

# Construction of a Home Exercise Prescription Solution for Youth During a Serious Public Health Emergency in China

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## Research article

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# Abstract

## Background

Coronavirus disease 2019 (COVID-19) was identified as a serious public health emergency. The Chinese government required people to stay at home. The purpose of this study was to analyse the effect of home exercise prescription solutions on the physical and mental health of youth during the COVID-19 period.

## Methods

A home exercise prescription was formulated after investigating and categorizing the home exercise status of 4000 undergraduates during the period of COVID-19. In this prospective cohort study, 200 young people were recruited for a home exercise prescription intervention, and 200 individuals did not undergo any intervention for 4 weeks in February 2020. Physical and mental health indexes including anxiety factors, obsessive-compulsive symptoms factors, depression factors, somatization subscale factors, and sleep and diet factors were evaluated.

## Results

Of 4,000 undergraduates living at home, 64.8% were dissatisfied with their physical and mental condition. Ninety-three percent wanted to adopt an exercise practice at home during the period of COVID-19. In the prospective cohort study, the average anxiety scores and sleep and diet scores before the intervention were  $2.14 \pm 0.43$  and  $2.24 \pm 0.54$ , respectively, in the intervention group. After 4 weeks, participants reported that negative emotions were reduced. The scores for all factors were less than 2 points, and there were significant differences between the pre-intervention and post-intervention time points ( $P < 0.05$ ). Differences between the two groups were statistically significant at 2 and 4 weeks ( $P < 0.05$ ).

## Conclusion

There was an urgent need for home exercise programmes for youth during the period of COVID-19. Formulating appropriate home exercise prescriptions could help maintain physical and mental health, enhance immunity, and prevent disease.

**Trial registration** *ChiCTR, ChiCTR2000030090, Registered February 24th, 2020.*

<http://www.chictr.org.cn/edit.aspx>

## Background

The coronavirus disease 2019 (COVID-19) was declared a Public Health Emergency of International Concern (PHEIC) by the World Health Organization (WHO) and progressively developed into a global pandemic in March 2020 [1]. COVID-19, as an acute respiratory infectious disease, broke out in Wuhan in December 2019 and has been classified as a category B infectious disease; however, COVID-19 has been treated with preventive and control measures of a category A infectious disease in China [2]. COVID-19

spread rapidly in more than 100 countries around the world in March 2020 [1]. China and some national governments have successively announced the suspension of work and classes and an order to stay at home [3]. Young adults are lively and sociable in daily life. When faced with the tense situation of COVID-19, young people were isolated at home for a long time, and their physical and mental health were inevitably affected [4]. Therefore, in this serious public health emergency, constructing home exercise and health solutions to allow for the maintenance of physical and mental health, enhance immunity, and prevent the spread of COVID-19 is a not a negligible issue.

The prescription of exercise was proposed by American physiologist Rapovich in the 1950s. Exercise prescriptions began to be used by the WHO in the 1970s and have gradually gained international acceptance. An exercise prescription is based on the evaluation of an individual's physical status (body mass index (BMI), cardiopulmonary function, muscle strength, and so on) and the development of an appropriate exercise programme to guide the patient to perform scientific, rational, planned, and purposeful exercise. Exercise prescriptions are widely used in sports, fitness and medical fields, and their effects have been confirmed [5-7]. Therefore, according to the survey on the physical and mental health and exercise status of youth during the period of COVID-19, the purpose of this study was to explore home exercise prescription solutions to cope with major public health emergencies.

## Methods

### Survey on the status of home exercise among youth

In February 2020, a survey was performed regarding the physical, mental, and exercise status of 4000 undergraduates from five universities in China. Participants were 18-35 years old, with a median age of 25 years. Among them, 2880 (72%) undergraduates had a BMI of 18.5-24. The male to female ratio was 1:1.5 (Table 1). Regarding the status of home exercise, 3720 (93%) people thought that they needed a home exercise practice during the period of COVID-19. A total of 3240 (81%) undergraduates exercised at home, but 76% had no specific plan. A total of 45.9% spent a lot of time each day playing games and watching movies or TV shows. A total of 2592 (64.8%) undergraduates were dissatisfied with their physical and mental conditions. Fifty-eight percent did not know or knew little about exercise prescriptions. In terms of home exercise type, 2280 (57%) undergraduates performed yoga or simple stretching exercises at home. Seventeen percent performed running exercises, and only 5.7% performed equipment training. Regarding the purpose of home exercise, 1320 (33%) undergraduates exercised to lose weight and keep fit. Thirty-three percent exercised to enhance their physical fitness and prevent an illness, and 14% exercised to relieve stress and relax (Fig. 1).

### Formulating home exercise prescriptions for youth

According to the survey data, home exercise prescriptions for young people were formulated by a team of sports medicine doctors, sports rehabilitation doctors, and psychologists (Fig. 2). The home exercise prescription was based on the FITT-VP principle of the ACSM's Guidelines for Exercise Testing and Prescription. F (Frequency) indicates a once per day exercise practice in the home exercise prescription. I

(intensity) indicates low or medium aerobic exercise at 40-60% of heart rate reserve. The anti-resistance strength was 50% of the one repetition maximum (1RM). The first T (Time) indicated 45-60 minutes per exercise session according to the prescription. The second T (Type) indicated the alternation between aerobic practice and anti-resistance practice. V (volume) was three to four aerobic practices and three anti-resistance practices per week. P (Progression) was evaluated weekly and monthly. Additionally, home exercise prescription practice videos were recorded to instruct the individuals on how to perform the exercises. Moreover, a "Sports and Health" MOOC (Massive Open Online Course, <https://www.icourse163.org>) created by Professor Jian Li in December 2018, which covered the basic aspects of sports health, sports nutrition and sports injury prevention, was provided to young people.

The home exercise prescription was a universal prescription that supplemented the daily activities and exercise equivalents of healthy young people. However, the prescription was not suitable for people who had muscle-building or fat-loss needs. The prescription was carried out by youth at home, excluding individuals with heart disease, lung disease, or motor system diseases. Moreover, the home exercise prescription was not recommended for patients with a cold, fever or suspected COVID-19. Young people with BMI <18.5 or BMI  $\geq$  24 should initially perform low-load exercise during the anti-resistance portion of the programme to prevent injuries. Females could reduce their exercise programme according to their specific situation during their menstrual period. Exercise programmes were mainly tailored to local conditions and were combined with entertainment such as music, video, etc. during exercise practice. If discomfort or injury occurred, the exercise was terminated.

### **Study on home exercise prescription for youth**

From February 27th to March 27th, 2020, a prospective random cohort study on home exercise prescriptions for young people during COVID-19 was conducted. The study was registered with the Chinese Clinical Trial Registry (ChiCTR2000030090) and was approved by the local ethics committee. A total of 400 young people staying at home during the period of COVID-19 were recruited and were aged 18-35 with a median age of 25. The male to female ratio was 1:1. BMI ranged from 18.5 to 24 (Table 2). According to random computer allocation, 200 participants were assigned to the home exercise prescription intervention group. All participants underwent the home exercise prescription intervention and "Sports and Health" MOOC online learning for 4 weeks. The daily exercise duration was 45-60 minutes, with an average of 52 minutes. Participants performed aerobic training 4 days per week and anti-resistance training 3 days per week. Another 200 participants were assigned to the control group that did not receive an intervention. All participants were assessed according to the factors of anxiety, obsessive-compulsive disorder, depression, somatization subscale, and other factors (sleep and diet) using the Symptom Check List 90 (SCL-90) scale at 2 and 4 weeks[8]. Every exercise practice was monitored and evaluated through online videos. A self-assessment was performed after each exercise practice. The self-assessment factors included mood and physical changes after exercise and whether the exercise intensity was appropriate. The sports doctors reviewed the completion of the home exercise prescriptions and the status of exercise training. The results were analysed statistically using SPSS 20.0.

Comparisons of different factors before and after the intervention were performed within and between groups. Two-way repeated measures ANOVA was used, and  $P < 0.05$  indicated a significant difference.

## Results

In the intervention group, home exercise prescription completion and exercise intensity met the standards. The physical condition was comfortable, and negative emotions were relieved after exercise. Ninety-five percent of participants indicated that the home exercise prescription was effective and that they were willing to continue to practice for a long time. The scores of anxiety factors and sleep and diet factors before the intervention were  $2.14 \pm 0.43$  and  $2.24 \pm 0.54$  on average. Obsessive-compulsive scores, depression scores, and somatization subscale scores were  $1.91 \pm 0.28$ ,  $1.75 \pm 0.34$ , and  $1.82 \pm 0.34$ , respectively. The anxiety scores of 12 (3%) young people were greater than 3, and the sleep and diet scores of 20 (5%) people were greater than 3, which indicated a state of psychological problems and the requirement for psychological counselling. After 2 weeks of intervention, the scores of anxiety factors and sleep and diet factors decreased significantly and were  $1.73 \pm 0.20$  and  $1.82 \pm 0.29$ , respectively. After 4 weeks of the intervention, the scores of all factors were less than 2. There were statistically significant differences ( $P < 0.05$ ) in all indicators among the preintervention, 2 weeks of intervention, and 4 weeks of intervention timepoints (Fig. 3). In the control group, the scores of all five factors increased at 2 and 4 weeks. Scores of anxiety, somatization subscale factors, and other factors (sleep and diet) were greater than 2. There were significant differences between the two groups during the 4th week. However, there were no significant differences between the two groups in terms of cardiopulmonary function or muscle endurance.

## Discussion

Exercise prescription refers to the use of scientific prescriptions to improve the physical condition of an individual. Purposeful and planned scientific exercises enhance physical fitness and prevent diseases [5-7]. Exercise prescription includes exercise frequency (F), intensity (I), type (T), time (T), volume (V) and progression (P). A detailed pre-exercise assessment is required before prescription formulation. Moreover, precautions during exercise practice should be included. Since China implemented the strategic goal of "nationwide fitness", exercise and health elements have become an important part of people's daily lives. Exercise prescription is widely used in sports fitness and medical activities and include goals such as muscle building, fat loss and disease rehabilitation, and the effects of the prescription are significant [5-7]. Since the epidemic of COVID-19 occurred, long-term home isolation to prevent the spread of COVID-19 posed a severe challenge for people's exercise health [4]. According to the results of a previous survey of 4,000 undergraduates, young people had an urgent need for home exercise training. The participants did not know how to exercise at home because of a lack of professional guidance. Therefore, sports medicine practitioners should provide good home exercise guidance to help improve the health of young people.

A long-term lack of exercise at home leads to a series of physical and mental health problems. During the SARS outbreak in 2003, researchers conducted psychological health surveys of undergraduates, and the results showed that anxiety, fear, and hypochondriasis factors increased significantly [9]. Previous research confirmed that young people were prone to psychological problems such as anxiety and depression in crisis situations [7,10,11]. Additionally, psychological problems gradually led to physical illness. The outbreak of the COVID-19 epidemic led to the majority of young people staying at home for a long time, and their physical and mental health were severely affected [4]. Some studies have indicated that scientific and rational exercises could improve the body's blood circulation, promote the body's metabolism, and stimulate dopamine and endorphin secretion [12,13]. Thus, the body has a relaxed and pleasant feeling after exercise. Exercise stimulates the release of dopamine and endorphins, which are also known as the "happy hormone" and "youth hormone" [12,13]. According to reports, the incidence of diseases such as angiocardopathy, cerebrovascular disease, osteoporosis, and diabetes in people with good exercise habits was significantly lower than in those without good exercise habits [5,14,15]. Moreover, lymphocytes, NK cells and monocytes were rapidly mobilized to the blood at the onset of scientific and rational exercise. Exercise improves immune surveillance and inflammation and might have beneficial effects on immunity [16,17]. However, long-term continuous exercise reduces immunity, and the levels of plasma free radicals and prostaglandins increase, which reduces lymphocyte function and immunity [16,17]. Therefore, professional sports medicine practitioners are required to formulate scientific and rational exercise programmes that help individuals maintain physical and mental health and avoid sports injuries. Additionally, exercise requires a reasonable diet, and nutrition is also very important. Replenishing nutrients needed by the body before and after exercise while avoiding excessive intake of sugars, fats and other components are important aims to keep the body nutritionally balanced. Moreover, it is important to prevent sports injuries. Participants participated in the MOOC of "Sports and Health" through the internet to obtain guidance on sports nutrition and sports injury prevention.

The home exercise prescription was universal among the population, and the prescription was complementary to daily activities and exercise. Because of the lack of favourable pre-exercise evaluation conditions, an online questionnaire was used for the survey to formulate home exercise prescriptions in this study. Home exercise prescription was used as a daily activity and exercise supplement. The prescription recommended 6-7 days of exercise practice per week, alternating between aerobic training and anti-resistance training. The exercise intensity was low to moderate. In terms of exercise types, considering that the space and equipment were limited at home, all programmes were designed to be easy to learn, without requirements for special space or equipment. The exercise programmes were all safe and not likely to cause injury. Previous studies have reported that approximately 1% of adolescents had systemic multiligament laxity, which can easily lead to shoulder, elbow and wrist injuries during exercise training [18,19]. Therefore, we did not include pull-up, push-up, or other limb anti-resistance training exercises. For obese young people with a BMI  $\geq 24$ , the prescription suggested that the exercise intensity should be reduced to prevent lower limb joint injuries when carrying out lower limb weight-bearing exercises. For those who were unwell at home or had their menstrual period, a cold or suspected COVID-19, the prescription recommended reducing the training volume or stopping training [20]. After 4

weeks of the exercise prescription intervention, the participants had a high completion rate of the exercise prescription with moderate exercise intensity, and no injuries occurred; the prescription was very popular with young people.

## **Conclusion**

During a serious public health emergency (COVID-19), young people had an urgent need for home exercise. Formulating appropriate home exercise prescriptions could help individuals maintain physical and mental health, strengthen immunity and prevent disease.

## **Abbreviations**

COVID-19: Coronavirus disease 2019; PHEIC: Public Health Emergency of International Concern; WHO: World Health Organization; BMI: body mass index; ChiCTR: Chinese Clinical Trial Registry ; ACSM: American College of Sports Medicine; 1RM: one repetition maximum; MOOC: Massive Open Online Course; SCL-90: Symptom Check List 90; SPSS: Statistical Product and Service Solutions; ANOVA: Analysis of Variance.

## **Declarations**

### **Acknowledgements**

The authors would like to express their thanks to all participants and staff involved in this study.

### **Authors' Contributions**

All authors participated in formulating the home exercise prescription and managing the study. YX, YL and LY participated in the collection of data and drafted the paper. JL and LLL made substantial contributions to the conception and design of this study, reviewed the paper for important intellectual content and provided final approval of the version to be published. MML, LY, DYS, and KX were responsible for the survey, participated in project coordination and assisted with the paper. Each author participated sufficiently in this work to take public responsibility for the appropriate portions of the paper. All authors read and approved the final paper.

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### **Availability of data and materials**

The datasets used and/or analysed in the present study are available from the corresponding author on reasonable request.

### **Conflict of Interest**

The authors report no conflicts of interest in this study.

### **Ethics approval and consent to participate**

This study was performed in accordance with the ethical standards outlined in the Declaration of Helsinki. All participants provided informed written consent prior to participation in this study. This research was approved by the Institutional Review Boards at the University of West China Hospital, Sichuan University, Chengdu, Sichuan, China (No. 2020-189). The study was registered with the Chinese Clinical Trial Registry (ChiCTR2000030090).

### **Consent for publication**

Not applicable.

### **Competing interests**

The authors declare that there are no competing interests.

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## Tables

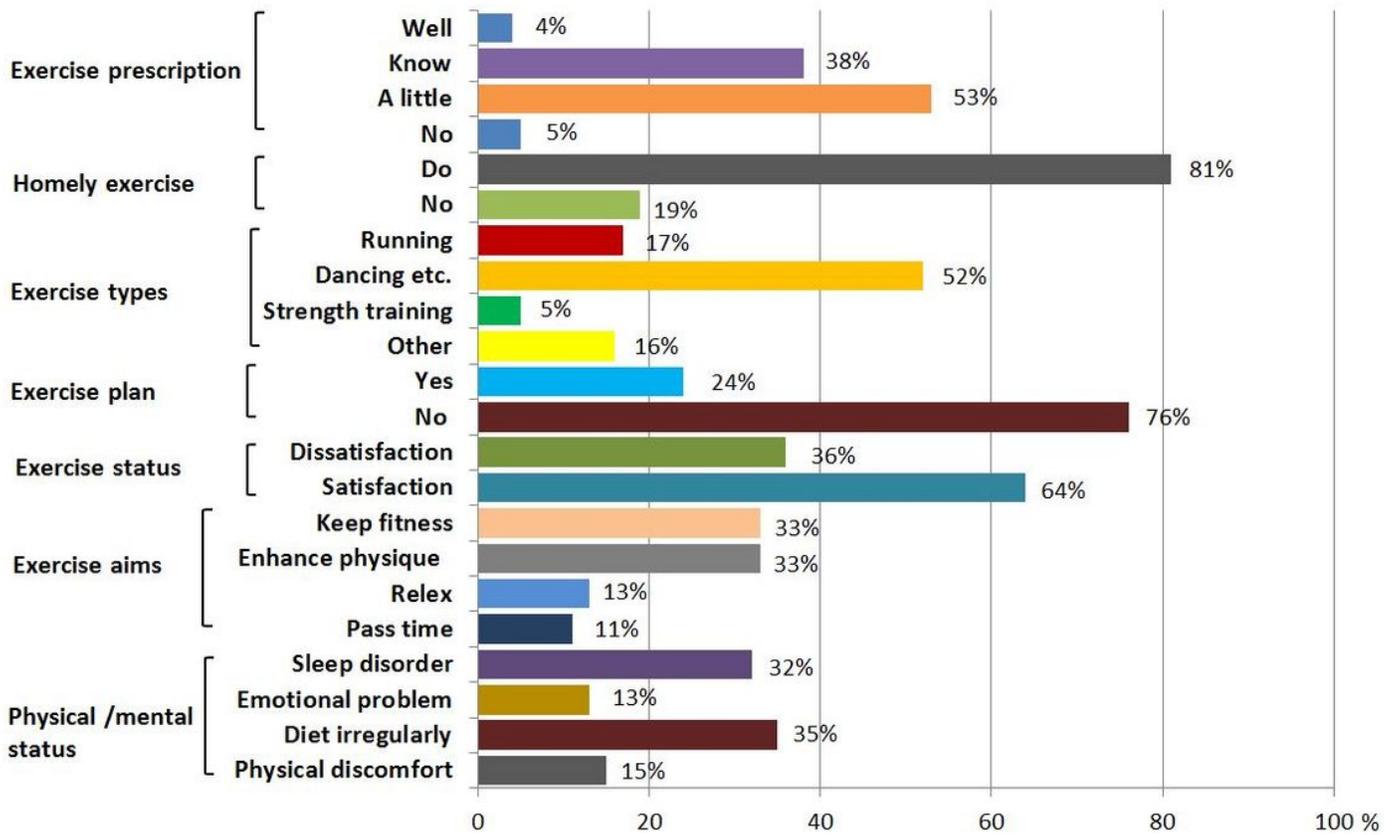
**Table 1:** General demographics of the 4,000 undergraduates included in the survey during the period of COVID-19. BMI: Body Mass Index.

Characteristics	Variables	Outcomes
<b>Age(year)</b>	≤18y	280 (7%)
	18-30y	3400 (85%)
	≥30y	320 (8%)
<b>Gender</b>	Male:Female	1:1.5
<b>Region</b>	City:Countryside	1.5:1
<b>Major</b>	Arts	1320 (33%)
	Science	920 (23%)
	Medicine	1560 (39%)
	Sports	200 (5%)
<b>BMI</b>	≤18.5	720 (18%)
	18.5-24	2880 (72%)
	≥24	400 (10%)

**Table 2:** The general information of 4000 young people recruited in this study.

Characteristics	intervention group	Control group	<i>P</i>
<b>Age</b> (year)	18-35(25)	18-35(25)	<i>n.s</i>
<b>Gender</b>	1:1	1:1	<i>n.s</i>
Male:Female			
<b>Major</b>	33%33%	33%33%	<i>n.s</i>
Arts	33%33 %	33%33 %	
Science	34%34%	34%34%	
Medicine			
<b>BMI</b>	18.5-24 (21.06±1.61)	18.5-24 (21.08±1.78)	<i>0.895</i>
<b>Region</b>	1:1	1:1	<i>n.s</i>
City%Countryside			

## Figures



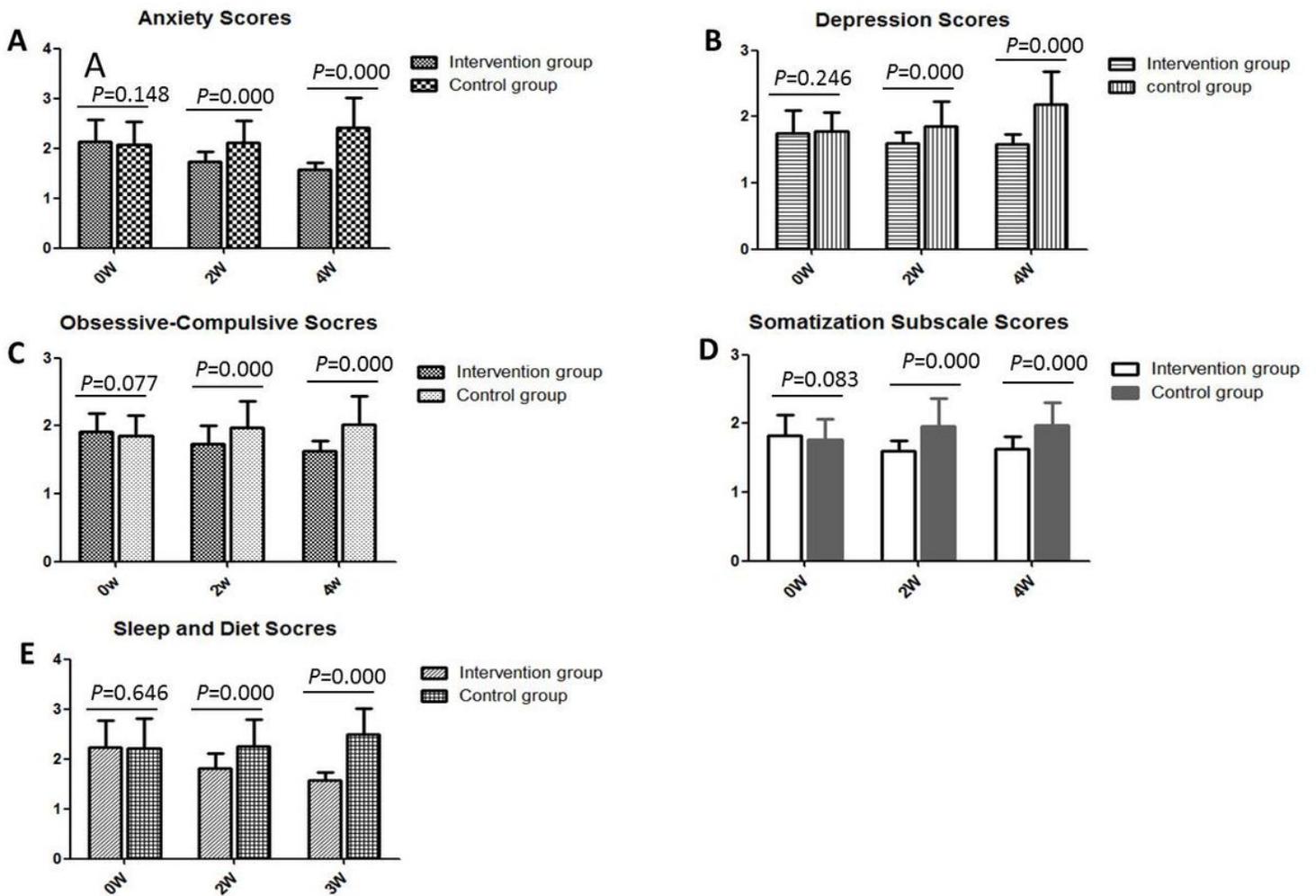
**Figure 1**

Data on the physical, mental, and exercise status of 4,000 undergraduates from the survey during the period of COVID-19.

<p><b>Monday( Aerobic exercise )</b></p> <p>①running laps/on treadmill, 20 min/set, 2 sessions ;</p> <p>Or exercise bike training, 20 min/set , 2 sessions ;</p> <p>②jumping rope, 3-5 min/set, 2 sessions.</p>	<p><b>Tuesday ( Resistance exercise )</b></p> <p>①Wall sit exercise, 1 min/set , 10 sets;</p> <p>②Upper limb resistance exercise : dumbbell/resistance band ( 50% of one repetition maximum (1RM) ) : 1 min/set, 10 sets;</p> <p>③Plank exercise : 1 min/set, 10 sets.</p>	<p><b>Wednesday ( Aerobic exercise )</b></p> <p>①Aerobics or Yoga exercise : 30 min;</p> <p>②Tai Chi exercise : 10 min.</p>	<p><b>Thursday ( Resistance exercise )</b></p> <p>①Upper limb resistance exercise : dumbbell/resistance band ( 50% of one repetition maximum (1RM) ) : 1 min/set, 10 sets;</p> <p>②Lower limb resistance exercise : hip- and knee-stretching resistance exercise : 1 min/set, 10 series;</p> <p>③crunch exercise : 20 repetitions/set, 5 sets.</p>
<p><b>Friday ( Aerobic exercise )</b></p> <p>①running laps/on treadmill, 20 min/set, 2 sessions ;</p> <p>Or exercise bike training, 20 min/set , 2 sessions ;</p> <p>②Skipping rope, 3-5 min/set, 2 sessions.</p>	<p><b>Saturday ( Resistance exercise )</b></p> <p>①Wall sit exercise, 1 min/set , 10 sets;</p> <p>②Upper limb resistance exercise : dumbbell/resistance band ( 50% of one repetition maximum (1RM) ) : 1 min/set, 10 sets;</p> <p>③Plank exercise : 1 min/set, 10 sets.</p>	<p><b>Sunday ( Aerobic exercise )</b></p> <p>①Aerobics or Yoga exercise : 30 min;</p> <p>②Tai Chi exercise : 10 min.</p>	

**Figure 2**

Recommended Weekly Home Exercise Prescription.



**Figure 3**

The scores of five factors (anxiety, obsessive-compulsive, depression, somatization subscale, and sleep and diet) decreased after the home exercise prescription intervention. In particular, anxiety scores and sleep and diet scores were significantly reduced in the intervention group. There were significant differences between the two groups ( $P < 0.05$ ) in all indicators after two and four weeks of intervention.