Exploring the Motivation of Adolescent' Participation in Physical Exercise: An Evolutionary Psychology Perspective

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Abstract

The extant scholarly discourse pertaining to adolescents' engagement in physical exercise predominantly comprises superficial observations and introductory comprehension, demonstrating a dearth of comprehensive analysis regarding the intricate psychological mechanisms at play. This investigation endeavours to delve into the foundational impetuses driving teenagers' participation in physical activity through the lens of evolutionary psychology theory. Furthermore, it aims to scrutinize the motivational processes and mechanisms by integrating the tenets of planned behavioural theory. A sample comprising 887 valid questionnaires was gathered from middle school, high school, and college students. Subsequently, a structural equation modelling approach, integrating regression and factor analysis, was employed to validate the initial model and associated hypotheses. This study utilized a quantitative research methodology along with a cross-sectional research design. Empirical investigation confirmed six hypotheses derived from the study. Notably, four evolutionary motives—namely, the inclination to avoid harm, mitigate disease risk, foster group affiliation, and pursue mate acquisition—exerted substantial direct effects on teenagers' intentions towards physical exercise. Moreover, these motives also demonstrated indirect impacts on teenagers' physical exercise intentions through subjective norms, attitudes, and perceived control over their physical exercise behaviour. Adolescents' engagement in physical exercise is shaped not solely by superficial factors and external stimuli but is also propelled by intrinsic motives rooted in evolutionary and natural selection mechanisms. An evolutionary perspective sheds light on the nuanced understanding of adolescents' physical exercise, consolidating disparate research on exercise motivation. Building upon this understanding, governmental bodies and educational institutions can devise novel policies and initiatives to foster physical activity among youth, facilitating the maintenance of robust physical health alongside educational pursuits.

Keywords: Teenager, Physical Exercise, Motivation, Evolutionary Psychology, Planned Behavioural Theory.

Introduction

Physical exercise encompasses activities directed towards bodily development, health enhancement, fitness improvement, mental regulation, and cultural enrichment (Liang, 1994; Navarro et al., 2021; Qijie, Yin, & Liping, 2022). Regular and moderate engagement in physical exercise is recognized to bolster both physical and mental well-being (Jiang et al., 2022; Qijie et al., 2022). Conversely, insufficient or lack of physical exercise may precipitate various physical health issues such as hypertension and mental health disorders like depression, thereby diminishing individuals' quality of life and potentially shortening their lifespan (Haible et al., 2020). However, recent surveys and studies indicate a general dearth of physical exercise among Chinese youth, with a sustained decline in their physical fitness levels, posing a significant threat to their overall development (An et al., 2019; Wang et al., 2019).

The predominant focus of existing research has been on extrinsic factors influencing adolescents' exercise behaviour. However, scholars contend that augmenting youth participation in physical exercise necessitates not only external conditions such as economic investment and policy interventions but also cultivating fitness awareness and igniting intrinsic motivation (Gillison, Standage, & Skevington, 2006; Kalajas-Tilga et al., 2020). For instance, Zhang et al. (2012) surveyed 28,648 adolescents across eight Chinese cities to explore the determinants of extracurricular physical exercise, revealing that exercise interest and motivation were the foremost influencing factors, while economic and policy variables served as enabling but not pivotal factors limiting adolescents' involvement in extracurricular physical activities. Consequently, fostering exercise motivation emerges as a pivotal aspect in encouraging adolescents to engage in and sustain physical exercise (Kalajas-Tilga et al., 2020). A nuanced examination of teenagers' exercise motivation

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holds potential to furnish a robust theoretical framework for devising effective youth physical exercise guidance policies and steering China's youth exercise behaviour.

Motivation, defined as the psychological impetus or intrinsic urge that initiates and perpetuates an organism's actions, directing them towards specific objectives (Osterloh & Frey, 2000), has been a subject of exploration in understanding adolescents' engagement in physical exercise. Scholars have predominantly approached this inquiry through lenses such as self-determination theory and social ecological models (Gillison et al., 2006; Nogg et al., 2021). However, these investigations often exhibit a surface-level comprehension and inference of adolescents' exercise motivation, primarily grounded in content and cognition, thereby obscuring the deeper psychological mechanisms underlying adolescents' physical activity. Moreover, there remains a paucity of thorough analyses concerning the motivational drivers behind adolescents' exercise behaviours. Previous scholarly works pertaining to adolescents' engagement in physical exercise predominantly offer superficial introductions and comprehension, with a dearth of comprehensive examination of the underlying psychological processes. This research endeavours to delve into the fundamental motivations driving adolescents' participation in physical exercise, drawing upon evolutionary psychology theory. Furthermore, it seeks to scrutinize the motivational processes and mechanisms by integrating the planned behaviour theory.

Thus, this investigation aims to delve into the evolutionary impetuses propelling adolescents towards physical exercise, grounded in evolutionary psychology, while elucidating the processes and mechanisms through which these evolutionary motivations influence adolescents' readiness and engagement in physical activity. Firstly, it endeavours to advocate for the incorporation of evolutionary psychology within the realms of physical exercise and sports. Secondly, by delineating these evolutionary motivations, this inquiry seeks to amalgamate disparate strands of research on physical exercise motivation, fostering a comprehensive and nuanced understanding of adolescent physical activity. Thirdly, the findings of this research endeavour to furnish theoretical underpinnings for devising effective policies and strategies aimed at activating adolescents' intrinsic motivation to partake in physical exercise and sports. The structure of this study will encompass sections dedicated to a review of pertinent literature on physical exercise motivation and evolutionary psychology, the delineation of research methodology, presentation and analysis of results, and subsequent discussion, culminating in a conclusive summary.

Literature Review

Physical Exercise Motivation

Motivation, an intrinsic force steering all human endeavours, initiates and sustains behavioural patterns (Kalajas-Tilga et al., 2020). Specifically, in the context of physical exercise, motivation denotes the internal drive compelling individuals to partake in such activities (Nogg et al., 2021). This psychological impetus not only propels individuals to engage in physical exercise but also guides their endeavours towards specific objectives aligned with personal thoughts, desires, or ideals (Folk et al., 2022; Timo et al., 2016). Previous scholarly inquiries into adolescent physical exercise motivation have revealed a multifaceted landscape, where motivations stem not merely from physiological needs but also from psychological and social factors. This spectrum encompasses both intrinsic and extrinsic motivations, as well as a range of motivational states, including deficit motivation and surplus motivation (Wang et al., 2019).

For instance, drawing from the self-determination theory, researchers have delineated three categories of adolescent physical exercise motivation: internal motivation, external motivation, and non-motivation (Gillison et al., 2006). Internal motivation arises from individuals' inherent interest in the exercise regimen itself, whereas external motivation emanates from external rewards associated with physical exercise programs. Non-motivation characterizes individuals lacking any impetus for engagement in such activities, resulting in either non-participation or cessation of exercise efforts.

Internal motivation serves as a potent catalyst not only for engaging individuals in physical exercise but also for profoundly influencing their emotional well-being and mental health (Ntoumanis et al., 2021). Specifically, intrinsic motivation encompasses a diverse array of factors including physical fitness, psychological well-being, body sculpting, recreational interests, therapeutic aims, and personal development goals (Ntoumanis et al., 2021). Apart from these internal drivers, external motivational factors also exert considerable influence on adolescent physical exercise behaviours. These encompass the emphasis and encouragement towards physical exercise and sports participation by educational institutions and families (Vasconcellos et al., 2020). Furthermore, aspirations for peer admiration and social acceptance emerge as pivotal external incentives driving adolescents' participation in physical exercise. Concerns such as avoiding social ridicule due to weight issues or evading self-blame for perceived physical inadequacies similarly impact adolescents' involvement in diverse physical

exercise programs. Nonetheless, despite the potential of external motivators to initiate engagement in physical exercise, they often fall short in sustaining long-term adherence to exercise regimens (Ntoumanis et al., 2021).

Several scholars have endeavoured to elucidate the determinants of adolescent physical exercise behaviours through the lens of social ecology (Boulton, Horne, & Todd, 2018). Central to the social ecology perspective is the notion that individual behaviours are influenced by factors beyond the psychological realm and are intricately linked to environmental stimuli. This theoretical framework systematically analyses external influences on adolescent physical exercise, spanning five dimensions: individual, interpersonal, organizational, community, and public policy (Solmon, 2015). Moreover, adolescents' motivations for physical exercise exhibit variations based on age, gender, geographical location, economic status, and other factors (Navarro et al., 2021). Notably, gender differences are prominent, with males generally displaying higher exercise motivation levels than females (Elder et al., 2007). Female college students are often motivated by appearance and weight management concerns, whereas male counterparts are driven by performance-related goals such as seeking challenges, enhancing strength and endurance, fostering competitiveness, and garnering social recognition (Kilpatrick, Hebert, & Bartholomew, 2005). Additionally, disparities in exercise motivation are observed across different academic grades, with rural students displaying higher motivation levels compared to their urban counterparts. Despite the identification of numerous motivational factors driving adolescent participation in physical exercise, the underlying processes and mechanisms remain inadequately explained. Thus, there is a pressing need to introduce new theories and methodologies to engender innovative research outcomes and deepen understanding in this domain.

Evolutionary Psychology

Evolutionary psychology, rooted in Darwinian evolutionary theory and incorporating insights from biology, psychology, and anthropology, posits that contemporary human behavioural traits are fundamentally shaped by psychological mechanisms developed during the process of evolution and natural selection (Ghiselin, 1973; Whiten, 1999). This theory rests on two foundational principles: first, that contemporary human genes are the outcome of prolonged evolutionary processes and natural selection, and second, that the human brain and neurocognitive system continue to evolve based on the genetic coding inherited from ancestors (Neuberg & Schaller, 2015). Throughout this evolutionary process, genetic elements conducive to survival and reproduction are perpetually replicated, reinforced, and amplified, leading to the emergence of distinct psychological mechanisms tailored to address various evolutionary challenges (supported by extensive evidence from cognitive science, neuroscience, and biology, which indicates that the brain harbours different psychological systems and subsystems to tackle diverse evolutionary challenges) (Neuberg & Schaller, 2015). These psychological mechanisms, developed to navigate recurrent threats to survival and reproduction such as avoiding harm, expanding social networks, enhancing status, seeking mates, and caring for offspring, are conceptualized in evolutionary psychology as motivational systems engineered by evolutionary processes (Schaller et al., 2017). Individuals are born with these evolutionary motivational systems to facilitate information processing and decision-making regarding interactions between their bodies and the external environment, significantly influencing beliefs, cognition, perceptions, and behaviours (Griskevicius & Kenrick, 2013).

Evolutionary psychology constitutes a burgeoning field with considerable potential, offering a robust framework for understanding and researching human behaviour, including physical exercise. While there may be numerous proximate causes and immediate motivations for human behaviour, the ultimate evolutionary function of these behaviours is often less apparent. However, all humans share a common evolutionary motivational system, presenting a novel and valuable perspective for establishing a unified motivation system for physical exercise. Building upon Maslow's hierarchy of needs theory, Kenrick et al. (2010) analysed human evolutionary motivation from three dimensions: evolutionary function, developmental sequence, and cognitive performance, culminating in a pyramid model of basic human evolutionary motivation. Subsequently refined by Griskevicius and Kenrick (2013), this model identified seven core human motivations, including avoiding harm, disease avoidance, social interaction, status enhancement, mate seeking, mate retention, and kinship care. Considering the unique context of physical exercise among young individuals, this study proposes that four primary evolutionary motivations—avoiding harm, disease avoidance, social interaction, and mate seeking—are key factors shaping the trends in physical exercise and activity among youth. For a detailed exposition of each evolutionary motivation, readers are referred to the works of Kenrick et al. (2010) and Griskevicius and Kenrick (2013).

Viewed through the lens of planned behaviour theory (Jekauc et al., 2015), teenagers' engagement in physical

exercise can be construed as a deliberate behaviour. Accordingly, this study aims to scrutinize the impact, process, and mechanism of evolutionary motivation for physical exercise on adolescent exercise behaviour. Planned behaviour theory, building upon its predecessor, the theory of reasoned action, posits that human behaviour is not entirely voluntary but is influenced by external environmental factors (Ajzen, 2020). Therefore, perceived behavioural control has been incorporated into the theory of reasoned action to elucidate how individuals form and modify behavioural patterns. According to planned behaviour theory, the most effective way to predict whether individuals will engage in a particular behaviour is to understand their behavioural intentions—their willingness to perform the behaviour and the effort they intend to exert towards it. Three factors influence behavioural intention: attitudes towards the behaviour, subjective norms, and perceived behavioural control (Ajzen, 2020). Perceived behavioural control exerts a stimulating effect on behavioural intention, with the closer alignment between perceived and actual control enhancing the accuracy of behaviour prediction. Moreover, subjective norms, attitudes, and perceived behavioural control are shaped by individuals' beliefs about the outcomes of behaviour and their evaluations of these outcomes (Ajzen, 2020). Evolutionary motivation can profoundly impact individuals' beliefs, attitudes, cognition, and evaluations. Based on the foregoing analysis, this study posits hypotheses and an initial model (see Figure 1) for investigation:

H1: *Four evolutionary motives have direct impacts on teenagers' physical exercise intention.*

H2: *Evading harm have a direct impact on teenagers' subjective norm, attitude, and perceived behavioural control.*

H3: *Disease avoidance have a direct impact on teenagers' subjective norm, attitude, and perceived behavioural control.*

H4: *Affiliation (group) have a direct impact on teenagers' subjective norm, attitude, and perceived behavioural control.*

H5: *Mate acquisition have a direct impact on teenagers' subjective norm, attitude, and perceived behavioural control.*

H6: *Evolutionary motives have indirect impacts on teenagers' physical exercise intention through subjective norm, attitude, and perceived behavioural control.*

Drawing upon prior discourse and the development of hypotheses, the research framework depicted in Figure 1 has been formulated.

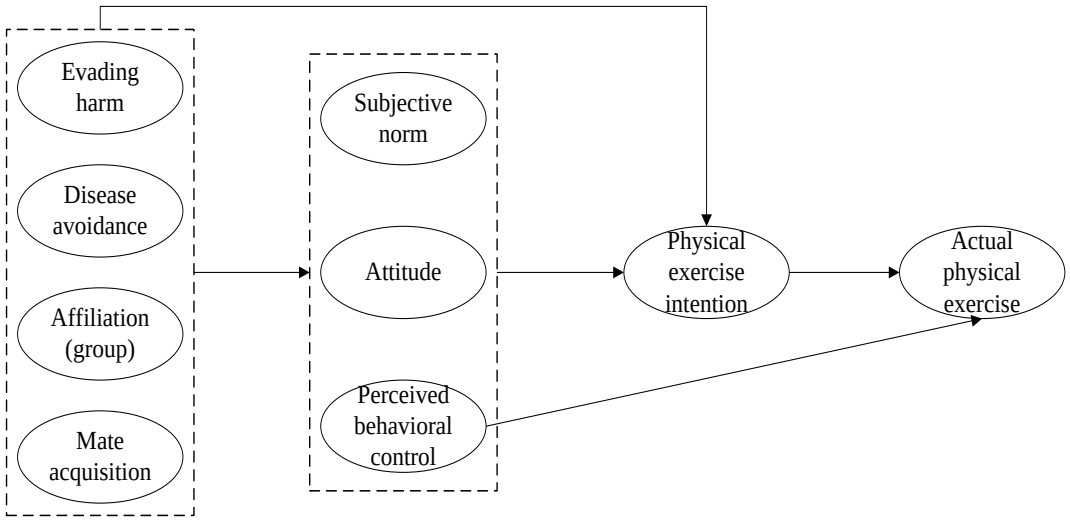

Figure 1: Initial Model.

Methodology

The study employed a quantitative research methodology, employing a cross-sectional research design due to data collection occurring at a single point in time. This methodological choice was deemed appropriate for the study's objectives. Furthermore, a convenience sampling technique was employed for data collection due to the lack of prior knowledge about the population. Subsequently, structural equation modelling (SEM) was utilized to examine the proposed model and associated hypotheses, given its robustness in analysing relationships between latent variables and their indicators. Specifically, various analyses including reliability testing, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), model fit assessment, path analysis, and mediating effect analysis were conducted to scrutinize the collected data.

Data Collection

An online electronic questionnaire was developed using the Chinese platform, Questionnaire Star. The distribution of questionnaires was facilitated through the Internet and social media platforms such as WeChat, targeting middle school, high school, and college students. Respondents accessed the online questionnaire by scanning a QR code and subsequently provided their assessments. Out of 1384 respondents, 1049 completed questionnaires were obtained, resulting in a completion rate of 75.79%. These completed questionnaires underwent further scrutiny, which involved analysing trap questions, response times, missing data, and other observable anomalies such as excessively consistent scores. Following this screening process, 887 questionnaires were deemed valid, representing a valid completion rate of 84.56%.

Profile of Respondents

Regarding the demographic characteristics of participants, this study considered factors such as gender, age, and educational background. Within the valid sample, there were 436 male respondents, constituting 49.15% of the total sample, while 451 were female, comprising 50.85% of the total sample. In terms of age distribution, the largest proportion of respondents fell within the 13 to 14-year-old bracket, accounting for 338 individuals or 38.11% of the sample, followed by 277 respondents aged between 15 and 16 years old, and 272 respondents aged between 17 and 18 years old. Regarding educational attainment, approximately 39.68% of respondents were middle school students, 33.15% were high school students, and 27.17% were enrolled in college (refer to Table 1 for details).

Table 1

Respondents Profile

Demographic Characteristics		Frequency (N = 887)	Percentage (%)
Gender	Male	436	49.15
	Female	451	50.85
Age (year)	13-14	338	38.11
	15-16	277	31.23
	17-18	272	30.66
Education Level	Middle-school students	352	39.68
	High-school students	294	33.15
	University students	241	27.17

Measurement

Adolescents' actual engagement in physical exercise was assessed utilizing the Physical Activity Rating Scale (PARS-3) developed Liang (1994). The PARS-3 scale comprehensively evaluates adolescents' physical activity levels over the past month, considering three key dimensions: exercise intensity, duration, and frequency. Regarding exercise intensity, participants were queried about the level of exertion during physical activities, with response options ranging from light exercise (e.g., walking, calisthenics) to high intensity sustained exercise (e.g., running, swimming). Exercise duration was gauged by inquiring about the duration of each physical activity session, categorized into various time intervals ranging from less than 10 minutes to 60 minutes or more. Additionally, exercise frequency was assessed by querying participants about the frequency of engaging in physical exercise activities, ranging from less than once a month to about once a day. Responses were scored on a scale ranging from 1 to 5 for exercise intensity and frequency (e.g., 1=light exercise, 5=high intensity and sustained exercise) and from 0 to 4 for exercise duration (e.g., 0=less than 10 minutes, 4=60 minutes or more). The overall exercise level was determined by multiplying scores across these three dimensions, resulting in three categories: low exercise (scores of 19 or below), moderate exercise (scores between 20 and 42), and high exercise (scores of 43 or higher).

Subjective norm, attitude, perceived behavioural control, and physical exercise intention were assessed using the Exercise Attitude scale developed by Mao, Yan and Mao (2003). Subjective norm was measured using seven items, while the remaining variables were evaluated using eight items each. Participants indicated their level of agreement with each item on a Likert-five scale ranging from 1 (completely disagree) to 5 (completely agree). Furthermore, following the approach of Neel et al. (2016), all four evolutionary motives were evaluated using six items each. For instance, evading harm was

assessed using items such as "I frequently contemplate strategies to protect myself from potentially dangerous individuals" and "I am motivated to safeguard myself from potential threats posed by others."

Reliability and Validity

Reliability pertains to the extent of consistency in outcomes obtained from repeated measurements of the same entity utilizing the same methodology, while validity concerns the extent to which a measuring instrument or method accurately captures the intended constructs. Initially, the reliability of indicators was assessed through Cronbach's Alpha and items-total correlation to ascertain their internal consistency. Results indicated that the reliability coefficients for all eight latent factors with multiple indicators exceeded 0.8, and the corresponding items-total correlations ranged between 0.4 and 0.8. Moreover, no improvement in Cronbach's Alpha for latent factors was observed upon removal of any specific indicator. Thus, all indicators demonstrated satisfactory reliability.

Subsequently, a factor analysis was conducted to explore the potential dimensionality and validity of the indicators (excluding consideration of actual physical exercise in this analysis). The KMO statistic yielded a value of 0.963 with a significance level of 0 in Bartlett's test of sphericity, and eight eigenvalues exceeding 1 were generated. The cumulative explained variance reached 78.283%, indicating favourable sample adequacy according to (Hair et al., 2010).

The CR of the eight latent factors surpassed the recommended threshold of 0.6 proposed by Bagozzi and Yi (1988). Additionally, AVE values exceeded the cut-off point of 0.5, indicative of convergent validity and the effectiveness of the measurement models in representing the data, as suggested by Fornell and Larcker (1981). Furthermore, the square root of the AVE values on the diagonals exceeded the corresponding inter-correlations estimated between the latent factors, underscoring the scale's robust discriminant validity (refer to Table 2).

Table 2

Discriminant Validity of All Constructs Considered for the Model

Constructs	1	2	3	4	5	6	7	8	9
1. Physical Protection	0.79[a]								
2. Disease Avoidance	0.63[b]	0.86							
3. Affiliation (Group)	0.61	0.33	0.84						
4. Mate Acquisition	0.48	0.31	0.29	0.82					
5. Subjective Norm	0.46	0.27	0.31	0.45	0.84				
6. Attitude	0.56	0.50	0.54	0.47	0.38	0.81			
7. Perceived Behavioural Control	0.49	0.53	0.46	0.60	0.57	0.34	0.79		
8. Physical Exercise Intention	0.46	0.45	0.59	0.32	0.35	0.47	0.40	0.36	
9. Actual Physical Exercise	0.43	0.55	0.35	0.49	0.53	0.38	0.56	0.61	0.35

[a] square root of AVE (diagonal).

[b] Correlation estimated between constructs.

Model Fit and Hypotheses Test Results

The findings from the fitting analysis (refer to Table 3) suggested that the initial model could be broadly accepted, elucidating that teenagers' intentions towards physical exercise could be elucidated by four evolutionary motives, subjective norms, attitudes, and perceived behavioural control, accounting for over 70% of its variance. Examination of coefficient estimations (refer to Figure 2) revealed that the estimated coefficients from evading harm, disease avoidance, group affiliation, and mate acquisition to teenagers' physical exercise intentions were 0.12 ($t=6.59$, $p<0.001$), 0.16 ($t=5.87$, $p<0.001$), 0.31 ($t=3.08$, $p<0.01$), and 0.22 ($t=3.23$, $p<0.01$) respectively, thus corroborating H1. Furthermore, the estimated coefficients from evading harm to teenagers' subjective norms, attitudes towards physical exercise, and perceived behavioural control were 0.27 ($t=2.91$, $p<0.01$), 0.18 ($t=3.34$, $p<0.01$), and 0.04 ($t=1.42$, $p>0.05$) respectively, providing partial support for H2. Similarly, estimated coefficients from disease avoidance to teenagers' subjective norms, attitudes towards physical exercise, and perceived behavioural control were 0.22 ($t=3.07$, $p<0.01$), 0.13 ($t=4.28$, $p<0.01$), and 0.06 ($t=1.13$, $p>0.05$) respectively, offering partial support for H3. Moreover, estimated coefficients from group affiliation to teenagers' subjective norms, attitudes towards physical exercise,

and perceived behavioural control were 0.15 (t=5.23, p<0.001), 0.27 (t=7.18, p<0.001), and 0.09 (t=3.25, p<0.01) respectively, thereby supporting H4. Additionally, estimated coefficients from mate acquisition to teenagers' subjective norms, attitudes towards physical exercise, and perceived behavioural control were 0.19 (t=3.88, p<0.001), 0.36 (t=6.92, p<0.001), and 0.18 (t=4.14, p<0.01) respectively, thus corroborating H5. Furthermore, the estimated results of paths among subjective norms, attitudes towards physical exercise, perceived behavioural control, physical exercise intentions, and actual physical exercise were consistent with previous studies pertaining to the planned behaviour theory.

Table 3

Default Model Fit Indices

Indices		Default Model	Criteria
Absolute Fit Indices	χ^2/df	2.58 (2273.3/882)	(1,3)
	p	0	<0.05
	N	887	>200
	SRMR	0.042	<0.05
	RMSEA	0.047	<0.08
Incremental Fit Indices	CFI	0.97	>0.9
	TLI	0.97	>0.9
	IFI	0.97	>0.9
	NFI	0.95	>0.9
	RFI	0.94	>0.9
Parsimonious Fit Indices	PNFI	0.77	>0.5
	PGFI	0.75	>0.5

Method: Maximum Approximate Estimation

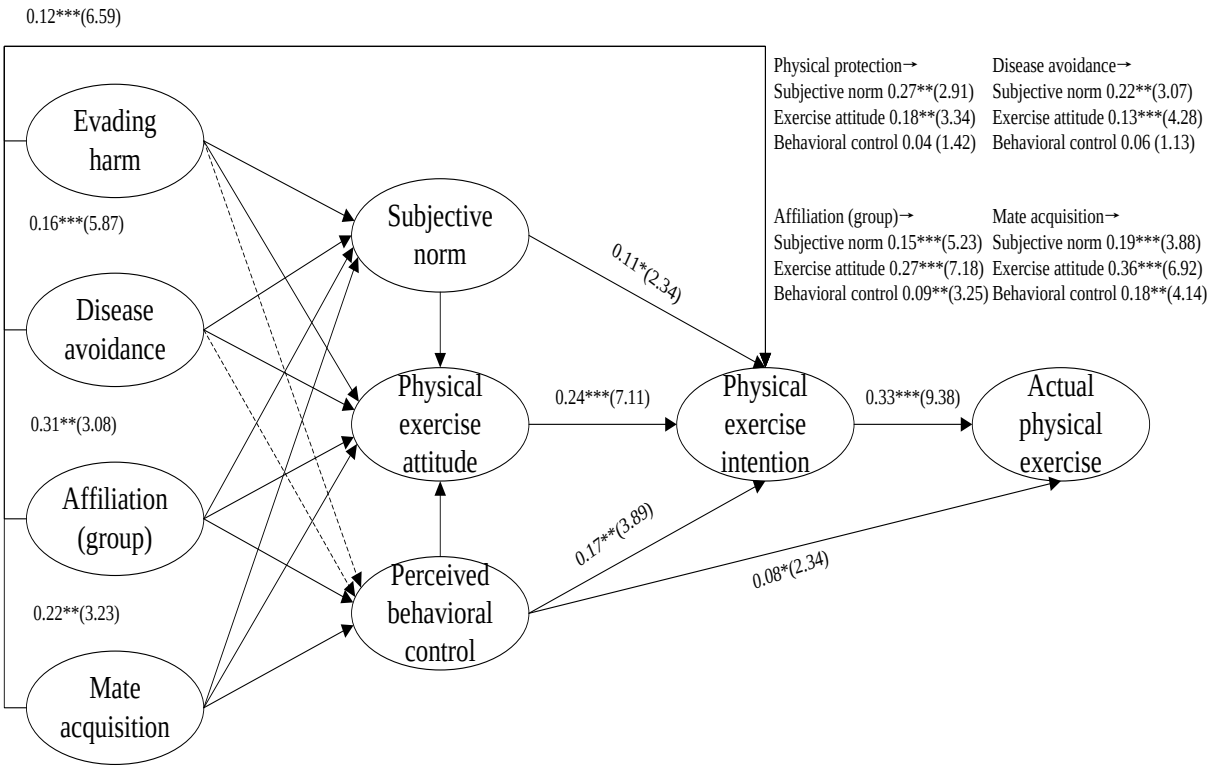

Figure 2: Test Results of Model.

Note: ***p<0.001, **p<0.01, *p<0.05, T values in the brackets.

The mediating roles of subjective norms, attitudes towards physical exercise, and perceived behavioural control in the relationship between four evolutionary motives and adolescents' physical exercise intentions were examined using a bootstrap method. The outcomes revealed significant mediating effects for subjective norms, attitudes towards physical exercise, and perceived behavioural control (refer to Table 4). For instance, the indirect effects of subjective norms (β = 0.141, 95% CI [0.027, 0.255], excluding 0), attitudes towards physical exercise (β = 0.176, 95% CI [0.033, 0.324], excluding 0), and the pathway 'subjective norm → attitude' (β = 0.046, 95% CI [0.005, 0.127], excluding 0) between evading harm and physical exercise intention were statistically significant. Moreover, the direct effect from evading harm to physical exercise intention was 0.36 ($p < 0.001$) with a 95% CI [0.048, 0.679], not encompassing 0. Consequently, it can be inferred that subjective norms and attitudes towards physical exercise partially mediated the influence of evading harm on physical exercise intention. Hence, H6 received empirical support.

Table 4

The Mediating Role of Subjective Norm, Attitude and Perceived Behavioural Control Between Evolutionary Motives and Physical Exercise Intention

Paths	Effect Type	Effect	SE	95% Confidence-Interval
EH → PEI	Direct effect	0.36***(7.25)	0.161	[0.048, 0.679]
EH → SN →PEI	Mediating effect	0.141	0.058	[0.027, 0.255]
EH → PEA →PEI	Mediating effect	0.176	0.074	[0.033, 0.324]
EH → SN → PEA →PEI	Mediating effect	0.046	0.031	[0.005, 0.127]
DA → PEI	Direct effect	0.64***(10.62)	0.186	[0.279, 1.005]
DA → SN →PEI	Mediating effect	0.194	0.091	[0.017, 0.374]
DA → PEA →PEI	Mediating effect	0.110	0.049	[0.015, 0.208]
DA → SN → PEA →PEI	Mediating effect	0.198	0.097	[0.012, 0.342]
AG →PEI	Mediating effect	0.071	0.034	[0.018, 0.152]
AG → SN →PEI	Direct effect	0.73***(12.12)	0.185	[0.371, 1.097]
AG → PEA →PEI	Mediating effect	0.275	0.124	[0.037, 0.522]
AG → PBC →PEI	Mediating effect	0.171	0.083	[0.017, 0.343]
AG → SN → PEA →PEI	Mediating effect	0.218	0.101	[0.025, 0.421]
AG → PBC → PEA →PEI	Direct effect	0.57***(11.39)	0.167	[0.244, 0.898]
MA →PEI	Mediating effect	0.303	0.105	[0.099, 0.511]
MA → SN →PEI	Direct effect	0.61***(9.78)	0.178	[0.264, 0.962]
MA → PEA → PEI	Mediating effect	0.295	0.135	[0.043, 0.571]
MA → PBC →PEI	Mediating effect	0.237	0.118	[0.015, 0.477]
MA → SN → PEA →PEI	Direct effect	0.74***(12.87)	0.189	[0.371, 1.115]
MA → PBC → PEA→PEI	Mediating effect	0.415	0.151	[0.122, 0.714]

Discussion

Previous literature has predominantly examined the motivation behind physical exercise among youth through lenses such as self-determination theory and social ecological models (Nogg et al., 2021; Solmon, 2015). However, these discussions merely scratch the surface of adolescent physical exercise motivation, offering a superficial synthesis from various perspectives without delving into the deeper underlying psychological mechanisms. This study, grounded in an evolutionary framework, identifies the evolutionary drivers underpinning physical exercise among adolescents, aiming to provide a more profound elucidation and comprehension of adolescent physical exercise behaviour. Notably, extant research has failed to conduct thorough explorations of the motivational mechanisms shaping physical exercise behaviour in adolescents. While some scholars have analysed factors influencing adolescent physical exercise behaviour and established corresponding analytical frameworks based on the theory of planned behaviour (Jekauc et al., 2015),

these frameworks overlook motivational factors, limiting their explanatory power.

Ajzen (2020) highlighted that an ideal theoretical model guiding exercise psychology research should possess several characteristics: (1) incorporation of multi-level theoretical constructs, as only multi-level theoretical structures demonstrate robust predictive capabilities for behaviour; (2) inclusion of both content-related and process-oriented theoretical constructs, acknowledging individual differences (content-related constructs) and theories elucidating the mechanisms underlying behaviour change (process-oriented constructs); (3) provision of clear and systematic operational definitions of constructs, ensuring interconnection among multiple constructs within a theoretical system through operational definitions. Building upon the theoretical framework of planned behaviour, this study integrates evolutionary motivation to construct a novel evolutionary motivation-planned behaviour framework model, enhancing the comprehensiveness and depth of understanding of adolescent physical exercise.

On this foundation, policymakers and educational institutions can devise novel policies and programs to promote physical exercise among youth, thereby facilitating the maintenance of a healthy physique amidst academic pursuits. Particularly, emphasis should be placed on the significance of physical exercise in evading harm, preventing disease, fostering social connections, and facilitating mate acquisition.

Theoretical and Practical Contributions

The research offers both theoretical and practical contributions. Theoretically, adopting an evolutionary psychology framework to elucidate the motivations driving adolescents' involvement in physical exercise yields several implications. Evolutionary psychology posits that certain behaviours and motivations can be interpreted as adaptations that have evolved over time to promote survival and reproductive success. Applying this perspective to adolescent physical activity engagement may reveal that motives such as social status attainment, mate attraction, and physical fitness enhancement are intertwined with evolutionary processes. This approach facilitates a deeper understanding of the underlying factors and influences shaping adolescents' participation in physical activity. Furthermore, it illuminates the evolutionary advantages of physical activity during the critical developmental phase of adolescence, thereby informing future research endeavours.

Understanding the evolutionary psychology behind adolescent participation in physical exercise can greatly benefit intervention and program design. By acknowledging the evolutionary drivers that influence adolescents' engagement in physical activity, interventions can be tailored to resonate with these intrinsic motivations. For instance, highlighting the social aspects of physical activity, such as team sports, may appeal to adolescents' desire for social status and acceptance. Additionally, framing physical fitness as a means to enhance attractiveness and reproductive fitness could be compelling. By aligning interventions with evolutionary motivations, it's possible to boost adolescents' motivation for physical exercise, leading to improved physical and mental well-being. This study also highlights the importance of recognizing psychological aspects of adolescence and increasing physical activity, which could inform psychology departments and contribute to promoting adolescent health.

Limitations and Future Directions

Despite its significant contributions, the study has several limitations that suggest potential avenues for future research. Firstly, employing an online survey raises concerns about self-selection bias, as participants who opt to participate may differ in characteristics or motivations from those who do not, impacting the findings' generalizability. Future studies could address this issue by utilizing a mixed-methods approach, combining online surveys with interviews or observations for a more comprehensive understanding of adolescent motivation for physical exercise.

Secondly, relying solely on self-report metrics in the online survey risks social desirability bias, where participants may provide responses aligned with social norms or researcher expectations rather than their true motivations. To mitigate this, future research could integrate objective measures like wearable fitness trackers or behavioural observations to complement self-reports and provide a more accurate portrayal of adolescents' physical activity levels and motivations.

Thirdly, while the study focuses on evolutionary psychology, it's important to recognize that other psychological and sociocultural factors also influence adolescent exercise behaviours. Future studies could adopt a more inclusive approach by integrating evolutionary psychology with other theoretical perspectives to gain a holistic understanding of motivational factors.

Additionally, while SEM is a robust statistical method, it comes with assumptions and restrictions. Future studies could explore alternative statistical methods like longitudinal analysis or latent class analysis to capture the

dynamic nature of adolescent motivation for physical activity and identify motivational profiles among adolescent subgroups. Lastly, the study's restriction to China, a developing country, limits its generalizability. Future research could explore other countries to broaden the applicability of findings.

Conclusion

This study developed a model for adolescent physical exercise incorporating evolutionary psychology and planned behaviour theory. Using questionnaires and structural equation modelling, the initial model and assumptions were tested, modified, and refined. Results revealed that four evolutionary motivations directly influenced adolescents' exercise intentions: evading harm, disease avoidance, affiliation (group), and mate acquisition. Evading harm directly impacted subjective norms and exercise attitudes, while disease avoidance influenced subjective norms and attitudes. Affiliation (group) directly affected subjective norms, attitudes, and perceived behavioural control, while mate acquisition impacted subjective norms, attitudes, and perceived behavioural control. Moreover, evading harm and disease avoidance indirectly influenced exercise intentions through subjective norms and attitudes, while affiliation (group) and mate acquisition indirectly affected exercise intentions through subjective norms, attitudes, and perceived behavioural control. Future research should focus on devising practical policies and measures to leverage evolutionary motivations and promote adolescent exercise behaviour.

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