

# The Effect of Athletes' Mental Skills and Toughness on Exercise Fatigue and Continuous Training Intention: Take Roller Skating as an Example

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**Abstract:** Sufficient physical activity can lead to higher self-confidence, quality of life, and mental health in college students. Conversely, insufficient physical activity can lead to obesity, cardiovascular disease, and even depression or cancer. Although college students do not exercise enough, they are more concerned about body shape and obesity than health. These concerns also lead to health problems such as stress and anxiety in college students. The study pointed out that roller skating exercise can train body shape and strengthen muscles. Therefore, this study investigates the factors influencing the intention of continuous training in roller skating by taking the students of college roller skating clubs as the subject. The results showed that altruism and mindfulness affect athletes' mental skills and mental toughness, which in turn reduce exercise fatigue and increase continuous training intention. The results will provide practical suggestions for college roller skating club instructors, organizations promoting roller skating sports, and subsequent related research.

**Keywords:** Altruism; Mindfulness; Mental Skills; Mental Toughness; Exercise Fatigue; Continuous Training Intention

## 1. Introduction

The World Health Organization states that inadequate physical activity ranks as the fourth highest risk factor for human mortality<sup>[1]</sup>. Higher habitual exercisers have a reduced likelihood of dying from natural causes than non-exercisers or those with little exercise<sup>[2]</sup>. Inadequate exercise in college students may lead to obesity, cardiovascular disease, osteoporosis, hypertension or even depression and cancer. Conversely, research has found

that adequate physical activity leads to higher self-confidence, self-efficacy, quality of life and self-esteem, and psychological well-being<sup>[3]</sup> among college students. In addition, studies have shown that roller skating can train body shape, strengthen muscles, and improve body balance<sup>[4,5]</sup>. Multiple studies have investigated the factors that affect behavioral intention. First, Suggested that mindfulness has a moderating effect on physical activity intentions and further influences behaviors<sup>[6]</sup>. Secondly, Suggested that athletes' physical and mental skills during training lead to the formation of the sports personality<sup>[7]</sup>, which affects their long-term training intentions. Finally, studies have shown that exercise and cognitive fatigue affect physical performance and exercise intention<sup>[8]</sup>.

Although the aforementioned study context is not the same as the sport context, these variables may also have a causal relationship in roller skating. The study collected research data through questionnaires. The purpose was to understand the factors influencing the continuous training intention of college roller skating club members in China. The results were analyzed statistically to test the validity of the hypotheses. The study also provides practical suggestions for college roller skating club instructors, relevant organizations, government offices responsible for promoting roller skating sports, and references for subsequent research.

## 2. Literature Review and Research Hypotheses

### 2.1 Altruism

Defined altruism as a motivational state to increase the well-being of others. In schools, altruism can enhance students' positive values,

including tolerance, fairness, equality, and love, respect for differences, integrity, honesty, kindness, and diversity. Teachers can enhance peer support by motivating students to reciprocate altruism. To summarize the above, this study defines altruism as a beneficial act done voluntarily by members of a roller skating club to assist others in their training without expectation of reward. Investigated the effects of altruism traits such as honesty-humility and conscientiousness on student achievement in physical education classes. The results showed that students' altruism traits were related to the learning adaptability of physical training. The above study showed that altruism has a positive impact on physical education learning and training and is very important.

## 2.2 Mental Skills

Mental skills are a collection of teachable cognitive abilities that form the foundation for effective learning and performance. Also stated that mental skills are one of the biggest reasons for achieving outstanding sports results. Ong and Griva (2017) defined mental skills as techniques and strategies that teach or improve athletes' skills and abilities<sup>[9]</sup>. These skills and abilities facilitate better performance in competition. Therefore, this study defines athletes' mental skills as a set of methods for training the abilities of individuals in roller skating sports clubs, including setting training goals, imagination, self-confidence, and the ability to focus on roller skating performance. In addition, Ding and Tang (2022) analyzed the relationship between psychological factors and the health of Chinese players<sup>[10]</sup>. The results showed that when players' altruism improves, their confidence also does. That makes them healthier accordingly. Therefore, this study concludes that when the altruism of the roller skating club members increases, their mental skills also do. The following hypotheses are proposed:

H1: The altruism of roller skating club members positively affects their mental skills.

## 2.3 Mental Toughness

Proposed that mental toughness is a blend of personality traits that allows one to excel even when challenged by difficulties and stress<sup>[11]</sup>. This ability is essential for athletes. Mental toughness is a psychological asset that allows

a person to achieve goals under various stresses and difficulties; the ability to control oneself well, reduce anxiety, and be confident; the ability to overcome many things well and be more stable even under stress, and an attitude that determines how effectively a person It is an attitude that determines how effectively a person faces challenges and stress. Therefore, this study defines mental toughness as the ability of individuals in the roller skating sports club to handle challenges, stress, difficulties, anxiety, and trust in others during the training process. Explored the motivational antecedents of athletes' mental toughness<sup>[12]</sup>, which mentioned that altruism could reduce athletes' anxiety and affect their mental toughness. Therefore, this study concludes that when the altruism of the roller skating club members increases, their mental toughness also does. The following hypotheses are proposed:

H2: The altruism of roller skating club members positively affects their mental toughness.

## 2.4 Mindfulness

Indicated that mindfulness is a unique form of awareness and attention that can be considered as a tendency to enhance well-being. Mindfulness is useful for treating various mental disorders, relieving normal life stress, and promoting positive self-acceptance. Therefore, this study defines mindfulness as the degree to which individuals in the roller skating club experience their training without judgment and accept themselves at the moment. Furthermore, Investigated the effects of mindfulness as a form of present-oriented mental training on exercise cognition<sup>[13]</sup>. Therefore, this study concludes that when the mindfulness of the roller skating club members increases, their mental skills also do. The following hypotheses are proposed:

H3: The mindfulness of roller skating club members positively affects their mental skills.

Examined the impact of mindfulness training on the mental toughness and emotional intelligence among amateur basketball players<sup>[14]</sup>. The findings of the study indicate that mental toughness and emotional intelligence of athletes can be enhanced through positive thinking training. Therefore, this study concludes that when the mindfulness of the roller skating club members increases,

their mental toughness also does. The following hypotheses are proposed:

H4: The mindfulness of roller skating club members positively affects their mental toughness

## 2.5 Exercise Fatigue

Defined exercise fatigue as a state in which an individual is unable to exert the necessary motor power<sup>[15]</sup>. Exercise fatigue refers to a state in which the muscles during exercise do not fail to maintain a certain level of performance, or the exerciser is unable to maintain their intended exercise intensity<sup>[16]</sup>. After prolonged exercise, some fatigue signals such as lack of concentration and motivation appear. These signals are fed back from the brain to exercise, either consciously or unconsciously, resulting in decreased exercise performance. Therefore, the present study defines exercise fatigue as the bottleneck of the muscles of roller skating club members after a period of training, which prevents them from sustaining an increased level of exercise and a certain functional state, or can no longer maintain their intended exercise intensity. In addition, Explored the connection between psychological changes and increased fatigue in athletes during intensive training<sup>[17]</sup>. The study mentioned that athletes would have higher mental skills that regulate tension and stress. Therefore, this study concludes that when the mental skills of roller skating club members increase, their exercise fatigue decreases. The following hypotheses are suggested:

H5: The mental skills of roller skating club members negatively affect their exercise fatigue.

Investigated the effect of mental toughness on exercise fatigue in super marathon athletes. The results indicated that mental toughness would strengthen the tolerance of exercise fatigue due to perseverance and persistence when athletes surpass their self-imposed limits. Therefore, this study concludes that when the mental toughness of roller skating club members increases, their exercise fatigue decreases. The following hypotheses are suggested:

H6: The mental toughness of roller skating club members negatively affects their exercise fatigue.

## 2.6 Continuous Training Intention

Stated that an individual's behavior could be predicted by their behavioral Intention in the Theory of Planned Behavior (TPB). Behavioral intention was defined as an individual's inclination towards performing the target behavior<sup>[18]</sup>. Secondly, Defined physical training intention as the motivation to engage in physical training behaviors through the individual's decision-making process<sup>[3]</sup>. Further, Studied the factors influencing students' physical education learning strategies. In addition, Studied the factors influencing individual exercise participation<sup>[19]</sup>. The results showed that fatigue affects individuals' exercise participation. Therefore, this study concludes that when the exercise fatigue of roller skating club members decreases, their continuous training intention increases. The following hypotheses are suggested:

H7: The exercise fatigue of roller skating club members negatively affects their continuous training intention.

In conclusion, this study also suggests that the altruism and mindfulness of roller skating club members affect exercise fatigue through the mediating effect of their mental skills and mental toughness. Moreover, mental skills and mental toughness would affect the continuous training intention of roller skating through the mediating effect of exercise fatigue. Consequently, the following mediating hypotheses are proposed:

H8: Mental skills mediate the relationship between altruism and exercise fatigue.

H9: Mental skills mediate the relationship between mindfulness and exercise fatigue.

H10: Mental toughness acts as a mediator in the relationship between altruism and exercise fatigue.

H11: Mental toughness serves as a mediator in the relationship between mindfulness and exercise fatigue.

H12: Exercise fatigue serves as a mediator in the relationship between mental skills and continuous training intention.

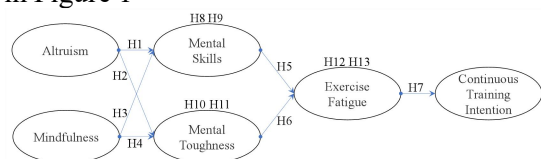
H13: Exercise fatigue acts as a mediator in the relationship between mental toughness and continuous training intention.

## 3. Method

### 3.1 Conceptual Framework

The conceptual framework of this study is grounded on the literature in Chapter 2 to

develop a relationship grid diagram as shown in Figure 1



**Figure 1. Conceptual Framework**

### 3.2 Participants and Data Collection

This study was conducted using an online electronic questionnaire. The period of distribution was from 2023/11/15 to 2023/12/15. A total of 422 valid questionnaires were collected. Based on the proposed formula for sample size requirements for Creative Research Systems (2022), the sample size requirements for the total population are met at a statistical confidence level of 95% and a confidence interval of 5%. The study design has passed the ethical review process of the Human Research Ethics Committee of Zhaoqing University (approval number: 2023-1106-03). This study uses a well-established scale for online measurement. The class teacher sends a link to the questionnaire to the students via WeChat or QQ and the students can complete the questionnaire test independently using a computer or on a cell phone. Before accessing the questionnaire system, instructions appear, explaining the purpose of the survey, how to answer the questions and what to look for, etc. Confidentiality is assured as all invited participants in the process are voluntary, and written informed consent is obtained from both the subjects and the school for all items.

### 3.3 Measures and Analysis Methodology

The scale investigated the gender, department, academic system, and average exercise time per day of the subjects. Their opinions on all variables, rated on a five-point Likert scale ranging from strongly disagree 1 to strongly agree 5, were also measured. After designing the scale questions, experts and scholars were invited to review the questionnaire and provide their feedback. In this study, descriptive statistical analysis and inferential statistical examination of the questionnaires were conducted by using the SPSS 23.0 measurement method for the valid samples collected involves using frequency distribution tables for data analysis, descriptive statistics,

reliability and validity analysis, structural equation tests, and indirect effect tests.

The Altruism scale was derived from the scale used by Liu et al. (2018)<sup>[20]</sup>. In this study, it was modified to include questions such as "I like to help others during the roller skating training, although it is not necessary." and a total of 4 questions were designed. The Mindfulness scale was based on the same scale of Lau et al. (2006)<sup>[21]</sup>. It was modified to include questions such as "During the roller skating training, I focused more on observing my experience than figuring out what the training meant." and a total of 5 questions were designed. The Mental Skills scale was based on the same scale of Azaiez et al. (2013)<sup>[22]</sup>. It was modified to include questions such as "I set roller skating training goals to improve my daily performance." and a total of 5 questions were designed. The Mental Toughness scale was derived from the same measurement tool used by Madrigal and colleagues (2013)<sup>[23]</sup>. It was modified to include questions such as "I have strong self-confidence in my ability to rollerblade." and a total of 7 questions were designed. The Exercise Fatigue scale in view the fatigue. It was modified to include questions such as "After roller skating training, I feel exhausted." and a total of 5 questions were designed. The Continuous Training Intention scale was based on the same. It was adapted to incorporate questions like "I plan to stay in the roller skating club," resulting in a total of three questions being formulated.

## 4. Data Analysis

### 4.1 Descriptive Analysis

**Table 1. Frequency Distribution**

Category	Label	Frequency	Percentage
Gender	Male	267	63.3
	Female	155	36.7
Department	General	319	75.6
	Physical Education	103	24.4
Academic System	Undergraduate	332	78.7
	Graduate School	90	21.3
Average Exercise Time per Day	Less than 30 minutes	186	44.1
	31-60 minutes	155	36.7

	61-90 minutes	48	11.4
	91 minutes or more	33	7.8

The total number of valid samples in the present study was 422. Gender is predominantly male, accounting for 63.3%. Department is predominantly general, accounting for 75.6%. Academic system is predominantly undergraduate, accounting for 78.7%. Average exercise time per day is predominantly less than 30 minutes, accounting for 44.1%, as shown in Table 1.

#### 4.2 Convergent Validity

According to Hair and Anderson (1998), Nunnally (1994), and the criterion proposed by Fornell and Larcker (1981) for assessing convergent validity: (1) Standardized Factor Loading should be higher than 0.50 for each variable. (2) Composite Reliability should be higher than 0.60. (3) Average Variance Extracted (AVE) should exceed 0.50. As depicted in Table 2, the AVE values ranged from 0.617 to 0.922, suggesting that each item demonstrated sufficient credibility. The Composite Reliability of all the constructs exceeds 0.7, which meets the recommended standard. This means that the six constructs are internally consistent. The Average Variance Extracted (AVE) exceeds 0.5, which meets the above criterion and indicates good convergent validity of the constructs, as shown in Table 2.

**Table 2. Convergent Validity**

Construct	Std.	SMC	CR	AVE
Altruism	0.895-0.914	0.801-0.835	0.948	0.821
Mindfulness	0.731-0.886	0.534-0.785	0.908	0.665
Mental Skills	0.617-0.898	0.381-0.806	0.904	0.658
Mental Toughness	0.752-0.902	0.566-0.814	0.944	0.709
Exercise Fatigue	0.774-0.915	0.599-0.832	0.947	0.781
Continuous Training Intention	0.885-0.922	0.783-0.850	0.927	0.809

Note: Std.= Standardized factor loading; SMC= Squared Multiple Correlation; CR= Composite Reliability; AVE= Average Variance Extracted.

#### 4.3 Discriminant Validity

Fornell and Larcker (1981) argued that discriminant validity hinges on both

convergent validity and the correlations between constructs. They proposed that the square root of the Average Variance Extracted (AVE) for each construct should exceed the correlation coefficient between that construct and any other construct. As illustrated in Table 3, the square root of the diagonal AVE values is indeed greater than the correlation coefficients between different constructs. Consequently, the constructs in the present study demonstrate discriminant validity.

**Table 3. Discriminant Validity**

	AVE	ALT	MIN	MSK	MTG	EFT	CTI
ALT	0.821	0.906					
MIN	0.665	0.682	0.815				
MSK	0.658	0.580	0.591	0.811			
MTG	0.709	0.670	0.560	0.658	0.842		
EFT	0.781	0.689	0.644	0.619	0.600	0.884	
CTI	0.809	0.675	0.579	0.551	0.669	0.574	0.899

Note1: The items represented in bold on the diagonal are the square roots of the Average Variance Extracted (AVE), while the off-diagonal elements denote the correlation estimates between constructs.

Note2: ALT=Altruism; MIN=Mindfulness; SK=Mental Skills; MTG=Mental Toughness; EFT=Exercise Fatigue; TI=Continuous Training Intention

#### 4.4 Goodness-of-Fit

When the sample size in Structural Equation Modeling (SEM) exceeds 200, the Chi-Squared value ( $\chi^2 = (n-1)F_{min}$ ) tends to become excessively large. A large Chi-Squared value often leads to a lower P-value, increasing the likelihood of rejection. Therefore, this study was based on Bollen and Stine (1992) suggestion to fix the Chi-Squared value with Bootstrap. After correcting the Chi-Squared value, the re-estimated Goodness-of-Fit is within the allowable range, as shown in Table 4.

**Table 4. Goodness-of-Fit**

Indices	Standard	Index Value	Judgement
$\chi^2$ (Chi-square)	The smaller the better	528.816	
$\chi^2/DF$	<3	1.433	Yes
GFI	>0.9	0.960	Yes
AGFI	>0.9	0.952	Yes
RMSEA	<.05	0.032	Yes

CFI	>0.9	0.988	Yes
NFI	>0.9	0.960	Yes
NNFI	>0.9	0.986	Yes

Note: CFI= Comparative Fit Index; TLI= Tucker-Lewis Index; RMSEA= Root Mean Square Error of Approximation; GFI= Goodness-of-Fit Index; NFI= Normed-Fit Index; AGFI= Adjusted Goodness-of-Fit Index

#### 4.5 Path Analysis

As shown in Table 5 and Figure 2, standardized Regression Coefficient of Altruism (ALT) on Mental Skills (MSK) = 0.167,  $p < 0.05$ , so the hypothesis holds. H2: Unstandardized Regression Coefficient of Altruism (ALT) on Mental Toughness (MTG) = 0.323,  $p < 0.05$ , so the hypothesis holds. H3: Unstandardized Regression Coefficient of Mindfulness (MIN) on Mental Skills (MSK) = 0.179,  $p < 0.05$ , so the hypothesis holds. H4: Unstandardized Regression Coefficient of Mindfulness (MIN) on Mental Toughness

(MTG) = 0.125,  $p < 0.05$ , so the hypothesis holds. H5: Unstandardized Regression Coefficient of Mental Skills (MSK) on Exercise Fatigue (EFT) = 0.723,  $p < 0.05$ , so the hypothesis holds. H6: Unstandardized Regression Coefficient of Mental Toughness (MTG) on Exercise Fatigue (EFT) = 0.499,  $p < 0.05$ , so the hypothesis holds. H7: Unstandardized Regression Coefficient of Exercise Fatigue (EFT) on Continuous Training Intention (CTI) = 0.535,  $p < 0.05$ , so the hypothesis holds.

The findings support the research question of the conceptual framework. Altruism (ALT) and Mindfulness (MIN) can explain 44.6% of Mental Skills (MSK). Altruism (ALT) and Mindfulness (MIN) can explain 49.2% of Mental Toughness (MTG). Mental Skills (MSK) and Mental Toughness (MTG) can explain 47.0% of Exercise Fatigue (EFT). Exercise Fatigue (EFT) can explain 33.9% of Continuous Training Intention (CTI).

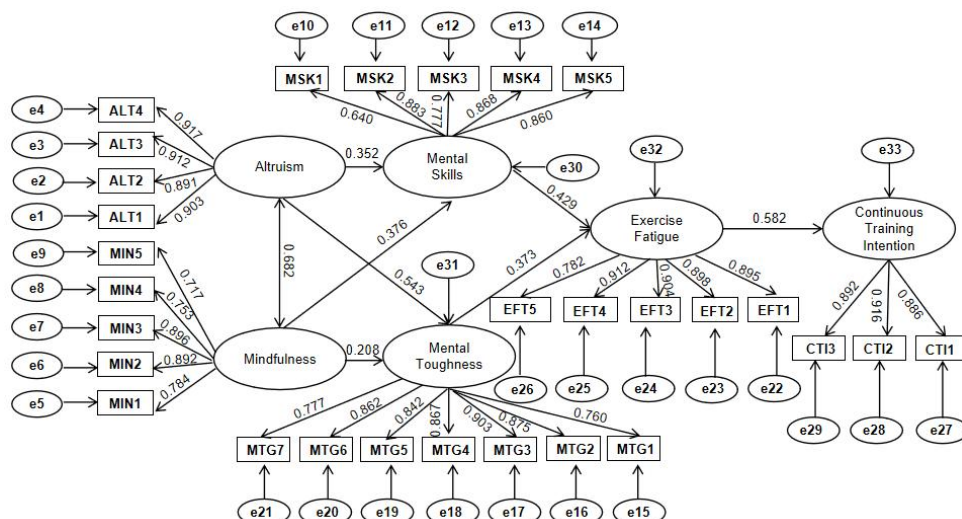


Figure 2. SEM Statistical Model Diagram

Table 5. Path Analysis

Hypothesis	IV	DV	Unstd.	S.E.	Unstd./S.E.	p-Value	R <sup>2</sup>
1	ALT	MSK	0.167	0.030	5.635	0.000	0.446
3	MIN	MSK	0.179	0.031	5.794	0.000	
2	ALT	MTG	0.323	0.036	8.972	0.000	0.492
4	MIN	MTG	0.125	0.034	3.663	0.000	
5	MSK	EFT	0.723	0.089	8.136	0.000	0.470
6	MTG	EFT	0.499	0.064	7.792	0.000	
7	EFT	CTI	0.535	0.044	12.271	0.000	0.339

Note1: IV= Independent Variable; DV= Dependent Variable; Unstd. = Unstandardized Regression Coefficient;

S.E.= Standard Error

Note2: ALT=Altruism; MIN=Mindfulness; MSK=Mental Skills; MTG=Mental Toughness; EFT=Exercise

Fatigue; CTI=Continuous Training Intention

#### 4.6 Mediating Effects

According to Table 6, the hypothesis H8, which states that Altruism (ALT) influences Exercise Fatigue (EFT) Intention (CI) through Mental Skills (MSK), is supported ( $p < 0.05$ ). The confidence interval [0.044 to 0.228] excludes 0, indicating that the indirect effect is statistically significant and holds true. H9: Mindfulness (MIN)→Mental Skills (MSK)→Exercise Fatigue (EFT) Intention (CI),  $p < 0.05$ . The confidence interval does not contain 0 [0.058 to 0.233], indicating that the indirect effect holds. H10: This indicates that

there is a significant indirect effect of Altruism (ALT) on Exercise Fatigue (EFT) Intention (CI) through the mediator Mental Toughness (MTG). The p-value is less than 0.05, suggesting statistical significance. Additionally, the confidence interval [0.072 to 0.298] does not include zero, which further supports the conclusion that the indirect effect is significant and exists. H11: Mindfulness (MIN)→Mental Toughness (MTG)→Exercise Fatigue (EFT) Intention (CI),  $p < 0.05$ . The confidence interval does not contain 0 [0.013 to 0.174], indicating that the indirect effect holds. H12: Mental Skills (MSK)→Exercise Fatigue (EFT)→Continuous Training Intention (CI),  $p < 0.05$ . The confidence interval does not contain 0 [0.196 to 0.609], indicating that the indirect effect holds. H13: This suggests that there is a significant indirect effect of Mental Toughness (MTG) on Continuous Training Intention (CI) through the mediator Exercise Fatigue (EFT). The p-value is less than 0.05, indicating statistical significance. Furthermore, the confidence interval [0.127 to 0.529] excludes zero, which strengthens the conclusion that the indirect effect is statistically significant and exists between Mental Toughness (MTG), Exercise Fatigue (EFT), and Continuous Training Intention (CI).

**Table 6. Mediating Effects**

Parameter	Estimate	Lower	Upper	P
ALT→MSK→EFT	0.121	0.044	0.228	0.007
MIN→MSK→EFT	0.129	0.058	0.233	0.001
ALT→MTG→EFT	0.161	0.072	0.298	0.003
MIN→MTG→EFT	0.062	0.013	0.174	0.020
MSK→EFT→CI	0.387	0.196	0.609	0.001
MTG→EFT→CI	0.267	0.127	0.529	0.002

## 5. Discussion and Conclusion

### 5.1 Practical Contributions

The results of the study revealed that all direct hypotheses hold. Both mental skills and mental toughness affect the continuous training intention of roller skating through the mediating effect of exercise fatigue. Therefore, this study proposes the following practical directions to strengthen altruism, mindfulness, mental skills, and mental toughness for roller skating club members.

The college roller skating clubs instructors should hold regular activities to promote Altruism so that the club athletes can

communicate with each other and share the various difficulties they encounter during practice. Through mutual support, club members can build a spirit of mutual aid and reciprocity, a sense of belonging to each other, and a culture of Altruism. In this way, athletes will not be alone in facing the pressure of roller skating training and will be able to improve their confidence and continuous training intention. Secondly, the club should cultivate and enhance the Mindfulness of its members. The way to do this is to have the club members meditate before training and observe the movements they can focus on. This includes the ability to relieve anxiety and improve focus, motivation, stress tolerance, pain tolerance, self-confidence, motivation, and energy during roller skating training. In addition, encourage the roller skating club members to improve mental skills and mental toughness through goal-setting training, pre-imagined training content, relaxation, and self-talk. The mental skills and toughness exercises can enhance the mental tolerance range of club members to promote roller skating training performance. These include higher willingness to train, motivation, stamina, composure, self-control, desire for challenge, confidence and judgment, positive attitude and enthusiasm, predictability and coordination, as well as stable and focused emotions, and willingness to accept criticism and guidance. Moreover, club members can also look back on recent successful training experiences, pre-competition routines, and stress training to firmly believe that they have the traits or abilities to rollerblade learning. Imagine in advance what to do if the practice does not go well or if a slip occurs, and how to block negative emotions quickly when they come. By doing so, roller skating club members can improve their self-belief and emotional intelligence, thus enhancing their mental toughness. Through the above practices, roller skating club members habitually practice personal altruism, mindfulness, mental skills, and mental toughness, thus reducing exercise fatigue and enhancing the continuous training intention of roller skating.

### 5.2 Limitations and Future Research

This study focuses on the members of several college roller skating clubs in China and will be expanded to include other types of sports

clubs in the future. The future study will also compare the differences in the impact of continuous training intention among different sports club members. Second, due to the time constraints of the study, as well as the differences in training styles of collegiate roller derby clubs in China and the setup of competition programs in each province. The results of this study may not accurately represent the effects of sustained training intentions on all college roller derby club members, and a more comprehensive approach will be utilized for future research sampling.

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