

# COVID-19: Exercise Behavior of College Students Communicating at Home

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## Research Article

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# Abstract

**Background:** During the outbreak and spread of COVID-19, the extension of college students' time spent studying at home changed their physical exercise behavior and affected the physical activity behavior of the whole family.

**Methods:** A questionnaire survey was conducted among 1,582 college students using a specific measurement scale. A total of 305 urban college students were selected as research subjects. SPSS24.0 and AMOS24.0 were used for statistical analysis.

**Results:** During the COVID-19 transmission period, the pair correlation coefficients of exercise behavior, exercise attitude, and family exercise conditions were 0.63, 0.36, and 0.25, respectively. The influence on family exercise behavior is as follows: college students' exercise behavior (0.403), family exercise support (0.329), and college students' exercise attitude (0.257). The most significant influence on family exercise support is college students' exercise attitude (0.509). The regression model of family exercise behavior standardization had 0.74 and 0.44 explanatory power to family exercise behavior and family exercise support, respectively.

**Conclusions:** The individual-level interventions were assessed by considering the interaction between individual exercise behavior and individual factors. In addition, the exercise environment exhibited a regulatory role and should be controlled. At the interpersonal level, the communication of the college students regarding exercise behavior was bidirectional. Exercise support for family members is an important factor affecting two-way communication and has a significant effect. With the development of the exercise behavior theory, the interaction between individuals is the origin of the spread of group behavior. The data suggest that instead of one-way influence two-way influence mechanisms should be proposed to assess the transformation from the individual to group exercise behavior.

## Introduction

The global COVID-19 outbreak in 2020 resulted in several health concerns at an unprecedented level. Concomitantly, as China's aging population increases, aging diseases increase, and the health status of the subjects affected requires continuous improvement. Significant interest has been observed in physical exercise. Moderate-intensity physical activity has been shown to prevent various chronic diseases, such as cardiovascular disease, cancer, anxiety, and depression, which in turn improve the quality of life.[1, 2] Although the health benefits of physical activity are well established, previous studies demonstrated a significant decline in the proportion of the physical activity population aged 15-29 years, [3, 4] with a reduction in the activity of approximately 24% or 1.01METs/ day.[5] However, college students belong in this age cutoff. Therefore, the improvement of the college students' exercise has become a major topic of investigation.

Wilbur Schramm was the founder of the following communications: "We're not all god and we're not all animals. Our dissemination proves that we are fully human. "Practice indicates which part of the various

components of today's society, from families to schools, associations, institutions, companies, and enterprises, is not dependent on communication. The latter refers to the behavior of transmitting and receiving information.[6] Some scholars have reported the concept of "sports communication". Several studies have assessed sports information, sports and mass communication, and sports media communication, whereas a limited number of researchers have discussed how sports behavior is spread from an empirical perspective. After reviewing various studies, it was found that social support [7, 8] was an important predictor of physical activity and an important way of interpersonal communication during physical exercise.

Ajzen [9] introduced social support into the theory of physical exercise behavior, and Kawachi and Berkman [10] proposed that social support included family and friends' action support, emotional support, information support, and idea support.[11-14] However, the survey report indicated that college students exhibited a goodwill to exercise, but lacked companionship and support from family and friends, which was an important factor hindering their exercise.[15] Among adolescents, middle-aged, and elderly people, social support was significantly correlated with physical activity level.[16]

Therefore, the present study examined the exercise behavior of college students according to the three following perspectives:(1) Individual assessment of the exercise behavior, behavioral attitude, goal attitude, cognitive attitude, and exercise environment, (2) interpersonal assessment examining how the exercise behavior of the college students affect the sports behavior of family members, and whether the exercise support of family members is an important way to spread the exercise behavior, (3) empirical assessment aiming to provide a reference for the development of the current exercise behavioral theory.

## **Theoretical Basis**

### **Ternary interaction decision theory**

In 1986, Bandura and Michael published the social cognition theory based on the social learning theory. The main content was based on individual behavior being neither driven by internal factors alone nor controlled by external stimuli alone. By contrast, it was determined by the interaction among individual cognition, and other internal factors, such as behavior and the environment. The core idea of the model was "ternary interactive determinism"[17] (as shown in Figure 1). The prominent feature of the model was that the environment could affect people's behavior and lifestyle, and conversely, people's behavior could also affect the environment. This is the nature of the interaction between the environment and the behavior.

### **System theory**

According to the principle of system integrity and the principle of hierarchy,[18] all parts of the whole influence and restrict each other. The hierarchy of the system resembles a box. The high-level system is composed of the middle-level system, and the middle-level system is composed of the lower-level system. During physical exercise, personal factors, personal surroundings, and personal behavior constitute the

low-level part of the exercise system. Family, school and work units constitute the middle-level system, exercise groups, and social groups constitute a high-level system.

Different levels of the system participate in different system functions. It is generally accepted that greater binding strength is present between elements of low-level systems, while the binding strength between elements of high-level systems is lower. The system with the higher combination strength between the elements exhibits higher certainty. By contrast, the system with lower strength between elements exhibits higher flexibility. Therefore, the middle and low-level systems are composed of families and individuals with a stronger degree of integration, and the connections between the elements possess higher certainty, which is consistent with the main investigation of the present study.

## **Methods**

### **Research objects and data collection**

Third and fourth year undergraduate students in the colleges and universities of Xinjiang were used as the subjects of the questionnaire survey. The recruitment was performed during the period of March 2 to March 8, 2021. A total of 40 teaching classes and 1,582 students were randomly selected. The "questionnaire star" was made from the qr code, the class teacher information was collected from March 10, 2021 - March 30 in the class, and the WeChat information, the QQ, and nailing group questionnaire qr code were also obtained. A total of 1,582 questionnaires were sent out and 1,536 were collected, of which 334 subjects were city residents, and 378 and 824 were and rural residents, respectively. According to the needs of the study, 334 subjects living in cities were selected as the research subjects, and 305 valid questionnaires were obtained, with an effective rate of 91.32%, following the elimination of the questionnaires with incomplete answers, unanswered key questions, and inconsistent test answers.

The demographic variables of the subjects were as follows: 162 girls, 143 boys, 178 Han subjects, 127 ethnic minorities, 123 juniors, and 181 seniors. A total of 156 and 149 science and art students, respectively, participated in the study.

### **Research Scale**

The questionnaire content design included the following six parts: (1) Demographic variables, (2) individual exercise behavior of college students, (3) college student attitude exercise, (4) family exercise conditions, (5) college student exercise and family support, (6) family exercise behavior. The demographic variables included gender, grade, ethnicity, home address, and college of study. 5-point Likert scale was used for all questions in the questionnaire. Table 1 indicates the exact details.

### **Model construction and hypothesis**

#### **Model Construction**

Based on the principle of system theory and the ternary interactive decision model of the social cognition theory, a ternary interactive system model of physical exercise was constructed (Figure 2). In order to analyze the influence of college students' exercise behavior on family exercise behavior, a conceptual model of family exercise behavior was constructed (Figure 3).

## Research Hypothesis

Based on the conceptual model of family exercise behavior and previous studies, seven hypotheses were proposed (see Table 2). It should be noted that, due to the closure of COVID-19, the personal exercise environment is consistent with the family exercise environment, which provides a basis for the control of exercise conditions in the study.

## Results

### Reliability and validity analysis of the questionnaires

In order to avoid wrong inference, the homogeneity test was carried out prior to questionnaire data integration. Since the data were all categorical variables, SPSS24.0 was used. The chi-square test assessed the contribution of gender, grade, ethnicity, and school of study of the research subjects in affecting the answers to the questionnaire. The P values of the test results were all higher than 0.05 (as shown in Table 3). Therefore, the null hypothesis was not rejected, that is, there was no difference in the sampling and expected frequencies of different genders, grades, ethnicity, and school of study. AMOS24.0 was used to conduct confirmatory factor analysis on all questions of the questionnaire, and its convergence validity and discriminated validity are shown in tables 4 and 5.

Table 4 indicates that in the case of non-standardization, the P values of significance estimates of all parameters were less than 0.01, suggesting that all questions in the questionnaire were authentic. In the standardized condition, the factor load was higher than 0.6 and the SMC value of the question reliability was higher than 0.36. Moreover, the CR value of the composition reliability was higher than 0.7, indicating that the questionnaire exhibited internal consistency. The convergence validity was higher than 0.5, indicating that each dimension could be accurately measured.

In Table 5, the characters in bold correspond to the open square root value of the dimension convergence validity AVE, whereas the other values are Pearson correlation coefficients between the two dimensions. The square root value of AVE was compared with the Pearson's correlation coefficient as follows: 0.871 was higher than 0.626, 0.744, 0.251, and 0.513, indicating a significant difference between college students' exercise behavior and other dimensions. 0.838 was higher than 0.626, 0.738, 0.364, and 0.644, indicating a significant difference between college students' exercise attitude and other dimensions. Similarly, exercise conditions, support for family exercise, and family members' behavior were also significantly different from other dimensions.

### Structural equation regression model analysis

In order to verify the theoretical hypothesis, the regression model was used for analysis, and the results are shown in Figure 4.

### **Evaluation of regression model**

In order to determine the accuracy of the model, the non-standardized parameters, standardized parameters, and model fit were evaluated respectively, and the results are shown below.

The null hypothesis in Table 6 indicates that there is no difference in the influence of non-observed and observed variables on the observed values. The statistical results were as follows: The residuals of all variables were positive, and a  $P < 0.05$  was obtained, rejecting the null hypothesis. It was noted that each variable had an error term and that the influence of the unobserved variable on the observed value was non-significant. The data further indicated that every observed variable in the regression model was real and had a significant effect on the observed value.

The null hypothesis in Table 7 is the following: In the case of non-standardization, the load of one factor is set as 1 and it is assumed that the influence of other factors on the dimension is not significant. The statistical results indicated that the P values of all other factors were less than 0.05, rejecting the null hypothesis. Therefore, in the case of non-standardization, other factors exhibited a significant influence on the dimension. In the case of standardization, it was generally considered that factor load higher than 0.6 was acceptable and factor load greater than 0.7 was ideal. Therefore, it was considered that all factors (including the factor with a load of 1) had a significant effect on the dimension.

Table 8 indicates that the running results of the fitness indicators of the regression model were all within the ideal range, indicating that the model exhibited optimal fitness. It should be noted that the null hypothesis used in the analysis (Table 8) was the following: There is no correlation between the latent variables.  $P > 0.05$  indicates no significant correlation between potential variables, that is, there is a correlation between potential variables, and the null hypothesis is rejected. In addition, a correlation test was also required for external latent variables. The pair correlation coefficients of the college students' exercise behavior, exercise attitude, and exercise conditions were 0.63, 0.36, and 0.25 respectively. Since these values were less than 0.7, the data suggested no collinearity problem among the three.

### **Regression model results and analysis**

The regression model of the standardized family behavior in Figure 4 was reported from two aspects of model path coefficient and model explanatory power, as shown in Table 9.

In Table 9, under non-standardized conditions, the P of "MC- > SU" = 0.318 > 0.05, indicating that family exercise conditions exhibited no significant impact on family exercise support and that hypothesis H3 was not valid. The result "MC- > CA" P = 0.303 > 0.05 indicated that family exercise conditions exhibited no significant influence on family exercise behavior, suggesting that hypothesis H7 was not valid. The P-value of other assumptions was less than 0.05, indicating that the other assumptions were true. It was concluded that H3 and H7 were not tenable, while H1, H2, H4, H5, and H6 were tenable. The results

indicated that family exercise conditions exhibited no significant influence on family exercise support and family exercise behavior, while college students' exercise behavior and attitude exhibited significant influence on family exercise support, and college students' exercise behavior, while attitude exhibited significant influence on family exercise behavior.

According to the standardized path coefficient value, the most influential factor on family exercise support was college students' exercise attitude (0.509), followed by college students' exercise behavior (0.178). The most direct influence on family exercise behavior was caused by college students' exercise behavior (0.403), followed by support for family exercise (0.329) and the least was college students' exercise attitude (0.257). According to the non-standardized and standardized data, the college students' attitude and behavior of exercise had a mediating effect on their family members' exercise support when they could influence their family members' exercise behavior.

The analysis demonstrated the following results:  $0.19 < SMC \leq 0.33$  indicating that the explanatory power of the model was weak. When  $0.33 < SMC \leq 0.67$  a medium explanatory power of the model was achieved and when  $0.67 < SMC$  a good explanatory power of the model was evident. Therefore, the regression model exhibited a moderate explanatory power for family exercise support (0.44) and good explanatory power for family exercise behavior (0.74).

## Discussion

### Individual Level

According to the three-way interactive decision theory, three factors are responsible for affecting the individual's response to a certain behavior. In the present study, these factors were the college students' exercise behavior, the individual factor, and the exercise environment. Bandura believes that the personal factor is the sum of personal perception characteristics, [17] including knowledge, attitude, motivation, outcome expectation, cognition, and planning. The classical theory of psychological behavior investigates the effects of personal factors on behavior. According to the stage change theory, Si Qi suggested that psychological factors exerted a direct and indirect influence on the stage of disregard, conditional dependence, action, and maintenance of college students' exercise behavior.[19] Guo et al. [20] indicated that college students exhibited a transition from not exercising to exercising in school, accompanied by the rapid development of college students' sports awareness, sports knowledge, and other cognitive knowledge. Certain differences have been noted in the equilibrium decision effect and self-efficacy among college students at different stages. Dong Baolin and MAO Lijuan suggested that subjective experience, exercise commitment, and exercise investment exhibited a significant direct influence on the exercise habit of college students. In the mechanism of exercise engagement, subjective experience had a moderating effect, while exercise commitment had a partial mediating effect. Concomitantly, long-term physical exercise exhibited a beneficial effect on mental health. Zhang et al. [21] indicated that long-term physical exercise exhibited an optimal impact on college students' mental

health and impression management. Compared with self-esteem and life satisfaction, continuous physical exercise was more likely to affect feelings related to physical activity, such as body worth. It was observed that exercise behavior interacted with individual factors, which was consistent with the theoretical basis of the present study (Figure 4).

Certain studies have assessed the exercise environment as an important factor affecting college students' exercise. Chen et al. [22] indicated that compared with the subjective initiative of college students to participate in physical exercise, the exercise environment and conditions exerted reduced restriction on physical exercise participation. The environment and conditions of the school exercise were better than those of the external environment. Consequently, college students may withdraw from physical exercise due to the lack of these conditions after their integration in society. It is suggested that the focus of school physical education should be on improving students' interest in sports and psychological attachment, rather than emphasizing on the conditions of exercise. Certain studies have suggested different views on this topic. According to Cheng and Dong, [23] subjective experience and exercise atmosphere are internal and external factors that promote college students' extracurricular physical exercise, while exercise atmosphere exerts both direct and indirect effects on extracurricular physical exercise. Chang and Dong[24], and Paulson [25] et al. conducted an experimental study on environmental support strategies and concluded that environmental support exhibited an optimal intervention effect on the exercise behavior of college students in a certain University, while it could effectively promote the "intention to behavior" transformation of the students. Therefore, the exercise environment could affect both the exercise behavior and individual factors. Table 9 indicates that the non-standard path coefficients of family exercise conditions and college students' family support, and family exercise behaviors were 0.055 and 0.051, with P values higher than 0.05 (that is, assuming that H3 and H7 were not valid). Figure 4 indicates that the correlation coefficient between exercise conditions and exercise behavior of college students was 0.25, which was considered to be weak. Therefore, it is considered that the exercise environment is a regulatory variable. A good exercise environment exhibited an optimal promotion effect on exercise behavior and personal factors, whereas a bad exercise environment exhibited a limited impact on the closed home exercise of college students.

### **Interpersonal level**

Le Bon [26], the founder of group psychology, stated the following: Groups have always played an important role in history, but never as much as now. The unconscious behavior of groups, instead of the conscious behavior of individuals, has become a major feature of the present era. The reflection of the group's influence on individuals is a major topic of investigation. An example includes the Olympics, which contain group sports events. A total of 131 core journal articles with the theme of "college students" and "exercise behavior" were retrieved from CNQI. Although certain studies have examined sports associations and college students of different grades, the majority of the research content focused on current situation description and feature comparison, and only a limited number of studies investigated the spread and diffusion of exercise behavior from the perspective of groups. Fletcher [27] proposed that college students' motivation to exercise mainly originates from intimate

relationships, such as family, friends, and others. Ryan and Deci [28] suggested that relevance was an important feature of motivation. Therefore, the assessment of group exercise behavior is expected to become a new field of sports research.

College students are the most active group in society. Under the influence of the environment, the rapid development of self-awareness, and the improvement of their knowledge and skills, college students gradually receive a leading role in their families and society. College students' physical exercise behavior not only promotes their own health but also plays an important role in the family and even society. In the present study, the family was regarded as a group to explore the spread of exercise behavior among people in the family. The social psychologists Levine et al. [29], and Niles and McGrath [30] defined the group as a number of people who had emotional connections and often communicated with each other. The University is the last stage of receiving systematic physical education and the key link of connecting the students with social physical education. With the continuous improvement of knowledge and educational background, the status of the college students in the family has gradually increased. Therefore, college students are likely to become the leaders of the family. Foddy and Smithson [31] demonstrated in their study that the group members would be influenced by those who believed to have higher abilities. As can be seen from Table 9, the explanatory power of the regression model on family exercise behavior was 0.74, and its influence on family exercise behavior was as follows: College students' exercise behavior (0.403), college students' support for family exercise (0.329), and college students' attitude toward exercise (0.257). The data indicated that the regression model of family exercise behavior could better explain and predict family exercise behavior. As the leaders of family health, college students can promote family exercise through group activities, language support and health information acquisition in order to form family exercise groups. According to Schramm's bidirectional communication theory, the transmission of exercise behavior among family members is not one-way, but bidirectional. As disseminators and initiators of exercise behaviors, college students drive their families to exercise. After the family members begin to exercise, they will feedback the information to college students. At that time, college students act as receivers.

### **Exercise behavioral theory**

At present, the research on exercise behavior is more focused on the individual level, such as exploring the factors that stimulate the individual to participate in physical exercise, the individual psychological feeling of exercise, and the psychological effect after exercise. The theoretical models of physical exercise research include rational behavior and planned behavioral theory, health belief model, stage change theory, self-efficacy theory, self-determination theory, and social ecology. From a theoretical model point of view, health belief model research corresponds to eliminating the possibility of "preventive health behavior", whereas the reasonable behavior theory model assesses only "behavioral intention". The theory of planned behavioral study destination examines mainly the "behavioral factors", whereas the self-efficacy theory focuses on assessing the "behavior, emotional, and cognitive factors". Self-determination "motivation" is the focus of the theoretical research. In addition, the theoretical model research phases change. The endpoint of the study of the exercise behavioral ecology model was "exercise activity

(occurrence)". The basis of the aforementioned theoretical model is that physical exercise behavior is affected by multiple factors, such as individual psychology, physiology, behavior, and environment. In other words, the study of exercise behavior in the aforementioned theories is one-way and extends from influencing factors to the creation and maintenance of the behavior.

Practice is the basis of unity of objective law and subjective initiative. This reflects that individual consciousness and environment are mutually influenced, and behavior is the basis of their unity. The social learning theory suggests that people are thinking organisms with the potential to guide themselves. Human behavior is subject to the environment, which also affects its own physiology, cognition, and surrounding environmental factors. Concomitantly, individual cognition plays an extremely important role in behavior. Therefore, the interaction between the environment and the subject is two-way and not one-way.

Man himself is a social being. Its behavior is not only influenced by his own psychological factors, but also by the people around him, as well as by the social environment. The essence of sports is based on the cultural practice of human beings acting on themselves and promoting their self-improvement through their own body movements purposefully and consciously. The attribute of the culture determines the sociality of sports, and the progression of the sports culture is the continuous expansion of its audience. A large number of systematic reviews have demonstrated the powerful effects of using theoretical model guidance in experimental interventions. At present, the existing theory of exercise behavior can explain and predict individual exercise behavioral patterns from different angles and improve individual exercise behavior. However, certain theoretical and practical deficiencies are present following the assessment of the exercise group. In conclusion, it was proposed that the study of exercise groups may become a new field of research in sports science, while the interaction between individuals is the origin of the spread of group behavior.

## **Conclusion**

For intervention at the individual level, the interaction between individual exercise behavior and individual factors should be considered. The exercise environment has a regulatory effect and should be controlled.

At the interpersonal level, the communication of college students' exercise behavior is bi-directional, and the support for family exercise is an important factor affecting the bi-directional communication, which has a mediating effect.

With regard to the development of the theory of exercise behavior, the interaction between individuals is the origin of the spread of group behavior. Researchers should break through the thinking boundary of a one-way influence pattern and assess the two-way influence model, which can eventually extend the investigation of the individual exercise behavior and lead to the assessment of the group exercise behavior.

# Abbreviations

BE: College students' exercise behavior includes intensity, duration and frequency of exercise.

TA: Goal attitude refers to an individual's positive, negative or neutral evaluation of exercise at different general levels.

BA: Behavioral attitude refers to an individual's positive, negative or neutral evaluation of their participation in exercise.

CB: Behavioral cognition refers to an individual's definite cognition and evaluation of certain results caused by participating in exercise.

ATT: College students exercise attitude, including TA, BA and CB above.

MC: Family exercise condition.

SU: Exercise and support your family.

CA: Family exercise behavior.

# Declarations

## Ethics approval and consent to participate

Informed Consent Please note: All participants have given informed consent.

## Consent for publication

Not applicable

## Availability of data and materials

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

## Competing interests

The authors declare that they have no competing interests.

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## Authors' contributions

RL conducted data analysis and wrote the whole article, DYP provided help in writing and submission, STL participated in data collection and collation.

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Not applicable

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## Tables

**Table 1** Operation Definition of Questionnaire Variables and Source of Questions



From	Operational definition	Problem	Source
	<p data-bbox="289 829 836 955">Behavioral cognition (CB) refers to an individual's definite cognition and evaluation of certain results caused by participating in exercise</p>	<p data-bbox="885 178 1161 241">BA3 I'm not keen on physical exercise</p> <hr/> <p data-bbox="885 273 1096 336">BA4 I don't like exercising</p> <hr/> <p data-bbox="885 367 1161 430">BA5 I'm reluctant to exercise</p> <hr/> <p data-bbox="885 462 1144 567">BA6 I would rather sleep than take exercise</p> <hr/> <p data-bbox="885 598 1185 703">BA7 I have no emotional experience with exercise</p> <hr/> <p data-bbox="885 735 1177 798">BA8 I like to exercise every day</p> <hr/> <p data-bbox="885 829 1144 934">CB1 Exercise can relieve anxiety and irritability</p> <hr/> <p data-bbox="885 966 1169 1029">CB2 Exercise can be cathartic</p> <hr/> <p data-bbox="885 1060 1169 1123">CB3 Exercise can strengthen one's will</p> <hr/> <p data-bbox="885 1155 1185 1281">CB4 Exercise is beneficial to yourself, your family and your country</p> <hr/> <p data-bbox="885 1312 1193 1417">CB5 I think exercise is becoming more and more accepted</p> <hr/> <p data-bbox="885 1449 1153 1554">CB6 It is wise to advocate "national fitness"</p> <hr/> <p data-bbox="885 1585 1185 1648">CB7 I'm in favor of exercise for everyone</p>	
<p data-bbox="94 1669 235 1795">Family exercise condition ☒MC☒</p>	<p data-bbox="289 1669 795 1795">College students' evaluation of their own exercise conditions and environment, including time, venue, equipment</p>	<p data-bbox="885 1669 1185 1774">MC1 Home life is stressful and there is little time for exercise</p> <hr/> <p data-bbox="885 1806 1193 1963">MC2 Home space is very tight, and often it is impossible to find the right place to exercise</p>	<p data-bbox="1258 1669 1526 1711">ChenShanping [22]</p>

From	Operational definition	Problem	Source
		MC3 I'm do not possess the sports equipment I need	
Exercise and support your family ☒SU☒	College students support family members to participate in exercise	SU1 In terms of physical exercise, I can help my parents or other relatives <hr/> SU2 I am a big supporter of physical activity for parents or other family members <hr/> SU3 I often encourage my parents or other relatives to take part in physical exercise	ChenShanping [34]
Family exercise behavior ☒CA☒	Exercise-related behaviors of college students' family members, including group activities, information acquisition, watching and learning of sports events	CA1 I exercise regularly with family members while at home <hr/> CA2 Family members watch sports on TV <hr/> CA3 Family members also enjoy physical exercise	ChenShanping [34]
		CA4 We use mobile apps for exercise	ChenLuosong[35]

**Table 2** Hypothesis of Factors Influencing Exercise Behavior of Family Members

N	Hypothesis
H1	College students' exercise behavior affects family members' exercise behavior, and the relationship is positive.
H2	College students' attitude to exercise affects family members' exercise behavior, and the relationship is positive.
H3	Family exercise conditions affect family members' exercise behavior, and the relationship between them is negative.
H4	College students' support to family exercise affects family members' exercise behavior, and the relationship is positive.
H5	The influence of college students' exercise behavior on their family's exercise support is positive.
H6	There is a positive relationship between college students' attitude towards exercise and their family's support for exercise.
H7	Family exercise conditions affect family exercise support, and the relationship is negative.

**Table 3** Chi-square Test of Demographic Variables used in the Questionnaire

C	Gender	Grade	National	Institute
<b>P</b>				
Gender		<b>.629</b>	<b>.079</b>	<b>.238</b>
Grade	.926		<b>.386</b>	<b>.471</b>
National	3.084	1.905		<b>.249</b>
Institute	1.393	1.504	1.327	

**Table 4** Convergent Validity of the Questionnaire

From	Title	Parameter significance estimation				Factor load	Question reliability	constitutes reliability	convergence validity
		Unstd.	S.E.	t-value	P				
BE	BE1	1.000				.813	.661	.904	.759
	BE2	1.168	.064	18.282	***	.915	.837		
	BE3	1.086	.061	17.865	***	.883	.780		
ATT	TA	1.000				.858	.736	.876	.703
	BA	1.053	.063	16.784	***	.881	.776		
	CB	.855	.056	15.143	***	.773	.598		
MC	MC1	1.000				.775	.601	.812	.590
	MC2	.970	.086	11.328	***	.762	.581		
	MC3	1.048	.092	11.343	***	.766	.587		
SU	SU1	1.000				.699	.489	.789	.556
	SU2	1.081	.107	10.118	***	.780	.608		
	SU3	1.094	.108	10.127	***	.755	.570		
CA	CA1	1.000				.825	.681	.898	.688
	CA2	1.053	.059	17.691	***	.876	.767		
	CA3	1.019	.061	16.597	***	.831	.691		
	CA4	.875	.057	15.285	***	.782	.612		

Note: \*\*\* corresponds to a value less than 0.001, same as below

**Table 5** Discriminative Validity of the Questionnaire

Form	AVE	SU	MC	CA	ATT	BE
SU	.556	<b>.746</b>				
MC	.590	.295	<b>.768</b>			
CA	.688	.715	.339	<b>.829</b>		
ATT	.703	.644	.364	.738	<b>.838</b>	
BE	.759	.513	.251	.744	.626	<b>.871</b>

**Table 6** Non-standardized Variable Residual Analysis

Variable	Residual	S.E.	C.R.	P
BE	.673	.080	8.399	***
MC	.562	.079	7.159	***
ATT	.241	.027	8.920	***
e22	.226	.038	5.951	***
e18	.171	.026	6.574	***
e1	.345	.034	10.117	***
e2	.224	.029	7.647	***
e3	.186	.026	7.017	***
e4	.089	.011	8.215	***
e5	.090	.011	7.973	***
e6	.107	.011	9.647	***
e7	.366	.048	7.698	***
e8	.389	.047	8.362	***
e9	.425	.053	7.957	***
e13	.302	.031	9.899	***
e14	.226	.026	8.780	***
e15	.319	.032	10.016	***
e16	.303	.029	10.444	***
e19	.374	.040	9.449	***
e20	.288	.035	8.206	***
e21	.365	.040	9.139	***

**Table7** Non-standardized and Standardized Factor Load

Factor From			Non-standardized parameter				Sta. load
			Factor load	S.E.	C.R.	P	
BE1	<--	BE	1				0.813
BE2	<--	BE	1.139	0.062	18.338	***	0.892
BE3	<--	BE	1.113	0.06	18.615	***	0.904
TA	<--	ATT	1				0.854
BA	<--	ATT	1.034	0.058	17.89	***	0.861
CB	<--	ATT	0.89	0.055	16.29	***	0.802
MC1	<--	MC	1				0.778
MC2	<--	MC	0.956	0.083	11.538	***	0.754
MC3	<--	MC	1.047	0.09	11.629	***	0.769
CA1	<--	CA	1				0.828
CA2	<--	CA	1.044	0.057	18.401	***	0.872
CA3	<--	CA	1.003	0.059	16.869	***	0.822
CA4	<--	CA	0.885	0.055	16.042	***	0.794
SU1	<--	SU	1				0.720
SU2	<--	SU	1.047	0.091	11.515	***	0.778
SU3	<--	SU	1.037	0.093	11.101	***	0.737

**Table 8** Regression Model Suitability Index Report

Fitness index	Ideal numerical	Result
CHI-SQUARE	the smaller the better	108.935
CHI/DF	0~3	1.159
P-value	≥0.05	.139
GFI	≥0.8&0.9	.958
AGFI	≥0.8&0.9	.940
CFI	≥0.9&0.95	.995
RMSEA	≥0.08	.023

**Table 9** Path Coefficients of Regression Models

Latent variable path			Non-standardized				Standardized	
			Path	S.E.	C.R.	P	Path	Explanatory power
SU	←	BE	0.137	0.060	2.291	0.022	0.178	0.44
SU	←	ATT	0.657	0.114	5.756	***	0.509	
SU	←	MC	0.055	0.055	0.999	0.318	0.065	
CA	←	BE	0.399	0.058	6.894	***	0.403	0.74
CA	←	MC	0.051	0.049	1.03	0.303	0.047	
CA	←	SU	0.422	0.085	4.976	***	0.329	
CA	←	ATT	0.425	0.113	3.752	***	0.257	

## Figures

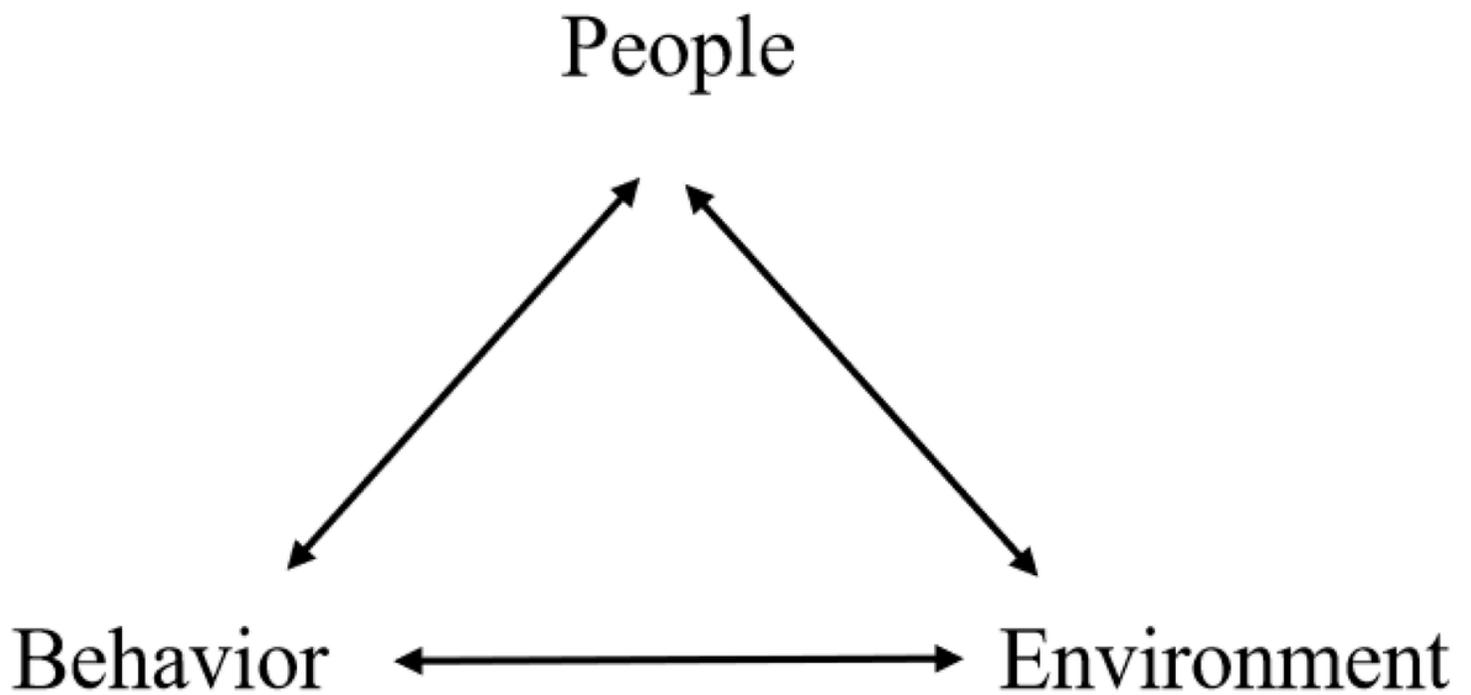
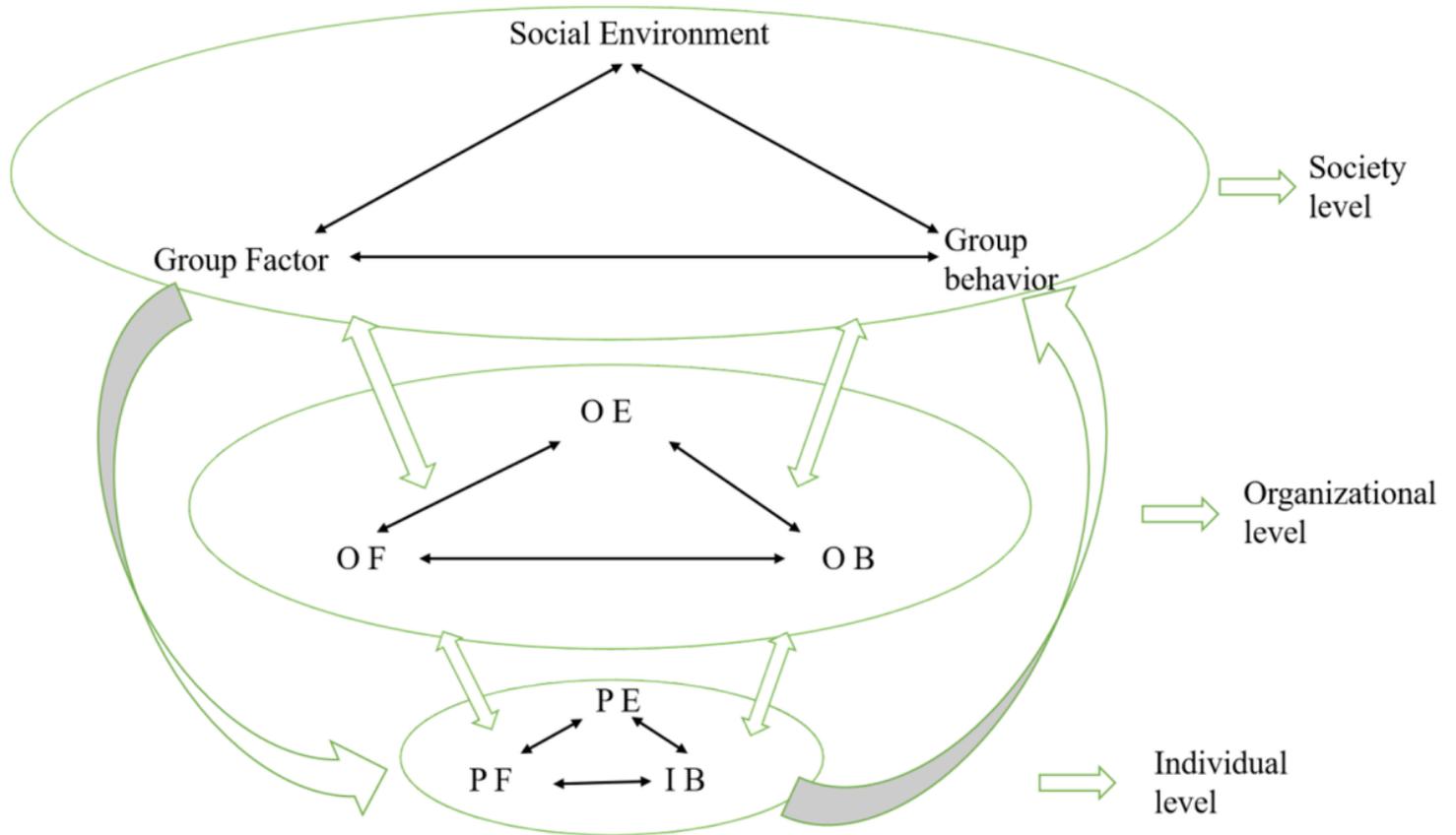


Figure 1

### **Ternary interactive determinism**

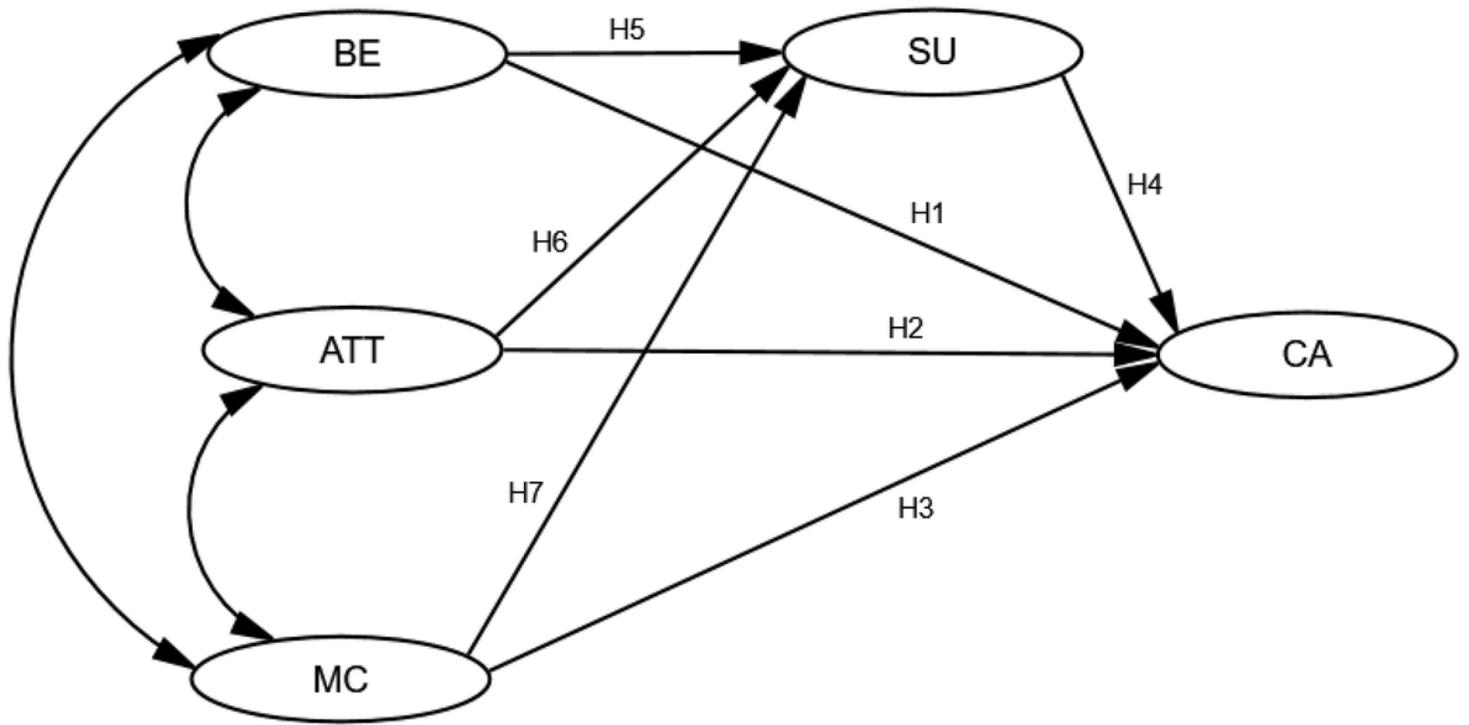
Bandura's ternary interactive determinism is based on absorbing the merits of behaviorism, humanism and cognitive psychology and critically pointing out their respective shortcomings, which has its own distinct characteristics. Bandura pointed out that "behavior, human factors, and environmental factors actually act as interconnected, interactive determinants."



**Figure 2**

**Three dimensional interactive system model of physical exercise**

According to the theory of social ecology, human communication is divided into three levels: individual, organization and society, and each level contains three factors: human, behavior and environment. Not only the three factors influence each other, but also the three levels influence each other and feedback information.



**Figure 3**

**Conceptual model**

According to Figure 2, in order to analyze the influence of college students' exercise behavior on family exercise behavior, a conceptual model of family exercise behavior is constructed. Abbreviations see list of abbreviations.

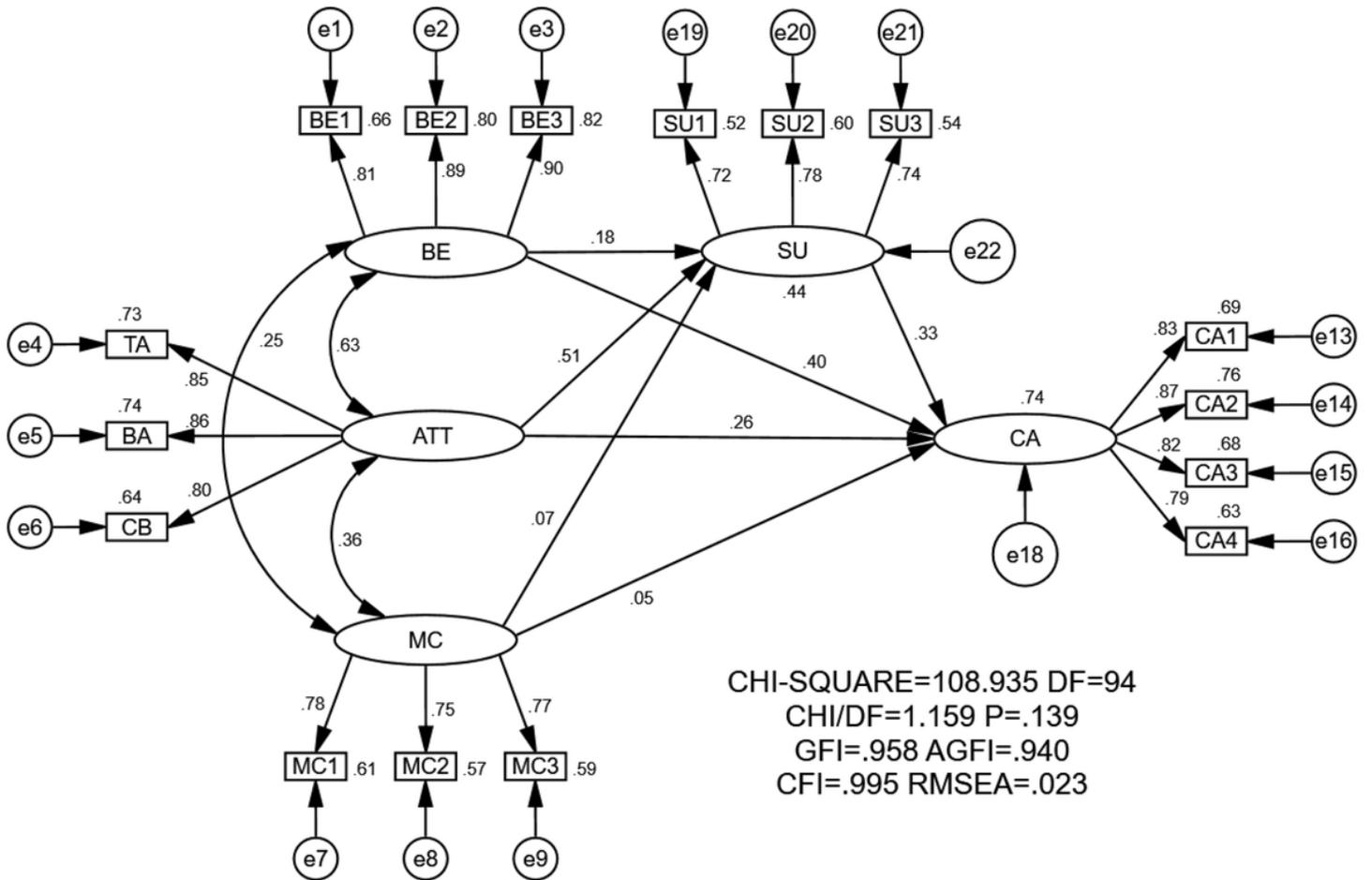


Figure 4

Regression Model of Standardized Family Exercise Behavior

FIG. 4 is a standardized regression model of family exercise behavior (CA) shown in FIG. 3.