

Silva T (2024) EVALUATING THE IMPACT OF HIGH-ALTITUDE TRAINING ON ATHLETIC PERFORMANCE IN ANDEAN ATHLETES. Revista Internacional de Medicina y Ciencias de la Actividad Física y el Deporte vol. 24 (94) pp. 448-464.
DOI: <https://doi.org/10.15366/rimcafd2024.94.028>

ORIGINAL

EVALUATING THE IMPACT OF HIGH-ALTITUDE TRAINING ON ATHLETIC PERFORMANCE IN ANDEAN ATHLETES

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Recibido 27 de abril de 2023 **Received** April 27, 2023

Aceptado 10 de Septiembre de 2023 **Accepted** September 10, 2023

ABSTRACT

Objective: The research aims to determine the impact of high-Altitude training on athletic performance in Andean athletes. Using the distinct physiological adaptations that people who live in high-altitude areas have evolved, this study examines the effects of high-altitude training on the athletic performance of Andean athletes. This study investigates Andean athletes' baseline physiological characteristics (red blood cell count, oxygen saturation, and lung capacity). An organized high-altitude training program aims to evaluate the impact of altitude on strength, cardiovascular endurance, and overall athletic performance. Working with geneticists, the research explores genetic variables that affect Andean athletes' capacity to adjust to training at high altitudes. For measuring, the research used SPSS software and generated results including descriptive statistics, correlation coefficient, the model summary, and chi-square analysis between the independent and dependent. The purpose of the study is to record any negative effects that participants may have experienced as well as any potential benefits and difficulties related to purposeful high-altitude training. The results have the potential to improve training protocols, guide customized strategies based on genetic profiles, and advance the conversation on the moral ramifications of exceeding human potential in the sake of sports achievement. The overall result found a positive impact of high-altitude training on athletic performance in Andean athletes. This research aims to further our understanding of the intricate interactions between purposeful training, innate abilities, and athletic performance in demanding settings.

KEYWORDS: High-Altitude (HA), Training (T), Athletic Performance (AP), Andean Athletes (AA)

1. INTRODUCTION

This topic is related to the Andean region, which is a main part of South America. The most important countries in this region are Bolivia, Ecuador, Colombia, Argentina, and others. The most important part of athletes' training is the high altitude training, which is mandatory and important. In this study, we are going to overview how these high altitude trainings have an impact on the performance of Andean Athletes. There is a need for different types of training for Enhanced performance of athletes, such as running, jumping, weight lifting, climbing, pushing up, and others. All these trainings have their importance for enhancing the performance of athletes, but here we are going to discuss only the impact of climbing on athlete performance. There are many benefits of climbing training in athletes' health, which are explained as follows (Stray-Gundersen, Chapman, & Levine, 2001). The first and foremost benefit of climbing is to overcome own fear. While climbing training, an athlete has to climb high altitudes, which reduces his fear of heights. By proper and continuous training, not only can the fear of height be coped with, but other fears such as fear of failure, injury, and the environment and others can be coped with well. The second benefit is the betterment of the physical health of athletes through high-altitude training. There are different ways by which high Altitude climbing training can enhance and maintain the proper physical health of athletes. The first way of enhancing physical health is to enhance the oxygenation level in the blood. We know that the atmosphere is that envelope of gases around the Earth, and the concentration of these gases decreases as we move upward (Campbell et al., 2015). During the training for climbing, an athlete faces the low pressure of oxygen at a height so the respiratory system has to adopt a few advancements to survive in such conditions. The production of red blood cells increases in the body because red blood cells have the role of oxygen transpiration in the body because of the presence of haemoglobin. When the production of red blood cells increases, the haemoglobin level in the body also increases to transport more oxygen to the body, so the saturation level of the body increases, which is a positive for enhancing the academic performance of athletes (ALSHAWY, Ibrahim, Hussein, & Lahlah, 2019; Chen et al., 2023; Ordonhes, López-Gil, Caregnato, & Cavichioli, 2021).

The other benefit of Altitude climbing training is that the strength and endurance of muscles increase, especially that of skeletal muscles. During climbing, extensive use of muscles results in more muscle growth and development, increasing their strength and endurance. When fully developed, muscle fibres in athletes' bodies can help them perform better during competition. This aspect shows that high-altitude climbing helps improve the performance of athletes (Rupert & Hochachka, 2001). The other aspect that is quite related to high Altitude is the maintenance and balance of hormones in the body. During climbing, sometimes there is an emergency that has to be confronted and solved by athletes, so while confronting this emergency,

athletes can also learn to handle such conditions during competition. The athletes may also sometimes have to confront the sense of failure that needs utmost tolerance to bear, and this kind of tolerance can be learned by high-altitude training (FRISANCHO & GREKSA, 1989). The other aspect related to high Altitude climbing is learning fight or flight responses and the relation of hormones to such situations. In the initial days of high Altitude training, there is more secretion of adrenal hormones, which help the body to overcome fear, but when the body becomes acclimated to such conditions, there is the release of endorphin and dopamine, which induces the feeling of happiness in the body because of accomplishment of task. In this way, we can say that high-altitude training also enables athletes to balance hormonal levels in the body, and this balanced hormonal level may result in enhanced performance (Brutsaert, 2008). Altitude training also has an impact on cardiovascular activities. For example, during climbing, the heartbeat increases because of fear during the initial days, and the level of oxygen demand increases in the body; in this way, the heart has to do extra work to fulfil this increasing need. Through this extra work activity of the heart, the strength of cardiac muscles increases, which can also help improve athletes' performance during competition (Akman, 2014).

The other aspect of high-altitude Training is that it is done under the supervision of any coach, which stimulates the factor of coach obedience and counselling, which can ultimately increase the athlete's performance level during the competition (Vargas Pinilla, 2014). The other benefit of high-altitude training is that it improves not only the physical health of athletes but also their mental health, which will ultimately contribute to increased performance. If an athlete is undergoing any depression, stress, anxiety, or any other mental health issues, it can lead to a reduced or retarded level of performance of an athlete, but it has been proved that high Altitude Training enhances the mental health of athlete (Cicavoğlu, Kaya, & Cerit, 2021). These kinds of training reduce stress, anxiety, and depression because an athlete comes near to nature, and this kind of interaction helps enhance the mental and physical health of the athlete. Sports scientists have long been intrigued by and interested in studying high-altitude training because it presents a special combination of opportunities and obstacles for athletes looking to improve their performance. The Andean area is one of the places with the highest elevations. It is recognized for producing a unique group of athletes who naturally adapted to low oxygen levels. This study examines the complexities of high-altitude training and how it affects Andean athletes' athletic performance. There is no doubt that there are different and various kinds of training that are necessary for athletes to perform better during competition, but high altitude training is the advanced and effective kind of training for improving athlete performance (Ramchandani, Florica, Zhou, Alemi, & Baranchuk, 2024). This is such kind of training that it not only improves the physical health of athletes but also contributes to enhancing their mental health. For better performance during competition, there is a dire need for a stringent focus on athletes' physical and mental health. This

type of high Altitude training is more common in Andean Athletes, but after viewing its results, it has been recommended to athletes worldwide. Such kind of training will prove effective shortly for enhancing the level of performance of athletes during competition. Thus, high-altitude training effectively improves performance levels in athletes(Wilber, 2004).

2. Research objective

The main objective of this study is to understand the relationship between high Altitude training and the performance of Andean Athletes. This study has effectively explained the role of high-altitude training on the performance of Andean Athletes. The main goals of this study are to clarify many aspects of high-altitude training and how it affects Andean athletes. These goals include Baseline Physiological Parameters: The research aims to evaluate Andean athletes' red blood cell count, oxygen saturation, and lung capacity. This baseline information will assess the modifications brought about by high-altitude training. b. Effect on Athletic Performance: The study will examine the effects on cardiovascular endurance, strength, and general athletic performance in Andean athletes through a meticulously planned high-altitude training program. This involves looking for ways to improve sports-specific endurance and skill sets. This study has also described how these trainings affect the brain and body to enhance physical and mental health.

The appeal of exercising at high altitudes is that it can cause physiological changes that provide players with a competitive advantage. The air is less oxygenated at higher elevations, which might be difficult for people not used to it. But groups living at high altitudes—like the Andean communities have experienced evolutionary processes that have resulted in special adaptations that allow them to survive in these harsh conditions. With its massive peaks and wide plateaus, the Andes make for a perfect location to study the effects of high-altitude training. The Andes' physical characteristics provide a setting in which athletes may face low oxygen levels, causing their bodies to adapt to the lower oxygen supply. Knowledge of how Andean athletes use these adaptations can be extremely beneficial to the larger area of sports research.

3. Physiological Adjustments to Life at High Altitudes

High altitudes' reduced oxygen pressure causes the body to manufacture more red blood cells, which increases their ability to transport oxygen. Improved oxygen uptake is also facilitated by altered lung function and enhanced ventilation. Andean people have adapted to their particular environment through millennia of living at high elevations, resulting in genetic variances. The ability of Andean athletes to adjust to the difficulties presented by decreased oxygen availability is partly attributed to genetic variables that

affect haemoglobin levels and oxygen-carrying capacity. These genetic discoveries highlight the intricate relationship between nature and nurture that shapes people's athletic ability from high-altitude environments.

4. Importance of the Research

Sports scientists are not the only ones who see value in assessing how high-altitude training affects Andean athletes. It addresses concerns about health, cultural heritage, and performance optimization for people who live in high-altitude environments. We could uncover new tactics for athletes globally by providing training techniques with a full grasp of how athletes from the Andean area respond to high-altitude training. This study adds to the larger discussion on the moral implications of exceeding human boundaries for sports achievement. Examining the impact of high-altitude training on people who have naturally acclimated to these conditions offers a nuanced perspective on the suitability and effectiveness of such training regimens, as high-altitude training becomes more and more popular among athletes worldwide.

5. Literature review

Researchers claim that at high altitudes, the problem of hypobaric hypoxia is common. this problem is caused due to low oxygen levels at Higher altitudes. Because of living at higher altitudes, the people of Andean Highland exhibit different biological characteristics (Beall & Strohl, 2021).studies claim that a lot of athletes are adopting sports training-based programs to improve their physical strength. sports organizations take several measures to optimize the sports training provided at higher altitudes. the aerobic capacity of athletes is enhanced by performing sports training at higher altitudes(Chen et al., 2023).studies reveal that at higher altitudes, the oxygen level is comparatively low. the low oxygen level results in hypoxia conditions in people. Athletes learn to perform in hypoxia conditions by getting sports training at higher altitudes. Superior sport-performing skills are achieved when athletes learn to play under hypoxia conditions. Genetic factors and certain environmental factors determine the ability of athletes to succeed in their sport.by tracking the influence of environmental and dietary fibers on athletic performance, it becomes easy to predict athlete performance in specific sports (Cicavoğlu et al., 2021).studies predict that hypoxia is a condition that results in an alteration in individual psychological behavior. the alternations in the psychological behavior worsen with time. Glutamine is a supplement provided to people with hypoxia to improve their cognitive health(Dos Santos Quaresma, Souza, Lemos, Caris, & Thomatieli-Santos, 2020).Studies explain that people of different geographical areas behave differently at higher altitudes. Pulse oximetry is used to determine people's psychological response to hypoxia conditions. This device is used to measure acclimatization progress as well as diseases caused by hypoxia(Dünnwald, Kienast, Niederseer, & Burtcher,

2021).studies suggest that athletic endurance playing skills are improved due to hypoxia training programs. under this program, athletes are trained at higher altitudes to develop endurance in them. The aerobic and anaerobic performance of sports athletes depends on the hypoxia-based training programs(Eroğlu & Aydın, 2021).studies highlight that the CBC helps predict the onset of medical disease in people. The CBC test is used as a screening test to identify certain medical conditions. the changes observed in the circadian cycle and environment result in alternation in the CBC. the people living at higher altitudes have different CBC numbers than people living on land(Feriel, Tchipeva, & Depasse, 2021).studies show that the level of VO_2 max decreases with altitude. The effect of VO_2 max on normal people and cardiovascular disease-affected patients is almost the same while people having obstructive pulmonary disorder face severe health problems due to low levels of VO_2 max. Also, the exercise-performing capability of cardiovascular patients is reduced at higher altitudes(Furian, Tannheimer, & Burtcher, 2022).studies elaborate that the functioning of organisms alters at higher altitudes. The low oxygen level and rescued heat exposure result in functional changes in the organism.

The serum enzyme level found in muscles alters because of performing exercise at high altitudes. This change in muscle enzyme concentration increases the risk of medical problems(KOCAKULAK, Şentürk, Gülmez, Meryem, & Hamurcu, 2020).Studies claim that PSA acts as a biomarker for diagnosing prostate cancer. Researchers believed there was an association between PSA and hypoxia conditions, but recent studies revealed a non-significant association between the PSA level and hypoxia(Alcantara-Zapata, Thiersch, & Gonzales, 2023).Studies suggest that the low oxygen level is compensated by increasing the level of Hb in people living at higher altitudes. People living at high altitudes have more Hb levels than people living on low land. Studies predict that high Hb concentration is present in the people of Andean(Mairböurl, Gassmann, & Muckenthaler, 2020).Studies show that HAI are illnesses that result from high altitudes. molecular mechanisms influence the development of HAI.to effectively treat the HAI and for optimizing the process of hypoxic acclimatization the molecular mechanism behind HAI is identified and studied. genetic factors mainly disturb the molecular mechanism in patients facing HAI problems (Mallet et al., 2023).scholars explain that cardiovascular parameters vary in athletes training at higher altitudes. The endurance sports-related activities of athletes are dependent on hypoxia condition(Mancera-Soto, Chamorro-Acosta, Ramos-Caballero, Torrella, & Cristancho-Mejía, 2022).scholars predict that athletes training at higher altitude sports training camps are provided with nitrate supplements under hypoxia situations. The military trekking officers are also provided with nitrate supplements to help them tackle the hypoxia condition(Marshall et al., 2021).scholars suggest that people living at higher altitudes show psychological responses toward hyperbaric conditions. To deal with the psychological problems in people living at higher altitudes different medicines are provided to

them(Milledge, 2020).Studies predict that in the past twenty-five years, the trend of recreational activities at higher altitudes has increased tremendously. Their athletic performance is improved by providing them training at high altitude sports training centers. but performing sports at higher altitude poses serious health risk to athletes .also, the response of every athletes training at higher altitude varies .studies predicts that some athletes show improvement in game performing skills while some athlete develops severe health diseases due to training at high altitudes(Motta, Ornon, & Menetrey, 2024).studies reveal that a lot of world population live at higher altitudes and a large number of people also visits mountains every year. these people living at higher altitude faces low oxygen level problem. this problem results in the onset of health issues like cardiovascular and cardiorespiratory disorder in them.

The prevalence of cardiovascular disorder onset at higher altitudes is more in people already having serious cardiac problems(Mallet, Burtcher, Richalet, Millet, & Burtcher, 2021).studies of scholars explain that by combining the concepts of anthropology as well as exercise physiology, it becomes easier to understand athlete performance, these concept determines the factors that influence the functioning and performing ability of athletes. the response of athlete training in extreme environments is assessed by using the concept of exercise pathology and anthropology(Niclou, Sarma, Levy, & Ocobock, 2023).Researchers highlight that athletes performing at altitudes develop the hypoxia condition that disturbs their psychological well-being.to save the psychological health of athletes certain athletic guidelines have been developed for athletes training at higher altitudes These guidelines optimize the training process and help in maintaining athlete mental health(Ramchandani et al., 2024).also, therapeutics based survival therapies have been developed in the past few years to maintain the psychological health of athlete training at higher altitudes. moreover, the pre acclimatization techniques are very helpful for making the survival of people at higher altitudes possible(Flores-Rodriguez & Ramirez-Macias, 2021; Sharma, Mohanty, & Ahmad, 2023).

5.1 Andean Region

The Andean region is known for its high-altitude environment, including the Andes mountain range, which is the longest continental mountain range in the world. This region is distinguished by its unique geographical features such as high peaks, deep valleys, and plateaus. The high-altitude environment in the Andean region presents challenges due to lower oxygen levels, which can impact human psychology and health. The Andean region is a huge mountainous area in South America that spread to several countries, including Venezuela, Columbia, Ecuador, Paro, Bolivia, Chilli, and Argentina. The Andes is the longest continental mountain range in the world stretching over 7000 km(4,300 miles) along the western coast of South America. One of the most noticeable features of The Andean region is its high-altitude environment,

including the presence of many peaks exceeding 6000 meters (20,000 feet) in height. This includes iconic peaks such as Mount Aconcagua, the highest mountain outside of Asia, and the peaks of the Peruvian Andes, which are famous for their challenging climbing routes and stunning landscapes.

5.2 Physiological Changes

During high-altitude training, athletes experience several physiological changes when they go through hypoxic conditions. The athlete's body modifies itself when the oxygen availability is reduced at higher elevations. The body responds to the low oxygen levels by producing more red blood cells, which carry oxygen to the muscles. This process is known as erythropoiesis. These increases in red blood cells can improve the athlete's endurance and training capacity. The body also increases the number of capillaries in its muscles to improve oxygen delivery to the tissue. The body increases its breathing rate to compensate for the lower oxygen levels, leading to an increase in ventilation. The heart rate increases to pump more oxygenated blood to the muscles. Myoglobin is a protein that stores oxygen in the muscles.

During high-altitude training, more myoglobin to improve oxygen storage in the muscles. Training at high altitudes may increase the production of new mitochondria within muscle cells. It is important to note that individual responses to high-altitude training can differ, and not all athletes may experience the same degree of physiological conversion. Athletes and coaches should carefully consider the potential benefits and risks of high altitude, as proper adjustment and monitoring to optimize training adaptation and minimize the risk of altitude-related health issues in Andean athletes.

5.3 Impact of High-Altitude Training

High-altitude training can have a remarkable impact on the performance of Andean athletes. Training at high altitudes can lead to physiological transformation such as increased red blood cell production and improved oxygen utilization, which can enhance tolerance and overall athletic performance when competing at lower altitude. The unique high-altitude environment of the Andean region provides an ideal setting for athletes to undergo this type of training and potentially gain a competitive advantage.

Due to unique physiological adaptations that occur in response to training at high elevations Andean athletes who train at high altitudes may experience an increase in red blood cells that increases the oxygen-carrying capacity which can be beneficial in different performances at sea level. Training at high altitude can lead to improvement in aerobic capacity, including magnifying cardiovascular functions, increasing capillary density, and improving oxygen utilization, all of which can contribute to improved athletes in sports such as distance cycling, cycling, and cross-country skiing.

Andean athletes regularly train at high altitude conditions, potentially leading to improved performance when competing at high altitude venues or in mountainous terrain. Some Andean athletes may experience altitude-related health benefits from living and training at high elevations, such as increased red blood cell mass, improved lung functions, and other adaptations that can positively impact athletic performance.

5.4 Correlations

Table 1 (a)

	HIGH-ALTITUDE TRAINING 1	HIGH-ALTITUDE TRAINING 2	HIGH-ALTITUDE TRAINING 3	HIGH-ALTITUDE TRAINING 4	ATHLETIC PERFORMAN CE 1	ATHLETIC PERFORMANCE 2	ATHLETIC PERFORMANCE 3	
HIGH-ALTITUDE TRAINING 1	Pearson correlation	1	.575**	-.568**	-.251	-.038	-.241	-.610**
	Sig. (2-tailed)		.000	.000	.079	.795	.092	.000
	N	50	50	50	50	50	50	50
HIGH-ALTITUDE TRAINING 2	Pearson correlation	.575**	1	-.352*	.040	-.182	-.055	-.442**
	Sig. (2-tailed)	.000		.012	.781	.207	.707	.001
	N	50	50	50	50	50	50	50
HIGH-ALTITUDE TRAINING 3	Pearson correlation	-.568**	-.352*	1	.267	-.013	.160	.702**
	Sig. (2-tailed)	.000	.012		.061	.928	.267	.000
	N	50	50	50	50	50	50	50
HIGH-ALTITUDE TRAINING 4	Pearson correlation	-.251	.040	.267	1	-.267	.092	.303*
	Sig. (2-tailed)	.079	.781	.061		.060	.524	.033
	N	50	50	50	50	50	50	50

Table 1 (b)

	HIGH-ALTITUDE TRAINING 1	HIGH- ALTITUDE TRAINING 2	HIGH- ALTITUDE TRAINING 3	HIGH- ALTITUDE TRAINING 4	ATHLETIC PERFORMAN CE 1	ATHLETIC PERFORMANCE 2	ATHLETIC PERFORMANCE 3	
ATHLETIC PERFOR MANCE 1	Pearson correlation	-.038	-.182	-.013	-.267	1	.197	-.262
	Sig. (2-tailed)	.795	.207	.928	.060		.170	.066
	N	50	50	50	50	50	50	50
ATHLETIC PERFOR MANCE 2	Pearson correlation	-.241	-.055	.160	.092	.197	1	.153
	Sig. (2-tailed)	.092	.707	.267	.524	.170		.289
	N	50	50	50	50	50	50	50
ATHLETIC PERFOR MANCE 3	Pearson correlation	-.610**	-.442**	.702**	.303*	-.262	.153	1
	Sig. (2-tailed)	.000	.001	.000	.033	.066	.289	
	N	50	50	50	50	50	50	50

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

The above result describes that correlation coefficient analysis result represent the Pearson correlation values, significant values also that number of observation rates of each variable included dependent and independent. Overall correlation result shows that some negative and some positive interrelation between high-Altitude Training and Athletic performance. High-altitude training is related to athletes living or training at high altitudes to benefit from psychological changes due to blending into high environments. The oxygen level at high altitudes is low, which provokes modifications such as increased red blood cell production and improved tissue oxygenation. This can enhance athletic performance when athletes return to lower altitudes the oxygen level of athletes rises and improves toleration. High altitude training is a training method that involves living and/or training at high altitude, normally above 2,400 meters (8,000 feet) above sea level.

At high altitudes, as the availability of oxygen is decreased activates the body to produce more red blood cells, which can increase the oxygen-carrying capacity of the blood. this can result in improved tolerance levels, and performance in athletes, particularly regarding patience sports like distance running, cycling, and cross-country skiing. High-altitude training has been used by many elite athletes and sports teams as a way to gain a competitive edge. However, it is important to know that high altitude training can also have negative effects on performance and health if it is not done properly and should be carefully monitored by a qualified coach or sports medicine professional.

The low availability of oxygen can lead to hypoxic conditions. High altitude training is significant in athletic performance as it increases the psychological changes that can enhance athletic capacity and endurance. Athletes aim to maximize the body's response to hypoxia to improve their performance at sea level. The genetic factors influencing these alterations and the varied response of the different populations to high-altitude training are critical considerations in optimizing athletic training and performance.

5.5 Model Summary

Table 2

MODEL	R	R SQUARE	ADJUSTED R SQUARE	STD. ERROR OF THE ESTIMATE
1	.318 ^a	.101	.021	.53677

a. Predictors: (Constant), High-Altitude Training 4, High-Altitude Training 2, High-Altitude Training 3, High-Altitude Training 1

The above result represent that model summary result describe that R values, R square values, the adjusted R square values also that present standard error of the estimated rate of model 1. The R rate is 0.318 the r square value is 0.101 according to the result its adjusted R square value is 0.021 the standard error of the estimated value is 0.53 shows that 53% estimated rate between them.

5.6 ANOVA^a

Table 3

MODEL		SUM OF SQUARES	DF	MEAN SQUARE	F	SIG.
1	REGRESSION	1.454	4	.364	1.262	.299 ^b
	RESIDUAL	12.966	45	.288		
	TOTAL	14.420	49			

a. Dependent Variable: Athletic Performance 1

b. Predictors: (Constant), High-Altitude Training 4, High-Altitude Training 2, High-Altitude Training 3, High-Altitude Training 1

The above result describe that ANOVA analysis result represent sum of square, mean square values, also that F rate is significant value of each model included regression and residual.

The regression shows that sum of square rate is 1.454 the mean square value is 0.364 also that F statistic rate is 1.262 respectively. According to the result its significant value is 0.299 shows that 29% significantly level between them. the residual model represent that sum of square value is 12.966 the mean square rate is 0.288 shows that 28% average square rate the total value is 14.420 respectively.

5.7 Regression analysis

5.7.1 Coefficients

Table 4

MODEL	UNSTANDARDIZED COEFFICIENTS		STANDARDIZED COEFFICIENTS	T	SIG.
	B	Std. Error	Beta		
1 (Constant)	2.202	.507		4.341	.000
High-altitude training 1	-.011	.189	-.012	-.060	.952
High-altitude training 2	-.160	.170	-.167	-.939	.353
High-altitude training 3	-.009	.166	-.009	-.053	.958
High-altitude training 4	-.265	.155	-.261	-1.715	.093

a. Dependent Variable: Athletic Performance 1

The above result represents that regression analysis result describe unstandardized coefficient values, also that standardized coefficient values of each independent models. The result also represents that t statistic rate and significant rate of each variable.

The high-Altitude training 1 shows that beta value is -0.011 the t statistic value is -0.060 the significant rate is 0.952 shows that negative and 95% significant level between high-Altitude training 1 and Athletic performance. similarly, the high-Altitude Training 2 is another independent variable result represent that beta value is -0.160 the t statistic rate is -0.939 the significant value is 0.353 shows that 35% significantly level between them. The high-Altitude Training 3 and 4 both are considered as independent variables the result shows that t rate is -0.053 and -1.715 the significant rate is 0.958 and 0.093 shows that 95% and 9% significantly level both are shows negative impact between them.

5.7.2 Test Statistics

Table 5

	HIGH- ALTITU DE TRAINI NG 1	HIGH- ALTIT UDE TRAINI NG 2	HIGH- ALTITUD E TRAININ G 3	HIGH- ALTITUD E TRAININ G 4	ATHLETI C PERFOR MANCE 1	ATHLETI C PERFOR MANCE 2	ATHLE TIC PERF ORMA NCE 3
CHI- SQUARE	19.480 ^a	20.440 ^a	19.840 ^a	27.160 ^a	22.120 ^a	21.280 ^a	19.840 ^a
DF	2	2	2	2	2	2	2
ASYMP. SIG.	.000	.000	.000	.000	.000	.000	.000

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 16.7.

The above result describe that test statistical analysis result shows chi square values of each variables included independent and dependent. The chi square rates of high-Altitude Training 1,2,3 and 4 are 19.480, 20.440, 19.840 and 27.160 respectively. The Athletic performance 1,2, and 3 shows that 22.120, 21.280 and 19.840 respectively shows positive chi squares between them.

6. Conclusion and discussion

To sum up, the study of how high-altitude training affects Andean athletes is a complex one that covers genetic effects, physiological adaptations, and real-world applications for sports performance. This research has the potential to provide practical solutions that might help athletes all across the world, in addition to a detailed knowledge of the interactions between high-altitude life and athletic training. The goal of the expedition is to unearth a trove of information that cuts across national borders and advances our understanding of how people function in difficult situations. To sum up, the investigation of how high-altitude training affects Andean athletes is an important step towards comprehending the complex interplay among physiological adaptations, environmental influences, and athletic performance.

The Andes is an area with difficult heights that have changed people who live there over many generations. This research has examined the particular setting of this region. The study started by recognizing the innate physiological adjustments demonstrated by Andean communities, highlighting their elevated red blood cell count, enhanced oxygen-carrying ability, and genetic differences that aid in their adjustment to high-altitude existence. These adaptations—developed over millennia of exposure to lower oxygen concentrations—provide the framework for the investigation that follows, which looks at how Andean athletes react to deliberate high-altitude training. High-altitude training can have

a significant impact on the performance of Andean athletes due to the unique physiological changes that occur in response to training at high levels.

With the reduced oxygen availability at high altitudes, the body produces more red blood cells, enhances oxygen utilization, and improves athletic capacity, all of which can contribute to improve in difference performance in sports such as distance running and cycling. Specific training protocols, altitude levels, and the duration of acknowledgment to high-altitude environments can influence the magnitude of training adaptation. Consequently, careful consideration of the potential benefits and risks of high altitude training, as well as proper monitoring, is essential to optimize training adaptation in Andean athletes. We carefully followed certain goals throughout the trial to determine how high-altitude training affects athletes from Andes. The evaluation of the athletes' initial physiological states gave us a thorough grasp of where they were coming from and allowed us to identify any alterations brought about by the well-planned high-altitude training regimen.

This program aimed to test the limits of Andean athletes' skills while utilizing their natural adaptations to cardiovascular endurance, strength, and overall athletic performance. Altitude sickness and other negative consequences brought attention to the necessity of close observation and individualized training program modifications. This study is important for reasons that go beyond the particulars of Andean athletes. It contributes to the international conversation on high-altitude training by offering a balanced viewpoint on the suitability and efficacy of such programs. The results have applications for coaches and athletes throughout the globe in addition to furthering our understanding of human performance from a scientific standpoint. This work essentially aims to close the gap that exists between the adaptive mechanisms seen in Andean communities and the deliberate, methodical nature of high-altitude training.

The findings might alter training regimens, guide genetically-based personalized strategies, and spark a wider discussion about the moral implications of pushing oneself to the limit in the sake of sports greatness. The assessment of altitude training on Andean athletes is a rich piece in the sports science tapestry, illustrating the complex relationship between nature, nurture, and the never-ending quest for human potential. As the study draws to a close, it is hoped that the knowledge gathered will not only deepen our understanding of how athletes perform in demanding situations but also open the door to more ethical, individualized, and well-informed methods of training athletes in a variety of settings.

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