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Relationship between physical activity and eudaimonic well-being in college students based on Ryff's six-factor model of psychological well-being

Zhanjia Zhang^{1*} , Jiajin Tong² , Zhonghui He¹ and Xin Qi¹

Abstract

Eudaimonic well-being, a key construct in positive psychology, is linked to both mental and physical health in college students. This study investigated how different intensities of physical activity (PA) correlate with multiple aspects of eudaimonic well-being among college students, using Ryff's six-factor model as a framework. A total of 1,131 undergraduate students (mean age = 19.74 years) completed questionnaires measuring different intensities of PA and various dimensions of eudaimonic well-being. Multiple regression analyses were performed to explore associations between varying PA intensities and the six dimensions of eudaimonic well-being, controlling for gender, age, and Body Mass Index. Moderate-intensity PA was the most consistent predictor of multiple dimensions of eudaimonic well-being, including environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance ($\beta = 0.09$ to 0.14 , p 's < 0.01). Vigorous-intensity PA demonstrated positive associations with positive relations with others, purpose in life, and self-acceptance ($\beta = 0.09$ to 0.10 , p 's < 0.01), whereas light-intensity PA was not significantly related to any dimensions of eudaimonic well-being (p 's > 0.05). Our findings suggest that the association between PA and eudaimonic well-being differs based on both the intensity of PA and the specific aspect of eudaimonic well-being. Future research should continue to explore why specific intensities of PA are associated with particular dimensions of eudaimonic well-being.

Keywords Physical activity, Eudaimonic well-being, College students

College students constitute a distinct demographic group, marked by their transition from adolescence to adulthood. This period is characterized by substantial changes and challenges, such as academic pressures, social dynamics, and personal development, with many are often living away from the comfort and familiarity of home for the first time [1]. Findings from the 2024 National College Health Assessment revealed that 34% of college students reported experiencing anxiety, while 25% reported depression [2]. The rising prevalence of mental health challenges among college students has increasingly concerned the public, administrators, researchers, and legislators, prompting

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universities to adopt diverse strategies aimed at mental health prevention within this group [3].

Research on mental health in college students has traditionally emphasized negative functioning, overlooking the positive dimensions and assuming that the absence of psychological distress signifies mental health [4]. As the importance of positive psychology has increasingly been recognized, positive dimensions of mental health, such as psychological well-being, have attracted growing interest from health psychology scholars [5]. In their groundbreaking work on positive psychology, Seligman and Csikszentmihalyi [6] advocated shifting the focus of mental health research from “only preparing the worst things in life to also building positive qualities.”

Hedonic well-being and eudaimonic well-being represent two contemporary frameworks highlighting the positive facets of psychological well-being [7]. The concept of hedonic well-being revolves around the pursuit of pleasure and satisfaction in life. It is commonly associated with experiencing high levels of positive affect and overall life satisfaction, while simultaneously maintaining low levels of negative affect [8]. Eudaimonic well-being, on the other hand, prioritizes the fulfillment of human potential and the pursuit of positive, meaningful functioning in life [9]. Although the specific conceptualization of eudaimonic well-being varies, Ryff's six-factor model is the most widely used framework for operationalizing it [10]. According to Ryff's perspective, eudaimonic well-being consists of six domains of positive psychological functioning, including (a) autonomy (i.e., the sense of self-determination and being independent), (b) environmental mastery (i.e., the capability to manage life's demands effectively and shape the external environment), (c) personal growth (i.e., the feeling of continuous growth and self-improvement), (d) positive relations with others (i.e., maintaining high-quality relationships with others), (e) purpose in life (i.e., belief that one's life is meaningful, goal-oriented, and driven by a sense of direction), and (f) self-acceptance (i.e., the positive self-regard and acceptance of one's past experiences).

Within the college student population, research on positive well-being has primarily focused on hedonic well-being, while studies on its eudaimonic counterpart are relatively scarce, despite evidence that hedonic and eudaimonic well-being are two distinct dimensions of well-being [11] and that the latter has stronger associations with health biomarkers than hedonic well-being [12]. Researchers have long been intrigued by the factors that contribute to well-being. Ryff and Singer [13] proposed that actively engaging in health behaviors may foster eudaimonic well-being.

As a modifiable health behavior, physical activity (PA) is characterized as “any bodily movement produced by the contraction of skeletal muscles that increases energy

expenditure above a basal level [14].” Engaging in regular PA is linked to numerous health benefits, including a lower risk of cardiovascular diseases, type 2 diabetes, and hypertension. It also improves cognitive performance and contributes to stronger muscles and bones [15]. While the benefits of PA on negative psychological symptoms (e.g., depression and anxiety) and hedonic well-being (e.g., positive emotions) are well-documented, our understanding of the link between physical activity and eudaimonic well-being is still in its early stages, as this area is notably underrepresented in existing well-being research [16]. A small but growing body of research has explored the association between these two factors in college students, but the findings are mixed. For example, while Lapa [17] observed that PA was positively related to self-acceptance and environmental mastery in college students in a cross-sectional study, Ferguson et al. [18] found that health-enhancing PA was not related to the total level of eudaimonic well-being among female college students. Therefore, further research on the association between PA and eudaimonic well-being in the college student population is warranted.

In previous studies, many have treated eudaimonic well-being as a single, holistic variable or focused solely on one of its components. Few studies have examined the relationship between PA and all six components of eudaimonic well-being simultaneously based on Ryff's six-factor framework. In addition, PA is a complex behavior encompassing various parameters, which are typically described using the FITT principle (frequency, intensity, time, and type). Past research, however, has often used total metabolic equivalent as the sole indicator of PA, which might limit our understanding of its comprehensive relationship with eudaimonic well-being.

Bringing these considerations together, the primary goal of this study was to explore the association between PA and eudaimonic well-being in greater detail based on Ryff's six-factor model. Specifically, we aimed to investigate how varying intensities of PA were related to six dimensions of eudaimonic well-being in a sample of college students. Self-Determination Theory (SDT) posits that PA facilitates a sense of competence, autonomy, and relatedness, which align well with the core components of eudaimonic well-being [19]. Previous research has also demonstrated that PA was positively associated with personal growth and purpose in life [20]. These findings suggest that engaging in PA may be positively associated with multiple components of eudaimonic well-being. In addition, intensity is a key parameter of PA, with research indicating that it may have distinct effects on both subjective well-being and eudaimonic well-being [21, 22]. Based on this, we expected that different intensities of PA would have varying relationships with the components of eudaimonic well-being. The comprehensive understanding of

the relationship between PA and eudaimonic well-being would contribute valuable insights into promoting positive mental health among college students.

Methods

Participants

The participants were 1,131 undergraduate students from a public university in Beijing, China. The participants had a mean age of 19.74 years ($SD = 1.37$), with females comprising 47.3% of the sample. The sample was relatively evenly distributed across the four academic years, with 25.0%, 23.8%, 23.3%, and 27.9% of participants in the first, second, third, and fourth years, respectively. The average height of participants in the sample was 1.70 m, and the average weight was 62.06 kg. In addition, none of them were student-athletes. After receiving ethical approval from the relevant institutional review board, participants were recruited through required courses offered to all students across the university. The authors visited classes to explain the purpose of this study and invite undergraduate students to participate. Participants were assured that their personal information would be kept confidential and that their names would not appear on any of the study measures. Upon signing an informed consent form, participants were instructed to fill out a series of questionnaires addressing both their PA and aspects of eudaimonic well-being. The survey was administered online using the platform Wenjuanxing, a widely used Chinese survey platform. Only complete questionnaires could be successfully submitted. Initially, 1,170 questionnaires were collected, and after excluding those with invalid responses (e.g., responses that did not follow the required format), data from 1,131 participants were included in the final analysis.

Measures

Physical activity

PA was assessed using the short version (7 items) of International Physical Activity Questionnaire (IPAQ-SF), a widely used instrument for estimating the weekly time of various intensities of PA [23]. Participants were instructed to report the number of days, hours, and minutes they engaged in vigorous-intensity PA, moderate-intensity PA, and light-intensity PA (indicated by walking) over the past week. Total minutes per week were calculated by multiplying the number of days and minutes per day of each intensity of PA, with higher minutes per week indicating a higher level of engagement in that particular intensity of PA. Positive associations between IPAQ-SF scores with objectively measured PA have been documented in diverse populations, including the Chinese population [24].

Eudaimonic well-being

The 18-item version of Ryff's Psychological Well-Being Scale (RPWB) was utilized to assess the indicators of eudaimonic well-being [25]. The RPWB consists of six subscales, each measuring one of the six components of eudaimonic well-being based on Ryff's six-factor model: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance, with each subscale comprising three items. Participants responded to each item using a 7-point Likert scale, ranging from 1 (strongly disagree) to 7 (strongly agree). Negatively phrased items were reverse-coded, and responses were summed to calculate a total score for each subscale, with higher scores reflecting greater levels of the corresponding eudaimonic well-being component. The RPWB has been shown to possess validity and reliability in studies conducted with the Chinese population [26]. In the present study, the subscales achieved acceptable levels of internal consistency, as indicated by Cronbach's alpha scores ranging from 0.70 to 0.78. Additionally, we conducted a Confirmatory Factor Analysis, which yielded model fit indices indicating an acceptable fit: Comparative Fit Index (CFI) = 0.909, Root Mean Square Error of Approximation (RMSEA) = 0.081, and Standardized Root Mean Square Residual (SRMR) = 0.060.

Covariates

As part of the covariates, participants reported their gender, age, height, and weight due to their known associations with PA and eudaimonic well-being [27, 28]. Participants' Body Mass Index (BMI) was determined by dividing their body weight in kilograms by the square of their height in meters (kg/m^2). These variables were accounted for in the analysis to reduce their potential confounding impact on the relationship between PA and eudaimonic well-being.

Statistical analysis

Descriptive statistics for all variables were calculated, with continuous variables presented as mean with standard deviation, and categorical variables as counts with percentage. The normality of numerical variables was assessed using skewness and kurtosis values, such that variables were considered normally distributed if skewness ranged from -2 to 2 and kurtosis from -7 to 7 [29]. Pearson bivariate correlations were utilized to examine the relationships among all numerical variables. To provide a more stable and reliable estimate of the relationship between variables, particularly given the large sample size, we conducted additional analyses using the bootstrap method to calculate confidence intervals for the correlation coefficients (presented in the supplementary file). The internal consistency of each RPWB subscale was evaluated using Cronbach's alpha [30].

Table 1 Summary of descriptive statistics

Variables	Mean or <i>n</i>	SD or %
Vigorous-intensity PA (min/week)	76.95	110.69
Moderate-intensity PA (min/week)	117.68	130.53
Light-intensity PA (min/week)	272.11	208.38
Autonomy	14.86	3.57
Environmental mastery	14.24	3.55
Personal growth	17.27	3.04
Positive relations with others	15.08	3.70
Purpose in life	14.96	4.20
Self-acceptance	14.47	3.83
Age (years)	19.74	1.37
BMI	21.44	3.45
Gender		
male	596	52.7%
female	535	47.3%

A set of multiple linear regression analyses was carried out to explore how varying intensities of PA relate to the six facets of eudaimonic well-being. In these models, each component of well-being served as a criterion variable, respectively. In each regression model, vigorous-intensity PA, moderate-intensity PA, and light-intensity PA were entered as predictor variables. These models controlled for age, gender, and BMI to account for their potential confounding effects. A potential concern when including vigorous, moderate, and light-intensity PA in the same model is multicollinearity. To evaluate multicollinearity, the variance inflation factor (VIF) was calculated, such that a VIF value less than 5 indicates low correlation among predictors and suggests no severe multicollinearity issues [31]. The significance level for all analyses was set at $p < 0.05$. All analyses were conducted using R (version 4.3), with initial data collation performed in an Excel file. Furthermore, given the large number of comparisons in our models, we applied the Bonferroni correction to control for the inflation of Type I error. The originally significant associations were not affected by this correction and remained statistically significant.

Results

Descriptive statistics and bivariate correlations

Descriptive statistics for PA with different intensities, dimensions of eudaimonic well-being, and covariates are presented in Table 1. The data indicated that the distributions of all numerical variables were normal, as the skewness and kurtosis were within acceptable ranges. Participants engaged in an average of 76.95 min per week of vigorous-intensity PA, 117.68 min per week of moderate-intensity PA, and 272.11 min per week of light-intensity PA. The mean scores for the six dimensions of eudaimonic well-being ranged from 14.24 for environmental mastery to 17.27 for personal growth. Overall, participants demonstrated moderate to high levels of eudaimonic well-being across all dimensions.

Bivariate correlations among numerical variables are showed in Table 2. Overall, the results demonstrated a pattern of small but significant positive relationships between PA and eudaimonic well-being. Specifically, moderate-intensity PA showed significant positive correlations with all dimensions of eudaimonic well-being, ranging from $r = 0.07$ to $r = 0.18$ (p 's < 0.05). Vigorous-intensity PA was not significantly correlated with personal growth ($r = 0.05$, $p = 0.079$), but did show significant positive correlations with the other dimensions ($r = 0.07$ to 0.15 , p 's < 0.05). In contrast, light-intensity PA was significantly correlated with autonomy ($r = 0.08$, $p = 0.007$) and environmental mastery ($r = 0.08$, $p = 0.006$), but not with the other dimensions of eudaimonic well-being.

Associations between PA and eudaimonic well-being

The standardized coefficients of the multiple regression models are summarized in Table 3. The results indicated no multicollinearity issues in any of the models, as the VIF values were all well below the threshold of 5. The regression models revealed various significant relationships between different intensities of PA and the six dimensions of eudaimonic well-being. Vigorous-intensity PA was significantly associated with positive

Table 2 Bivariate correlations among variables

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Vigorous-intensity PA (min/week)	-										
2. Moderate-intensity PA (min/week)	0.4***	-									
3. Light-intensity PA (min/week)	0.17***	0.22***	-								
4. Autonomy	0.07*	0.07*	0.08**	-							
5. Environmental mastery	0.11***	0.15***	0.08**	0.3***	-						
6. Personal growth	0.05	0.1***	0.02	0.25***	0.43***	-					
7. Positive relations with others	0.15***	0.16***	0.05	0.2***	0.59***	0.48***	-				
8. Purpose in life	0.13***	0.14***	0.05	0.3***	0.58***	0.52***	0.46***	-			
9. Self-acceptance	0.13***	0.18***	0.05	0.33***	0.73***	0.42***	0.63***	0.53***	-		
10. Age (years)	-0.07*	-0.06*	-0.01	0.01	0.02	-0.15***	-0.09**	-0.09**	-0.06	-	
11. BMI	0.02	0.01	0.03	-0.01	-0.07*	-0.04	-0.07*	-0.03	-0.07*	0.07*	-

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

Table 3 Associations (standardized coefficients with standard errors) between PA and Eudaimonic well-being indicators

Variables	Autonomy	Environmental mastery	Personal growth	Positive relations with others	Purpose in life	Self-acceptance
Vigorous-intensity PA (min/week)	0.032 (0.033)	0.053 (0.033)	0.024 (0.032)	0.103 (0.032) **	0.094 (0.033) **	0.071 (0.032) **
Moderate-intensity PA (min/week)	0.039 (0.033)	0.115 (0.033) ***	0.092 (0.032) **	0.121 (0.032) ***	0.105 (0.033) **	0.142 (0.032) ***
Light-intensity PA (min/week)	0.058 (0.030)	0.048 (0.030)	0.007 (0.030)	0.016 (0.030)	0.016 (0.030)	0.008 (0.030)
Gender	-0.185 (0.062) **	-0.037 (0.061)	0.210 (0.061) ***	0.101 (0.061)	0.098 (0.061)	-0.048 (0.061)
Age (years)	0.010 (0.030)	0.033 (0.030)	-0.132 (0.029) ***	-0.064 (0.029) *	-0.074 (0.030) *	-0.038 (0.029)
BMI	-0.032 (0.030)	-0.080 (0.030) **	-0.007 (0.030)	-0.062 (0.030) *	-0.014 (0.030)	-0.078 (0.030) **
R-squared	2.0%	3.4%	4.1%	4.8%	3.7%	4.4%
N	1131	1131	1131	1131	1131	1131

*: $p < 0.05$; **: $p < 0.01$; ***: $p < 0.001$

relations with others ($\beta = 0.103$, $p = 0.002$), purpose in life ($\beta = 0.094$, $p = 0.004$), and self-acceptance ($\beta = 0.071$, $p = 0.029$). Moderate-intensity PA showed significant positive associations with environmental mastery ($\beta = 0.115$, $p < 0.001$), personal growth ($\beta = 0.092$, $p = 0.005$), positive relations with others ($\beta = 0.121$, $p < 0.001$), purpose in life ($\beta = 0.105$, $p = 0.001$), and self-acceptance ($\beta = 0.142$, $p < 0.001$). Light-intensity PA did not show significant associations with any of the eudaimonic well-being dimensions. Regarding the covariates, gender and age had significant effects on certain dimensions of eudaimonic well-being such that females scored lower in autonomy ($\beta = -0.185$, $p = 0.003$) but higher in personal growth ($\beta = 0.210$, $p < 0.001$), while age was negatively associated with personal growth ($\beta = -0.132$, $p < 0.001$) and purpose in life ($\beta = -0.074$, $p = 0.012$). BMI was negatively associated with environmental mastery ($\beta = -0.080$, $p = 0.007$) and self-acceptance ($\beta = -0.078$, $p = 0.009$).

To better illustrate the positive correlations between vigorous-intensity PA and moderate-intensity PA and eudaimonic well-being dimensions, we divided participants into high and low PA groups based on tertiles. The differences in eudaimonic well-being dimensions between these two groups are visually represented in bar graphs, which can be found in the supplementary file.

Discussion

Understanding the factors that contribute to eudaimonic well-being in college students is crucial for promoting their overall physical and mental health. The current study was conducted to address the gap in the in-depth understanding of the relationship between PA and eudaimonic well-being among college students. Specifically, we used Ryff's six-factor model [10] as a framework to examine how different intensities of PA relate to various dimensions of eudaimonic well-being. Consistent with our hypothesis, the findings suggest that PA is linked to various dimensions of eudaimonic well-being, with the strength and nature of these relationships varying by PA intensity. Our study contributes to the literature by expanding our understanding of the nuanced

relationships between PA and different aspects of eudaimonic well-being.

Overall, the results indicated that engagement in PA was associated with higher levels of eudaimonic well-being. However, the relationship between PA intensity and its various dimensions differed, highlighting the complexity of these associations. Moderate-intensity PA appeared to be the most salient predictor of eudaimonic well-being, showing significant positive associations with environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. This suggests that moderate-intensity PA may be particularly associated with a broad range of well-being aspects. Vigorous-intensity PA, on the other hand, was a significant predictor of positive relations with others, purpose in life, and self-acceptance. Compared with moderate-intensity PA, vigorous-intensity PA was not associated with personal growth and environmental mastery. It is possible that the higher physical demands and intensity of vigorous PA may lead to increased negative experiences such as discomfort, fatigue, and pain [32, 33], which could counteract its benefits for certain aspects of eudaimonic well-being. Additionally, vigorous intensity PA might be less enjoyable or more difficult to maintain consistently [34], reducing its potential to foster personal growth and a sense of control over one's environment. In contrast, light-intensity PA did not show significant associations with any of the eudaimonic well-being dimensions. This finding suggests that light-intensity PA might not be sufficiently intensive to generate the physiological and psychological benefits needed to impact eudaimonic well-being.

Our results partially support previous findings on PA and well-being. A longitudinal study by Kim et al. [35] demonstrated that moderate-intensity PA was positively associated with eudaimonic well-being, whereas vigorous-intensity PA was not a significant predictor of it. While in another study [36], both moderate-intensity PA and vigorous-intensity PA were found to be positively associated with eudaimonic well-being. Our findings build on previous research by emphasizing that different

intensities of PA may influence eudaimonic well-being dimensions differently. Additionally, previous research has also examined the relationship between PA intensity and hedonic well-being, which is another common approach to conceptualize well-being, and have similarly shown that PA intensity affects hedonic well-being differently [22, 37]. Therefore, regardless of the aspect of well-being being investigated, PA intensity is a crucial factor to consider when examining the relationship between PA and well-being.

Despite the need for further research to fully understand why PA promotes eudaimonic well-being, it is likely that the experiences individuals have during PA and the health benefits derived from PA could serve as possible mechanisms. For instance, engaging in PA can induce positive affect [38], which has been identified as a significant and consistent antecedent of eudaimonic well-being [39]. A qualitative study by Ferguson et al. [18] provides further insight into the potential mechanisms through which PA contributes to eudaimonic well-being. Participants in the study indicated that PA contributed to goal setting and pursuit, fostered bonding experiences, promoted self-reflection, and supported the development of a strong and capable body. These aspects of the PA experience were inherently consistent with the definitions of various dimensions of eudaimonic well-being. For instance, goal setting and striving during PA were associated with personal growth and purpose in life, while bonding experiences contributed to positive relations with others. Future research should continue to explore the mechanisms in greater detail underpinning the relationship between PA and eudaimonic well-being, allowing for the development of more targeted interventions.

It is of note that although we found moderate-intensity PA and vigorous-intensity PA to be associated with certain dimensions of eudaimonic well-being, it explained only a small portion of the variance in the latter, as indicated by the low R-squared values. Additionally, there are currently no standards that dictate the meaningfulness of a significant association between PA and eudaimonic well-being. Despite this, we believe that these results can still be meaningful, as previous research has shown that even small changes in eudaimonic well-being can have profound effects on various health outcomes [40, 41]. Moreover, PA is a complex health behavior that encompasses various factors such as time, context, and type of activity [42]. Future research should explore these factors in more detail. For instance, Chatzisarantis and Hagger [43] found that engaging in recreational sports had a stronger association with eudaimonic well-being compared to participating in competitive sports. This suggests that different types of PA may also have varying impacts on eudaimonic well-being. Similarly, it is argued

that, compared to the quantity of PA, the quality of PA may have a greater impact on it [18].

Universities hold a critical responsibility in promoting the psychological well-being of students, as higher education should not only focus on academic achievement but also on the happiness and well-being of students [44]. Our findings have implications for policy and program development aimed at enhancing the psychological well-being of college students. University administrators and policymakers should create environments and programs that promote both moderate-intensity PA and vigorous-intensity PA. Encouraging consistent engagement in moderate-intensity PA is particularly important, as it has been shown to foster a broad range of well-being aspects, which, in turn, could contribute to the overall mental health of the college student population.

Limitations

It is important to acknowledge several limitations of this study. First, the current study adopted a cross-sectional design, which prevents us from determining the causality and directionality of the relationship between PA and eudaimonic well-being. Future research using longitudinal and experimental designs would help to explicate the causality and directionality of these relationships. Secondly, the sample in this study was drawn exclusively from college students in China, which restricts the applicability of the findings to university students in other cultural contexts. Additionally, the measurement of PA in the current study was based on self-report methods, which may introduce recall bias and social desirability bias. Although the IPAQ is widely used and has been validated for reliability and validity in various populations, it may still overestimate the actual PA levels of college students [45]. Therefore, future studies should utilize objective measures of PA, such as wearable devices and accelerometers, to provide more accurate assessments and a more detailed understanding of the relationship between PA and eudaimonic well-being. The strengths of our study include examining associations between different intensities of PA and various domains of eudaimonic well-being, representing a substantial first step in enhancing our understanding of the nuanced relationships between PA and these domains.

Conclusion

The current study conducted a comprehensive examination of the relationship between different intensities of PA and multi-dimensional eudaimonic well-being among college students. Our findings suggest that this relationship varies depending on the intensity of PA and the specific aspect of eudaimonic well-being. Notably, moderate-intensity PA was the most consistent factor associated with various dimensions of eudaimonic well-being,

including environmental mastery, personal growth, positive relations with others, purpose in life, and self-acceptance. This study contributes important evidence to the growing body of literature on the nuanced effects of PA intensity on different dimensions of eudaimonic well-being. University administrators and policymakers can use this evidence to enhance students' eudaimonic well-being by promoting and facilitating consistent engagement in moderate-intensity PA and vigorous-intensity PA. Future research should continue to explore the underlying mechanisms and explicate why specific intensities of PA are associated with particular dimensions of eudaimonic well-being.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s40359-025-02752-7>.

Supplementary Material 1

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Author contributions

Conceptualization: ZH. Data curation: ZZ and JT. Investigation: ZZ and XQ. Writing - original draft: ZZ.

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Data availability

The dataset analyzed during the current study can be retrieved from the public data repository OSF (<https://osf.io/n3qu7/>).

Declarations

Ethical approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The study protocol was approved by the Peking University Institutional Review Board (#20240408). Written informed consent was obtained from all participants.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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