

The effects of Tai Chi and Baduanjin activities on physical interventions with substance use disorders: A systematic review and meta-analysis

Zhiming Tang¹ , Zhicheng Zhu¹, Xia Zhang² and Ying He¹

Abstract

Objective: To evaluate the effect of Tai Chi (TC) and Baduanjin (Bdj) activities on the physical intervention of compulsory segregation drug addicts through a meta-analysis system.

Methods: Six commonly used databases were searched by computer to collect publicly available studies on the physical interventions of TC and Bdj activities for drug addicts from the time of database construction to May 2021. Two researchers independently screened the literature according to the inclusion and exclusion criteria, jointly extracted the data, and evaluated the quality of the literature, and conducted Meta-analysis using RevMan 5.4 software.

Results: A total of 16 randomized controlled trials (RCTs) from 15 publications were included. Meta-analysis indicate that compared with the control group, TC and Bdj had significant effects on blood pressure, lung capacity, heart rate, closed-eye single-leg stand, and seated forward bending in drug addicts, as evidenced by: systolic pressure MD = -4.66, 95%CI = [-7.94, -1.39], $p = .005$; diastolic pressure MD = -3.49, 95%CI = [-5.45, -1.52], $p = .0005$; spirometry MD = 12.68, 95%CI = [43.83, 197.52], $p = .002$; heart rate MD = -2.78, 95%CI = [4.76, -.8], $p = .006$; MD = 1.47, 95%CI = [6.1, 14.84], $p < .00,001$ for one-leg stand with eyes closed, MD = 3.08, 95%CI = [1.8, 4.36], $p < .00,001$ for seated forward bend; however, the effect of TC and Bdj on BMI MD = .01, 95%CI = [-.54, .56], $p = .97$; grip strength MD = .68, 95%CI = [-.99, 2.34], $p = .43$; body fat percentage MD = .04, 95%CI = [-.59, .67], $p = .91$ had no effect.

Conclusions: Tai Chi and Bdj can improve the cardiovascular system, cardiorespiratory fitness, balance, and body flexibility of drug addicts better than conventional rehabilitation.

Keywords

Tai Chi and Baduanjin, drug addicts, physical intervention, meta-analysis

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Introduction

According to the United Nations Office on Drugs and Crime World Drug Report 2020 (UNODC, 2021), the number of drug users worldwide reached 269 million as of 2018, and cannabis remains the most used drug globally, which is associated with the legalization of cannabis use in some countries. This is followed by opioids and amphetamine-type stimulants (ATS), where methamphetamine (MA) use is on the rise in parts of North America and Asia, which is consistent with drug use reports from China in recent years. Current drug abuse trends

in China are gradually shifting from traditional drugs to newer drugs, with traditional opioid heroin and newer drug MA accounting for 92.7% of use (Network, 2020). Both heroin and

¹Chengdu Sport University, Chengdu, China

²Southwest Medical University, Luzhou, China

Corresponding author:

Zhiming Tang, Chengdu, Chengdu Sport University, Chengdu, Sichuan 610041, China.

Email: 291475737@qq.com



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MA addicts can lead to extreme psychological and psychiatric dependence, causing severe damage to the nervous, immune, respiratory and circulatory systems, and leading to a range of symptoms such as memory loss, cognitive dysfunction, and breathing difficulties. Drug abuse not only poses a serious danger to the person and their family, but also induces a range of criminal activities that undermine public safety.

Tai Chi (TC) and Baduanjin (Bdj) are two different forms of TCM guided activities, which were used by the ancient Chinese to prevent and treat illnesses and to prolong life. The effect is achieved by adjusting the breath, mind and body, that is, by adjusting the posture, breathing and mind, to achieve a balance of Yin and Yang, harmonize the Qi and blood, unblock the meridians, and harmonize the functions of the internal organs (Duan, 2009). Studies have shown that TC and aerobic exercise may have similar neurological patterns (Wei et al., 2013), causing changes in regional structure, and that long-term practice of TC and Bdj has better cognitive function (Chen et al., 2020; X. Wang, Wu, Ye, Wang, & Zheng, 2021). In addition, TC and Bdj are effective in improving gait balance and stability (Ge et al., 2021), preventing falls in the elderly (Dong et al., 2021; Huang et al., 2017), and is better tailored (Li et al., 2018). Research in China and abroad has shown that TC and Bdj are also effective in improving the psychological symptoms of different groups of people and can effectively relieve depression and anxiety (Cai et al., 2022; Marc et al., 2011; Zhu, Li, Li, & Wan, 2021). However, the effect of TC and Bdj on physical rehabilitation is still controversial. Therefore, this paper evaluates the effect of TC and Bdj activities on physical intervention for drug addicts through meta-analysis.

Data and Methods

Data Sources and Search Methods

The computer retrieved the dissertations, journal papers, and conference papers on the physical and mental rehabilitation of drug addicts by TC and Bdj from Chinese National Knowledge Infrastructure (CNKI), Wanfang, Chinese Scientific Journal (VIP), Web of Science, PubMed, and Cochrane library built to May 2021, without language restrictions, and retrieved in the same way after 2 months. The search was conducted as follows: Chinese websites were searched using CNKI, Wanfang, VIP, taking Knowledge Network as an example: SU = ("TC" + "Bdj" + "Qigong" + "Guided Exercise") and SU = ("MA" + "Opioid" + "Heroin" + "Drug Addiction" + "Drug Dependence" + "Drug Treatment"), and the references of these literature were checked to prevent omission; English-language search sites take PubMed as an example (Appendix).

Inclusion and Exclusion Criteria of the Literature

Inclusion criteria: Study design: a randomized controlled trial study of TC and Bdj activities intervention for drug

addicts; Participants: drug addicts in compulsory isolation facilities who met the DSM-5 Diagnostic and Statistical Manual of Mental Disorders criteria for substance use disorders or the Chinese Classification and Diagnostic Criteria of Mental Disorders (CCMD-3) criteria for substance dependence diagnosis; Interventions: The experimental group was based on TC or Bdj intervention, while the control group used the conventional methods of the drug rehabilitation center, such as productive labor, legal education, and broadcast gymnastics; Outcome indicators: primary indicators included blood pressure and lung capacity; secondary indicators included BMI, body fat rate, heart rate, grip strength, seated forward bending, and standing on one foot with eyes closed.

Exclusion criteria: conference abstracts for which full-text information was not available; literature reviews; mixed interventions with multiple different types of exercise; studies with repeated publications or incomplete data; study subjects who had not undergone exercise intervention for 12 weeks or more; study sample size less than 10 cases.

Literature Screening and Data Extraction

Two researchers searched individually and imported the relevant literature into EndNote literature management software to exclude duplicate literature. The literature was then screened independently according to the literature inclusion and exclusion criteria, and when the two investigators disagreed, they discussed with a third party to solve the problem. Data extraction was performed according to a pre-made data extraction form, and data extraction information included the author name, year, participants and gender, experimental/control sample size, interventions, intervention plan, time, and evaluation index.

Quality Evaluation

The risk assessment tool provided by the Cochrane Collaboration Network was used to evaluate the included literature, including seven entries on random sequence generation, allocation concealment, participant blinding, outcome assessment blinding, data completeness, selective reporting, and other sources of risk of bias.

Statistical Analysis

Meta-analysis was performed using the RevMan 5.4 software provided by the Cochrane Collaboration Network. The outcome indicators included in this paper were continuous variables and the same units were tested for each indicator, so mean difference MD (Mean Difference) was chosen as the effect indicator. Heterogeneity was tested by p value, and when $p \geq .1$, no heterogeneity or low heterogeneity existed, fixed-effect model was used for analysis; when

$p < .1$, high heterogeneity was used, random-effect model was used for analysis. Sensitivity analyses were performed for indicators with high heterogeneity ($I^2 \geq 40\%$) by means of item-by-item deletion studies. In addition, subgroup analyses and risk of bias discussions were performed for the main indicators.

Results

Search Results

151 articles were included in the literature through the search, and 4 articles from other sources. Including 30 literature in English and 121 in Chinese. Imported into EndNote to exclude duplicate literature to get 92, read the titles and abstracts to exclude 64 literature, by full-text intensive reading of the remaining 28 literature, excluding data similarity and mixed interventions and outcome indicators irrelevant literature, finally included 15 publications (Geng, 2016; Geng et al., 2016; Jiang, 2017; Kui, 2018; Liu, 2019; F. Wang, 2015; S. Wang, Zhang, & Liu, 2019; M. Zhang, 2018; W. Zhang, 2020; Z. Zhang, 2019; Zheng, 2019; D. Zhu et al., 2018; Zhu et al., 2020; D. Zhu et al., 2016; H. Zhu, 2013), Z. Zhang (2019) consisted of two randomized controlled trial (RCTs) which lead to 15 publications and 16 RCTs. (Table 1) Among them, 12 were in Chinese and 3 were in foreign language (Figure 1).

Characteristics of Included Studies

Literature Quality Evaluation and Risk Bias Analysis

Among the 15 included publications, 11 of them described the methods of randomized sequences in detail, 3 mentioned the allocation concealment scheme and the use of assessment blinding, and 1 was double-blinded. 15 publications reported complete data without selective reporting and other risks of bias (Table 2).

Results of Meta-Analysis

Meta-Analysis of Main Indicators

Blood pressure was finally included in 13 publications, 14 RCTs (908 drug addicts) and spirometry was finally included in 13 RCTs (878 drug addicts). The results showed that TC and Bdj activities had a significant effect on systolic blood pressure ($p = .005$), diastolic blood pressure ($p = .0005$), and spirometry ($p = .002$) in drug addicts compared to conventional rehabilitation (Figures 2 to 4).

Heterogeneity was tested for $I^2 \geq 40$ by individual study-by-study exclusion, and heterogeneity was significantly reduced after excluding two studies one by one for systolic blood pressure (M. Zhang, 2018; Z. Zhang, 2019) ($I^2 = 65\%$, $p < .0001$); after excluding two studies for diastolic

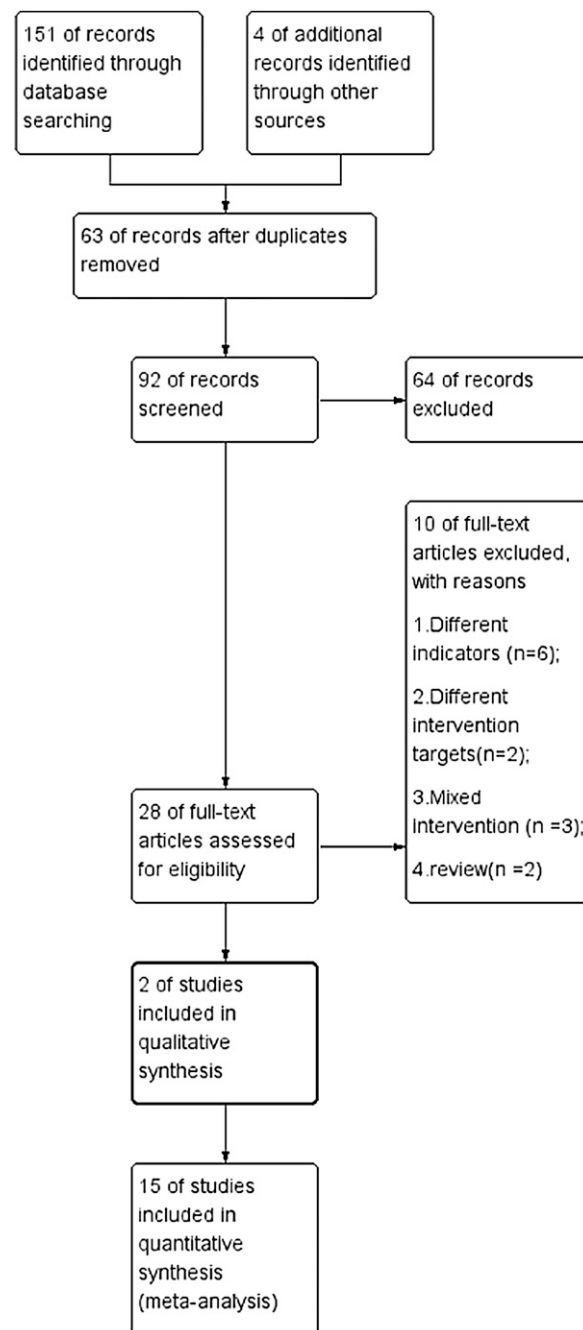


Figure 1. PRISMA flowchart.

blood pressure (Jiang, 2017; S. Wang et al., 2019), heterogeneity was significantly reduced compared to the original heterogeneity of $I^2 = 64\%$ ($I^2 = 0\%$, $p = .002$).

Meta-Analysis of Secondary Indicators

Tai Chi and Bdj had no effect on BMI ($p = .97$), body fat percentage ($p = .91$), and grip strength ($p = .43$), but had positive effects on heart rate ($p = .006$), closed-eye single-

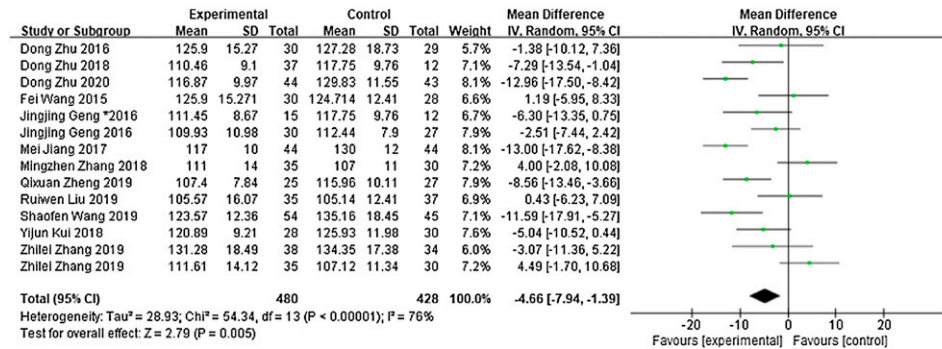


Figure 2. Meta-analysis of systolic pressure.

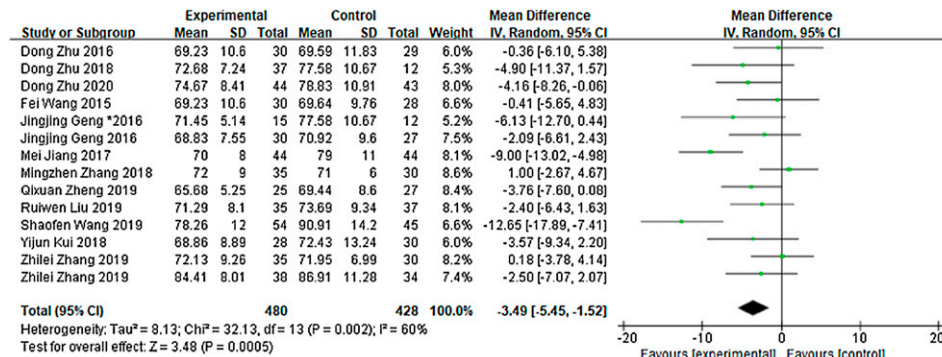


Figure 3. Meta-analysis of diastolic pressure.

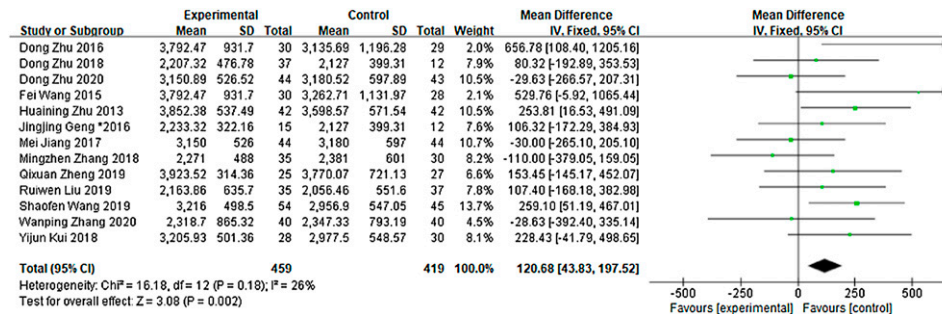


Figure 4. Meta-analysis of vital capacity.

leg stand ($p < .00,001$), and seated forward bend ($p < .00,001$) in drug addicts (Table 3).

Heterogeneity was tested by individual study-by-study exclusion method for $I^2 \geq 40$; BMI was reduced by excluding two studies with $I^2 = 42\%$, $p = .3$ (Liu, 2019; S. Wang et al., 2019); heart rate was reduced by excluding one study with I^2 from 45% to 0%, $p = .006$ (Zheng, 2019); grip strength was significantly reduced by excluding one study with $I^2 = 30\%$, $p = .98$ (D. Zhu et al., 2016); heterogeneity was reduced from 89% to 38% after excluding two studies one by one with eyes closed, $p < .00,001$ (W. Zhang, 2020; H. Zhu, 2013); heterogeneity was significantly reduced after

excluding two studies with seated forward bending ($I^2 = 25\%$, $p < .00,001$) (Zheng, 2019; H. Zhu, 2013).

Subgroup Analysis of the Effect of TC and Bdj on Blood Pressure in Drug Addicts

To investigate the source of heterogeneity, subgroup analysis was conducted on the main index of blood pressure. It was speculated that the effect of TC and Bdj on drug addicts might be governed by gender, experimental period, exercise frequency and weekly exercise duration. Therefore, the included studies were grouped by gender:

Table 1. Characteristics of included studies.

Author (year)	Gender	Parti- pants	Interventions	Intervention Plan	Time	Evaluation index
		E/C	E/C			
Kui (2018)	Male	28/30	Baduanjin/routine rehabilitation	3/Week, 60 min/times	17 weeks	Vital capacity, heart rate, eye closed standing on one leg, sitting forward bend, grip strength
S. Wang et al. (2019)	Male	54/45	Tai Chi and Baduanjin/ routine rehabilitation	5/Week, 60 min/times	20 weeks	BMI, vital capacity, blood pressure, heart rate, eye closed standing on one leg, Sitting forward bend
Jiang (2017)	Male	44/44	Heart exercise (Tai Chi and Qigong)/ gymnastics	7/Week, 60 min/times	24 weeks	BMI, blood pressure, vital capacity, heart rate, sitting forward bend, eye closed standing on one leg
Geng (2016)	Female	30/27	Tai Chi/gymnastics, sign language exercises	5/Week, 45 min/times	12 weeks	Blood pressure, eye closed standing on one leg
M. Zhang (2018)	Female	35/30	Tai Chi/gymnastics	5 times/week, 50 min/ times	24 weeks	BMI, blood pressure, vital capacity, Sitting forward bend, eye closed standing on one leg
Geng (2016)	Female	15/12	Tai Chi/traditional gymnastics	3/Week, 60 min/times	24 weeks	Blood pressure, vital capacity, eye closed standing on one leg, Sitting forward bend
F. Wang (2015)	Male	30/28	Tai Chi/Traditional gymnastics	5/Week, 45 min/times	12 weeks	BMI, blood pressure, vital capacity, Sitting forward bend, eye closed standing on one leg
Liu (2019)	Female	35/37	Tai Chi/Aerobaerobics	3/Week, 60 min/times	12 weeks	BMI, blood pressure, vital capacity, eye closed standing on one leg, sitting forward bend, grip strength
D. Zhu et al. (2016)	Male	30/29	Tai Chi/Broadcast gymnastics	5 times/week, 50 min/ times	12 weeks	BMI, blood pressure, vital capacity, heart rate, grip strength, Sitting forward bend, eye closed standing on one leg
D. Zhu et al. (2018)	Female	37/12	Tai Chi/Broadcast gymnastics	3/Week, 60 min/times	24 weeks	Blood pressure, vital capacity, heart rate, grip strength, Sitting forward bend, standing on one leg with eyes closed
Z. Zhang (2019)	Male	38/34	Tai Chi/gymnastics, sign language exercises	5 times a week, 1 time for 50 minutes, 4 times for 20 minutes	24 weeks	BMI, blood pressure, heart rate, eye closed standing on one leg, grip strength, Sitting forward bend
Z. Zhang (2019)	Female	35/30	Tai Chi/Routine rehabilitation	5 times a week, 1 time for 50 minutes, 4 times for 20 minutes	24 weeks	BMI, blood pressure, heart rate, eye closed standing on one leg, grip strength, Sitting forward bend
Zheng (2019)	Male	25/27	Tai Chi/gymnastics	5/Week, 60 min/times	12 weeks	BMI, blood pressure, vital capacity, heart rate, eye closed standing on one leg, sitting forward bend, grip strength
H. Zhu (2013)	Male	42/42	Tai Chi/queue training	3/Week, 120 min/times	40 weeks	BMI, vital capacity, Sitting forward bend, eye closed standing on one leg
W. Zhang (2020)	Female	40/40	Tai Chi/traditional rehabilitation exercises	5/Week, 60 min/times	12 weeks	Sitting forward bend, eye closed standing on one leg, vital capacity,
D. Zhu et al. (2020)	Male	44/43	MBE/setting up exercises to radio music	5/Week, 60 min/times	24 weeks	BMI, blood pressure, heart rate, vital capacity, eye closed standing on one leg, Sitting forward bend

Table 2. Study the Quality Evaluation Form.

Publications	Random Sequence Generation	Allocation concealment	Blinding of Participants And personnel	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Reporting	Other Bias	Total score (/7)
Kui 2018	Unclear risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	3
S. Wang et al. 2019	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
Jiang 2017	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
Geng 2016	Unclear risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	3
M. Zhang 2018	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
Geng 2016	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
F. Wang 2015	Low risk	Low risk	High risk	High risk	Low risk	Low risk	Low risk	5
Liu 2019	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
D. Zhu et al. 2016	High risk	High risk	High risk	High risk	Low risk	Low risk	Low risk	3
D. Zhu et al. 2018	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk	6
Z. Zhang 2019	Low risk	Unclear risk	Low risk	Low risk	Low risk	Low risk	Low risk	6
Zheng 2019	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
W. Zhang 2020	Low risk	Unclear risk	High risk	High risk	Low risk	Low risk	Low risk	4
D. Zhu et al. 2020	Low risk	Low risk	High risk	Low risk	Low risk	Low risk	Low risk	6
H. Zhu 2013	Unclear risk	High risk	High risk	High risk	Low risk	Low risk	Low risk	3

Table 3. Meta-Analysis of the Influence of TC and Bdj on Secondary Indexes.

Item Index	RCTs	Number (E/C)	Model	MD	95%CI	p (Test for Overall Effect)	p (heterogeneity)	I ² , %
BMI	13	467/441	Random	.01	[-.54,.56]	=.97	<.1	57
Heart rate	9	335/294	Random	-2.78	[-4.76,-.8]	=.006	<.1	45
Body fat perc-entage	10	343/299	Fixed	.04	[-.59,.67]	=.91	>.1	8
Grip strength	7	228/199	Random	.68	[-.99,2.34]	=.43	<.1	48
Stand on one leg with your eyes closed	16	562/510	Random	1.47	[6.1,14.84]	<.00001	<.1	89
Sit and reach	15	532/483	Random	3.08	[1.8,4.36]	<.00001	<.1	54

male, female; experimental period: = 12 weeks, > 12 weeks; exercise frequency (times/week): = 3 times, > 3 times; and exercise duration (minutes/week): ≤ 250 minutes, > 250 minutes for grouping.

Tai Chi and Bdj had a significant effect on blood pressure in all subgroups except the female, systolic blood pressure ≤ 250 minutes, and = 12 weeks subgroups ($p \leq .05$) (Table 4). Regarding the source of heterogeneity, the heterogeneity was

significantly reduced compared to the overall heterogeneity when the number of exercise sessions per week = 3 and the duration of exercise per week ≤ 250 minutes. Diastolic blood pressure female subgroup heterogeneity $I^2 = 12\%$ was significantly lower compared to overall heterogeneity $I^2 = 60\%$. Thus, weekly exercise duration and weekly exercise number may be sources of blood pressure heterogeneity, and gender differences may be a source of diastolic blood pressure heterogeneity.

Table 4. Subgroup Analysis of Blood Pressure of Drug Addicts Treated by TC and Bdj.

Index	Characteristics	Group	Study (Number)	MD	95%CI	p (Test for Overall Effect)	p (heterogeneity)	I ² , %	
Systolic pressure	Gender	Male	8 (573)	-7.5	[-11.14,-3.85]	<.0001	<.1	67	
		Female	6 (335)	-1.14	[-5.05,2.78]	=.57	<.1	59	
		Total	14 (908)	-4.66	[-7.94,-1.39]	=.005	<.1	76	
	Time	=12 weeks	12 (845)	-1.83	[-4.44,.78]	=.17	<.1	57	
		>12 weeks	9 (610)	-5.83	[-1.35,-1.3]	=.01	<.1	81	
		Total	21 (1455)	-3.55	[-6.16,-.94]	=.008	<.1	76	
		Weekly exercise frequency	=3 times	4 (206)	-4.64	[-7.78,-1.5]	=.004	>.1	5
	Weekly exercise time	>3 times	12 (840)	-5.4	[-7.02,-3.78]	<.00001	<.1	79	
		Total	16 (1046)	-5.24	[-6.68,-3.8]	<.00001	<.1	73	
		≤250 minutes	10 (582)	-1.6	[-3.63,.43]	=.12	=.1	38	
		>250 minutes	6 (464)	-8.79	[-12.51,-5.07]	<.00001	<.1	69	
		Total	16 (1046)	-4.51	[-7.34,-1.68]	=.002	<.1	73	
	diastolic pressure	Gender	Male	8 (573)	-4.65	[-7.42,-1.87]	=.001	<.1	64
			Female	6 (335)	-1.43	[-3.27,.41]	=.13	>.1	12
Total			14 (908)	-3.3	[-4.52,-2.07]	<.00001	<.1	60	
Period		=12 weeks	12 (845)	-.85	[-2.11,-.41]	=.19	>.1	35	
		>12 weeks	9 (191)	-4.46	[-7.45,-1.47]	=.003	<.1	72	
		Total	21 (1455)	-2.39	[-4.03,-.75]	=.004	<.1	64	
		Weekly exercise frequency	=3times	4 (206)	-3.71	[-6.39,-1.02]	=.007	>.1	0
Weekly exercise time		>3times	12 (840)	-3.41	[-5.58,-1.24]	=.002	<.1	65	
		Total	16 (1046)	-3.52	[-5.24,-1.8]	<.0001	<.1	54	
		≤250 minutes	10 (582)	-1.54	[-3.04,-.03]	=.05	>.1	0	
		<250 minutes	6 (464)	-6.05	[-8.86,-3.23]	<.0001	<.1	60	
		Total	16 (1046)	-3.52	[-5.24,-1.8]	<.0001	<.1	54	

Discussion

Mechanisms Related to Drug Addiction and Treatment

The mechanism of brain “addiction” is one of the world’s most difficult problems, and the theory of reward circuit mechanism is mainly popular, but there is no direct human experimental evidence. It is widely believed that after prolonged drug abuse, reward mechanisms are severely disrupted, with increased euphoric neurotransmitters, including dopamine (DA) and 5-hydroxytryptamine (5-HT), and decreased inhibitory neurotransmitters, such as gamma-aminobutyric acid (GABA), in the ventral tegmental area (VTA), nucleus accumbens (NAcc), amygdaloid nucleus (AC), and striatum, hippocampus, and prefrontal cortex (PFC), thus stimulating the motivation to use drugs (Koob & Volkow, 2010; Leshner, 1997).

Moreover, the transformation of addictive behaviors seems to depend on changes in transcriptional and epigenetic plasticity in the brain (Nestler, 2014), that is, changes in chromatin structure associated with alterations in gene expression, including those induced by the response of the fully differentiated adult brain to a range of environmental stimuli (e.g., addictive drugs) (Nestler & Lüscher, 2019). Of course, understanding the neurobiological mechanisms of addiction clearly is to find better ways to implement abstinence treatment for drug addicts. At present, China has developed a treatment system in which pharmacotherapy is the mainstay, supplemented by exercise, education, and psychosocial interventions. However, pharmacotherapy is still in the developmental stage, no direct and effective evidence of drug withdrawal has been developed, and the neurobiological mechanisms of the human body are changing at different stages of addiction (Lynch et al., 2013), and drug abuse also produces

different individual differences in neurobiological factors (Koob & Volkow, 2016). This increases the difficulty of pharmacological treatment. The predominant pharmacotherapy currently available is the receptor agonist treatment approach (Ballester et al., 2017). It is the replacement of more addictive and unsafe drugs with less addictive drugs, commonly methadone and buprenorphine, which have significant limitations and excessive use can lead to new dependencies in recovering addicts. Therefore it is important to actively seek other methods for multiple modalities of abstinence.

Summary of Common Drugs in the Drug Abuse Studies

Among the 15 publications, there were nine studies on the abuse of ATS (Geng, 2016; Geng et al., 2016; Liu, 2019; M. Zhang, 2018; Z. Zhang, 2019; D. Zhu et al., 2018; D. Zhu et al., 2020; D. Zhu et al., 2016) and one study on the heroin (S. Wang et al., 2019). Six other studies did not explicitly mention the type of drug abuse of the study subjects, but one of them mentioned that MA accounted for about 75% (Jiang, 2017), two studies mentioned that MA accounted for the majority but did not give a specific percentage (Kui, 2018; Zheng, 2019), and the remaining three studies were completely unclear about the type of drug abuse of the study subjects (F. Wang, 2015; W. Zhang, 2020; H. Zhu, 2013).

A Meta-Analysis of TC and Bdj on the Physical of Drug Addicts

Compared with other exercises, TC and Bdj have the advantages of lower exercise intensity, higher generalizability and lower risk. It has become an indispensable part of the rehabilitation system of major drug rehabilitation centers in China. Tai Chi and Bdj have a good regulating effect on the emotional condition of drug addicts. However, the specific mechanism is not clear, and it is generally believed that TC and Bdj are achieved by adjusting the breath, body, and mind. The present study showed that guided exercise for more than 12 weeks not only lowered blood pressure and improved the cardiovascular system of drug addicts, but also significantly improved balance and increased flexibility. Balance is closely related to the human vestibular cerebellum, and the improvement of balance reflects from the side that TC and Bdj can improve the cerebellum of drug addicts. In addition, the study showed no significant differences in BMI, grip strength, and body fat percentage indexes compared to the control group. Therefore, TC and Bdj have a certain effect on the physical rehabilitation of drug addicts, but other exercise modalities (such as strength training) need to be intervened together to achieve a comprehensive rehabilitation effect.

Subgroup Analysis

Subgroup analysis of blood pressure indexes suggested that TC and Bdj were more effective in men than in women; second, the longer the intervention period, the better the treatment effect, and the number of interventions per week and the duration of intervention were directly proportional to the effect, the more interventions and the longer the duration, the better the effect.

Sensitivity Analysis

Sources of heterogeneity were sought by means of a case-by-case exclusion study. Heterogeneity was reduced after eliminating 1–2 studies one by one for blood pressure, BMI, heart rate, grip strength, closed-eye unipodal stance, and seated forward bend indexes in drug addicts, but the combined effect p values were not significantly different compared to the overall combined effect values, indicating that the meta-analysis results were stable.

Limitations

Only 6 commonly used electronic databases were searched, and there were limitations in the comprehensiveness of the included studies; subgroup groups were divided into only four groups of gender, time, weekly exercise frequency, and weekly exercise duration, and factors such as type of drug use and age were not considered; the methodological use of some studies was flawed, such as the use of randomized groups, hidden allocation, and blinding, which increased the risk of bias.

Conclusions

Tai Chi and Bdj had a significant improvement on the cardiovascular system of the drug addicts, and the longer the intervention, the better the effect. In addition, TC and Bdj improved cardiorespiratory fitness and greatly improved balance and body flexibility.

Declaration of Conflicting Interests

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ORCID iD

Zhiming Tang  <https://orcid.org/0000-0002-3904-2086>

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Appendix

Search

Number Query

#1	"Substance-related Disorders" [Mesh]
#2	((((((((((((((((((((((((((((((Substance Use [Title/Abstract]) OR (Substance Uses [Title/Abstract])) OR (Use, Substance [Title/Abstract])) OR (Drug Abuse [Title/Abstract]) OR (Abuse, Drug [Title/Abstract])) OR (Drug Dependence [Title/Abstract])) OR (Dependence, Drug [Title/Abstract])) OR (Drug Addiction [Title/Abstract]) OR (Addiction, Drug [Title/Abstract])) OR (Substance Use Disorders [Title/Abstract]) OR (Disorder, Substance Use [Title/Abstract]) OR (Substance Use Disorder [Title/Abstract])) OR (Drug Use Disorders [Title/Abstract]) OR (Disorder, Drug Use [Title/Abstract])) OR (Drug Use Disorder [Title/Abstract]) OR (Organic Mental Disorders, Substance-Induced [Title/Abstract]) OR (Organic Mental Disorders, Substance Induced [Title/Abstract])) OR (Substance Abuse [Title/Abstract]) OR (Abuse, Substance [Title/Abstract])) OR (Substance Abuses [Title/Abstract]) OR (Substance Dependence [Title/Abstract]) OR (Dependence, Substance [Title/Abstract])) OR (Substance Addiction [Title/Abstract]) OR (Addiction, Substance [Title/Abstract])) OR (Chemical Dependence [Title/Abstract]) OR (Chemical Dependences [Title/Abstract]) OR (Dependence, Chemical [Title/Abstract])) OR (Dependences, Chemical [Title/Abstract])) OR (Prescription Drug Abuse [Title/Abstract]) OR (Abuse, Prescription Drug [Title/Abstract]) OR (Drug Abuse, Prescription [Title/Abstract]) OR (Drug Habituation [Title/Abstract]) OR (Habituation, Drug [Title/Abstract]))
#3	"Tai Ji" [Mesh]
#4	(((((Tai-ji [Title/Abstract]) OR (Tai Chi [Title/Abstract])) OR (Chi, Tai [Title/Abstract])) OR (Tai Ji Quan [Title/Abstract]) OR (Ji Quan, Tai [Title/Abstract])) OR (Quan, Tai Ji [Title/Abstract])) OR (Taiji [Title/Abstract])) OR (Tai Chi [Title/Abstract])) OR (Tai Chi Chuan [Title/Abstract])
#5	"Qigong" [Mesh]
#6	(Qi Gong [Title/Abstract]) OR (Ch'i Kung [Title/Abstract])
#7	#1 OR #2
#8	#3 OR #4 OR #5 OR #6
#9	#7 AND #8