



Physical activity as a protective factor against anxiety disorder among social media addicted adolescents: a multivariate analysis in Physical Education context

Actividad física como factor protector contra los trastornos de ansiedad en adolescentes con adicción a las redes sociales: un análisis multivariado en el contexto de la Educación Física

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Received: 15-04-26

Accepted: 30-04-26

How to cite in APA

Padillah, R., Setyosari, P., Hambali, I., Indreswari, H., Trisno, Z., Saputra, A. A., & Setiabudi, M. A. (2026). Physical activity as a protective factor against anxiety disorder among social media addicted adolescents: a multivariate analysis in Physical Education context. *Retos*, 80, 556-565. <https://doi.org/10.47197/retos.v80.119254>

Abstract

Introduction: The rapid growth of social media use among adolescents has been associated with increasing levels of anxiety disorders. Despite extensive research on digital addiction and mental health, limited attention has been given to the role of physical activity within Physical Education (PE) as a protective factor against anxiety in adolescents with social media addiction. **Objective:** This study aims to examine the relationship between social media addiction and anxiety disorder, and to investigate the protective role of physical activity within the Physical Education context.

Methodology: A cross-sectional design was employed involving 1,500 adolescents ($M_{age} = 15.42 \pm 1.67$ years). Data were collected using validated instruments measuring social media addiction, anxiety disorder, and physical activity levels. Statistical analyses included CFA, reliability testing, and SEM.

Results: Social media addiction significantly predicted anxiety disorder ($\beta = 0.48, p < .001$). Physical activity showed a significant negative association with anxiety ($\beta = -0.36, p < .001$) and acted as a moderating variable, weakening the relationship between social media addiction and anxiety disorder (β interaction = $-0.18, p < .001$). The model demonstrated good fit indices (CFI = 0.95; TLI = 0.94; RMSEA = 0.052; SRMR = 0.041).

Conclusions: Physical activity plays a significant protective role in reducing anxiety among adolescents with social media addiction. Integrating structured physical activity into Physical Education programs may serve as an effective strategy for promoting mental health in school settings.

Keywords

Physical activity; anxiety disorder; social media addiction; adolescents; physical education; mental health.

Resumen

Introducción: El rápido crecimiento del uso de las redes sociales entre los adolescentes se ha asociado con un aumento en los niveles de trastornos de ansiedad. A pesar de la abundante investigación sobre la adicción digital y la salud mental, se ha prestado una atención limitada al papel de la actividad física, en el contexto de la Educación Física (EF), como factor protector frente a la ansiedad en adolescentes con adicción a las redes sociales.

Objetivo: Este estudio tiene como objetivo examinar la relación entre la adicción a las redes sociales y los trastornos de ansiedad, así como investigar el papel protector de la actividad física en el contexto de la Educación Física.

Metodología: Se empleó un diseño transversal que involucró a 1.500 adolescentes ($M_{edad} = 15,42 \pm 1,67$ años). Los datos se recopilaron mediante instrumentos validados que midieron la adicción a las redes sociales, los trastornos de ansiedad y los niveles de actividad física. Los análisis estadísticos incluyeron Análisis Factorial Confirmatorio (AFC), pruebas de fiabilidad y Modelado de Ecuaciones Estructurales (SEM).

Resultados: La adicción a las redes sociales predijo significativamente los trastornos de ansiedad ($\beta = 0,48; p < ,001$). La actividad física mostró una asociación negativa significativa con la ansiedad ($\beta = -0,36; p < ,001$) y actuó como variable moderadora, debilitando la relación entre la adicción a las redes sociales y los trastornos de ansiedad (β de interacción = $-0,18; p < ,001$). El modelo presentó buenos índices de ajuste (CFI = 0,95; TLI = 0,94; RMSEA = 0,052; SRMR = 0,041).

Conclusiones: La actividad física desempeña un papel protector significativo en la reducción de la ansiedad entre adolescentes con adicción a las redes sociales. La integración de actividad física estructurada en los programas de Educación Física puede constituir una estrategia eficaz para promover la salud mental en el entorno escolar.

Palabras clave

Actividad Física; trastornos de ansiedad; adicción a las redes sociales; adolescentes; educación física; salud mental.



Introduction

The increasing penetration of digital technology has fundamentally transformed adolescents' daily lives, particularly through the widespread use of social media platforms (Khanal, 2025; McAlister et al., 2024; Rafla et al., 2014). While social media provides opportunities for communication, identity exploration, and social interaction, excessive use has been consistently associated with negative psychological outcomes, including anxiety disorders (Marano et al., 2025; Shoshani et al., 2024; Tahıllođlu et al., 2021; Ulvi et al., 2022), emotional dysregulation (Helvich et al., 2024; Weinstein, 2023), and decreased well-being (Indreswari et al., 2022; Szawarnoga et al., 2025; White-Gosselin & Poulin, 2024; Zacharias et al., 2026). Adolescents with high levels of social media addiction are particularly vulnerable to maladaptive processes such as social comparison (Burnell et al., 2024; F. Pikó et al., 2024; Feng et al., 2025), fear of missing out (FoMO) (Bloemen & De Coninck, 2020; Fabris et al., 2020; Younis et al., 2025; Zhang, 2025), and sleep disruption (Cal-Herrera et al., 2025; Celik & Güler, 2025; Lin et al., 2024; Ndubisi et al., 2025; Yu & Zhang, 2023), all of which contribute to heightened anxiety symptoms. Consequently, excessive social media use has emerged not only as a behavioral concern but also as a significant mental health issue among adolescents, highlighting the urgent need to identify protective mechanisms capable of reducing anxiety risks in the digital era.

From a theoretical perspective, the relationship between social media addiction and anxiety can be explained through the Compensatory Internet Use Theory, which suggests that individuals engage excessively in online activities to cope with negative emotions, ultimately reinforcing psychological distress (Kardefelt-Winther, 2014; Weidman et al., 2012). However, while risk factors have been widely documented, significantly less attention has been given to protective mechanisms that may mitigate these adverse effects.

In parallel, the stress-buffering hypothesis provides a relevant framework for understanding how certain behaviors or resources can reduce the negative impact of stressors on psychological outcomes. Within this framework, physical activity can be conceptualized as a potential buffering factor that attenuates the relationship between social media addiction and anxiety disorder.

Within the domain of sport pedagogy, Physical Education (PE) has evolved into a holistic educational field that integrates physical, cognitive, and emotional development (Indreswari et al., 2021; Lee & Sneed, 2026; Wang & Wang, 2022). Drawing on embodied cognition theory, movement-based experiences are understood to play a crucial role in shaping emotional regulation and psychological resilience (Kiverstein & Miller, 2015; Niedenthal, 2007). Furthermore, Self-Determination Theory (SDT) highlights how physical activity can fulfill basic psychological needs autonomy, competence, and relatedness there by enhancing well-being and reducing vulnerability to anxiety (Dalipe et al., 2025; Sturm et al., 2020).

To establish a more comprehensive explanatory model, these theoretical perspectives are interconnected within the present study. Compensatory Internet Use Theory explains how excessive social media engagement may increase adolescents' vulnerability to anxiety, while Self-Determination Theory clarifies how physical activity may enhance psychological well-being through the fulfillment of basic psychological needs. In addition, the stress-buffering hypothesis provides the conceptual basis for understanding how physical activity may weaken the negative psychological effects of social media addiction. Together, these theories form an integrated framework explaining both the risk and protective mechanisms underlying adolescent anxiety in the digital era.

Although physical activity has been widely recognized for its mental health benefits, most studies have treated it as an independent predictor rather than a dynamic protective mechanism within the context of behavioral addiction. This represents a critical gap in the literature, particularly in the digital era, where adolescents face increasingly complex psychological risks.

This study goes beyond traditional associations by proposing a protective mechanism model in which physical activity functions as a psychological buffer against digital behavioral addiction. Specifically, this research introduces a digital-era psychological resilience model that integrates social media addiction, physical activity, and anxiety disorder within the Physical Education context.

Therefore, this study addresses the following research gaps:



- Limited theoretical integration of behavioral addiction and physical activity within Physical Education research
- Lack of empirical models examining buffering mechanisms in digital-related psychological risks
- Insufficient evidence on the role of physical activity as a resilience factor, rather than merely a predictor

Based on the theoretical framework and previous empirical findings, the following hypotheses were proposed:

- H1: Social media addiction positively predicts anxiety disorder among adolescents.
- H2: Physical activity negatively predicts anxiety disorder among adolescents.
- H3: Physical activity moderates the relationship between social media addiction and anxiety disorder, such that higher levels of physical activity weaken the positive association between social media addiction and anxiety.

Building on these theoretical perspectives, this study integrates Compensatory Internet Use Theory, Self-Determination Theory, and the stress-buffering hypothesis into a unified conceptual framework. Social media addiction is conceptualized as a behavioral risk factor that increases vulnerability to anxiety (Ding & Ma, 2025; Nan et al., 2024), while physical activity is positioned as a psychological resource that fulfills basic psychological needs (Dunton et al., 2023; Gråstén et al., 2021; Shangguan et al., 2025). Furthermore, drawing on the stress-buffering hypothesis, physical activity is proposed to function as a moderating mechanism that attenuates the negative impact of social media addiction on anxiety. Therefore, this study advances a digital-era psychological resilience model, in which physical activity operates not only as a direct predictor but also as a buffering mechanism within the Physical Education context.

Method

Research Design

This study employed a quantitative cross-sectional design to examine the relationships among social media addiction, physical activity, and anxiety disorder within a natural school setting.

Participants

A total of 1,500 adolescents aged 13–18 years participated in the study. Participants were recruited using stratified random sampling from public and private secondary schools in Indonesia to ensure proportional representation across gender, school type, and educational level. The inclusion criteria were: (1) adolescents aged between 13 and 18 years, (2) actively enrolled in junior or senior secondary schools, and (3) active users of social media platforms for at least the previous six months. The exclusion criteria included students with diagnosed severe psychiatric disorders, incomplete questionnaire responses, or absence during the data collection period. Elimination criteria were applied to questionnaires with substantial missing data (>10%) or patterned responses indicating low response validity.

Table 1. Demographic Characteristics of Participants

Variable	Category	n	%
Gender	Male	720	48%
	Female	780	52%
Age (years)	Mean (SD)	15.42 (1.67)	—
School Type	Public	870	58%
	Private	630	42%
Education Level	Junior Secondary	780	52%
	Senior Secondary	720	48%

Instruments



All constructs were measured using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree).

Social Media Addiction

Social media addiction was measured using the Social Media Addiction Scale adapted from adolescent digital addiction instruments developed in previous behavioral addiction studies. The scale consisted of 6 items measuring compulsive social media engagement, emotional dependence, and loss of behavioral control. Previous studies demonstrated satisfactory validity and reliability across adolescent populations. The instrument underwent translation and back-translation procedures to ensure cultural and linguistic suitability for Indonesian participants. The scale employed a single-factor structure.

Anxiety Disorder

Anxiety disorder was assessed using an adolescent anxiety instrument adapted from standardized anxiety assessment measures. The instrument consisted of 7 items assessing excessive worry, nervousness, emotional tension, and anxiety-related symptoms. Previous validation studies supported its construct validity and reliability in adolescent populations. The Indonesian version was culturally adapted using expert judgment and pilot testing procedures. The instrument demonstrated a unidimensional factorial structure.

Physical Activity

Physical activity was measured using the Physical Activity Questionnaire for Adolescents (PAQ-A) developed by Kowalski et al. The scale consisted of 8 items evaluating moderate-to-vigorous physical activity performed during the previous seven days, including sports participation, exercise frequency, and daily movement engagement. Previous cross-cultural studies demonstrated good psychometric properties among adolescent populations. The Indonesian adaptation showed acceptable reliability and construct validity. The instrument employed a single-factor structure.

Table 2. Measurement Instruments and Psychometric Properties

Variable	Instrument	Sample Item	α
Social Media Addiction	Social Media Addiction Scale	"I feel anxious when I cannot access my social media accounts."	0.91
Anxiety Disorder	Anxiety Disorder Instrument	"I often feel nervous or worried without a clear reason."	0.89
Physical Activity	PAQ-A	"During the last 7 days, how often did you engage in physical activity?"	0.87

Validity and Reliability

Confirmatory Factor Analysis (CFA) indicated a good model fit.

Table 3. Model Fit Indices

Fit Index	Value	Recommended Threshold	Interpretation
CFI	0.95	> 0.90	Good Fit
TLI	0.94	> 0.90	Good Fit
RMSEA	0.052	< 0.08	Acceptable
SRMR	0.041	< 0.08	Good Fit

All constructs met reliability and convergent validity criteria:

Table 4. Reliability and Validity Metrics

Construct	Cronbach's Alpha	CR	AVE
Social Media Addiction	0.91	0.93	0.68
Anxiety Disorder	0.89	0.91	0.64
Physical Activity	0.87	0.88	0.56

Procedure

Data were collected during regular school hours under teacher supervision. Prior to participation, all adolescents and their parents or legal guardians received informed consent forms explaining the study



objectives, confidentiality procedures, voluntary participation, and the right to withdraw at any time without consequences.

Questionnaires were administered anonymously within classroom settings and completed within approximately 25–30 minutes to reduce response bias and improve data accuracy.

This study adhered to the ethical principles outlined in the Declaration of Helsinki concerning research involving human participants.

Data Analysis

Data analysis was conducted using SPSS and AMOS software. The following statistical procedures were applied:

Table 5. Data Analysis Techniques

Analysis Method	Purpose
Descriptive Statistics	To summarize participant characteristics and variables
Pearson Correlation	To examine relationships among variables
Structural Equation Modeling	To test hypothesized relationships
Moderation Analysis	To examine interaction effects

Ethical Clearance

This study was approved by Research Ethics Committee, Community Service, and Publication Ethics Committee of the Universitas PGRI Banyuwangi-Indonesia.

Results

Psychometric Properties

All instruments demonstrated strong internal consistency and construct validity.

Table 6. Standardized Factor Loadings and Reliability

Construct	Item	Loading	CR	AVE
Social Media Addiction	SMA1	0.78	0.93	0.68
	SMA2	0.82		
	SMA3	0.85		
	SMA4	0.81		
Anxiety Disorder	ANX1	0.76	0.91	0.64
	ANX2	0.80		
	ANX3	0.83		
	ANX4	0.79		
Physical Activity	PA1	0.72	0.88	0.56
	PA2	0.75		
	PA3	0.78		
	PA4	0.74		

All factor loadings exceeded the recommended threshold (> 0.70), indicating satisfactory convergent validity. No items were removed during the CFA procedure because all items met the recommended loading criteria and contributed adequately to construct reliability.

Descriptive Statistics and Correlations

Table 7. Means, Standard Deviations, and Correlations

Variable	Mean	SD	1	2	3
1. Social Media Addiction	3.45	0.68	—		
2. Anxiety Disorder	3.21	0.74	0.52***	—	
3. Physical Activity	2.87	0.71	-0.29***	-0.41***	—

*** $p < .001$

The results indicated a moderate positive correlation between social media addiction and anxiety disorder ($r = 0.52$), suggesting that higher levels of social media addiction were associated with higher anxiety symptoms. Physical activity demonstrated moderate negative correlations with anxiety disorder ($r = -0.41$) and low-to-moderate negative correlations with social media addiction ($r = -0.29$), indicating that higher physical activity levels were associated with lower anxiety and lower social media addiction tendencies.

Structural Equation Model

Table 8. Structural Model Results

Path	B	SE	t-value	p-value	Interpretation
Social Media Addiction → Anxiety	0.48	0.05	9.60	< .001	Moderate-to-strong effect
Physical Activity → Anxiety	-0.36	0.04	-9.00	< .001	Substantial protective effect

Table 9. Structural Model Fit Indices

Fit Index	Value	Recommended Threshold
χ^2/df	2.84	< 3.00
CFI	0.95	> 0.90
TLI	0.94	> 0.90
RMSEA	0.052	< 0.08
SRMR	0.041	< 0.08

The Structural Equation Modeling (SEM) analysis demonstrated that social media addiction significantly predicted anxiety disorder, while physical activity significantly predicted anxiety disorder in a negative direction.

Based on the proposed hypotheses:

- H1 was supported because social media addiction significantly predicted anxiety disorder.
- H2 was supported because physical activity significantly and negatively predicted anxiety disorder.

Moderation Analysis

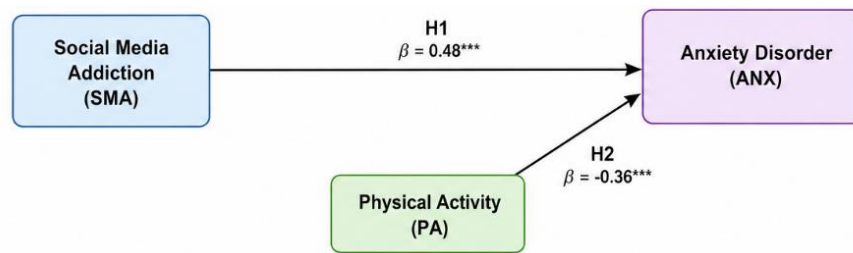
Table 10. Moderation Effect

Interaction Term	β	SE	t-value	p-value
Social Media Addiction × Physical Activity → Anxiety	-0.18	0.03	-6.00	< .001

The interaction effect was statistically significant, indicating that physical activity moderates the relationship between social media addiction and anxiety disorder. Specifically, higher levels of physical activity weaken the positive association between social media addiction and anxiety. This finding supports the buffering role of physical activity, consistent with the stress-buffering hypothesis.

Figure 1 illustrates the structural relationships among social media addiction, physical activity, and anxiety disorder within the proposed conceptual model. The model demonstrates that social media addiction positively predicts anxiety disorder, indicating that higher levels of problematic social media use are associated with increased anxiety symptoms among adolescents. In contrast, physical activity negatively predicts anxiety disorder, suggesting that adolescents who engage more frequently in physical activity tend to report lower levels of anxiety. The figure also presents the standardized path coefficients obtained from the Structural Equation Modeling (SEM) analysis, supporting the hypothesized relationships proposed in the study.

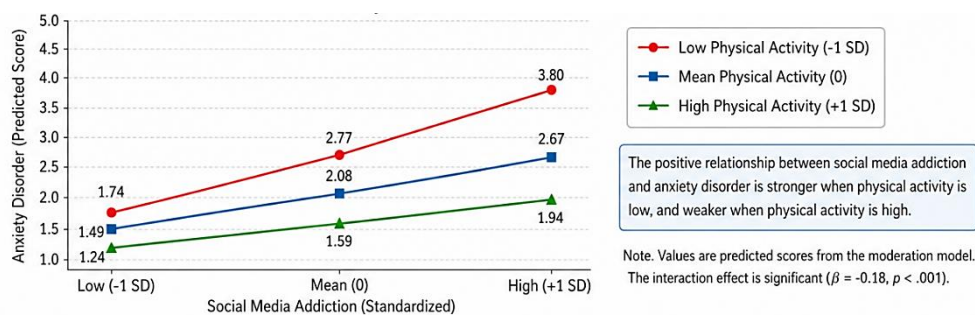
Figure 1. Structural Equation Model of the Hypothesized Relationships



Note. *** $p < .001$. H1: Social Media Addiction positively predicts Anxiety Disorder
H2: Physical Activity negatively predicts Anxiety Disorder

Figure 2 presents the moderation effect of physical activity on the relationship between social media addiction and anxiety disorder. The graph demonstrates that the positive association between social media addiction and anxiety disorder is stronger among adolescents with lower levels of physical activity. Conversely, among adolescents with higher levels of physical activity, the relationship between social media addiction and anxiety becomes weaker. This pattern indicates that physical activity functions as a buffering or protective factor that attenuates the negative psychological impact of excessive social media use. The findings support the stress-buffering hypothesis, suggesting that engagement in physical activity may enhance adolescents' psychological resilience against digital-related stressors.

Figure 2. Moderating Effect of Physical Activity on the Relationship Between Social Media Addiction and Anxiety Disorder



Discussion

The findings of this study provide robust empirical evidence that social media addiction significantly increases anxiety levels among adolescents. This result is consistent with previous international studies that have identified excessive digital engagement as a key risk factor for psychological distress, particularly due to mechanisms such as social comparison, fear of missing out (FoMO), and sleep disruption. The magnitude of the effect ($\beta = 0.48$) indicates a moderate-to-strong relationship, suggesting that social media addiction is a substantial predictor of anxiety disorder in adolescent populations rather than a peripheral factor.

More importantly, this study extends prior research by demonstrating that physical activity functions not only as a direct protective factor but also as a moderating mechanism. The negative association between physical activity and anxiety ($\beta = -0.36$) aligns with a large body of literature highlighting the mental health benefits of physical activity. However, unlike previous studies that primarily focused on direct effects, this study demonstrates a significant interaction effect ($\beta = -0.18$), indicating that physical activity attenuates the strength of the relationship between social media addiction and anxiety.

This finding supports the stress-buffering hypothesis, which proposes that protective resources can reduce the negative effects of psychological stressors. In addition, the findings are consistent with Self-Determination Theory, suggesting that engagement in physical activity may fulfill adolescents' needs for autonomy, competence, and relatedness, thereby supporting emotional well-being.

The present study also strengthens the relevance of embodied cognition theory within the context of adolescent mental health. Embodied cognition proposes that bodily movement and emotional processes are interconnected. In the context of Physical Education, movement-based activities may facilitate emotional regulation, stress reduction, and adaptive coping responses through direct bodily engagement. Therefore, physical activity is not merely a physiological behavior but also a psychologically embodied process that may contribute to resilience against anxiety associated with digital behavioral addiction.

From a theoretical perspective, this study contributes by integrating Compensatory Internet Use Theory, Self-Determination Theory, stress-buffering theory, and embodied cognition into a unified conceptual framework explaining both risk and protective mechanisms in adolescent anxiety. At the same time, the results support the Compensatory Internet Use Theory, suggesting that adolescents with higher levels of anxiety may engage in excessive social media use as a maladaptive coping strategy (Heriansyah et al., 2024;)(Hidayah et al., 2022; Junaedi et al., 2022; Kadafi et al., 2021; Khusumadewi et al., 2021; Rangka et al., 2023). Physical activity, therefore, serves as a healthier alternative regulatory mechanism. Methodologically, this study contributes through the use of Structural Equation Modeling and moderation analysis within a large adolescent sample to examine complex psychological relationships in the digital era. Practically, the findings highlight the importance of integrating structured physical activity into Physical Education programs as a school-based mental health promotion strategy for adolescents.

From a sport pedagogy perspective, these findings reinforce the pedagogical role of Physical Education as a platform for psychological intervention. Unlike purely clinical approaches, Physical Education provides a structured, accessible, and socially interactive environment in which students can develop emotional regulation, resilience, and social connectedness through movement-based activities. This positions Physical Education not merely as a domain for physical fitness, but as a strategic context for promoting mental health in the digital era.

Furthermore, this study contributes to the growing global discourse on the integration of Physical Education and mental health promotion. While previous research has emphasized either psychological or physical domains in isolation, this study offers an integrative perspective by demonstrating how movement-based interventions can address contemporary challenges associated with digital lifestyles.

Limitations

Despite its contributions, this study has several limitations. First, the cross-sectional design limits the ability to draw causal inferences regarding the relationships among variables. Future studies employing longitudinal or experimental designs are needed to establish causality. Second, the use of self-report measures may introduce response bias, particularly in assessing social media use and physical activity levels. Third, this study was conducted within the Indonesian context, which may limit the generalizability of the findings to other cultural settings. Future research should explore cross-cultural comparisons to validate the proposed model.

Practical Implications

The findings of this study have several important implications:

- 1) Physical Education curricula should integrate structured, mental health-oriented physical activities that promote emotional regulation and resilience
- 2) Schools should actively promote physically active lifestyles to counterbalance excessive screen time and sedentary behavior
- 3) Teachers should incorporate movement-based strategies that support psychological well-being within classroom and PE settings
- 4) Policymakers should support the development of school-based physical activity programs as preventive interventions for adolescent mental health.

Conclusions



This study introduces a digital-era psychological resilience model in which physical activity functions as a buffering mechanism against anxiety disorder among adolescents with social media addiction. The findings provide strong empirical support for re-conceptualizing physical activity not only as a health behavior but also as a critical psychological resource. In the context of increasing digital engagement, integrating structured physical activity into Physical Education represents a strategic and scalable approach to enhancing adolescent mental health. By positioning Physical Education within the broader framework of mental health promotion, this study highlights its relevance in addressing contemporary psychological challenges. Future research should extend this model through longitudinal and intervention-based studies to further validate the causal mechanisms and expand its applicability across diverse cultural contexts.

Acknowledgements

Researchers with the Indonesian Education Scholarship, Center for Higher Education Funding and Assessment, and Indonesian Endowment Fund for Education (BPI Number 202209090617). Doctoral Scholarship Program for Indonesian Lecturers, Center for Higher Education Funding and Assessment, and Ministry of Higher Education, Science and Technology of Republic Indonesia, (BPDDI Number 202508110865).

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