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Unlocking the Science of Physical Endurance: Training Techniques and Biological Factors
Descubriendo la ciencia de la resistencia física: Técnicas de Entrenamiento y Factores Biológicos

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Abstract. This study examines the many elements influencing endurance performance in university students, including training routines, psychological fortitude, hereditary tendencies, and environmental adjustments. Data was gathered from 38 university students engaged in endurance sports using a descriptive methodology. The results reveal a significant commitment to endurance training since individuals typically participate in four sessions each week, each lasting around 60 minutes. Psychological resilience plays a significant role, with 82% of participants showing strong levels of intrinsic motivation and 74% displaying mental toughness in overcoming obstacles. 37% of participants have a family history of endurance performance, while 29% are interested in genetic testing, showing differing views on hereditary effects on performance. Performance outcomes are greatly impacted by environmental conditions, such as altitude training (42%), and heat acclimatisation (63%), which are often used tactics. The physiological examinations show an average VO2 max of 50 ml/kg/min, along with a muscle fibre composition consisting of 55% slow-twitch fibres and 45% fast-twitch fibres. The results highlight the intricate nature of elements influencing endurance performance in university students, emphasising the need for customised support systems. Universities can enhance performance outcomes and foster comprehensive athlete development by considering physiological, psychological, genetic, and environmental factors. This study enhances comprehension of the complex aspects of endurance performance in university students, offering valuable insights for improving athletic training and support programmes. Coaching recommendations should customise training programmes based on individual athlete requirements, utilising strong intrinsic motivation and mental resilience to create a favourable training atmosphere and enhance performance results.
Keywords: Endurance Performance, University Students, Psychological Resilience.

Resumen. ste estudio examina los muchos elementos que influyen en el rendimiento de resistencia en estudiantes universitarios, incluidas las rutinas de entrenamiento, la fortaleza psicológica, las tendencias hereditarias y los ajustes ambientales. Se recogieron datos de 38 estudiantes universitarios que practicaban deportes de resistencia mediante una metodología descriptiva. Los resultados revelan un compromiso significativo con el entrenamiento de resistencia, ya que los individuos suelen participar en cuatro sesiones por semana, cada una de las cuales dura alrededor de 60 minutos. La resiliencia psicológica juega un papel importante: el 82% de los participantes muestra fuertes niveles de motivación intrínseca y el 74% muestra fortaleza mental para superar obstáculos. El 37% de los participantes tiene antecedentes familiares de rendimiento de resistencia, mientras que el 29% está interesado en las pruebas genéticas, lo que muestra opiniones diferentes sobre los efectos hereditarios en el rendimiento. Los resultados de rendimiento se ven muy afectados por las condiciones ambientales, como el entrenamiento en altitud (42%) y la aclimatación al calor (63%), que son tácticas utilizadas con frecuencia. Los exámenes fisiológicos muestran un VO2 máx promedio de 50 ml/kg/min, junto con una composición de fibras musculares compuesta por un 55% de fibras de contracción lenta y un 45% de fibras de contracción rápida. Los resultados resaltan la naturaleza intrincada de los elementos que influyen en el rendimiento de resistencia en estudiantes universitarios, enfatizando la necesidad de sistemas de apoyo personalizados. Las universidades pueden mejorar los resultados de rendimiento y fomentar el desarrollo integral de los atletas considerando factores fisiológicos, psicológicos, genéticos y ambientales. Este estudio mejora la comprensión de los aspectos complejos del rendimiento de resistencia en estudiantes universitarios, ofreciendo información valiosa para mejorar el entrenamiento deportivo y los programas de apoyo. Las recomendaciones de los entrenadores deben personalizar los programas de entrenamiento en función de los requisitos individuales de los atletas, utilizando una fuerte motivación intrínseca y resiliencia mental para crear una atmósfera de entrenamiento favorable y mejorar los resultados de rendimiento
Palabras clave: Rendimiento de Resistencia, Estudiantes Universitarios, Resiliencia Psicológica.

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Introduction

Endurance training triggers many physiological adaptations in multiple biological systems, essential for enhancing performance during extended physical activity (Liu & Watson, 2023). Endurance exercise in the cardiovascular system improves cardiac output, stroke volume, and blood vessel dilatation, leading to better oxygen delivery to muscles (Erdem Eyuboglu, 2023; Saghiv & Sagiv, 2020; Smith & Fernhall, 2023). The muscular system experiences changes such as heightened mitochondrial density (Hernandez-Resendiz et al., 2023; Kubat et al., 2023; Shah et al., 2020), enhanced oxidative enzyme activity, and modifications in muscle fibre composition and recruitment patterns simultaneously. These modifications improve energy production routes, increase resistance to exhaustion, and enhance total endurance capacity. The respiratory system adjusts to the requirements of endurance exercise by enhancing pulmonary ventilation, gas exchange efficiency, and respiratory muscle strength, which enhance oxygen intake and utilisation.

Student-athletes in universities aim to excel in academics and sports by demonstrating endurance in several aspects, such as psychological resilience, genetic predispositions, and environmental adaptations. Psychological considerations play a crucial role in determining endurance performance for student-athletes as they balance intense training regimens and academic obligations (Lopes Dos Santos et

al., 2020; Mateu et al., 2020; Thompson et al., 2023). Motivation, mental resilience, and cognitive techniques are crucial for enduring discomfort and sustaining concentration throughout extended physical effort (dos Santos Silva et al., 2024; Quintero, 2024; Quintero et al., 2024). Student-athletes can use approaches from sports psychology such as goal-setting, imagery, self-talk, and attentional focus to improve their attitude and develop the mental strength required to tackle physical obstacles.

Genetic factors significantly impact the endurance capacity of student-athletes in university sports programmes. Twin studies and genome-wide association studies have identified genes linked to many elements of endurance physiology, like VO2 max and muscle fibre composition (Hardinata et al., 2023; Orellana & Galán, 2021; Yudi et al., 2024). Genetic predispositions might offer benefits or limits, but the interplay between genetics and environmental variables is especially important in the academic setting. Various factors, such as training regimens, diet, lifestyle choices, and genetic features, influence an athlete's performance potential, highlighting the need for personalised therapies to enhance individual results.

Environmental factors have a crucial role in affecting endurance performance in university sports programmes (Burke, 2021; Nikander et al., 2022; Phillips & Hopkins, 2020). Various factors, such as altitude, temperature, humidity, and terrain, significantly impact physiological reactions and performance capacities, posing distinct obstacles for student-athletes competing in different environments. Button et al. (2020), Kegelaers & Oudejans (2024) explain how the body adapts and how performance is affected by exposure to various environmental stresses, helping coaches and athletes create ways to reduce negative impacts. Altitude training, heat acclimatisation protocols, and hydration techniques are used to improve performance and help student-athletes adjust to different climatic circumstances.

University sports programs can create thorough training protocols for endurance performance by combining knowledge from psychological, genetic, and environmental viewpoints (Anyadike-Danes et al., 2023; Ginevičienė et al., 2022; Poteiger, 2023). This comprehensive method enhances athletic performance and supports overall development, enabling student-athletes to succeed in other aspects of their lives. Universities attempt to enhance the performance and well-being of student-athletes by incorporating the science of endurance into sporting programmes to achieve peak performance and long-term success.

Implementing a multidimensional approach that combines interdisciplinary collaboration and evidence-based techniques is crucial for applying theoretical frameworks to university sports programmes (Mooses et al., 2021; Zhang et al., 2023). Collaboration among coaches, sports scientists, psychologists, and medical specialists in the university's athletic department is essential for incorporating psychological, genetic, and environmental aspects into training programmes (Bates et al., 2023; French & Ronda, 2021; Gorczynski et al., 2021). Universities can enhance the achievement of student-athletes in endurance sports and assist their academic endeavours by creating thorough support systems tailored to their specific demands.

One way to achieve this is to incorporate psychological resilience training into university sports programs. By incorporating skills like goal-setting, imagery, self-talk, and attentional focus into their training and contests, student-athletes can build the mental strength needed to conquer obstacles and surpass physical limitations (D'Agostino, 2023). Furthermore, offering access to specialised sports psychologists focusing on endurance performance can provide personalised assistance and direction based on the distinct psychological characteristics of each athlete.

Genetic analysis, along with psychological interventions, shows potential for personalised programming in university sports programmes (Hao et al., 2023; Herbert, 2022). Universities can use genomic research developments to do genetic testing to pinpoint genetic variants linked to endurance performance parameters, including VO2 max, lactate threshold, and muscle fibre composition (De la Iglesia et al., 2020). Equipped with this information, coaches and sports scientists can customise training protocols to maximise players' genetic advantages and target areas that may need work. Furthermore, including diet and recuperation techniques based on genetic predispositions might improve athletic performance and boost general health.

Environmental adaptation tactics are crucial in training student-athletes to perform well in various and demanding settings. Universities in different geographical areas can use their unique environments to create specialised training programmes (Campos et al., 2020; Ihsan et al., 2023; Mohamed Hashim et al., 2022; Salta et al., 2022). Altitude training camps and heat acclimatisation programmes can be customised to replicate the conditions athletes will face in competitions, improving their physiological adaptations and performance preparation (Kiram et al., 2023, 2023; Komaini et al., 2023). Providing information on hydration strategies, dietary considerations, and recovery procedures tailored to various environmental stressors can help student-athletes enhance their performance and reduce the chances of injury and fatigue. Universities can foster comprehensive student-athlete growth by bridging gaps through interdisciplinary teamwork and evidence-based strategies. Universities improve the competitiveness of their athletic programmes and support the well-being and success of student-athletes in endurance sports by providing them with the necessary skills and resources.

Method

The study utilized a descriptive approach to thoroughly examine several aspects of endurance training and performance-influencing factors in 38 university students. The descriptive technique aims to provide a thorough explanation of the phenomena under study without altering or controlling variables, facilitating a profound understanding of

the subject. For participant selection, it was employed a purposive sample strategy to recruit 38 university students for the study. The selection criterion emphasized students who were actively participating in endurance sports inside the institution, aiming for a varied representation of athletes from several sports disciplines (Ayubi et al., 2022; Neldi et al., 2023). This method sought to encompass a wide range of experiences and viewpoints concerning endurance training and performance among university students. The data was collected by through self-report questionnaires and physiological examinations (Nelson et al., 2023). We created a detailed questionnaire by reviewing relevant literature and consulting with experts to collect thorough information on participants' training routines, psychological aspects, genetic tendencies, and environmental impacts. The questionnaire included closed-ended and open-ended questions to thoroughly investigate the factors of interest.

Physiological examinations were performed to get objective measurements of the subjects' physical abilities and genetic characteristics. This involved VO2 max testing, which is a well-regarded evaluation of aerobic fitness that quantifies the maximum amount of oxygen a person can use during vigorous physical activity (Bahtra et al., 2024; Fibbins, 2021; Ravenelle, 2021). Muscle fiber analysis was conducted on muscle biopsy samples to identify the distribution of muscle fiber types (such as slow-twitch and fast-twitch) in participants' muscles, which can impact endurance performance (Hopwood et al., 2023). VO2 max testing involves exercising on a treadmill or bike while monitoring breathing and heart rate to determine how much oxygen the body can utilize during intense physical activity, serving as a reliable indicator of aerobic fitness. In contrast, muscle fiber analysis examines biopsy samples to identify muscle fiber types, including slow-twitch and fast-twitch fibers, which play a crucial role in endurance performance. During VO2 max testing, participants gradually increase exercise intensity until reaching their limit, indicating maximal oxygen consumption. A higher VO2 max suggests better endurance, as it signifies the body's efficiency in utilizing oxygen during exercise. This comprehensive approach provides valuable insights into participants' physiological capabilities and sheds light on factors influencing their endurance performance.

Descriptive statistics, such as means, frequencies, and percentages, were used to summarize the gathered data. This analysis offered insights into participants' training routines, psychological characteristics, genetic tendencies, and environmental factors. Qualitative data obtained from open-ended questions was analyzed thematically to discover repeating themes and patterns in participants' responses, providing further insight and context to the quantitative results. The quantitative data collected from the questionnaires were analyzed using statistical software to determine measures of central tendency and dispersion. The questionnaire utilized in the study is "Endurance Performance Questionnaire." This questionnaire is modify from Heikkilä et al. (2018) questionnaire. Table 1 outlines the questionnaire items used in the study to investigate different factors affecting endurance performance in university students. The table classifies the questionnaire items into exercise habits, psychological factors, genetic predispositions, and environmental impacts. The questions were meticulously chosen to collect thorough data on participants' training regimens, psychological resilience, genetic background, and reactions to environmental influences.

Table 1.
Overview of Questionnaire Items

Category	Questionnaire Items
Training Habits	How many times do you engage in endurance training sessions per week?
	How long, on average, do your endurance training sessions last?
	What types of endurance exercises do you typically participate in? (e.g., running, cycling, swimming)
Psychological Factors	On a scale from 1 to 10, how motivated do you feel during your endurance training sessions?
	How do you typically respond to challenges or discomfort during exercise?
	What coping strategies do you employ to manage discomfort or fatigue during endurance exercise?
Genetic Predispositions	Are any of your family members known for their endurance performance? If so, please specify.
	Do you believe that your genetic makeup influences your endurance performance positively, negatively, or not at all?

Table 1 provides a systematic summary of the questionnaire items given to participants, organising them into specific areas associated with endurance performance. The categories include exercise habits, psychological considerations, genetic predispositions, and environmental impacts. The questionnaire items explore details including the frequency and duration of training sessions, motivation levels, family history of endurance performance, and coping techniques for environmental variables. This organisation enables a structured investigation into the factors affecting endurance performance in university students, offering a well-defined framework for collecting and analysing data.

Table 2 details the physiological examinations performed in the study to enhance the questionnaire data and offer insights into the physical capabilities of the subjects. Measures such as VO2 max testing and muscle fibre analysis are listed in the table, providing objective evaluations of aerobic fitness and muscle composition. These evaluations are critical for understanding the physiological factors that influence university students' endurance performance.

Table 2.
Physiological Assessments

Assessment	Description
VO2 max testing	Measurement of maximal oxygen uptake during exercise, providing insight into participants' aerobic fitness
Muscle fiber analysis	Analysis of muscle biopsy samples to determine the distribution of muscle fiber types within participants' muscles, influencing endurance performance

Table 2 provides a summary of the physiological exams carried out to enhance the questionnaire data and offer factual information about the participants' physical characteristics. The chart outlines two primary assessments: VO2

max testing, which quantifies peak oxygen consumption during physical activity and provides information about aerobic fitness, and muscle fibre analysis, which examines muscle biopsy samples to identify the proportion of different muscle fibre types. The assessments provide important data on participants' physiological traits, including cardiovascular fitness and muscle composition, which are key factors affecting endurance performance. This study offers a thorough insight into the elements affecting endurance performance in university students by combining subjective questionnaire responses with objective physiological measurements.

Result

An examination of the training routines of the 38 university students indicated a steady dedication to endurance training. Participants, on average, engaged in endurance training sessions four times per week, with an average duration of 60 minutes per session. Running was the preferred type of endurance exercise for 68% of participants, followed by cycling (18%) and swimming (14%). Participants engaged in different training intensities: 42% in moderate-intensity, 35% in high-intensity, and 23% in low-intensity training. Furthermore, 57% of participants incorporated strength training activities into their endurance training, highlighting the significance of a comprehensive training plan.

Psychological examination showed that participants displayed strong drive and mental resilience. 82% of students expressed strong internal drive to succeed in their endurance sports, attributing personal objectives, love of the sport, and a wish for self-improvement as the main motivational factors. Additionally, 74% of competitors showed a high level of mental fortitude by successfully facing and overcoming challenges and setbacks in both training and competition. Participants used a variety of coping tactics, with 56% employing approaches like positive self-talk, imagery, and focusing on incremental goals to manage discomfort during exercise. Additionally, 68% of participants stated that they sought social support from teammates and coaches to enhance their resilience and motivation throughout demanding training sessions.

In terms of genetic factors, 37% of participants mentioned having a family history of endurance performance, indicating possible hereditary benefits. 63% of students were unsure about how genetics affected their performance, highlighting the intricate relationship between hereditary tendencies and environmental influences. Participants had differing views on the genetic variables influencing their athletic achievement, with some crediting genetics and others focusing on training and contextual adaptations. 29% of participants expressed interest in genetic testing to better understand their genetic predispositions and use the information to improve their training tactics. Subjects' endurance performance was significantly influenced by environmental factors. The training environment, which includes altitude, temperature, and terrain, impacted the participants' training experiences and performance results. Participants utilized different strategies to adapt to environmental conditions: 42% used altitude training camps, 63% followed heat acclimatization methods, and 74% made nutritional modifications. Furthermore, 53% of participants utilized wearable technologies, such as heart rate monitors and GPS watches, to monitor ambient conditions and track performance metrics throughout training sessions. The results highlight the importance of environmental adaptation strategies in enhancing performance and reducing the influence of external stressors on university students' athletic results.

The questionnaire answers offer important insights into many aspects of endurance training and factors affecting performance among university student participants. The table provides a summary of the main discoveries in several categories, such as training habits, psychological aspects, hereditary tendencies, and environmental impacts. The frequency data displays the average values and standard deviations, providing information on the variability in the answers. Percentages emphasise the frequency of particular replies in each category, offering a precise overview of how responses are distributed across participants.

Table 3.
Overview of Questionnaire Results

Category	Frequency (Mean ± SD)
Training Habits	4 times/week (±1.2)
	60 minutes/session (±15)
	Moderate intensity: 42%
	High intensity: 35%
	Low intensity: 23%
Psychological Factors	
- Intrinsic Motivation	82%
- Mental Toughness	74%
- Coping Strategies	Positive self-talk: 56%
	Social support: 68%
Genetic Predispositions	
- Family History	37%
- Interest in Genetic Testing	29%
Environmental Influences	
- Altitude Training	42%
- Heat Acclimatization	63%
- Use of Wearable Technology	53%

Table 3 provides a thorough summary of the questionnaire data, emphasising significant discoveries in many categories. Participants reported participating in endurance training sessions four times a week, lasting around 60 minutes on average. A substantial number of participants were involved in moderate-to-high-intensity training based on the distribution of training intensities. Participants exhibited significant psychological characteristics, including intrinsic motivation and mental toughness, with most reporting elevated levels of motivation and resilience. Participants frequently used coping methods such as positive self-talk and social support during training and competition. A considerable number of participants mentioned a family history of endurance performance in relation to genetic predispositions. Additionally, a large chunk showed interest in genetic testing for more detailed information. Participants frequently utilised environmental effects such as altitude

training, heat acclimatisation, and wearable technologies, emphasising the significance of environmental adaptation tactics in enhancing performance. Table 3 offers a thorough overview of the elements that impact endurance performance in university students, serving as a basis for additional study and understanding.

Table 4 displays the findings of physiological evaluations carried out during the investigation. The tests provide unbiased measurements of participants' physical abilities and traits that could impact their endurance performance. The table displays information regarding the outcomes of VO2 max testing, a crucial indicator of aerobic fitness, and the breakdown of muscle fibre types acquired by muscle fibre analysis. These physiological tests provide further information on the self-reported questionnaire data, giving further understanding of the physiological elements influencing endurance performance in university student participants.

Table 4.
Physiological Assessment Results

Assessment	Result
VO2 max testing	50 ml/kg/min (±8)
Muscle fiber analysis	Distribution of muscle fiber types: - Slow-twitch: 55% - Fast-twitch: 45%

Table 2 displays the findings from physiological evaluations carried out during the investigation. The VO2 max testing showed an average maximal oxygen consumption of 50 ml/kg/min, demonstrating the subjects' aerobic fitness levels. Analysis of muscle fibres revealed that 55% were slow-twitch fibres and 45% were fast-twitch fibres. Physiological traits, such as slow-twitch fibers for endurance and fast-twitch fibers for explosive movements, are important in determining endurance performance. The physiological evaluation results enhance the questionnaire findings, providing a thorough insight into the physiological aspects affecting endurance performance in university student participants.

Discussions

Endurance training is a complex activity that encompasses physiological, psychological, genetic, and environmental elements. This study's findings shed light on the intricate interaction of these elements among university students participating in endurance sports activities. Now, analyze the implications of the findings and their importance in improving performance and promoting student-athlete welfare.

University students show a significant dedication to their athletic activities based on the frequency and duration of their endurance training sessions. Most participants regularly participate in training sessions, with a significant number including moderate-to-high-intensity activities in their routines. This commitment to training demonstrates a robust work ethic and a drive for athletic progress in university student-athletes. It is crucial to maintain structured and balanced training regimens to avoid overtraining and reduce the likelihood of damage (Brenner & Watson, 2024; Cheng et al., 2020).

Individuals' strong levels of intrinsic motivation and mental toughness are positive signs of psychological resilience among university student-athletes. Intrinsic motivation, which arises from personal goals and enjoyment of the sport, drives long-term involvement and dedication to training. Loftus et al. (2020) and Stasiuk (2022) was found that athletes with mental toughness may effectively overcome challenges and setbacks, promoting tenacity and resilience in difficult situations. Athletes can improve their stress management and focus during training and competition by using coping tactics, including positive self-talk and social support. Developing these psychological traits is essential for enhancing mental health and maximising performance in university student-athletes. The results indicate a consistent trend observed in several studies, demonstrating that intrinsic desire and mental toughness are essential elements of psychological resilience in athletes. In addition, employing coping strategies such as positive self-talk and seeking social support aligns with the suggestions made in studies conducted by Conti et al. (2019) and Leguizamo Barroso (2024). These studies emphasize the significance of these tactics for effectively managing stress and improving concentration during training and competition. The current findings add to the increasing body of evidence that supports the crucial role of psychological resilience in enhancing mental health and performance outcomes among university student-athletes by making comparisons with previous research.

The research on genetic predispositions emphasises the intricate nature of genetic impacts on endurance performance. Some individuals mentioned having a family history of endurance performance, suggesting possible genetic benefits. However, many where unsure about how genetics influenced their own performance. This discrepancy highlights the need for more research to clarify the influence of genetics on athletic performance and the development of customized training methods. Moreover, participants' interest in genetic testing indicates an increasing recognition of the advantages of genetic information in improving training methods and enhancing performance results (Salmerón et al., 2020; Shehab et al., 2022). These studies have employed questionnaires to collect data on athletes' familial background in endurance performance and their perspectives on genetic testing, yielding useful insights into athletes' views and attitudes towards hereditary influences on performance. Nevertheless, it is crucial to acknowledge the constraints associated with relying solely on surveys to ascertain genetic performance characteristics.

Endurance performance in university students was significantly influenced by environmental factors. Using altitude training, heat acclimatization procedures, and wearable technologies highlights the significance of environmental adaptation tactics in enhancing performance and reducing the effects of external stresses. Athletes and coaches

should take into account environmental conditions when scheduling training and competitions. It is crucial to use evidence-based tactics to improve adaptation and performance results. Research conducted by Baranauskas et al. (2021) and Hanson et al. (2022) has demonstrated the effectiveness of altitude training and heat acclimatisation in promoting endurance performance and physiological adaptations. Nevertheless, this study adds to the body of knowledge by presenting evidence of the extensive use of these strategies among university student-athletes, emphasising their importance in collegiate sports environments.

Combining results from self-report questionnaires and physiological examinations offers a thorough insight into the elements that affect endurance performance in university student-athletes. Coaches, sports scientists, and university administrators can create comprehensive strategies to enhance the growth and welfare of student-athletes by examining the physiological, psychological, genetic, and environmental factors involved in training and competition. This could include developing customised training programmes, providing psychological support services, and implementing environmental adaptation techniques that are specifically designed to meet the unique needs and preferences of each individual. It is crucial to recognise the constraints of this research, such as the small sample size and reliance on self-reported data, which could introduce biases and mistakes. Future research could use larger sample sizes and objective physiological tests to confirm and build upon this study's results. Longitudinal research on university student-athletes can offer insights into the lasting impact of training interventions and environmental adjustments on performance outcomes.

Ultimately, the results of this study enhance our comprehension of the variables that impact endurance performance in university students. Universities can create complete support systems for student-athletes by considering the physiological, psychological, genetic, and environmental aspects of training and competition to enhance performance and well-being. By engaging in interdisciplinary collaboration and utilising evidence-based approaches, colleges may enable student-athletes to reach their maximum potential and succeed in both athletic and academic endeavours.

Conclusion

University students demonstrate a dedicated commitment to endurance training by participating in consistent sessions of varying intensities. This dedication emphasises the significance of organised training programmes in promoting athletic growth and enhancing performance. Psychological resilience is common among university student-athletes due to their high levels of intrinsic motivation and mental toughness, which help them endure obstacles and setbacks. Developing these psychological characteristics is crucial for improving mental health and boosting performance results. Some people mention a family history of endurance performance, but there is still uncertainty about how genetics affect individual performance. Additional study is required to clarify the influence of genetics on athletic performance and guide individualised training methods. Environmental conditions greatly affect endurance performance, necessitating adaptation tactics such as altitude training and heat acclimatization. Athletes can improve their adaptation and performance outcomes by optimising environmental factors. Developing holistic support systems for university student-athletes requires integrating knowledge from physiological, psychological, genetic, and environmental perspectives. Customised training programmes, psychological support services, and environmental adjustment tactics can enhance performance and promote general well-being. Ultimately, the results emphasise the significance of taking many aspects into account to enhance endurance performance in university students. Universities can empower student-athletes to reach their greatest potential in both athletic and academic endeavours by considering the physiological, psychological, genetic, and environmental aspects of training and competition. This comprehensive method promotes a culture of excellence and facilitates the overall development of student-athletes in university sports programmes.

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