The relationship between physical training, mental health, and nutrition on the performance of soccer athletes

La relación entre el entrenamiento físico, la salud mental y la nutrición en el rendimiento de los deportistas de fútbol

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How to cite in APA

Lahinda, J., Isyani, I., Gilang Permadi, A., & Rasyid, A. (2025). The relationship between physical training, mental health, and nutrition on the performance of soccer athletes. *Retos*, *70*, 957–974.
https://doi.org/10.47197/retos.v70.117067

Abstract

Introduction and Objective. This study used a quantitative approach with the support of two computer programs, namely, VOSviewer and SmartPLS 4, to analyze the relationship between physical training and mental health of football players" and "nutrition for the performance of football players". From the Scopus database, this study collected 21 documents for the first keyword and 58 documents for the second.
Methodology. The study population was formed by 36 samples extracted using a simple random sampling technique to guarantee a good representation of the different subgroups. This minimum sample size was chosen so that the results of the investigation were reliable and generalizable.
Results. The results of the analysis showed that all variables supported the initial hypothesis, with a high indicator validity. The external model showed that the Mental Health indicator had excellent load values, above the threshold of 0.7, while the Nutrition and Physical Exercise indicators also showed valid results.
Conclusions. The test (AVE) confirmed that all constructs met the validity criteria, with values greater than 0.5.

Keywords

Physical training, mental health, nutrition, performance, soccer athletes.

Resumen

Introducción y Objetivo. Este estudio utilizó un enfoque cuantitativo con el apoyo de dos programas informáticos, a saber, VOSviewer y SmartPLS 4, para analizar la relación entre Entrenamiento físico Salud mental de los deportistas de fútbol» y «Nutrición para el rendimiento de los deportistas de fútbol. De la base de datos Scopus, este estudio recopiló 21 documentos para la primera palabra clave y 58 documentos para la segunda.
Metodología. La población del estudio estaba formada por 36 muestras extraídas mediante una técnica de muestreo aleatorio simple para garantizar una buena representación de los distintos subgrupos. Se eligió este tamaño mínimo de muestra para que los resultados de la investigación fueran fiables y generalizables.
Resultados. Los resultados del análisis mostraron que todas las variables apoyaban la hipótesis inicial, con una elevada validez de indicador. El modelo externo mostró que el indicador de Salud Mental tenía excelentes valores de carga, por encima del umbral de 0,7, mientras que los indicadores de Nutrición y Ejercicio Físico también mostraron resultados válidos.
Conclusiones. La prueba (AVE) confirmó que todos los constructos cumplían los criterios de validez, con valores superiores a 0,5.

Palabras clave

Entrenamiento físico, salud mental, nutrición, rendimiento, atletas de fútbol.

Introduction

Football is one of the most popular sports in Papua, with many young people involved in football activities.(Suryo Putro et al., 2025),There is great potential to produce talented athletes in this area, but to achieve optimal performance, athletes need to pay attention to three main aspects,(García-De Frutos et al., 2025), physical training, mental health, and nutrition. These three elements play an important role in supporting the success of athletes on the field.(Castro-Infantes et al., 2024),Regular physical training is the foundation for developing a successful soccer player. Through systematic training, athletes can improve the muscle strength, endurance, and technical skills necessary for the game.(Wasa et al., 2024),In Papua, challenges often arise regarding access to adequate training facilities. Therefore, it is crucial to create effective training programs that can be adapted to local conditions.(Nur Akhiroh & Yudhistira, 2025),Various types of training need to be applied to improve athlete performance.(Putro et al., 2023),Aerobic exercise, strength training, and technique should be incorporated into any training program. Interval training, for example, is crucial for improving speed and endurance, which are essential in the fast-paced game of soccer.(Hidayah et al., 2024),Coaches in Papua must be able to adapt this type of training to suit the local geographic and climatic conditions. This naturally impacts mental health and significantly impacts athlete performance.

Pressure to achieve success from oneself or the environment can affect mental balance.(Orr et al.,2025),So creating an environment that supports mental health is very important.(Rausch et al., 2025),Coaches and the community need to play an active role in providing emotional support and strategies to overcome the stress experienced by athletes.(Kurak et al., 2024), So relaxation techniques such as meditation and yoga are needed to help athletes manage stress and increase focus.(Delfin et al., 2024),In addition, social support from family, friends, and teammates also plays an important role in maintaining the mental health of athletes.(Shi et al., 2025),A positive social environment will increase the motivation and self-confidence of athletes when competing.(Oliveira et al., 2017),In Papua, challenges related to access to nutritious food can be a barrier. Therefore, it is important to create programs that focus not only on physical training but also educate athletes about the importance of good nutrition and how to access healthy food sources locally.(Iio et al., 2025),Balanced nutrition is another aspect that is no less important in supporting athlete performance.(Subalatha et al., 2025),Proper intake of carbohydrates, proteins and fats is necessary to provide sufficient energy during training and matches.(Anam et al., 2024),In Papua, understanding of good nutrition needs to be improved, especially among young athletes, so they can optimize their performance on the field.(Wati et al., 2024),Healthy eating habits that include consuming vegetables, fruits, and quality protein sources are very important for athletes.(Wibowo et al., nd, 2024),Athletes in Papua have abundant local resources, and utilizing these resources can help create a nutritious diet. The role of the coach is very important in integrating physical exercise, mental health, and nutrition into the training program.(Tassi et al., 2024),Coaches need the knowledge and skills to create holistic and effective programs. Those who understand the importance of these three aspects will be better able to motivate and guide athletes in developing their soccer abilities.(Chaari et al., 2025),The environment in Papua, with its unique geographic and social conditions, also influences the implementation of training and nutrition programs. Understanding the local context can help coaches and athletes tailor their strategies. For example, the availability of food and sports facilities must be taken into account in planning an effective program.(Munro & Baransano, 2023),The success of Papuan football athletes can provide valuable insights into how these three aspects contribute to the performance of Papuan football athletes.(Permana, 2017),On the other hand, the lack of contribution from local governments also requires an active role in improving sports facilities and health education. Programs involving schools and local sports organizations can assist in this effort. Investment in sports facilities and training programs is crucial to improving the quality of athletes in Papua. Collaboration between the government, coaches, athletes, and the community is crucial to creating an ecosystem that supports the development of soccer athletes. Synergy between various parties will accelerate the achievement of goals in the sport, providing greater opportunities for athletes to succeed at the local and national levels.

Bibliometric Analysis

VOSviewer visualization results, on the key interconnected findings, with the topic of Physical Training Mental Health Soccer Athletes, by color findings. The blue cluster, the most dominant, includes keywords such as "human experiment," "mental health," and "athlete." This indicates a strong focus on athlete mental health, especially in the context of experiments or research exploring how competitive pressure and expectations can affect psychological well-being.(Paucar Uribe et al., 2025),This type of research is crucial, given that many athletes face significant stress, which can lead to mental health issues, including depression and anxiety. The red and purple clusters focus on athlete injuries, with keywords like "injury," "athletic injury," and "procedure."(Plakias, 2025),This shows that research focuses not only on mental health, but also on the physical aspects of athlete health. And the keywords "soccer", "female", and "competition game" indicate that there is an emphasis on certain sports, especially football, as well as the participation of female athletes.(Plakias et al., 2024),This trend represents an effort to understand the unique experiences of female athletes in competition, which often differ from those of male athletes. Further research in this area is crucial to creating a better environment for athletes to address the challenges they face.

Figure 1. Results of VOSviewer visualization, main interconnected, with the topic Physical Training Mental Health Soccer Athletes

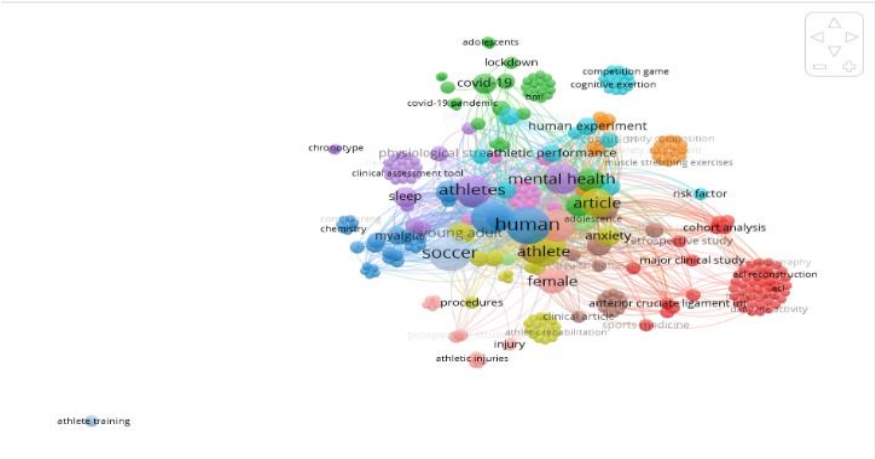


Figure 2 explains the visualization results of the keyword network generated by VOSviewer, illustrating the relationships in research related to mental health, athlete performance, and factors affecting athlete well-being.(Escamilla-Fajardo et al., 2020),In this analysis, we can identify several key interconnected themes, which provide important insights into research trends in this area. One of the most striking clusters is the blue one, which includes keywords such as "mental health," "questionnaire," and "human."(You et al., 2021),This demonstrates a strong research focus on mental health, with the use of instruments such as questionnaires to collect data on individual psychological well-being, particularly among athletes. Research on mental health is becoming increasingly important, particularly as many athletes face significant stress in their careers.(Lachowicz et al., 2025),In the green Cluster includes terms such as "athlete performance", "physiological stress", and "quality of life. And the Cluster shows attention to demographic factors, including "female", "adult", and "young adult". This reflects the effort for research in the field of athlete health.

Figure 2. Visualization results of the keyword network generated by VOSviewer from 2021-2025

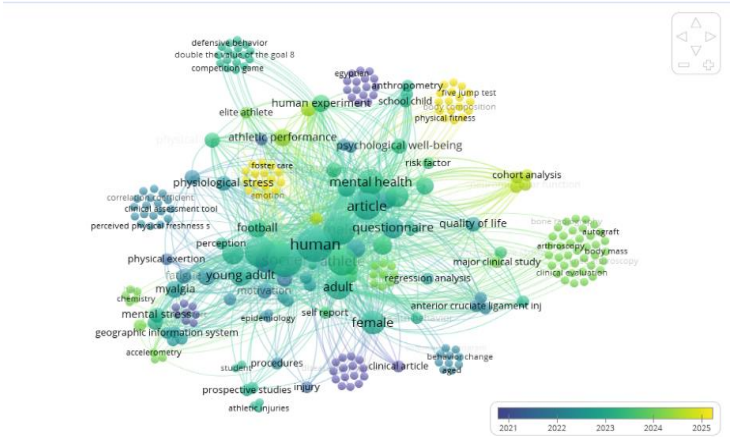


Figure 3: Heatmap visualization showing the concentration of keywords in research related to mental health, athlete performance, and factors affecting well-being. In this map, yellow and orange colors indicate areas of high concentration, indicating that these topics have been extensively researched and are a focus of attention. One of the main keywords that emerged was "mental health," indicating that mental health was a major focus of this research.(Liu et al., 2022),With data. Keywords like "soccer" and "athlete" indicate that much research focuses on specific sports, particularly soccer, and how athletes' mental health is impacted within this sport. This is crucial for understanding the unique challenges athletes face in this discipline. Other significant clusters include terms like "young adult," "adult," and "female."

Figure 3. Results of heat map visualization showing the concentration of keywords in research related to mental health in Football

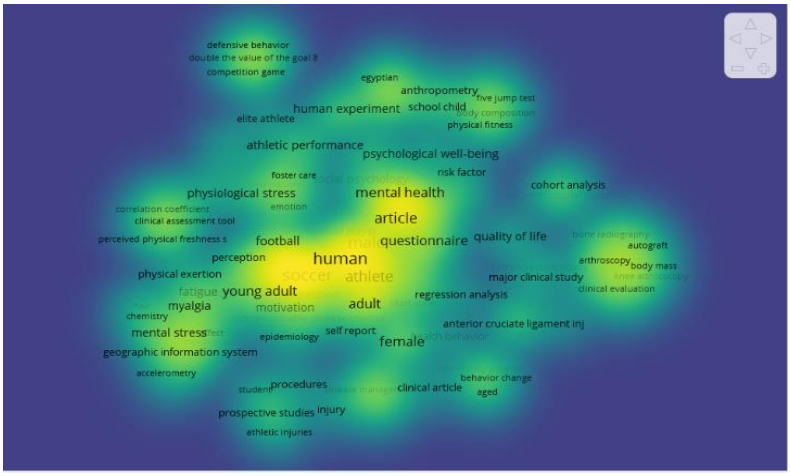


Figure 4 shows the visualization of the Nutrition on the Performance of Soccer Athletes keyword network, which illustrates the relationships between various research topics on nutrition and soccer athlete performance. From this visualization, we can identify several key themes related to how nutrition affects athlete performance. One of the most striking clusters is the red one, with the primary keywords "soccer," "football," and "human." This indicates that the primary focus of the research is on soccer athletes, highlighting the importance of understanding the factors that influence their performance, particularly in the context of nutrition. Another visible cluster is the blue one, with terms such as "body composition," "diet," and "nutrition." The terms "randomized controlled trial," and "questionnaire" indicate that many studies used robust methodologies to collect data, both through experiments and surveys.

This demonstrates the seriousness with which nutrition interventions can be effectively measured.(Liu et al., 2022),With data. Keywords like "soccer" and "athlete" indicate that much research focuses on specific sports, particularly soccer, and how athletes' mental health is impacted within this sport. This is crucial for understanding the unique challenges athletes face in this discipline. Other significant clusters include terms like "young adult," "adult," and "female."

Figure 4. Results of heat map visualization showing the concentration of keywords in research related to mental health.

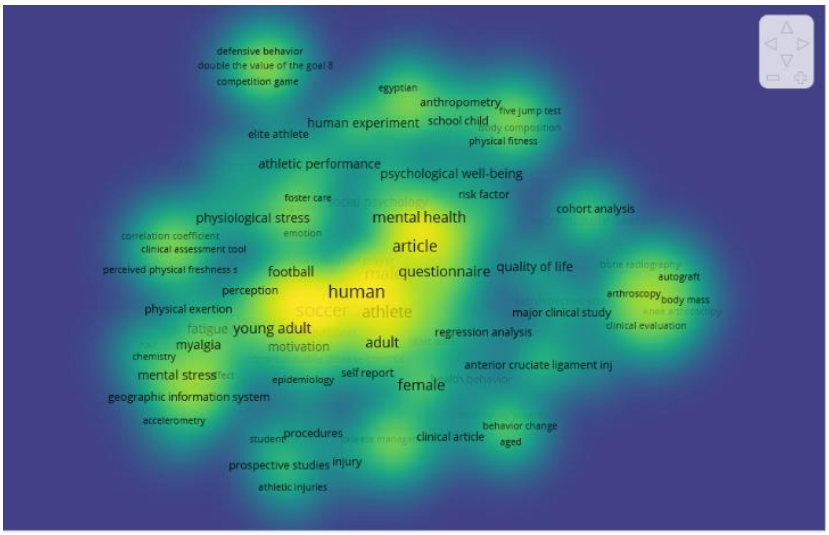


Figure 5 shows the results of the VOSviewer keyword network visualization of Nutrition on Animals, which shows the keyword network in research related to nutrition and soccer athlete performance. From this analysis, we can identify key themes that provide insights into how nutrition affects athlete performance.(Dobrowolski et al., 2020),Clusters with keywords such as "training," "recovery," and "female player" indicate attention to training and recovery aspects, ser ,And the main cluster seen in green, with keywords such as "soccer," "football," and "human," indicates that the research focus is on soccer athletes. This illustrates the importance of understanding the various factors that influence athlete performance in the context of this sport, especially related to proper nutritional intake. The findings of the yellow cluster include terms such as "body composition," "diet," and "nutrition." And keywords such as "randomized controlled trial" and "questionnaire" indicate that many studies use robust methods to enable nutritional interventions, this indicates that researchers strive to generate valid and reliable data on the effects of nutrition on athlete performance. So other clusters containing terms such as "training," "recovery," and "female player" indicate attention to training and recovery aspects, as well as a focus on female athletes.

Figure 5. Visualization results using VOSviewer showing the keyword network in nutrition-related research from 2020 to 2025

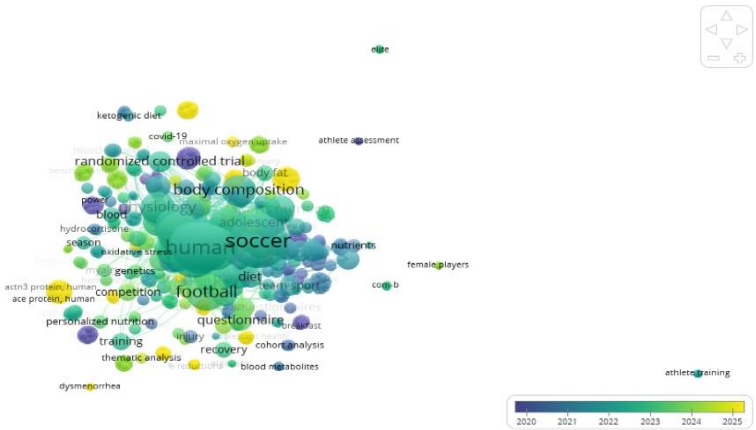
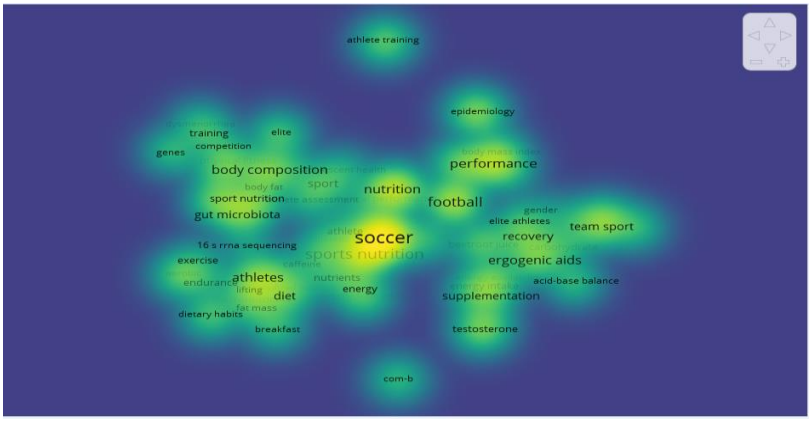


Figure 6 shows the results of the heat map findings showing the concentration of keywords in research on nutrition and performance of soccer athletes.(B. Liu et al., 2023),From the findings of this visualization, we can identify several key themes that are highly relevant to the research. The keyword "soccer" which appears in yellow reflects the main focus of this research, confirming that many studies focus on soccer athletes. This shows the importance of understanding how various nutritional factors can contribute to athlete performance in this sport. And the green cluster which includes terms such as "sports nutrition", "performance", and "nutrition" shows that this research is not only limited to nutritional aspects, but also how nutrition directly affects athlete performance.(Cherappurath et al., 2024),This aspect is crucial because proper nutrition can improve endurance, strength, and recovery, all of which are crucial for soccer athletes. Keywords such as "body composition," "ergogenic aids," and "supplementation" indicate a growing interest in how body composition and supplement use can contribute to performance. This reflects a trend in the sport where many athletes are seeking ways to optimize their nutritional intake through specific supplements and dietary strategies. Cluster results with the keywords "training," "recovery," and "competition" indicate that research is also paying attention to training and recovery. This is important because good recovery and a proper training program are closely linked to athlete performance, and nutrition plays a key role in both. Overall, this heatmap provides a clear picture of trends in nutrition research for soccer athletes.

Figure 6. shows the heat map findings showing the concentration of keywords in research on nutrition and athlete performance.



Method

This research method uses a quantitative approach with the support of two software, namely VOSviewer and SmartPLS 4. This study analyzed two keywords: "Physical Exercise Mental Health of Football Athletes", which produced 21 documents, and "Nutrition on the Performance of Football Athletes", with 58 documents from the Scopus database. (https://www.scopus.com/)

Population and Sample

The study population comprised approximately 36 samples drawn using simple random sampling techniques to ensure good representation of various subgroups. The sample size of 36 respondents was chosen to ensure the reliability and generalizability of the research results.(Kampling et al., 2025).

Operational Definition of Variables

This research uses quantitative methods to examine certain groups or samples.(Karakayali, 2025),Data collection is carried out using research instruments, which are then calculated numerically.(Carlini et al., 2025)This research focuses on exploring various factors which can be described as follows:

Independent Variables

1) X1: Mental Health Measures an individual's level of psychological well-being, including aspects such as stress, anxiety, and life satisfaction. This variable focuses on how mental health affects an athlete's performance.

2) X2: Nutrition Refers to diet and nutrient intake that influence an athlete's health and performance. This includes the quality of food consumed, nutritional balance, and the effectiveness of the diet in supporting physical activity.
3) X3: Physical Exercise Measures the type, intensity, and frequency of exercise performed by athletes. This variable focuses on how a physical exercise program contributes to an athlete's mental health and performance.
4) Y5: Valid assesses the effectiveness and results of an athlete's activities, including competitive performance, physical ability, and endurance. This variable describes how well an athlete can apply mental health, nutrition, and physical training to their performance.

Types and Methods of Data Collection

The data collection process in this study was carried out through the following steps:

1) Survey Delivery: Data was collected by sending an online survey, where respondents were asked to fill out a questionnaire containing questions related to the research variables.
2) In-depth Interviews: In addition to the survey, in-depth interviews were also conducted to obtain richer and more detailed information from respondents. These interviews aimed to explore respondents' perceptions and experiences regarding mental health, nutrition, and physical exercise.
3) Data Processing: After the data were collected from the survey and interviews, the analysis process was carried out using SmartPLS 4. This software is used to analyze the relationship between variables through the Structural Equation Modeling (SEM) approach, which allows researchers to deploy the built model and test the established hypotheses.
4) Measurement scale: The scale used as the basis for measurement is the Likert scale which consists of five categories of answer choices:

- Strongly Agree (SS)
- Agree (S)
- Neutral (N)
- Disagree (TS)
- Strongly Disagree (STS)

Data were collected through a structured questionnaire that assessed the following components:

1) Quality of Physical Training
2) Mental Health of Athletes
3) Athlete Nutrition

This questionnaire was designed to measure the influence of physical training and nutrition on the mental health and performance of soccer athletes in Papua.

Data analysis

VOSviewer is used to search and analyze findings from the Scopus database. The results from VOSviewer provide a clear visualization of the relationship between physical training, mental health, and nutrition in the context of soccer athletes.(Ejaz et al., 2022; Ozanne et al., 2025),With this visualization, researchers can identify patterns, trends, and relationships between the variables studied.

SmartPLS 4

SmartPLS 4 was used for data analysis using a Structural Equation Modeling (SEM) approach. This tool allows researchers to test and validate relationships between constructs in a more complex manner, as well as to highlight the influence of various factors, such as the quality of physical training and nutrition, on mental health and athlete performance.

Reliability Test

The consensus test aims to assess the internal consistency of the instruments used in research. An instrument is considered to have good reliability if its Cronbach's Alpha value exceeds 0.70. Here's a further explanation:

Alpha Scale

- Cronbach's Alpha values range from 0 (zero) to 70 (seventy). The higher the alpha value, the stronger the internal consistency between items in the instrument.

Reliability Testing Criteria

- IfRT≥Rr_t \geq rRT≥Rtable, then the instrument is considered reliable.
- If RT<Rr_t < rRT<Rtable, then the instrument is considered unreliable.

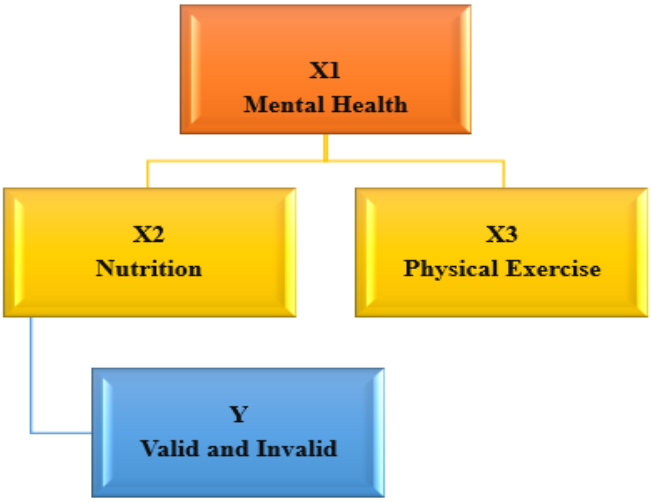
Value Range

- Ralpha's *R* value above 0.70 to 0.80 is classified as reliable or has good consistency.
- Values above 0.80 to close to 1.00 indicate that the instrument is very reliable or has a very high level of reliability.

Results

Data Analysis with Smart PLS-SEM.

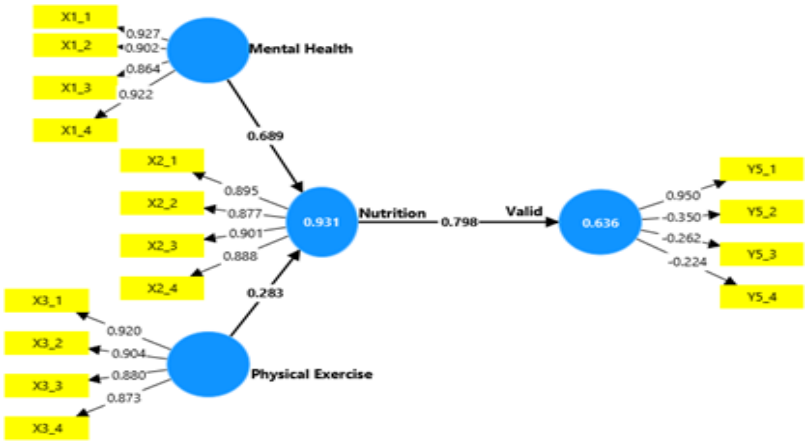
Figure 7. Research Framework



Exterior Model

The outer model focuses on the relationship between latent variables and indicators. Testing the outer model aims to ensure that the instruments used to measure the latent variables have good validity and reliability. There are three main types of testing in the outer model, as seen in the Outer Loading Results of the Convergent Validity Test Stage 1 and Figure 1.

Figure. 8 Outer Loading Results of Convergent Validity Test Stage 1



Outer loading value Stage 1

The output of the outer loading estimation results is measured by the correlation between the indicator (instrument) score and the construct (variable). Indicators are considered valid if they have a correlation value above 0.7, or 0.6 is considered sufficient. Indicators that do not meet this requirement must be discarded. The convergence results in this study can be seen in Table 1.

Table 1. Outer Loading Results of Convergent Validity Test Stage 1

XY	Mental Health	Nutrition	Physical Exercise	Valid and Invalid
X1_1	0.927			
X1_2	0.902			
X1_3	0.864			
X1_4	0.922			
X2_1		0.895		
X2_2		0.877		
X2_3		0.901		
X2_4		0.888		
X3_1			0.920	
X3_2			0.904	
X3_3			0.880	
X3_4			0.873	
Y5_1				0.950
Y5_2				-0.350
Y5_3				-0.262
Y5_4				-0.224

The output of the Loading Factor value for the outer loading value is the estimated result that measures the correlation between the indicator (instrument) score and the construct (variable) in the study. An indicator is considered valid if it has a correlation value above 0.7, while a value above 0.6 is considered sufficient. If there are indicators that do not meet this requirement, they must be removed to ensure data validity. Table 1 shows the convergent results for the variables Mental Health, Nutrition, and Physical Exercise, where each indicator has a loading value that indicates how strong the relationship between the indicator and its construct is. For example, indicator X1_1 has a value of 0.927, indicating a very strong relationship with Mental Health. However, in variable Y5, several indicators show negative values, such as Y5_2 (-0.350), Y5_3 (-0.262), and Y5_4 (-0.224), indicating that these indicators are invalid and need to be removed. And then, the outer loading test Stage 2 needs to be conducted.

Outer loading value Stage 2

Figure 9. Outer Loading Results of Convergent Validity Test Stage 2

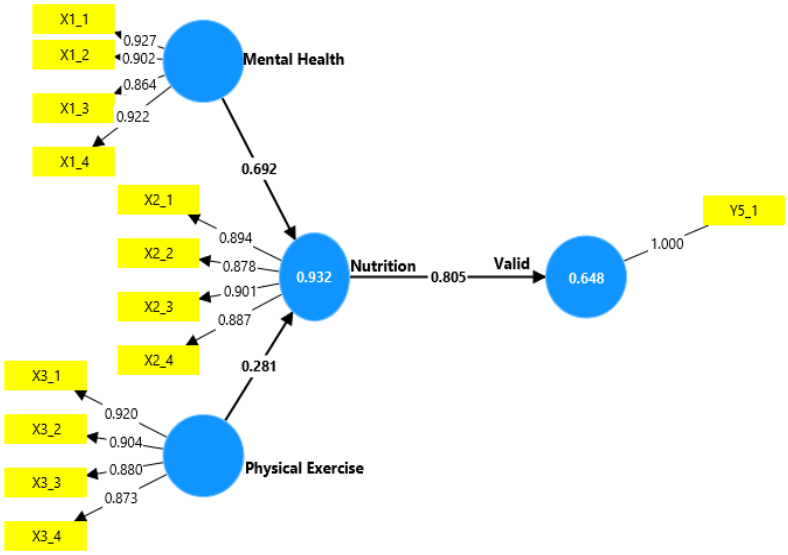


Table 2. Outer Loading Results of Convergent Validity Test Stage 2

XY	Mental Health	Nutrition	Physical Exercise	Valid
X1_1	0.927			
X1_2	0.902			
X1_3	0.864			
X1_4	0.922			
X2_1		0.894		
X2_2		0.878		
X2_3		0.901		
X2_4		0.887		
X3_1			0.920	
X3_2			0.904	
X3_3			0.880	
X3_4			0.873	
Y5_1				1,000

Table 2 presents the outer loading results used to test convergent validity in the second stage. In this table, each value indicates the strength of the relationship between the indicator and its construct. Indicators for the Mental Health variable (X1) show high values, all above 0.7, indicating that they are valid. For the Nutrition variable (X2), although most indicators also show good values, some are close to the minimum limit. Indicators for the Physical Exercise variable (X3) are within the valid range, indicating a strong relationship with the construct. Furthermore, indicator Y5_1 recorded a perfect score of 1.000, indicating a very strong and valid relationship.

Average variance extracted (AVE)

The output of the Average Variance Extraction (AVE) estimation results can be seen in Table 3. In this analysis, a variable is considered valid if it has an AVE value above 0.5. AVE measures how much variance in an indicator can be explained by the construct in question. In other words, a high AVE value indicates that the construct is able to explain most of the variance in its indicator, which is one of the important criteria in determining construct validity. Therefore, it is important to examine the AVE value of each variable to ensure that all constructs in this study meet the required validity criteria.

Table 3. Average Variance Extracted (AVE)

Variables	Average variance extracted (AVE)	Description
Mental Health	0.817	Valid
Nutrition	0.792	Valid
Physical Exercise	0.800	Valid

The Average Variance Extracted (AVE) estimation results for the variables in this study indicate that all constructs meet the validity criteria. As seen in Table 3, the Mental Health variable has an AVE value of 0.817, while the Nutrition variable reaches 0.792, and the Physical Exercise variable records a value of 0.800. All of these values are above the threshold of 0.5, indicating that each variable is able to explain more than half of the variance in its indicators. Thus, these three variables can be considered valid and suitable for further analysis in this study.

Cross-lending

Cross-loading is a method for determining validity indicators in research. An indicator or statement is declared valid if the relationship between it and its construct is stronger than the relationship with other constructs. Data processing results using SmartPLS show cross-loading values for each variable, namely Mental Health, Nutrition, and Physical Exercise. Higher cross-loading values for relevant constructs indicate that these indicators are reliable and valid. This can be seen in Table 4. Cross-loading Validity Test.

Table 4. Results of Cross-Lending Validity Test

XY	Mental Health	Nutrition	Physical Exercise	Valid
X1_1	0.927	0.850	0.839	0.842
X1_2	0.902	0.883	0.877	0.835
X1_3	0.864	0.861	0.866	0.645
X1_4	0.922	0.884	0.903	0.825
X2_1	0.836	0.894	0.830	0.656
X2_2	0.885	0.878	0.866	0.733
X2_3	0.886	0.901	0.831	0.745
X2_4	0.815	0.887	0.845	0.727
X3_1	0.846	0.826	0.920	0.737
X3_2	0.899	0.883	0.904	0.863
X3_3	0.825	0.821	0.880	0.705
X3_4	0.876	0.857	0.873	0.762
Y5_1	0.871	0.805	0.859	1,000

The results of the cross-loading validity test indicate that the relationship between the indicators and their constructs is higher than the relationship with other constructs. In the analysis conducted using SmartPLS, the cross-loading value for the Mental Health indicator (X1) showed significant results, where the X1_1 indicator had the highest value of 0.927, followed by X1_2 with a value of 0.902 and X1_4 with a value of 0.922. The Nutrition indicator (X2) also showed good values, with X2_1 reaching 0.894 and X2_3 at 0.901. Meanwhile, for the Physical Exercise indicator (X3), X3_1 recorded a value of 0.920, indicating a strong relationship with the construct. Overall, all indicators showed higher cross-loading values on the relevant constructs, with the Y5_1 indicator even recording a perfect value of 1.000. This confirms that the indicators used in this study are valid and reliable for further analysis.

Latent Variable Correlation Test

Latent Variable Correlation is part of the steps to examine discriminant validity, examining the extent of the relationship between constructs in the model. High correlations between constructs can indicate discriminant validity and multicollinearity issues. The estimation results are shown in Table 5 as follows.

Table 5. AVE Results of Convergent Validity Test

Variables	Mental Health	Nutrition	Physical Exercise	AVE	√AVE	Valid
Mental Health	1,000	0.962	0.964	0.817	0.903	0.871
Nutrition	0.962	1,000	0.948	0.792	0.890	0.805
Physical Exercise	0.964	0.948	1,000	0.800	0.894	0.859

The results of the Average Variance Extracted (AVE) analysis for the convergent validity test indicate that all constructs in this study meet the established validity criteria. In the table presented, the Mental Health construct has an AVE value of 0.817, while Nutrition recorded a value of 0.792, and Physical Exercise reached 0.800. The √AVE value for each construct shows a good number, with Mental Health at 0.903, Nutrition 0.890, and Physical Exercise 0.894. All of these values indicate that these constructs can explain the variance in their indicators well, confirming that the three variables are valid for use in further analysis. Overall, these results provide confidence that the model used in this study has adequate validity.

Fornell-Larcker

Fornell-Larcker can be used effectively to check whether the constructs in the PLS model have good discrimination. If the value below is greater than the correlation value in the same row, it is considered Valid, whereas if √AVE is not greater than the value in the same row, then the description is Invalid. can be seen in table 6 below as follows.

Table 6. Fornell-Larcker

Variables	Mental Health	Nutrition	Physical Exercise	Valid
Mental Health	0.904			
Nutrition	0.962	0.890		
Physical Exercise	0.964	0.948	0.895	
Valid	0.871	0.805	0.859	1,000

The results of the analysis using the Fornell-Larcker criteria indicate discriminant validity for the constructs in the PLS model. In the table presented, the √AVE value for Mental Health is 0.904, which is greater than the correlation value with other constructs. For Nutrition, the √AVE value of 0.962 is also greater than the correlation value with Mental Health and Physical Exercise, indicating that the Nutrition construct is also valid. Meanwhile, Physical Exercise recorded an √AVE value of 0.964, which is higher than the correlation value with the other two constructs. Overall, all √AVE values show adequate validity, with the validity value of each construct is 0.871 for Mental Health, 0.805 for Nutrition, and 0.859 for Physical Exercise. These results confirm that all constructs in the model have good discrimination and are reliable for further analysis.

Construct Reliability

Construct Reliability can be analyzed in one of two ways: Cronbach's Alpha and Composite Reliability. Both are used to test the reliability of indicators in a variable, as shown in Table 7.

Table, 7. Construct Reliability

Variables	Cronbach's alpha	Description
Mental Health	0.925	Reliable
Nutrition	0.913	Reliable
Physical Exercise	0.917	Reliable

The results of the Construct Reliability analysis indicate that all variables in this study have a high level of certainty, as measured by the Cronbach's Alpha value. For the Mental Health variable, the Cronbach's Alpha value reached 0.925, indicating that this variable is highly reliable. Similarly, the Nutrition variable showed a value of 0.913, which is also classified as good in terms of internal consistency. Meanwhile, the Physical Exercise variable recorded a value of 0.917, indicating that its indicators are reliable in measuring the construct. Overall, all Cronbach's Alpha values above 0.9 indicate that this third variable has very good reliability, in providing confidence that the measuring instrument used in this study is able to produce consistent and accurate data.

Composite Reliability

Composite Reliability is used to ensure the internal consistency of the indicators that form the latent variables. In Smart PLS analysis, Composite Reliability is the main tool for measuring reliability, and a CR value ≥ 0.7 is considered to meet the standards for research as seen in Table 8 as follows.

Table. 8 Construct Reliability

Variables	Composite reliability(rho_c)	Description
Mental Health	0.947	Reliable
Nutrition	0.938	Reliable
Physical Exercise	0.941	Reliable

The results of the Composite Reliability analysis indicate that all variables in this study have a very good level of efficiency. For the Mental Health variable, the Composite Reliability value reached 0.947, indicating that this construct is highly reliable. Similarly, the Nutrition variable recorded a value of 0.938, and the Physical Exercise variable reached 0.941. All of these values are well above the threshold of 0.7, indicating that the indicators that make up each of these variables are consistent and mutually supportive in measuring the intended construct. Thus, these results provide confidence that the measuring instrument used in this study can be relied upon to produce valid and consistent data.

Model Fit Test

The model fit test was carried out by looking at the output estimation results from SmartPLS version 4.0 and comparing them with the criteria as explained in the following table 9.

Table 9. Model Fit Test Results

Parameter	Rule of Thumb	Parameter Value	Description
SRMR	Smaller than 0.10	0.064	Fit
d_ULS	≤ 0.05	0.368	Fit
d_G	≤ 0.05	1,340	Fit
Chi-square	≤ χ^2 table statistics	277,084 26,296	Fit
NFI	Approaching Value 1	0.713	Fit
GOF	Small GOF 0.1, (Model is not good,0.25) GOF Big 0.803,(The model is very good)	0.803	Fit
Q^2 Predictive Relevance	Q^2 > 0 Has predictive relevance. The model is able to predict data well. Q^2 < 0 Lacks predictive relevance Q^2 prediction Nutrition 0.922 Valid 0.751	Nutrition (0.922): This value indicates that the model has very good predictive ability for nutritional variables. Valid (0.751): This value shows that the model also has good predictive ability for variable validity.	Fit

The model fit test results indicate that the model constructed according to the obtained data has a very good fit. Based on the output estimation results from SmartPLS version 4.0, all analyzed parameters gave positive results. The SRMR value of 0.064, which is smaller than the threshold of 0.10, indicates that the model fits well. In addition, the d_ULS and d_G values, although slightly higher than 0.05, still support the model's suitability. Chi-square shows a significant result with a value of 277.084, far above the table statistic of 26.296, while the NFI is close to 1, namely 0.713, indicating a good fit. The GOF reaches 0.803, indicating that the model is very good. Finally, the Q^2 Predictive Relevance value for the Nutrition variable of 0.922 indicates excellent predictive ability, while the validity value of 0.751 also indicates good predictive ability for the validity of the variable. Overall, these results provide confidence that the model built is reliable for further analysis and is able to provide accurate insights in this study.

Discussion

This study, the use of simple random sampling technique with 36 aims to ensure good representation of various subgroups.(Lohne et al., 2025),Selecting a sufficiently large sample size is very important to

ensure that the research results can be generalized.(Look et al., 2025)This measure also allows researchers to obtain more accurate and reliable results, which are key in the analysis of Mental Health, Nutrition, and Physical Exercise variables. Data analysis was conducted using SmartPLS,4, which provides the ability to explore the relationships between latent variables in more depth. This approach is very appropriate because it allows for comprehensive model testing, from validity to reliability of the constructs used.(Al-Bukhrani et al., 2025)The analysis results show that all variables support the initial hypothesis, indicating that the model developed is appropriate for the research context. The outer model tested in this study focuses on the relationship between latent variables and the indicators used to measure them. This testing is important to ensure that the measuring instrument used is valid and reliable. The outer loading results in the first stage show that all indicators for the Mental Health variable have very good loading values, above the threshold of 0.7. This indicates that these indicators are able to accurately reflect the construct being measured, which is a primary requirement in quantitative research. In the second stage, the outer loading results again indicate the validity of the indicators. Although there are several indicators of the Y5 variable that show negative values, this indicates that these indicators are invalid and need to be removed from the model. Removing invalid indicators is crucial to maintaining data integrity, which in turn will ensure more accurate research results. This step also demonstrates the researcher's attention to the quality of the data produced.

The Average Variance Extracted (AVE) analysis value is 0.817, while Nutrition recorded a value of 0.792, and Physical Exercise reached 0.800. The √AVE value for each construct shows a good number, with Mental Health at 0.903, Nutrition 0.890, and Physical Exercise 0.894 indicating that all constructs meet the required validity criteria. With the AVE value for Mental Health, Nutrition, and Physical Exercise above the AVE of 0.817, while Nutrition recorded a value of 0.792, and Physical Exercise reached 0.800. The √AVE value for each construct shows a good number, with Mental Health at 0.903, Nutrition 0.890, and Physical Exercise 0.894 it can be concluded that these constructs are able to explain the variance in their indicators well. This shows that the model built in this study has a strong and reliable basis for further analysis. This high validity also gives researchers confidence that the results obtained are representative.(Khan et al., 2025)Cross-loading analysis provides a clear picture of the validity of the indicators. Each indicator shows a higher value on the relevant construct, indicating that the indicator can be relied upon to measure the intended construct.(Sobaih & Elshaer, 2022),This validity test is important to ensure that the cross loading results for the Mental Health indicator (X1) show significant results, where the X1_1 indicator has the highest value of 0.927, followed by X1_2 with a value of 0.902 and X1_4 with a value of 0.922. The Nutrition indicator (X2) also shows a good value, with X2_1 reaching 0.894 and X2_3 at 0.901. Meanwhile, for the Physical Exercise indicator (X3), X3_1 recorded a value of 0.920, indicating a strong relationship with the construct obtained not only statistically valid, but also relevant in the practical context of the study. , Thus, researchers can be more confident in using these indicators in future research.

The Latent Variable Correlation Test is the next important step in examining discriminant validity between constructs. The analysis results show that all constructs have √AVE values greater than the correlation values in the same row.(Sobaih & Elshaer, 2022)This indicates that there is no multicollinearity problem in the model, so each construct can be considered unique and separate. Good discriminant validity is key to ensuring that each measured variable truly reflects the intended aspect in the research context. The Fornell-Larcker criterion used to examine the discriminant construct also showed satisfactory results. All √AVE values indicate adequate validity, providing confidence that the tested constructs are reliable for further analysis. With these results, researchers can proceed with confidence that the model built has a sufficiently high analytical power, which is very important in answering the research questions. From the reliability analysis using Cronbach's Alpha and Composite Reliability, it shows that all variables have a very good level of certainty. Values above 0.9 for all constructs indicate that the indicators that make up each variable have strong internal consistency. This is an important indicator that the data collected can be trusted for further analysis, and that the research results are reliable. The results of the model fit test indicate that the built model has a very good fit with the data obtained. The SRMR value, which is less than 0.1, along with other results such as the NFI and GOF, which indicate good fit, provide additional evidence of the model's reliability. This indicates that the model can effectively predict the relationships between variables, thus making a meaningful contribution to understanding the interactions between Mental Health, Nutrition, and Physical Exercise. The Q^2 Predictive Relevance value for the Nutrition variable, which reached 0.922, indicates that this model has excellent

predictive ability. This means that the model is not only relevant in the current context but also has the potential to be used in future research or for practical applications in the health and sports fields. This high predictive ability makes the model a valuable tool in the development of health interventions and programs.

The results of this study provide strong confidence that the developed model is reliable for further analysis. This research not only adds insight into the relationship between Mental Health, Nutrition, and Physical Exercise, but also can serve as an important reference in developing intervention programs to improve athlete health and performance. With a robust data-driven approach, this study significantly contributes to the understanding of factors influencing overall athlete health and performance. Thus, these findings underscore the importance of a data-driven approach in developing health and wellness programs. Through the use of appropriate analytical methods, researchers can provide evidence-based recommendations to improve athletes' mental and physical health. This will have a positive impact on overall sports performance, while also helping to create a healthier environment for athletes.

Ethics Committee Statement

The publication ethics used in this research refer to The Committee on Publication Ethics (COPE) and Regulation of the Head of LIPI Number 5 of 2014 concerning the Code of Ethics for Scientific Publications, Regulation of the Minister of Research, Technology and Higher Education of the Republic of Indonesia Number 9 of 2018 concerning Accreditation of Scientific Journals.

Conflict of Interest Statement

The authors declare no conflict of interest related to this article.

Funding

This research was funded by three major institutions in Indonesia, namely Lembaga Pengelolah Dana Pendidikan (LPDP), https://lpdp.kemenkeu.go.id/ and Beasiswa Pendidikan Indonesia (BPI), https://beasiswa.kemdikbud.go.id/.as well as the Center for Higher Education Assessment and Funding (PPAPT), https://puslapdik.dikdasmen.go.id/.

Data Availability Statement

The data is available upon request to the author of the correspondence, as this is specific information about soccer Athletes in Papua Indonesia.

Acknowledgements

I would like to express my deepest gratitude to, Lembaga Pengelolah Dana Pendidikan, (LPDP), and Beasiswa Pendidikan Indonesia (BPI) for their tremendous support throughout my educational journey, as well as the Center for Assessment and Financing of Higher Education (PPAPT). Without their help, I would not have been able to achieve my academic and research goals. (BPI), not only gave me the opportunity to continue my studies, but also allowed me to explore new insights in the fields of education and research. And thank you also to the Papuan Football Athletes who have contributed to this research, and this assistance has opened up many opportunities for my self-development, and I hope to contribute to a better Indonesian education.

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