

# A randomized controlled trial evaluating the effect of Tai Chi on the drug craving in women

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## Research Article

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# Abstract

**Purpose:** This study was conducted in the purpose of investigating the effect of Tai Chi on drug craving for women with drug disorders.

**Methods:** 112 women were recruited from a drug rehabilitation center in China, and 47 and 48 were finally analyzed in control group and exercise group, respectively. Exercise group underwent a three-month Tai Chi training, whereas the control group experienced no exercise intervention during the same time period. The drug craving was measured by visual analogue scale. In data analysis, repeated-measures were utilized to test the differences between the control and exercise group over the course of the experiment time.

**Results:** The mean of the craving score significantly dropped from pre-test (control: mean=5.38, SD=3.04; exercise: mean=4.68, SD=2.93) to post-test (control: mean=4.03, SD=2.73; exercise: mean=1.91, SD=1.90) in both groups (control group:  $t=3.84$ ,  $df=46$ ,  $p<0.001$ ; exercise group:  $t=5.941$ ,  $df=47$ ,  $p<0.001$ ), with more decrease witnessed in the exercise group. Repeated- measures analysis with a Huynh-Feldt correction showed the significant effect of time ( $F=27.383$ ,  $p<0.001$ ) as well as the study group by time interaction ( $F=3.52$ ,  $p=0.024$ ).

**Conclusion:** Tai Chi can ameliorate the drug craving in women and it could be a supportive treatment for drug addiction.

## 1. Introduction

Drug addiction has become a worldwide problem. According to World Drug Report 2018, around 275 million individuals, about 5.6% of worldwide population, have utilized drugs at least once [1]. Drug addiction can lead to a great variety of disorders and around 31 million people are suffering from the disorders [1]. Impaired brain function has been found to be one of the main disorders, usually accompanied by defective cognitive function, depression and drug craving [2, 3, 4, 5]. Moreover, the high relapse rate, a most common trait of drug use, largely hinders the efficacy of the drug addiction treatment [6]. Therefore, it is important for individuals who have drug dependence to accept effective and safe therapeutic treatment.

As the most common drug addiction treatment, medication or behavioral technique only show modest, even poor performance [7, 8]. As a result, scholars started to explore novel treatments for drug addiction, with exercise being one of them. Studies have consistently found the benefits of exercise in drug addiction treatment. Lynch et al. reviewed previous findings and concluded that exercise can not only serve to prevent drug use, but also reduce the relapse rate at the same time [9]. Indeed, exercise is found to play an effective role in ameliorating depression or anxiety and improve cognitive ability in methamphetamine (MA)-dependent individuals [10]. In fact, some studies reported that aerobic exercise even decreases drug craving in MA and cannabis [11, 12]. Taken together, previous findings have shown the advantages of exercise in drug addiction treatment.

Tai Chi (Taiji, Tai Chiquan) is a traditional Chinese mind-body health practice. By its definition, the exercise benefits both physical and mental health [13, 14], with its focused and slow movement helping release the muscle tension, as well as regulate and calm emotions. Some studies documented that Tai Chi might be a novel approach to treat addiction. Liu et al. reported that Tai Chi effectively reduces the level of smartphones addiction [15]. Zhu et al. indicated that Tai Chi could improve the life quality of MA type stimulant dependences [16]. Moreover, both Xu et al. and Lim et al. found that one's cognitive function is improved after certain engagement with Tai Chi training [17, 18] while it is worth pointing out that cognitive function enhancing training is considered as an approach for addiction treatment [19]. However, few studies have been conducted so far to look specifically into the effect of Tai Chi on drug craving. Craving inhibition can contribute to lower relapse [20]. Thus, this article is based on data from a randomized controlled trial assessing the effect of Tai Chi on drug craving in long-term drug dependent women.

## 2. Methods

### 2.1. Study Design

This study is a randomized controlled trial, designed to test the effect of a traditional Chinese exercise, Tai Chi, on individuals with drug dependence. There were two groups, control group and exercise group (with the intervention of Tai Chi training), both of which accepted traditional addiction treatments, including psychological counseling, law education and in group mutual-help. Exercise group was participating Tai Chi training. All participants' drug craving score was designed to be assessed at four time points - baseline, one month, two months and three months after the baseline. Approval of this study was obtained from the Ethic Committee of Institute of Intelligent Machines, Chinese Academy of Sciences, Hefei. All methods were performed in accordance with relevant guidelines and regulations. The study registered in Chinese Clinical Trial Registry before participants enrollment and clinical trial register number is ChiCTR1900026773 (date of first registration: 21/10/2019). As registered, this study should have lasted for six months, from October 2019 to May 2020. However, only a three-month long Tai Chi training could be finished before the outbreak of COVID-19. All participants were informed of the study content and signed written informed consent prior any assessments.

### 2.2. Participants

The sample size estimation used the power calculation, conducted by G\*Power (3.1.9.7). The estimated parameters were  $\alpha = 0.05$ , power = 0.8 and size effect = 0.25. The size effect value was according to a meta-analysis conducted by Etnier (1997) [21] and other two similar studies that were assessing the effect of exercise on drug craving [11, 22]. The estimated total sample size was 95 and considering the possible drop outs, this study recruited 112 drug dependent women, from Women Specific Drug Rehabilitation Center, Hefei, Anhui, China. The inclusion criteria were (1) women who were using illicit drugs more than six months; (2) they were in non-acute detoxification period. The exclusion criteria were (1) having severe basic diseases; (2) cannot do Tai Chi exercise; (3) cannot finish the six-month training;

(4) less than 16 or more than 60 years old; (5) medical history against exercise training. Of the 112 volunteers, 101 participants met the criteria and were randomly allocated to control group and exercise group.

## **2.3. Randomization and Intervention**

Participants were randomly assigned to exercise group or control group. The random assignments were implemented by an independent researcher who did not know the experimental procedures and the allocation outcomes were delivered in sequentially numbered, opaque, sealed envelopes. Participants in both groups received psychological counseling, law and anti-drug education including the influence of drug use on individuals, family, and society and mutual-help in group. Exercise group received a three-month Tai Chi training, with two sessions per day and five training days per week. In the first week, a counseling class was provided to arouse participants' interest in Tai Chi, along with a professional Tai Chi instructor coaching on site and correcting movements during the training. The attendance of training was recorded by a researcher. In this study, Tai Chi was considered as a moderate-intensity aerobic exercise, rather than a martial art or Kungfu. Different from normal exercises, Tai Chi requires participants to keep a peaceful mind state and stay focused during the training. Their mind needs to settle as 'still water', which is similar to a meditation process. The Tai Chi participants played in this study contained 24 movements and usually spent around 5 minutes. Participants were repeating the 24 movements for around 30 minutes per session. During the study, all participants were not accessible to any types of drugs, including prescription medication, such as methadone.

## **2.4. Outcome and Measurement**

The primary and only outcome of this study was craving score, assessed by cue-induced drug craving assessment. The measurement was visual analogue scale (VAS) that is used in psychometric field to measure subjective characteristics or attitudes that cannot be directly scaled [23]. Each individual was asked to mark their desire for drugs in a 10 centimeters long line that was equally divided into 10 segments and was marked from 0 to 10, when they were shown drug-related pictures. The larger score represents higher level of craving. For example, the left end (0) means 'no craving at all' and the right end (10) means 'desperate for drug'. All participants accepted this assessment in the beginning of this study (baseline) and at the end of each month after the start of the intervention, four times in total. All four-time assessments were conducted by same researcher, who was blinded to the groups. In addition, questionnaires collected participants' background information and other potential risk factors, including age, education, types of drugs, the age of the first-time consuming drugs, the duration of using drug (years), abstinent time (months), the frequency of using drugs (days per week), smoking and excessive drinking (more than four times per week).

## **2.5. Statistical analysis**

This study used intention-to-treat analysis and utilized multiple imputation to fill the missing data, caused by dropout [24, 25]. Participants who finished the baseline assessment were taken account into final data analysis. Independent t-test was utilized to analyze the difference of the baselines between exercise and

control groups. The difference of drug craving between groups and within group at four time-points was tested by repeated-measures analysis of variance (ANOVA). Paired t-test was utilized to confirm the difference of craving results from pre-and post-intervention. The confidence interval was 95% in this study and the differences were considered statistically significant when p value was less than 0.05. The results were presented by SPSS 25.

### 3. Results

This study finished recruitment in the end of October 2019 and the intervention was from October 2019 to May 2020. There were 101 participants were randomly assigned to exercise group and control group. from Three participants in each group dropped out before receiving baseline assessment. At the end of this study, there were 36 participants left in control group, with two dropouts in month 1, two in month 2 and seven in month three. In exercise group, 41 participants left, with two dropped out in month 1, four in month 2 and one in month 3. Details of enrollment and dropouts are shown in Fig. 1. Seventy-seven participants finished the three-month Tai Chi training, 41 in exercise group and 36 in control group. According to intention-to-treat principle, data from 95 participants, aged from 17 to 55, including 18 dropouts, were analyzed, 47 from control group and 48 from exercise group. There was no crossover situation in this study. The baseline data and background information are shown in Table 1. Except the duration of drug use, other indexes did not have statistically significant difference. Of 95 participants, 69 were MA-dependence, seven being heroin-dependence, two using other illicit drugs and the rest of them were polydrug-dependence that is individuals who were using more than one drugs, including heroin, ecstasy, MA or ketamine.

Figure 1 CONSORT flow diagram.

Table 1  
Baseline demographic and clinical characteristics of participants

Indexes	Mean (SD <sup>c</sup> )	
	Control group	Exercise group
Craving score <sup>a</sup> (baseline)	5.38 (3.04)	4.677(2.93)
Age	34.04(8.73)	32.54(8.18)
Age of the first-time consuming drugs (age)	23.40 (6.72)	23.23 (5.98)
The duration of using drugs (years)	10.55 (8.42)	8.39 (5.18) *
Abstinent time (months)	12.62 (6.11)	9.46 (6.11)
Frequency of using drugs (days/ week)	4.63 (3.43)	4.20 (2.61)
Education (years)	8.84 (2.90)	9.23 (2.61)
Excessive drinking <sup>b</sup>	43% (n = 20)	33% (n = 16)
Smoking	98% (n = 46)	90% (n = 43)
* Statistically significant difference between control group and exercise group		
<sup>a</sup> The craving score was assessed by visual analogue scale		
<sup>b</sup> Drinking more than 5 times per week		
<sup>c</sup> SD: standard deviation		

Figure 2 and Table 2 demonstrate the change of craving score in both groups. In control group, the craving score showed the reducing trend and it decreased from baseline (mean = 5.38, SD = 3.04) to month one (mean = 4.97, SD = 2.88) to month two (mean = 4.75, SD = 2.95) to month three (mean = 4.03, SD = 2.73). In exercise group, the craving score also had decreasing trend, but sharper. It dropped from baseline (mean = 4.68, SD = 2.93), to month one (mean = 4.03, SD = 2.98) to month two (mean = 3.25, SD = 2.52) to month three (mean = 1.92, SD = 1.91). The paired t-test examined the significant change between pre- and post-intervention in both groups (control group:  $t = 3.84$ ,  $df = 46$ ,  $p < 0.001$ ; exercise group:  $t = 5.94$ ,  $df = 47$ ,  $p < 0.001$ ). As shown in Table 3, the repeated-measures ANOVA with a Huynh-Feldt correction determined that the mean value of drug craving was significantly different between assessment stages (baseline, month one, month two and month three) ( $F = 27.383$ ,  $df = 2.362$ ,  $P < 0.001$ ). The effects of time-by-group were also significant ( $F = 3.520$ ,  $df = 2.362$ ,  $p = 0.024$ ).

Figure 2 The trend of mean craving score in exercise and control groups.

Table 2  
Mean (SD) craving scores in exercise and control group cross time

Groups	Baseline Mean (SD <sup>a</sup> )	Month one Mean (SD)	Month two Mean (SD)	Month three Mean (SD)	Paired t-test*	
					t (df)	p value
Exercise group	4.68(2.93)	4.03(2.98)	3.25(2.52)	1.92(1.91)	5.94 (47)	p < 0.001
Control group	5.38(3.05)	4.97(2.88)	4.75(2.95)	4.03(2.73)	3.84 (46)	p < 0.002

<sup>a</sup> SD: standard deviation

\* Paired t-test compared the craving scores between pre-test (baseline) and post-test (month three).

Table 3  
Results of repeated-measures ANOVA measuring changes in craving score across intervention study time-points

Repeated-measures ANOVA <sup>a</sup>	Time		Study group x time	
	F (df)	P value	F (df)	P value
	27.383 (2.362)	< 0.001	3.520 (2.362)	0.024

<sup>a</sup> ANOVA: analysis of Variance

## 4. Discussion

### 4.1. Main findings

The aim of this study is to assess the effect of Tai Chi on drug craving in long-term drug-dependent women. Comparison between exercise group and control group was made and the results show that 1) the mean drug craving score was decreasing in both groups; 2) repeated-measures and paired t-test showed the significant decrease of craving score across time and significant difference between groups. The results indicate that although drug craving score in both groups was decreasing, it dropped greater and faster in exercise group. Previous studies have not researched the effect of Tai Chi on drug craving, but research has been done on normal aerobic exercise. Wang et al. reported the similar results in a study of aerobic exercise applied in MA dependent individuals [11]. In their 12-week study, the craving score of exercise group dropped from around six to two and that of control group decreased from around six to five. The influence of aerobic exercise on craving was also found on cannabis-dependent adults. After a 2-week aerobic exercise training, the participants' cannabis craving significantly decreased [12]. Although the participants from these two studies mentioned above and current study vary in age, sex, race and the type of drug use, and despite the difference in exercise being involved in the study design, these studies

share the common argument that aerobic exercise or Tai Chi can contribute to the reduction of drug craving.

One possible explanation of the beneficial effect of Tai Chi on drug craving would be that the impaired dopaminergic system caused by drug use made recovery during exercises. Drug use can result in the deficits of dopamine receptors and transporters [26, 27]. Reduction of dopamine receptors can result in a state of anhedonia and this may cause more use of drugs [28, 29]. Exercises would grow the concentration of dopamine and increase the receptors of dopamine [9, 30]. In an animal study, aerobic exercise contributed to the increase of dopamine D2 receptors in rats [31]. Robertson et al. indicated that increased striatal dopamine D2/D3 receptors in MA-dependences are found after structured exercise training [33]. These findings support the idea that exercise may reduce drug craving.

Different from normal aerobic exercise, Tai Chi, the mind-body practice, requires participants to keep a peaceful and focused mind state during the whole process. Thus, Tai Chi is also called moving meditation and its mindfulness and spiritual focus are believed to be beneficial to craving decrease. The mindfulness-based approach can develop an insight that allows substance dependent individuals to have an aware reaction rather than an automatic respond when they are confronting desire or craving for the substance [33]. Tang et al. reported that mindfulness meditation can improve reduced activity in anterior cingulate cortex and adjacent prefrontal cortex to prevent and treat addiction [34]. In clinical trials, Vidrine et al. reported that mindfulness-based addiction treatment might prevent patients from deteriorating from early lapses and subsequently progressing to full relapse [35]. A 12-week and a 15-week follow-up studies demonstrated that meditation or mindfulness-based training can reduce drug craving or drug use [36, 37].

The spiritual focus, which is trained and enhanced during Tai Chi exercise [38, 39], can also contribute to craving reduction. The role of spirituality in addiction treatment has been proved by numerous studies and acknowledgement in some recovery programs [40]. Spiritual power is proved to have positive influence in alcohol addiction treatment [41]. For example, Alcoholics Anonymous, which has helped millions of individuals, is rooted in spirituality [42]. Attending substance abuse help group is identified as 'spiritual power' [43]. Avants et al. found that Spiritual Self-Schema therapy, a spiritual training practice, effectively decrease heroin and cocaine use [44]. Moreover, spiritual focus is used to relieve depression and anxiety [45, 46], which are ones of the main disorders of drug use in the first place [47].

## **4.2. Study limitations**

This study only recruited female volunteers and the findings could not be applied to their opposite gender without experiment with.

## **5. Conclusion**

This study showed that Tai Chi has a positive effect on reducing drug craving in drug dependent women. Based on the findings, Tai Chi can be used for reducing drug craving as a supportive treatment method,

working as an effective approach to be combined with traditional techniques in drug addiction treatment. In the future, studies may focus on the mechanism of how exercise affects drug craving and the change of dopamine receptors.

## Declarations

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### Author contributions

MW was responsible for all the data collection and paper writing.

YC was responsible for the project administration, writing and reviewing the paper.

Z was investigating the background information and writing the 'Introduction'

HL and CY were responsible for the coordination of venue and personnel, especially in incorporating data collection.

JL and YX were doing Data curation and writing the 'Method'

ZD provided the fundings.

ZM and YS was responsible for the project administration and supervision, as well as writing the conclusion.

### Declaration of interest statement

No potential conflict of interest was reported by the authors.

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## Figures

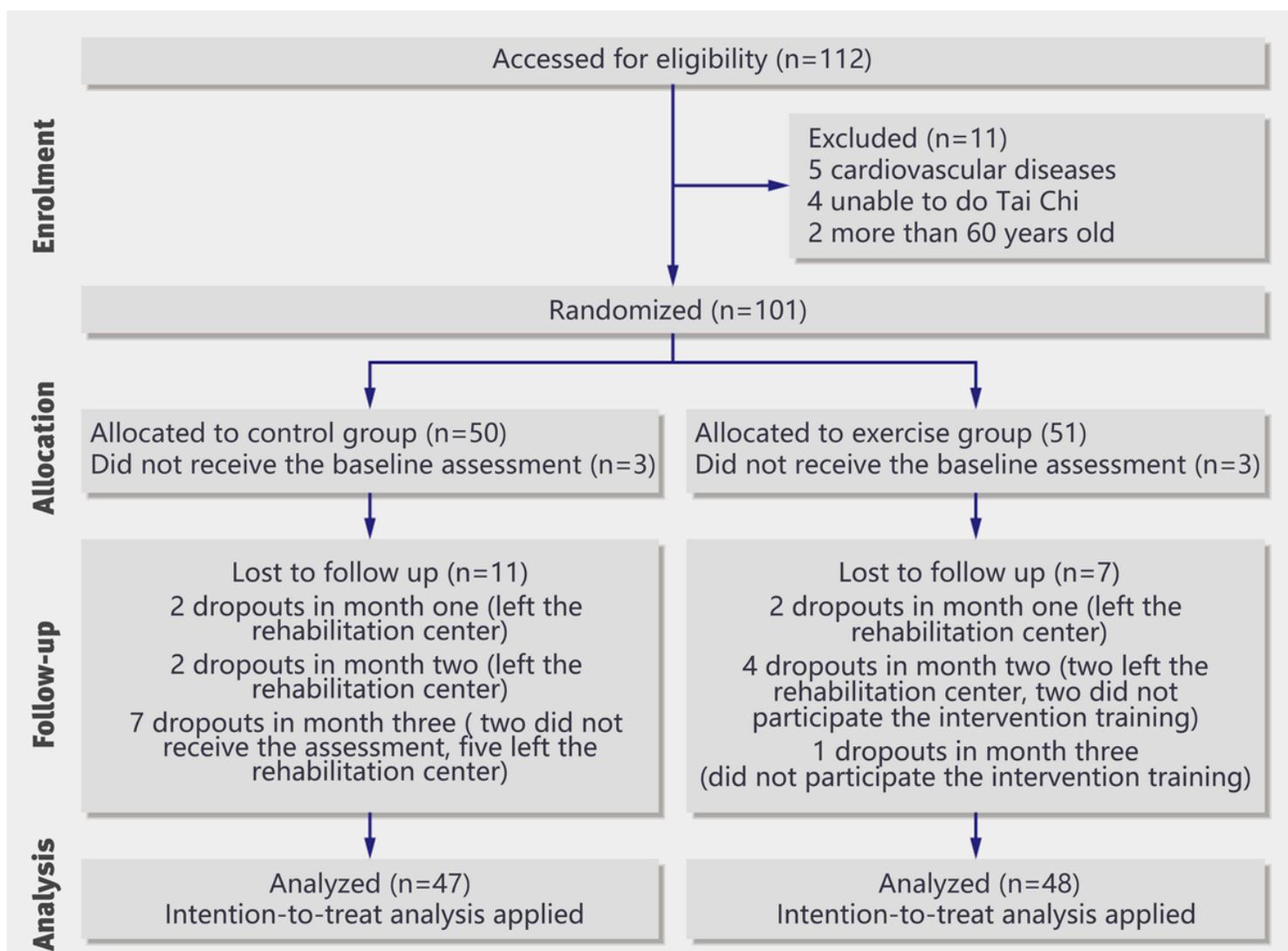
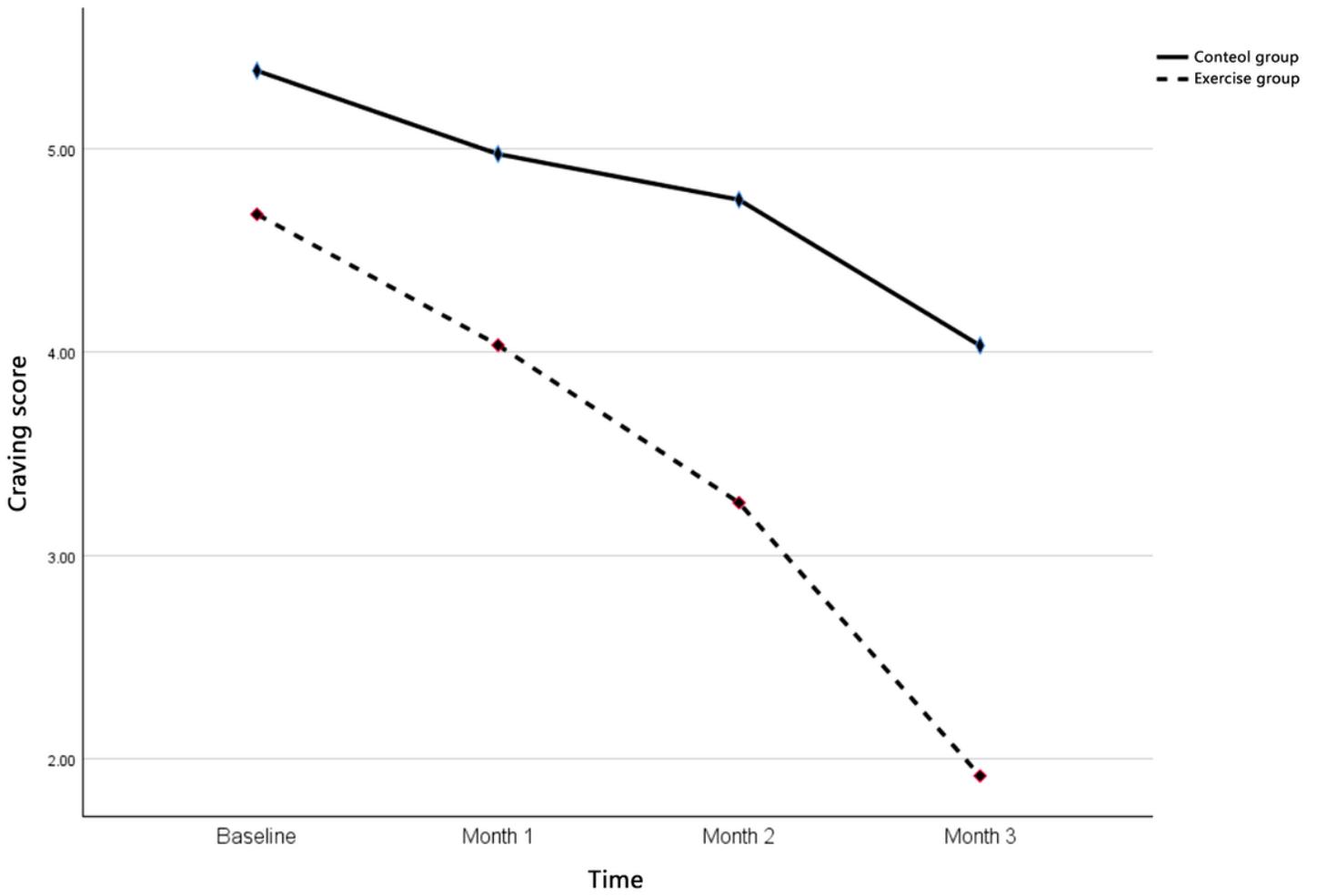


Figure 1

CONSORT flow diagram.



**Figure 2**

The trend of mean craving score in exercise and control groups.