals' meaning in life, psychological resilience, and participation in sports activities, thereby indicating that such activities can enhance individuals' meaning in life and their psychological resilience (Davydov et al., 2010; Joshua et al., 2016). During the COVID-19 pandemic, individuals' affirmation of their life value has been intensified through active participation in physical exercise (Youngwoon & Sondra, 2021). This engagement strengthens their capacity to manage stress, setbacks, and trauma. Notably, an exercise regimen maintained at three or more sessions weekly, with each session ranging from 30 to 60 min, yields

superior outcomes (Cagla & Nurcan, 2021). Such individuals display enhanced psychological traits, leading to a gradual improvement in their mental health standards.

The theory of embodied cognition stresses the integration of the body and mind, suggesting cognition arises from the dynamic interplay among body, mind, and environment, and underlining the pivotal role they play in the generation of cognition (Niedenthal et al., 2005). Moreover, the cognition process in the body is characterized as an active bidirectional interaction with the external environment (Singh, 2020). Taichi Chuan serves as a sport to not only promote physical health but also balance internal emotions. This synergy of internal and external activities amalgamates psychological processes with physical movements, steering towards a harmonious and unified state consonant with the unity of the body and mind proposed by the embodied cognition theory (Shapiro, 2007). Adolescents, by engaging in Taichi Chuan, experience an integration of their bodies with their external environment, shaping their situational awareness. The precise synchronization of Taichi movements with breath control promotes a relaxed state in adolescents, alleviating negative emotions. Moreover, the combination of relaxed and tense movements will also mobilize the attention of adolescents, causing them to generate more thoughts and have more positive emotional experiences. They can genuinely feel the value and achievement they receive from the process of interacting with the environment and others, actualizing embodied individual value and acknowledging the meaning of life (Baumeister & Landau, 2018). This process nurtures an optimistic mindset and cultivates resilience, empowering them to face hardship with an upbeat attitude, thereby fortifying their psychological resilience. This helps them confront adversities courageously, fostering a healthy mindset, and thus proactively adapting to society (Michal et al., 2018).

Consequently, the stronger meaning in life begets greater psychological resilience, further fostering the individual's mental health. Adolescents, in the course of practicing Taichi Chuan, convert the philosophical ethos inherent in Taichi Chuan into tangible actions and behaviors, relying on their limbs and trunk to understand its tenacity, flexibility, dynamism, tranquility (Iris et al., 2013). This helps adolescents validate their value of life, reduce psychological distress, permeates their cognition, and thereby promotes their psychological resilience, leading to an enhancement in their mental health states. Accordingly, Hypothesis 2 is proposed in this study: meaning in life and psychological resilience have a chained mediating effect in the impact of Taichi Chuan on adolescents' mental health.

### 2.3. The present study

Therefore, the purpose of this study is to explore the main effect of Taichi Chuan on adolescents' mental health, as well as the heterogeneous influencing factors. We take adolescents as subjects to construct a chained mediation model in Study 1 and Study 2 (see Figs. 1 and 2).

## 3. Method

### 3.1. How to select adolescents for Taichi Chuan participation

This study randomly selected a secondary school comprising both junior high school and senior high school sections, which did not offer Taichi Chuan course. Following a non-discriminatory promotion to all students, Taichi interest-oriented class was formed, allowing students to enroll based on their interests and conditions. Taichi Chuan instruction was then provided to the enrolled students. After some time, we concurrently assessed the psychological status and behavior of both students who learned Taichi Chuan and those who did not.

### 3.2. Data collection and participant characteristics

According to the age definition by the World Health Organization and the United Nations Population Fund, adolescents are categorized within the 10–19 age range. Physiologically, this group is experiencing enhanced bodily functions and a trend towards physical maturity. Psychologically, adolescents develop independent thinking and consciousness, though their cognitive maturity is still evolving, leading to complex emotional states.

Respondents were initially asked about their course participation and their familiarity with and evaluation of Taichi Chuan. Subsequently, they answered questions on their meaning in life, psychological resilience, and mental health based on recent experiences, followed by demographic information. After being informed of the study details, participants provided consent and completed the questionnaires anonymously. The entire survey process took approximately 30 min. This survey was supported by both school teachers and parents. The survey period lasted two weeks.

This study comprises two research projects. Study 1 involved administering questionnaires to 600 adolescents from one secondary school in Guangzhou to assess the impact of Taichi Chuan on adolescents' mental health and its chained mediating effects. Study 2 expanded the sample size by including an additional 250 adolescents from the same school and administering questionnaires again. This study controlled for the adolescents' age and grade, and repeated the measurement of the main effect of Taichi Chuan on adolescents' mental health and its chained mediating effects to examine whether the results were consistent with those of Study 1.

In Study 1, after the questionnaire screening process, 600 questionnaires were distributed across the students of the secondary school. Of these, 522 valid questionnaires were returned, yielding a recovery rate of 92 %. The participants included 522 adolescents, comprising 190 males and 332 females. Among them, 211 were only child, and 311 had siblings. The sample included 310 junior high school students and 212 senior high school students. In Study 2, another 250 questionnaires were distributed across the students of the secondary school. Of these, 200 valid questionnaires were returned, yielding a recovery rate of 80 %.

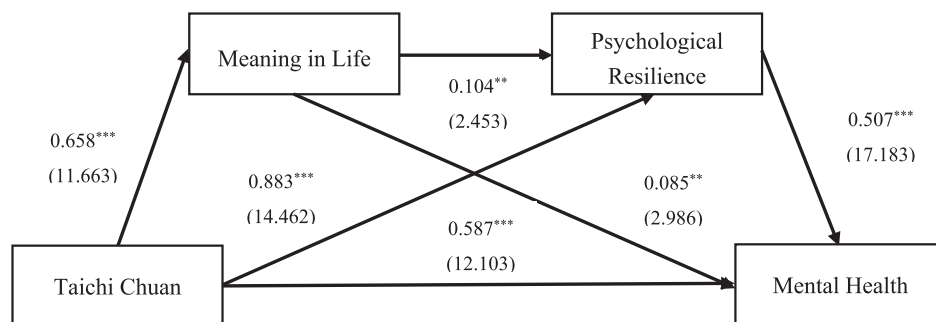


Fig. 1. Conceptual model in Study1.

Note: significance level: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , t-values in parentheses.

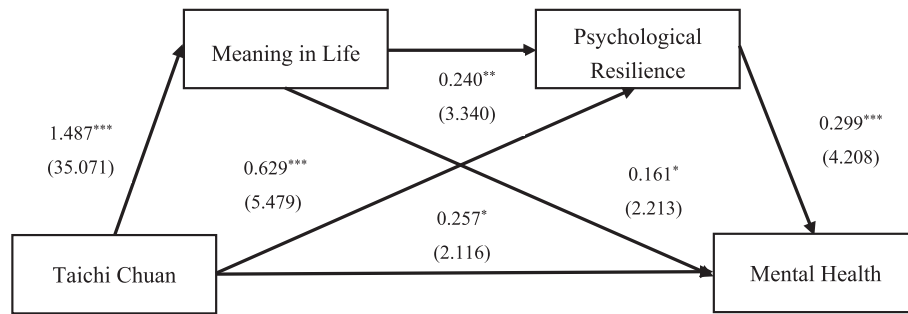


Fig. 2. Conceptual model in Study2.

Note: significance level: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , t-values in parentheses.

The participants included 200 adolescents, comprising 68 males and 132 females. Among them, 136 were only child, and 64 had siblings. The sample included 89 junior high school students and 111 senior high school students.

### 3.3. Measures

Reliable multi-item scales used in this study were adapted following a thorough review of relevant literature, with minor wording modifications to suit the current context. Most of the scales used have been previously validated in studies within the fields of sports and psychology. Table 1 presents the measures adopted in this research. All items were rated on a 5-point Likert scale, with responses ranging from “1 = very inconsistent” to “5 = very consistent” with the participant's experience. To ensure consistency between the original English and translated Chinese versions, the study employed the translation-back-translation method.

Meaning in life scale, revised by Steger et al. (2006), consists of 10 items across two dimensions: the presence of meaning in life and the search for meaning in life. All items are forward-scored, with higher overall scores indicating a stronger meaning in life. The psychological resilience scale, revised by Oshio et al. (2003), comprises 27 items across five dimensions: goal focus, emotional control, positive cognition, family support, and interpersonal assistance, with 12 items reverse-scored. A second-order factor measurement model with these five sub-factors was tested, yielding goodness-of-fit indices of  $\chi^2/df = 2.827$ , CFI = 0.953, NFI = 0.929, IFI = 0.953, RMSEA = 0.059, and SRMR = 0.030, supporting the model of overall psychological resilience as a second-order construct encompassing these five factors. The mental health scale, revised by Lukat et al. (2016), includes 25 items across five dimensions: happiness in life, willingness to learn, interpersonal harmony, exam calmness, and emotional stability, with 14 items reverse-scored. A second-order factor model was also tested for this scale, with goodness-of-fit indices of  $\chi^2/df = 4.249$ , CFI = 0.915, NFI = 0.892, IFI = 0.915, RMSEA = 0.079, and SRMR = 0.057, validating the overall conceptualization of mental health as a second-order construct across these dimensions.

### 3.4. Reliability and validity of the measurement

SPSS 26.0 and Amos 24.0 software were used to assess the reliability and validity of the questionnaire data collected. Reliability was evaluated through Cronbach's  $\alpha$ , composite reliability (CR), and average variance extracted (AVE). The Cronbach's  $\alpha$  values for meaning in life, psychological resilience, and mental health are 0.94, 0.977, and 0.968, respectively, all exceeding the threshold of 0.6 and indicating high internal consistency. A confirmatory factor analysis (CFA) was conducted using Amos 24.0 to assess measurement validity. The overall fit statistics ( $\chi^2/df = 2.921$ , CFI = 0.874, NFI = 0.82, IFI = 0.874, RMSEA = 0.061, and SRMR = 0.055) indicated that the measurement model fit the data well. The internal consistency of each construct was evaluated using

construct reliability (CR). As shown in Table 1, all CR values exceeded the threshold of 0.70, demonstrating high internal consistency and good reliability. Unidimensionality was further supported, with AVE values above 0.50 and composite reliabilities  $> 0.70$ . Factor loadings ranged from 0.645 to 0.834 (see Table 1), supporting high convergent validity as they exceeded the 0.70 benchmark. To assess discriminant validity, the correlation matrix was examined (see Table 2), confirming that the square roots of the AVE values were greater than inter-construct correlations, indicating strong discriminant validity. Overall, the measurement model demonstrated robust reliability and validity, providing a solid foundation for testing the research hypotheses.

## 4. Results

### 4.1. Common method deviation test

Because the data were collected from one online questionnaire and were self-reported for all of the variables, a threat of common method variance may be present (Podsakoff et al., 2003). A Harman's single-factor test was employed to check the extent to the method variance in the data, and any single factor would explain lower than 50 % of the variance in a principal component factor analysis with no rotation. The largest factor accounted for 46.49 %, being below the 50 % threshold, and the results indicated that no single component accounted for most of the variance and the CMB was not a threat in our study.

Second, we related all items to a common method factor and conducted a single-factor test employing CFA by using the method of Malhotra et al. (2006). The results showed that the fit of the single-factor model was poorly fitted ( $\chi^2/df = 6.042$ , CFI = 0.668, NFI = 0.628, IFI = 0.669, RMSEA = 0.098, and SRMR = 0.105), which indicated that CMV was not a serious problem in this study.

### 4.2. Study 1

In Study 1, the variables of gender, only-child status, and participation in other sports were primarily controlled, while age and grade were not. This study focused on measuring the main effect of Taichi Chuan on adolescents' mental health and its chained mediating effects.

#### 4.2.1. Testing for main effect

This study adopted regression analysis to examine the main effect of Taichi Chuan on mental health. The main effects model is as follows:

$$\text{Mental Health} = \beta_0 + \beta_1 \text{Taichi Chuan} + \beta_2 \text{Gender} + \beta_3 \text{Only-child} + \beta_4 \text{Other\_sport} + \varepsilon_i$$

The dependent variable, Mental Health, is a continuous variable, with higher scores indicating greater levels of mental health. The independent variable, Taichi Chuan, is categorical, coded as 0 for non-participation in Taichi Chuan activities and 1 for participation. Based on prior research, three control variables were included: Gender



**Table 1**  
Questionnaire items and CFA result.

Construct	Dimension	Item	Loading	T-value	CR	AVE
Meaning in Life	Presence of meaning	I am actively searching for a purpose or mission in my life.	0.795	–	0.94	0.609
		Currently, my life lacks a clear purpose.	0.754	19.026		
		I am endeavoring to understand the meaning of my life.	0.779	19.836		
		I have comprehended the meaning of my life.	0.794	20.334		
Psychological Resilience	Search for meaning	I am seeking something that imparts a sense of meaningfulness to my life.	0.791	20.249	0.977	0.614
		I am consistently trying to identify my life's purpose.	0.765	19.358		
		My life is characterized by a clear direction.	0.8	20.561		
		I am aware of what contributes to making my life meaningful.	0.781	19.912		
	Focus on goals	I have discovered a life purpose that is fulfilling.	0.775	19.693		
		I am continually pursuing elements that confer importance to life.	0.771	19.577		
		I have well-defined goals in life.	0.785	–		
		I generally grow more mature and gain experience after overcoming setbacks.	0.801	20.776		
	Emotional regulation	When faced with challenges, I typically formulate a plan and develop solutions.	0.772	19.784		
		In the presence of difficulties, I focus all my energy on overcoming them.	0.786	20.255		
		I establish goals for myself to drive my progress forward.	0.819	21.372		
		Failure often discourages me.	0.812	21.154		
	Positive cognition	I find it challenging to control my negative emotions.	0.798	20.657		
		Failures and setbacks lead me to question my abilities.	0.786	20.262		
		How long does it usually take for me to move past unpleasant experiences?	0.771	19.753		
		I am adept at adjusting my emotions in a short period.	0.762	19.454		
	Family support	My emotions fluctuate significantly, with pronounced highs and lows.	0.761	19.438		
		I believe that the process of engaging with something contributes more to personal growth than the outcome.	0.753	19.155		
		I perceive that adversity can have a motivating effect on individuals.	0.798	20.645		
		Adversity can sometimes facilitate personal growth.	0.803	20.817		
	Interpersonal assistance	I believe that every situation has a positive aspect.	0.797	20.625		
		My parents respect my opinions.	0.769	19.679		
		My parents frequently intervene in my decisions.	0.761	19.432		
		At home, I often feel unheard.	0.811	21.1		
Mental Health	Life satisfaction	My parents lack confidence in me and do not provide emotional support.	0.736	18.634		
		My parents avoid harsh criticism.	0.679	16.857		
		My parents consistently encourage me to put forth my best effort.	0.804	20.861		
		When I encounter unpleasant situations, I struggle to find someone suitable to confide in.	0.78	20.05		
	Enthusiasm for learning	I have a peer with whom I can discuss my difficulties.	0.779	20.008		
		When I require assistance in facing challenges, I am uncertain whom to approach.	0.834	21.903		
		I tend to keep my issues to myself rather than sharing them with others.	0.809	21.018		
		When confronting difficulties, I actively seek others to communicate with.	0.76	19.403		
	Interpersonal harmony	Even when I am in a negative mood, I am hesitant to express my feelings to others.	0.812	21.155		
		I live a joyful life.	0.667	–	0.969	0.553
		I have self-disdain.	0.684	14.55		
		I perceive myself as happy.	0.722	15.274		
	Calmness in testing	I feel pessimistic about the future.	0.799	16.69		
		I experience loneliness.	0.741	15.632		
		I find life monotonous and dull.	0.794	16.6		
		I find learning to be an enjoyable activity.	0.741	15.637		
	Emotional stability	I derive satisfaction from learning.	0.751	15.804		
		I perceive learning as meaningless.	0.804	16.78		
		I feel motivated by my studies.	0.716	15.155		
		I feel my strengths are being utilized.	0.772	16.198		
	Emotional stability	I feel others are willing to approach me.	0.695	14.767		
		I am warm-hearted and generous with people.	0.746	15.722		
		I am confident in expressing my opinions.	0.719	15.211		
		I am held in high regard among my classmates.	0.707	14.989		
	Emotional stability	I use humor to resolve conflicts.	0.645	13.819		
		I feel anxious at the mention of exams.	0.747	15.746		
		I fear examinations.	0.784	16.411		
		In class, I often struggle to answer questions well due to nervousness.	0.782	16.378		
	Emotional stability	I am afraid to face my teachers.	0.791	16.549		
		Performing poorly on exams makes me feel embarrassed.	0.694	14.743		
		I am prone to anger.	0.795	16.606		
		I become excited easily.	0.74	15.609		
	Emotional stability	I frequently engage in arguments.	0.761	16.002		
		My temperament is unpredictable.	0.767	16.1		

Note: CR = Composite reliability, AVE = Average variance extracted.

(categorical), coded as 0 for female and 1 for male; Only\_child status (categorical), coded as 0 for only child and 1 for non-only child; and Other sport (categorical), coded as 0 for non-participation in sports other than Taichi Chuan, and 1 for participation in such sports. The model was estimated using the Ordinary Least Squares (OLS) method, and the results are presented in Table 3.

The regression analysis indicates that Taichi Chuan is a significant predictor of mental health ( $\beta = 1.125$ ,  $t = 24.341$ ,  $p < 0.001$ ). Conversely, the control variables—gender ( $\beta = -0.024$ ,  $t = -0.516$ ), only child status ( $\beta = 0.043$ ,  $t = 0.951$ ), and participation in other sports ( $\beta = 0.061$ ,  $t = 0.947$ )—do not exhibit significant relationships with mental health. The model accounts for 56.4 % of the variance in mental

**Table 2**

Discriminant validity of measures and correlation matrix.

	Meaning in Life	Psychological Resilience	Mental Health
Meaning in Life	0.781		
Psychological Resilience	0.35	0.783	
Mental Health	0.469	0.745	0.744

Note: The numbers on the diagonal row are the square root of Average Variance Extracted (AVE). Off diagonal values are the correlations between the constructs.

**Table 3**

Regression analysis of Taichi Chuan on Mental Health in Study1( $n = 522$ ).

	Mental Health
Constant	3.028*** (49.175)
Taichi Chuan	1.125*** (24.341)
Gender	−0.024 (−0.516)
Only child status	0.043 (0.951)
Other_sport	0.061 (0.947)
R <sup>2</sup>	0.564
Adjusted R <sup>2</sup>	0.561
F	F (4,517) = 167.287, $p = 0.000$
D-W	1.774

Note: significance level: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ , t-values in parentheses.

health outcomes ( $R^2 = 0.564$ , Adjusted  $R^2 = 0.561$ ), a rate validated as statistically significant by the F-value ( $F(4,517) = 167.287$ ,  $p < 0.001$ ). The Durbin-Watson statistic ( $D-W = 1.774$ ) suggests no significant autocorrelation issues in the residuals. These findings demonstrate a strong positive association between the practice of Taichi Chuan and improved mental health outcomes, supporting Hypothesis 1. Despite incorporating gender, only child status, and engagement in other sports as control variables, these factors do not significantly predict mental health outcomes, highlighting the unique benefits of Taichi Chuan.

#### 4.2.2. Testing for the chained mediating effect

This study utilized the SPSS macro program Process, developed by Hayes (2009). Model number 6 was selected with a resampling size of 5000 and a default 95 % confidence interval to examine the chained mediating effects of meaning in life and psychological resilience between Taichi Chuan and mental health. A significant effect is indicated when the confidence interval does not encompass zero.

Taichi Chuan exhibits a significant direct influence on mental health ( $\beta = 0.587$ , 95 % CI = [0.492, 0.682],  $p < 0.001$ ), as demonstrated by the coefficients measured across various pathways (see Table 4 and Fig. 1). This indicates a consistent positive effect. Additionally, Taichi Chuan exerts an indirect effect on mental health through enhancements in both meaning in life and psychological resilience. Specifically, it significantly improves meaning in life ( $\beta = 0.658$ , 95 % CI = [0.547, 0.768],  $p <$

**Table 4**

Result of path coefficients in study1.

Path	coefficient	95 % CI		
		LLCI	ULCI	p
TC → MH	0.587	0.492	0.682	0
TC → ML	0.658	0.547	0.768	0
TC → PR	0.883	0.763	1.002	0
ML → PR	0.104	0.021	0.187	0.014
ML → MH	0.085	0.029	0.141	0.003
PR → MH	0.507	0.449	0.565	0

Note: 95 % CI = 95 % confidence interval, LLCI denotes the lower limit of the 95 % CI, ULCI denotes the upper limit of the 95 % CI; TC = Taichi Chuan, ML = Meaning in Life, PR = Psychological Resilience, MH = Mental Health.

0.001) and psychological resilience ( $\beta = 0.883$ , 95%CI = [0.763, 1.002],  $p < 0.001$ ). Furthermore, meaning in life positively affects psychological resilience ( $\beta = 0.104$ , 95 % CI = [0.021, 0.187],  $p = 0.014$ ) and contributes to mental health ( $\beta = 0.085$ , 95 % CI = [0.029, 0.141],  $p = 0.003$ ). Psychological resilience also plays a significant role in enhancing mental health ( $\beta = 0.507$ , 95%CI = [0.449, 0.565],  $p < 0.001$ ). These mediating pathways emphasize the importance of meaning in life and psychological resilience as mechanisms through which Taichi Chuan positively impacts mental health. The overall effect of Taichi Chuan on mental health is substantial at 1.125(95%CI = [1.034, 1.215],  $p < 0.001$ ), underscoring its comprehensive positive influence. The findings suggest that Taichi Chuan fosters improved mental health both directly and indirectly by enhancing psychological resilience and meaning in life, presenting Taichi Chuan as a viable strategy for mental health promotion.

To further examine the chained mediating effects, we employed the bootstrapping method with 5000 resamples, observing bias-corrected 95 % confidence intervals (see Table 5). We first consider the mediation effect of Taichi Chuan (TC) through Meaning in Life (ML) on Mental Health (MH), with an effect size of 0.056 (95 % CI: [0.011, 0.064],  $p < 0.001$ ). This result indicates a statistically significant mediation effect, suggesting that engaging in Taichi Chuan enhances Meaning in Life, which in turn positively influences Mental Health. Secondly, the path with Psychological Resilience (PR) as a mediator (TC → PR → MH) shows a considerably larger mediated effect, with an effect size of 0.347 (95 % CI: [0.236, 0.362],  $p < 0.001$ ). The clear statistical significance highlights that Taichi Chuan substantially elevates Psychological Resilience, thereby positively impacting Mental Health. Finally, the chained path involving both Meaning in Life and Psychological Resilience (TC → ML → PR → MH) results in an effect size of 0.035(95%CI: [0.001, 0.045],  $p = 0.002$ ). The statistically significant  $p$ -value further corroborates the existence of a chained mediation effect, where Taichi Chuan sequentially enhances Meaning in Life and Psychological Resilience, ultimately benefiting Mental Health. Overall, these findings robustly support the notion that Taichi Chuan promotes Mental Health through chained mediators, providing valuable insights into the psychological mechanisms underpinning its health benefits, thus confirming Hypothesis 2.

#### 4.3. Study 2

In Study 2, building on the control variables from Study1, age and grade were also controlled. The main effect of Taichi Chuan on adolescents' mental health and its chained mediating effects were measured again. It is evaluated whether the results were valid.

##### 4.3.1. Retesting for main effect

Based on research 1, two control variables in research 2 were added: Age (continuous), the age range for junior high school students is 13–15 years old, the age range for senior high school students is 16–18 years old; and grade (categorical), coded as 0 for junior high school and 1 for senior high school. After controlling for age and grade in Study 2, the results showed that age( $\beta = 0.017$ ,  $t = 0.711$ ), grade ( $\beta = -0.087$ ,  $t =$

**Table 5**

The chained mediating effect of Taichi Chuan on Mental Health in Study 1.

Path	Effect value	Bootstrap 95 % CI		
		Boot LLCI	Boot ULCI	p
TC → ML → MH	0.056	0.011	0.064	0
TC → PR → MH	0.347	0.236	0.362	0
TC → ML → PR → MH	0.035	0.001	0.045	0.002

Note: 95 % confidence interval with 5000 bootstrap samples, BootLLCI denotes the lower limit of the 95 % CI, BootULCI denotes the upper limit of the 95 % CI; TC = Taichi Chuan, ML = Meaning in Life, PR = Psychological Resilience, MH = Mental Health.

–1.103)—do not exhibit significant relationships with mental health. The regression analysis indicates that Taichi Chuan is a significant predictor of mental health ( $\beta = 0.257, t = 2.116, p < 0.036$ ). The result was consistent with the main effect measurements from Study 1.

4.3.2. Retesting for the chained mediating effect

This study utilized the SPSS macro program Process, developed by Hayes (2009). Model number 6 was selected with a resampling size of 5000 and a default 95 % confidence interval to examine the chained mediating effects of meaning in life and psychological resilience between Taichi Chuan and mental health. A significant effect is indicated when the confidence interval does not encompass zero.

Taichi Chuan exhibits a significant direct influence on mental health ( $\beta = 0.257, 95 \% CI = [0.019, 0.494], p < 0.05$ ), as demonstrated by the coefficients measured across various pathways (see Table 6 and Fig. 2). This indicates a consistent positive effect. Additionally, Taichi Chuan exerts an indirect effect on mental health through enhancements in both meaning in life and psychological resilience. Specifically, it significantly improves meaning in life ( $\beta = 1.487, 95\%CI = [1.404, 1.571], p < 0.001$ ) and psychological resilience( $\beta = 0.629, 95\%CI = [0.404, 0.853], p < 0.001$ ). Furthermore, meaning in life positively affects psychological resilience ( $\beta = 0.240, 95 \% CI = [0.099, 0.380], p = 0.001$ ) and contributes to mental health ( $\beta = 0.161, 95 \% CI = [0.018, 0.303], p = 0.028$ ). Psychological resilience also plays a significant role in enhancing mental health ( $\beta = 0.299, 95 \% CI = [0.160, 0.438], p < 0.001$ ). These mediating pathways emphasize the importance of meaning in life and psychological resilience as mechanisms through which Taichi Chuan positively impacts mental health. The overall effect of Taichi Chuan on mental health is substantial at 0.789 (95 % CI = [0.703, 0.876],  $p < 0.001$ ), underscoring its comprehensive positive influence. The findings suggest that Taichi Chuan fosters improved mental health both directly and indirectly by enhancing psychological resilience and meaning in life, presenting Taichi Chuan as a viable strategy for mental health promotion.

To further examine the chained mediating effects, we employed the bootstrapping method with 5000 resamples, observing bias-corrected 95 % confidence intervals (see Table 7). We first consider the mediation effect of Taichi Chuan (TC) through Meaning in Life (ML) on Mental Health (MH), with an effect size of 0.239 (95 % CI: [0.003, 0.484],  $p < 0.05$ ). This result indicates a statistically significant mediation effect, suggesting that engaging in Taichi Chuan enhances Meaning in Life, which in turn positively influences Mental Health. Secondly, the path with Psychological Resilience (PR) as a mediator (TC → PR → MH) shows a considerably larger mediated effect, with an effect size of 0.188 (95%CI:[0.078,0.317],  $p < 0.01$ ). The clear statistical significance highlights that Taichi Chuan substantially elevates Psychological Resilience, thereby positively impacting Mental Health. Finally, the chained path involving both Meaning in Life and Psychological Resilience (TC → ML → PR → MH) results in an effect size of 0.106 (95 % CI: [0.025, 0.226],  $p = 0.041$ ). The statistically significant  $p$ -value further corroborates the existence of a chained mediation effect, where Taichi

**Table 6**  
Result of path coefficients in Study 2.

Path	coefficient	95 % CI		
		LLCI	ULCI	p
TC → MH	0.257	0.019	0.494	0.036
TC → ML	1.487	1.404	1.571	0
TC → PR	0.629	0.404	0.853	0
ML → PR	0.240	0.099	0.380	0.001
ML → MH	0.161	0.018	0.303	0.028
PR → MH	0.299	0.160	0.438	0
TC → MH	0.789	0.703	0.876	0

Note: 95 % CI = 95 % confidence interval, LLCI denotes the lower limit of the 95 % CI, ULCI denotes the upper limit of the 95 % CI; TC = Taichi Chuan, ML = Meaning in Life, PR = Psychological Resilience, MH = Mental Health.

**Table 7**  
The chained mediating effect of Taichi Chuan on Mental Health in Study 2.

Path	Effect value	Bootstrap 95 % CI		
		Boot LLCI	Boot ULCI	p
TC → ML → MH	0.239	0.003	0.484	0.045
TC → PR → MH	0.188	0.078	0.317	0.002
TC → ML → PR → MH	0.106	0.025	0.226	0.041

Note: 95 % confidence interval with 5000 bootstrap samples, BootLLCI denotes the lower limit of the 95 % CI, BootULCI denotes the upper limit of the 95 % CI; TC = Taichi Chuan, ML = Meaning in Life, PR = Psychological Resilience, MH = Mental Health.

Chuan sequentially enhances Meaning in Life and Psychological Resilience, ultimately benefiting Mental Health. Overall, under the influence of chained mediator, these findings robustly supported the notion that Taichi Chuan could enhance the mental health of adolescents. The result was consistent with the chained mediating effect measurements from Study 1.

5. Discussion

5.1. The relationship between Taichi Chuan and mental health

This study's findings reveal a significant positive influence of Taichi Chuan on adolescents' mental health, confirming Hypothesis 1. Embodied cognition theory posits that the body and its somatosensory system play a pivotal role in cognitive processes, with cognition evolving through the activities of the body and sensorimotor system (Scott & Jeff, 2011). Through participation in Taichi Chuan by body, adolescents can effectively mobilize the function of various bodily systems, consequently, generating a deeper cognitive understanding of Taichi Chuan. Through engaging in Taichi Chuan, requiring slow and gentle movements with the body in a relaxed state during its practice, is helpful for physical and mental health. Taichi Chuan has many characteristics including movement and stillness, speed and slowness, firmness and softness (Taylor et al., 2020). Training Taichi Chuan can improve adolescents' impatient and impulsive nature. When adolescents' attention is focused, they can enter a state of physical and mental relaxation, effectively dissipating inherent feelings of tension, anxiety, and restlessness. Throughout the process of forming a cognitive understanding of Taichi Chuan, the proactive physical engagement of adolescents can facilitate positive emotional release. This, in turn, fosters tranquility of mind and harmony of body, thereby contributing to the corresponding enhancement of adolescents' psychological well-being.

5.2. The mediating role of meaning in life

This study's findings indicate that engaging in Taichi Chuan can enhance adolescents' mental health by improving their meaning in life, which acts as a complete mediator between Taichi Chuan and mental health. Positive psychology theory posits that the attainment of individual life meaning primarily hinges on the positive role of personal growth (Michael & Hogan., 2008). Taichi Chuan, an embodiment of Chinese martial arts, hinges upon the philosophy of gentleness subduing force and tranquility managing motion, which potentially catalyzes personal growth among adolescents. Adolescents often encounter multiple developmental challenges manifesting as symptoms including depressive moods, reduced communicative expression, and diffused attention. Extreme cases might display symptoms like pronounced inferiority, depression, and suicidal tendencies that negate the intrinsic value of life. In these contexts, consciously guiding adolescents to engage in Taichi Chuan. Firstly, it is same to meditation, has demonstrated benefits. Accompanied by calm music and aided by Taichi Chuan's words of command, such practice can help adolescents regulate their emotions. Coupled with straightforward physical routines, it can

concentrate their attention (Klein et al., 2019).

Secondly, we draw from the tenets of Chinese Taoist and water culture to clear their minds. Amidst all the elements in the world, none exhibits more gentleness and weakness than water. However, it is this same water that resists external aggression, maintaining its inherent nature, undefeated. In this way, Taichi Chuan mirrors the attributes of water—a manner employed in handling growth-related difficulties. The soft and flexibility of Taichi's movements, along with its internal power, are ingeniously applied to tackle and surmount obstacles tied to personal development (Iris et al., 2013). This process cultivates continuous self-affirmation, an enhancement of intrinsic motivation, culminating in the fulfillment of self-value and the understanding of life's purpose. When adolescents foster a robust meaning in life, it often bears significant implications for their mental health. This is mainly due to the tendency of individuals with a sharp meaning in life purpose to maintain healthier psychological states (Dulaney et al., 2018). Enhancing adolescents' meaning in life by Taichi Chuan, which serves as an external protective factor, they can have the ability to reject mental self-depletion and foster self-growth with a positive and confident attitude. Then, psychological distress is reduced and a healthy psychological state is nurtured.

### 5.3. The mediating role of psychological resilience

The study's findings also substantiate the partial mediating effect of psychological resilience between Taichi Chuan and mental health. Psychological resilience refers to individuals' capacity to actively cope when faced with setbacks or adversity and is a critical factor in maintaining mental health. Existing studies indicate that the greater individuals' participation in physical exercise, the higher the level of psychological resilience to adopt positive manners and to cope with stress and challenges, thereby maintaining a good level of mental health (Joachim & Sturmberg, 2018). In contrast to other physical activities, Taichi Chuan is characterized by its soft and slow movements, conducive to the development of patience and the fostering of a serene and composed mentality. The journey from commencing Taichi Chuan to participating in competitive events serves as a learning curve for adolescents. The victories and setbacks they encounter during this course assist in reinforcing their psychological enduring capacity and fortifying their psychological resilience (Brain et al., 2021), thereby enhancing their mental fortitude.

Moreover, the application of Taichi Chuan's philosophy, which accentuates the "unity of man with nature and the inherent naturalness of Dao" contributes significantly to the boost of adolescents' psychological resilience. Taichi Chuan practice necessitates a mental fusion of one's body with the natural world, emphasizing a comprehensive cultivation of physical and psychological aspects both internally and externally in nature's context. It aspires to establish a harmonious correlation between humans and nature, individuals and society, as well as within the individual themselves (Gray, 2014). Enlightening adolescents with the philosophy of harmonious coexistence between humans and nature, fosters an attitude of tenacity and resilience amidst life's adversities. Positioned within this harmonious nexus between humans and society, humans and nature, they persistently find ways to navigate and transcend challenges. During this process, adolescents not only experience an enhancement in their mental state, but their resilience towards adversity is also fortified. This plays a significant role in refining their mental health, equipping adolescents with the capacity to better adapt to societal norms, thereby facilitating the actualization of their self-worth (Heintzelman & King, 2016).

### 5.4. The chained mediating role of meaning in life and psychological resilience

To sum up, the study's findings reveal that between Taichi Chuan and mental health, meaning in life and psychological resilience play a

chained mediating role, confirming Hypothesis 2. When adolescents engage extensively in Taichi Chuan training, they actively seek meaning in life through the sport, appreciate the affirming valuation of self-worth that Taichi Chuan provide, and experience genuine joy and satisfaction in the process. Individuals who perceive a profound sense of life purpose have an innate capacity to unveil the underlying positive facets within adversity and hardship, delve into new potentials, and utilize both internal and external protective resources to intensify their psychological resilience (Soonhee & Ishita, 2023). An adaptation towards an optimistic demeanor and positive emotional state aids in shedding negative sentiments, encourages the confrontation of adversity-induced challenges (Abolghasemia & Taklavi, 2010). Furthermore, the degree of an individual's psychological resilience influences the selected coping mechanisms during stressful situations. As psychological resilience escalates, individuals tend towards proactive coping methods (Ibane et al., 2023), enhancing the understanding of life's worth. They approach life and learning with greater clarity of purpose throughout the process of self-growth, and they effectively develop positive emotions and appropriate manners to maintain an optimistic psychological state, thereby enhancing their level of mental health (Gregory & Fritz, 2015). In summary, based on the previous studies, this study explores the relationships among Taichi Chuan, meaning in life, psychological resilience, and mental health. It confirms the hypothesis of chained mediating model, providing practical guidance for promoting adolescents' mental health more effectively.

### 5.5. Limitations and future directions

This study substantiates the main effect of Taichi Chuan on adolescents' mental health, accentuating the varied influence of heterogeneous factors, notwithstanding the associated limitations. Primarily, it necessitates innovation in research methodologies. Even though the investigative approach implemented herein comprehensively addresses the core issue, future study will bolster this by incorporating experimental methods to enhance the substantive core of the article. Additionally, the current participant categorization could be rendered more humdrum. Future research intends to stratify the participants based on gender, thereby offering nuanced insights into the demographically-specific impacts of Taichi Chuan. Lastly, mental health is influenced by numerous factors, including various potential mediating and moderating variables that warrant further identification and examination in subsequent research.

## 6. Conclusions

This study primarily centers on verifying the mechanism by which Taichi Chuan impacts the mental health of adolescents, along with the chained mediating role played by meaning in life and psychological resilience. The findings are summarized as follows:

- (1) A significant positive correlation exists between any two variables among Taichi Chuan, meaning in life, psychological resilience, and mental health.
- (2) Taichi Chuan exerting a significant positive impact on adolescents' mental health.
- (3) Meaning in life and psychological resilience have a chained mediating role in the impact of Taichi Chuan on adolescents' mental health.

### CRedit authorship contribution statement

**Doudou Yang:** Writing – original draft, Methodology, Funding acquisition, Data curation. **Xiaoyan Wang:** Writing – review & editing, Resources, Funding acquisition, Conceptualization.



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## Declaration of competing interest

All the authors declare no conflict of interest.

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## Data availability

Data will be made available on request.

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