



Research article

A mental health informatics study on the mediating effect of the regulatory emotional self-efficacy

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Abstract: *Objective:* To identify the internal mechanism of the relationship between physical activity and mental health in home exercises. *Methods:* Participants were 2233 college students with an average age of 19.34 (SD = 1.07) recruited from southern China using analysis of variance (ANOVA) and hierarchical multiple regression. They completed the college student physical activity questionnaire, regulatory emotional self-efficacy scale (RES) and Symptom Checklist (SCL-90) to explore the internal mechanism of the relationship between home exercises and mental health in the context of fitness campaign. *Results:* Statistical analysis based on ANOVA and hierarchical multiple regression, and the results showed that gender differences is a critical factor influencing the effectiveness of home exercise on mental health in college students. Furthermore, individuals with regulatory emotional self-efficacy are more likely to keep exercising, which may stimulate the positive effect on enhancing mental health. *Conclusion:* Variable of emotion regulation efficacy play an important role in promoting college students positive emotions, stimulating potential, and improving physical and mental health. Further to advocate sports interventions for home-stay groups to improve their control of emotions, thereby reducing their anxiety and depression in the face of unexpected events.

Keywords: COVID-19; mental health informatics; home exercise; regulatory emotional self-efficacy

1. Introduction

Novel Coronavirus (COVID-19) due to its high infection rate, fast spread, and radiate around the world. Most countries have strictly measures to close the airport, station and other transportation channels (to prevent external proliferation), restrict travel-off (to prevent internal diffusion) and limit

people's movements, saying people would need to stay at home as much as they possibly. Affected by the spread of the new crown virus, schools at all levels in China have advocated for students to exercise at home. BBC reported that the home life lead to long coronavirus associated with psychological problems become more serious. The COVID-19 epidemic makes the students home home life, learning time and space changes have occurred, filling the panic all around in them, anxiety and uncertainty. Numerous studies have pointed that families to stay indoors for an extended period could lead to increase cases of adolescent mental healthy problems. Physical activity is an indispensable element in the battle against viruses, which might make a positive impact on mental health outcomes of adolescents [1,2].

Past studies have confirmed that physical activity (PA) has a positive effect on physical and mental health, mainly through outdoor aerobic exercises such as slow walking and jogging to alleviate people's anxiety, depression, tension and other psychological disorders [3,4]. Physical activity has a positive benefit on emotional regulation efficacy, physical activity that is beneficial to cultivate university's positive emotions deepen emotional regulation effectiveness, thus contributing to students' physical and mental health [5]. In addition, studies on the positive effects of physical activity on self-efficacy have been further confirmed.

Despite these outcomes, whether PA always positive impact on mental health, especially do some exercises in the context of staying indoors remains unclear. According to Bandura's theory of self-efficacy, physical activity enhance mental health only when an individual views as self-referenced beliefs because they have fully confident in physical activity abilities, which is crucial to them. From this perspective, PA may not always lead to greater mental health. Rather, individuals with a sense of self-efficacy are more likely to stick to exercises, which may be the key point to stimulating the positive function of home exercise to improve mental health. To verify the concept, we recommend that emotional self-efficacy is a mediator that determines the effect of PA on mental health. Because emotional self-efficacy refers to the trait emotional intelligence, while emotional functioning may provide promising way to enhance effective emotional processing and alter behavior [6]. Go by the above reasoning, we believe that people with regulatory emotional self-efficacy prefers to make a greater positive effect on PA and mental health. Moreover, the study confirm whether physical activity would relieve the anxiety and depression of college students, especially the long-term home life, forming the internal mechanism of the relationship between physical activity and mental health in home exercises.

1.1. Physical activity and adolescent' mental health

Generally, PA could enhance mental health in terms of psycho-social outcomes. Some studies emphasized that PA would benefit for health. Aerobic physical exercise (e.g., walking, jogging) could significantly fall off the level of excessive anxiety and depression, and further to find their energy and pleasure levels were significantly improved after physical exercises [7,8]. Furthermore, physical exercise without intervention seems to have potential benefits in reducing depression, and prior studies shown that PA in interventions had beneficial effects in reducing anxiety [9–12]. However, intervention design is poor in quality, mostly the research are cross-sectional and the temporal relationship between exposure (e.g., exercise, physical activity) and mental health outcome (e.g., depression, anxiety, cognitive function) has not been tested or showed any consistency.

More importantly, physical exercise is consistently related to depression and anxiety, which are indicators to individual mental health [13,14]. The positive impact between PA and mental health based on psycho-social mechanism. A prospective research of 4594 adolescents showed PA was negatively correlated with early depressive symptoms in adolescents, and young students participating in aerobic exercise programs were less likely to develop depression [15,16]. Several depiction and meta-analytic reviews have been indicated that aerobic forms of exercise, especially exercise plan or exercise sessions with several weeks could moderate reductions in anxiety after physical activity [17–19].

Just as suggested youths PA guidelines, except for daily exercises, adolescents should participate in moderate to vigorous physical activities for 60 minutes or more each day, which are developmentally appropriate, enjoyable, and various types of activities included [20,21].

1.2. Mediating role of regulatory emotional self-efficacy

However, physical exercise may not always enhance mental health, because at certain point individuals may lack of exercises commitment and exercise insists in PA. Commitment theory believes that commitment is an individual's intention or intention for a target behavior, and it could influence their future behavior. Exercise insists is rich in connotation, which not only reflects the usual regular exercise habits, but also reflects the individual's mental characteristics such as willpower and effort and positive emotional experience. But for adolescents, self-efficacy belief is particularly important index, which influence choice, effort, persistence and resilience in the motivation of exercise [22–24]. Corresponding with previous research on emotional self-efficacy, individual who feel efficacious to participant in physical activity, they prefer to essay, put in more effort, insist on a longer time to achieve a higher level of performance. Considering the recent trend of inactivity in youths, especially stay indoors during the COVID-19 spread, we should we should maintain the momentum of development and to participate in the PA.

Empirically, PA has a positive effect on emotion regulatory self-efficacy [25]. PA involvement is related to exercise self-confidence, which can effectively improve personal self-efficacy [26]. Moreover, PA is of great importance for maintaining the positive emotions of college students, improving the self-efficacy of emotional regulation, and promoting physical and mental health [27,28]. Noteworthy, most prior researches have indicated that the effectiveness of emotional regulation is of great significance to ease tension, maintain emotional stability and regulate emotional urges [29–31].

Regulatory emotional self-efficacy reflects individuals' perceived abilities to self-regulate, which may overrule or regulate negative emotions and impulsive expressions, and properly experience and express positive emotions. In fact, once confronted with a provocative environment and pressure, people experiencing positive emotional effects could raise cognitive function, buffer the disturbing impacts of aversion experience and promote adaptive response. As piror studies on emotional self-efficacy shown, individuals who are negative about everything, as long as they have the ability to regulate emotional self-efficacy, they will be full of motivation to physical activities, more likely to exert more effort, persist longer to achieve higher level of performance [32]. According to this idea, we put forward that regulatory emotional self-efficacy will mediate the PA and mental health.

According to the reasoning above and past results, we expect that regulatory emotional self-efficacy could effectively transform pessimism into positive emotions to improve regulation effectiveness, thereby enhancing the positive impact of PA on mental health. Based on the emotional

theory of physical exercise, it is proposed to incorporate the emotional regulation self-efficacy variables into the research framework, and construct a model diagram of the association between PA, emotional regulation effectiveness and mental health status (Figure 1). Therefore, the study aims to understand the mechanism of PA impact on mental health in an indoor environment while systematically investigate the relationship between various variables, which could effectively cut off the spread of the corona virus pandemic and enhance autoimmunity.



Figure 1. Conceptual model.

Note. PA = physical activity, RESE = regulatory emotional self-efficacy, MH = mental health

2. Methods

2.1. Procedure and participants

As the requirements of epidemic prevention and control, students of colleges and universities made full use of online platforms to conduct in-depth physical activity in China. Participants selected by random sampling from the college in southeast of China, and the form of online questionnaires was filled 2378 questionnaires were recovered, of which 2233 were valid questionnaires, with an effective recovery rate of 93.9%. The age range of students is 17 to 23 years old, and the average age is 19.79 (SD = 1.34) years old. In the course of receiving the data, the consent of the subjects is obtained, and the personal data and results are kept confidential. The data is only used for academic purposes.

2.2. Measurements

2.2.1 Physical activity questionnaire (PAQ)

Wu [33] revised Physical Activity Questionnaire (PAQ), which was adapted from the sport commitment intention table prepared by Chen et al. [34] to assess ones' exercise behavior. Among them, physical exercise commitment contain 4 items (e.g., It is a difficult for me to quit physical exercise), physical exercise insists on 4 items (e.g., I often participate in physical activities), and PAQ reliability and validity has been established. The participants indicated their responses on a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7), with the total score represents the the level in PA of the subjects. In this current study, Skewness is .00-.53, Kurtosis is .25-.87, and Cronbach's $\alpha = .93$.

2.2.2. Regulatory emotional self-efficacy scale

The Regulatory Emotional Self-Efficacy (RESE) scale was developed to assess perceived self-

efficacy [35], requires individuals to recall some certain thoughts about what they have experienced indoors with spread of the corona virus pandemic, with a 7-point scale from quite worst (1) to quit best (7) to measure. The 12 items categorized into three factors, positive (POS) affect (e.g., “what is your ability level to experience joy, when faced success?”), despondency-distress (DES) (e.g., “When you are alone, what is your ability level to avoid depression?”), and anger-irritation (ANG) (e.g., “When you are angry, what is your ability level to avoid getting angry?”). The retest reliability of total is .88, Cronbach’s $\alpha = .92$.

2.2.3. Symptom checklist (SCL-90)

The Symptom Checklist-90 (SCL-90) [36] is self-report of subjects’ symptoms, which basically covered the symptoms of psychosis (thinking, emotion, behavior, interpersonal relationships, etc.). Integrating and reviewing the symptom research on general mental health problems of college students, found that depression versus generalized anxiety disorder are the main indicators reflecting the mental health performance of adolescents. Depression refers to depressed emotions and moods, decreased interest in life, lack of desire to exercise, loss of activity, etc., which mainly contains 13 items. While generalized anxiety disorder refers to inability to calm, nervousness, nervousness and the resulting physical characteristics (e.g., tremor), with 10 items included. And the evaluation time is based on a special period or a specific time, with method divided into 5 levels (1 = none, 2 = mild, 3 = moderate, 4 = heavy, 5 = severe).

2.3. Data analysis

2.3.1. ANOVA

Analysis of variance (ANOVA) is really as a set of analytic procedures based on a comparison of two estimates of variance. Differences among variances are evaluated as ratios, where the variance associated with differences among samples means is in the numerator, and the variance associated with error is in the denominator. F distribution was these two variances form.

$$F = \frac{SSTR / (k-1)}{SSE / (N-k)} \sim df = (k-1, N-k) \quad (1)$$

That is, $SSTR$ is a sum of square of treatment, SSE is a sum of square of error, the group, $N = n_1 + n_2 + n_3 + n_4 \dots + n_k$.

$$SST = \sum_{ij} (x_{ij} - \bar{x})^2 = \sum_{ij} x_{ij}^2 - n\bar{x}^2 = \sum_{ij} x_{ij}^2 - \frac{(\sum_{ij} x_{ij})^2}{N} \quad (2)$$

$$SSTR = \sum_j \sum_i (\bar{x}_j - \bar{x})^2 = \sum_j n_j (\bar{x}_j - \bar{x})^2 = n_1 \bar{x}_1^2 + n_2 \bar{x}_2^2 + n_3 \bar{x}_3^2 + \dots + n_k \bar{x}_k^2 - N\bar{x}^2 \quad (3)$$

$$SSE = SST - SSTR \quad (4)$$

2.3.2. Hierarchical multiple regression

Mediation effect was usually carried out through hierarchical regression to confirm. It refers to affect the relationship between the variable ($X \rightarrow Y$) is not a direct causal relationship, but from M by one or more indirect effects of variable, so M is called mediating variable, and the indirect influence of X through M on Y called mediating effect.

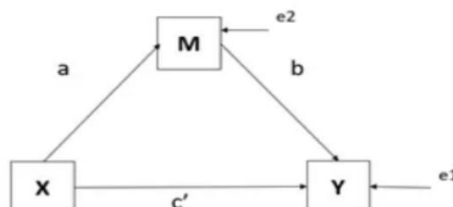


Figure 2. The basic model of mediating effect.

The regression equation is as follows,

$$Y = cX + e1 \quad (5)$$

$$M = aX + e2 \quad (6)$$

$$Y = c'X + bM + e3 \quad (7)$$

That is, c is the total effect of X on Y , a is the direct effect of X on M , b is the direct effect of M on Y after controlling the influence of X , c' is the direct effect of X on Y after controlling the influence of M , and $a*b$ is the mediating effect produced by the mediating variable M , meanwhile, there is $a*b = c - c'$.

3. Results

Table 1 shows the correlation of the study variables. Correlation shows that gender was significantly related to other variables, besides the average value of male adolescents PA is higher than female ($t(2231) = 14.18, p < .001$) and RESE ($t(2231) = 16.72, p < .001$), but for MH, the average value of female is higher than male, and gender has significantly correlated with MH ($t(2231) = 7.15, p < .01$). Just as expected, we also found physical activity was negatively correlated with mental health ($r = -.11, p < .01$) and regulatory emotional self-efficacy ($r = -.23, p < .01$). In addition, regulatory emotional self-efficacy and PA are positively significantly related ($r = .35, p < .01$).

Table 1. Correlation matrix for variables.

Variables	<i>M</i>	<i>SD</i>	<i>PA</i>	<i>RESE</i>	<i>MH</i>
<i>PA</i>	4.57	1.23	-		
<i>RESE</i>	5.23	.81	.35**	-	
<i>MH</i>	1.45	.58	-.11**	-.23**	-

(* $p < .05$, ** $p < .01$, *** $p < .001$.)

Note. PA = physical activity, RESEI = regulatory emotional self-efficacy, MH = mental health.

3.1. Gender differences

We gained that gender reached a significant level in physical exercise promises, physical exercise insists and anxiety perception, but has no significantly level in depression perception, through analysis of variance on the facets of each variable. In physical activity intention dimensions, male physical exercise commitments [$F(1, 2231) = 68.05, p < .01$] and physical exercise insists [$F(1, 2231) = 74.74, p < .001$] are significantly higher than female. Besides, for self-assessment of symptoms, the anxiety in male [$F(1, 2231) = 8.29, p < .001$] slightly higher than female.

Table 2. Gender descriptive and ANOVA summary in physical activity, regulatory emotional self-efficacy and mental health.

	Gender				$F(1, 5231)$
	Male		Female		
	M	SD	M	SD	
PEP	4.93	1.45	4.42	1.34	68.05***
PEI	4.81	1.27	4.36	1.14	74.74***
POS	5.73	.82	5.85	.74	13.65***
DES	5.24	1.00	4.98	.94	36.31***
ANG	5.04	1.16	4.63	1.10	68.085
Anxiety	1.48	.66	1.45	.60	8.29*
Depression	1.43	.64	1.42	.61	2.31

(* $p < .05$, ** $p < .01$, *** $p < .001$.)

Note. PEP = physical exercise promises, PEI = physical exercise insists, POS = positive affect, DES = despondency-distress, ANG = anger-irritation

3.2. Mediating role of regulatory emotional self-efficacy

Hierarchical regression analysis was chosen to acknowledge the mediating effect of regulatory emotional self-efficacy on PA and mental health. The results are indicated in Table 3. The study found physical activity has a significant explanatory power for regulatory emotional self-efficacy ($\beta = .35, p < .001$). Mental health also has a significant explanatory power for physical activity ($\beta = -.11, p < .001$). Moreover, mental health has a significant explanatory power for regulatory emotional self-efficacy ($\beta = -.23, p < .001$). When examining the exploratory power of physical activity and regulatory emotional self-efficacy for mental health, it was found that physical activity has significant explanatory power ($\beta = -.04, p < .05$) and regulatory emotional self-efficacy ($\beta = -.22, p < .001$). According to Baron and Kenny, the mediating impact was proved.

Table 3. Regression analysis of the mediating effect of regulatory emotional self-efficacy on physical activity and mental health.

	Regulatory emotional self-efficacy M		Mental health Y	
	Model 1	Model 2	Model 3	Model 4
Physical Activity x	.35***	-.11***		-.04*
Regulatory emotional self-efficacy M			-.23***	-.22***
R ²	.12	.01	.05	
Adj R ²	.12	.01	.05	
F	309.04***	28.59***	126.21***	
df	(1,2231)	(1,2231)	(1,2231)	(1,2231)

(Note. *p < .05, **p < .01, *** p < 0.01)

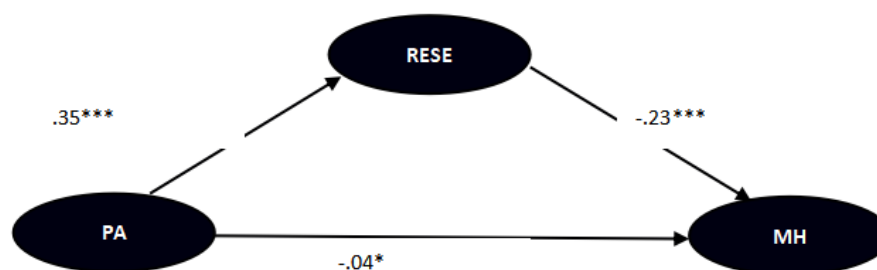


Figure 3. Regression analysis of the mediating effect.

Note. PA = physical activity, RESE= regulatory emotional self-efficacy, MH = mental health

4. Discussion

Based on theory of self-efficacy, we confirmed that regulatory emotional self-efficacy would mediate PA and mental health. Thus, we infer that the emotional regulation self-efficacy of college students is a key factor, and it has a mediating effect on the impact of physical activity on mental health in the home life of blocking the spread of the epidemic. To further support this view, we found that regulatory emotional self-efficacy could enhance the negative correlation between physical activity and mental health relevant factors anxiety and depression. Our investigation offered some contributions to physical activity research, especially for home exercises.

4.1. Gender in physical activity, regulatory emotional self-efficacy and mental health

The current findings regarding the association between gender and PA or mental health consistently with previous researches that have been conducted across sport area [37], including that gender is a critical factor that associated with college students' physical activity. Namely, the results revealed that male was significantly higher than female in PEP and PEI, which indicated male held more eager and perseverance to perform physical exercises than female. Generally, male students have strong independence and autonomy than female. Such physiological characteristics are fully reflected in sports, which providing a stage for their self-expression. Scholars have pointed out that gender differences are the sticking points in the intrinsic motivation of college students' sports motivation to differ [38–40]. Among them, male are more health-conscious, and exercise motivation is more pure than female.

Due to the spread of COVID-19 epidemic, students adopt online learning, physical education classes included, so that physical education indoors emerged. According to student feedback data, the anxiety and depression levels of male were higher than female during this period. As male prefer outdoor and confrontational sports, which could not carried out, instead of small-load, low-intensity sports indoors. Further more, female naturally prefer to communicate and chat with others, which is an effective way to soothe their emotions, while male belongs to a poor communication group. For them, more time is spent alone alone or with mobile phones, and online games become the best companions, which could deepen the level of anxiety and depression.

Although the study found gender has significant differences among variables, for example physical activity or mental health in home exercises, we encourage scholars to study other positive characteristics, emotions, and experiences that may benefit college students' mental health. Additionally, we either found regulatory emotional self-efficacy help students who studied in college could enhance the impact of PA on mental health [41,42].

4.2. The mediating role of regulatory emotional self-efficacy on physical activity

The study reveals the mediating effect of regulatory emotional self-efficacy on the impact of college students' physical activity on mental health, and provides some new insights at the theoretical and practical levels. Firstly, we introduced the use of psycho-social vision to comprehend the link PA to mental health. Except for the traditional view that physical activity tends to be seen as a habit and theorize, which impact on other psychological outcomes, and we emphasize the necessary of explaining the role of consciousness in shaping physical fitness. We provide a more specific basis for understanding the individual differences in mental health of college students during home exercise by focusing exclusively on the regulatory emotional self-efficacy as an intermediary effect.

Compared students with none in regulatory emotional self-efficacy, the influence of PA on mental health was enhanced when students held in regulatory emotional self-efficacy. As pointed out in previous studies, scholars have confirmed the association about PA and relative factors in mental health from a single perspective, such as the association between PA and self-efficacy [40], emotional regulation efficiency and mental health [41,42]. It is essential for us to think about how physical activity affects the mental health further, aiming to know the role does sports play, especially the public health in major disasters. Previous studies are relatively weak on the overall relationship of impact factors, failing to clarify the complex relationship between them. Therefore, the findings might be used

to solve puzzles, enrich existing theories, and provide reference value.

Additionally, we found that the overall framework of conceptual model, which has different impacts on factors. The positive effect of college students' physical exercise commitment is slightly higher than physical exercise insist, indicating that commitment is a prerequisite for doing sports. And inspecting regulatory emotional self-efficacy, male prefer to managing depression emotional effectiveness, while female is adept in managing positive emotional effectiveness. Scholars with retrospective study proved instrument reliability and revealed gender differences in regulatory emotional self-efficacy in recently study.

Our findings provide practical significance for physical activity intervention. Physical exercise commitment and management of depressed emotional effectiveness on mental health is more prominent, indicating that physical activity and self-efficacy belief are important indicators for enhancing mental health. In other words, physical activity could be integrated with self-efficacy belief to significantly increase the impacts of physical activity. However, the hypothesis demands further verification. It is recommended to concentrate on sublimation during exercise to adjust the sense of efficacy for improving the mental health of college students, especially staying indoors.

5. Conclusions

Throughout the study, the conclusions are as follows:

- 1) Male of college students showed a higher level in anxiety, during the home life of the “epidemic” in the fitness war.
- 2) Gender has a significant difference in the two dimension of physical activity, that is PEP and PEI in staying indoors.
- 3) Male college students have a significantly higher level of PES than females, and females have a higher level of POS than males. In terms of ANG, gender did not show differences.
- 4) Emotional regulation efficiency plays an intermediary role in the relationship between physical activity and mental health. We should pay attention to the importance of self-efficacy emotion regulation, as to enhancing the positive emotions, to arouse students' potential to promote the physical and mental health plays an important role.

Hence, we advocate exercise intervention for the person who stayed indoors to improve their emotional control, so as to alleviate their anxiety and depression in the face of unexpected events.

6. Limitations and future directions

Although the regulatory emotional self-efficacy observed beneficially mediate the association between PA and mental health, and the results of this study have a certain degree of universality from the perspective of the overall design of the study, some certain weaknesses in our research underscore the importance of future research. Just as mentioned previously, the first limitation related to causality because the study did not manipulate the emotional self-efficacy of participants. Further research might compare person who have received emotional self-efficacy training with those who have not tested the causal relationship among regulatory emotional self-efficacy, physical activity, and mental health. Additionally, the limitations due to lack of experimental intervention, this study relied on the self-reported measurement. Further, participants with different demographic characteristics and outcomes to verify the mediating impact of regulatory self-efficacy on other positive functions on physical

behavior should be included. Finally, we have not yet empirically tested the expansion mechanism behind the connection about PA and mental health, which needs to be explored in subsequent studies.

In spite of the cross-sectional nature and excludes causality of the study, our findings are consistent with emerging literature that indicates that a comprehensive understanding of the impacts of physical exercise on mental health requires more than an understanding of overall level of physical activity. We stressed the important potential role of regulatory emotional self-efficacy in encouraging the positive impact of physical exercise on mental health. Further research on the integration of physical activity and self-efficacy may open up important new ways to enhance health and provide new mechanisms for optimal self-regulation.

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Conflict of interest

No conflict of interest exists in the submission of this paper, and the paper is approved by all authors for publication. The paper was original research that has not been published for anywhere, and all authors listed have approved the manuscript that is enclosed.

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