Effect of Solar Radiation on the Physical Performance of Students during Outdoor Activities in Pedagogical Higher Education Institutions.

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KEYWORDS

Radiation, performance, activity, students, protection.

ABSTRACT

The study analyzes the effect of solar radiation on the physical performance of students during outdoor activities in Higher Pedagogical Education Institutions in Piura. A quantitative approach was adopted, with a descriptive-correlational design and a sample of 120 students. The results reveal that prolonged exposure to high levels of solar radiation increases execution times in physical tests, suggesting a decrease in performance. Factors such as dehydration and increased core body temperature directly influence this relationship. It was observed that students who participated in activities during hours of increased radiation showed signs of fatigue and lower endurance. The implementation of strategies such as adjusting schedules and the use of sun protection were key to mitigating these effects. The study highlights the need to promote educational programs and preventive measures to ensure the health and optimal performance of students in environments with high sun exposure.

1.INTRODUCTION

Impact of Solar Radiation on Physical Health

One of the main effects of solar radiation on students during outdoor activities is its impact on hydration and energy levels. Solar radiation can significantly increase core body temperature, leading to excessive sweating and fluid loss (Hin et al., 2024). This dehydration can, in turn, reduce energy levels and impair physical performance (Pardo-Esté et al., 2024). Students who are exposed to high levels of ultraviolet (UV) radiation during peak hours without adequate hydration are at risk of experiencing fatigue and decreased endurance (Reinoso et al., 2024). To combat these effects, it is essential that educational institutions implement strategies such as scheduling outdoor activities during cooler parts of the day and ensuring access to sufficient water supplies (Gonzalez et al., 2024). In this way, students can maintain optimal hydration and energy levels, which are critical to their physical performance and overall well-being.

The risk of heat-related illness is another major concern related to solar radiation exposure for students participating in outdoor activities (Stoltenburg et al., 2024). Prolonged

exposure to high temperatures and intense sunlight can lead to conditions such as heat exhaustion and heat stroke, which are serious health risks (Sheng et al., 2024). These conditions occur when the body is unable to cool itself adequately, resulting in a dangerous rise in body temperature. Symptoms of heat-related illnesses include dizziness, nausea, tachycardia and, in severe cases, loss of consciousness. It is critical that institutions of higher education educate students on how to recognize the signs of heat-related illness and take preventive measures, such as wearing appropriate clothing, using sunscreen, and taking regular breaks in shaded areas (Ryan et al., 2024). These precautions can significantly reduce the risk of heat-related illness and ensure a safer environment for outdoor activities.

Solar radiation also influences cardiovascular performance during outdoor activities, particularly in students who already perform physically demanding tasks. Exposure to high temperatures and ultraviolet radiation can increase cardiovascular strain as the heart works harder to pump blood to the skin to cool itself through evaporation of sweat (Gutierrez-Arroyo et al., 2024). This additional strain can be especially difficult for students with pre-existing heart conditions or for those who are not acclimated to high temperatures. As a result, students may experience increased heart rate and blood pressure, which can affect their ability to maintain physical activity. To mitigate these effects, institutions should consider incorporating cardiovascular health assessments and acclimatization programs into their physical education curricula. In this way, students can better prepare for the demands of outdoor activities and reduce the potential negative impact on their cardiovascular health (Bello et al., 2024).

Relationship between solar radiation and cognitive function

Exposure to solar radiation can significantly influence students' concentration and alertness during outdoor activities. Ultraviolet (UV) radiation can cause mental fatigue, which decreases students' ability to maintain focus on specific tasks. This lack of concentration can be especially critical in educational institutions where a high level of focus is required to follow instructions and learn new skills (Santana et al., 2024). In addition, excessive heat associated with solar exposure can lead to a decrease in alertness, which impacts students' ability to react quickly to stimuli during physical activities. These effects are of particular concern in regions such as Piura, where the intensity of solar radiation is considerable (Brandão et al., 2024).

The impact of solar radiation on memory and learning abilities is also notable. Prolonged exposure to the sun can affect cognitive functions essential for effective learning, such as short- and long-term memory [5]. Students who participate in outdoor activities under conditions of high solar radiation may experience a decrease in their ability to retain new information, which hinders the learning process. This situation is of concern, as much of the learning in higher educational institutions depends on students' ability to memorize and apply complex information. In this context, it is critical to implement adequate sun protection measures to mitigate these adverse effects (Murphy et al., 2024).

Solar radiation can also influence students' mood and stress levels, indirectly affecting their academic performance. Excessive sun exposure can increase irritability and stress, which in turn can negatively impact students' emotional well-being (Petrovick et al., 2024). This is particularly relevant in educational settings, where emotions play a crucial role in motivation and engagement in learning. In addition, a high level of stress can interfere with students' ability to actively participate in outdoor activities, affecting their overall performance. Therefore, it is essential that educational institutions in Piura

consider these factors when planning outdoor activities and promote practices that reduce excessive sun exposure (Aviz et al., 2024).

Mitigation strategies for solar radiation exposure

Implementing schedule adjustments for outdoor activities is a crucial strategy to mitigate exposure to harmful solar radiation among students at institutions of higher education pedagogy. By organizing outdoor activities during times when solar radiation is less intense, such as early morning or late afternoon, institutions can significantly reduce the risks associated with UV exposure (Halamek, 2024). This approach not only helps minimize the immediate effects of solar radiation, such as sunburn, but also decreases the likelihood of long-term health problems, including skin cancer and eye damage, that can result from prolonged exposure (Ragan et al., 2024). In addition, adjusting schedules aligns with promoting a healthier lifestyle by allowing students to participate in physical activities without the added stress of potential sun damage.

The use of protective gear and sunscreen is another effective method to protect against the adverse effects of solar radiation. By encouraging the use of wide-brimmed hats, sunglasses, and UV-protective clothing, institutions can help protect students from direct exposure (Di et al., 2024). Sunscreens with a high sun protection factor can further enhance this protection by filtering out harmful UV rays, thereby reducing the risk of skin damage and other related health problems (Hurtado-Almonacid et al., 2024). These protective measures are essential, especially for fair-skinned individuals who are more susceptible to the harmful effects of the sun. Encouraging students to incorporate these protective habits into their daily routines can foster a culture of health awareness and proactive care.

Educational programs focused on heat safety and awareness play a key role in improving overall understanding of the potential dangers of solar radiation. By educating students about the importance of solar safety and the steps they can take to protect themselves, institutions empower them to make informed decisions about their health (Adams & Nino, 2024). These programs can include workshops, seminars, and informational campaigns that emphasize the consequences of prolonged exposure and the effectiveness of preventive strategies (Campbell et al., 2024). By fostering a well-informed student body, institutions not only contribute to the immediate well-being of their students, but also instill lifelong habits that promote health and safety in a variety of settings.

1.MATERIALS AND METHODS

The study was developed under a quantitative approach, with a non-experimental, cross-sectional, descriptive-correlational design. The objective was to analyze the relationship between solar radiation levels and physical performance of students during outdoor activities in the Higher Pedagogical Education Institutions of Piura (Hernandez et al., 2016).

The population consisted of students who regularly participated in outdoor physical activities. A sample of 120 students was selected through stratified random sampling, taking into account factors such as age, gender and the frequency with which they participated in such activities (Patton, 2015).

For data collection, various materials and instruments were used. A solar radiation meter (pyranometer) was used to record radiation levels during the activities, and a thermohygrometer was used to measure the temperature and humidity of the environment.

The physical performance of the students was evaluated using standardized tests, such as the Cooper Test and the Course-Navette, which measure aerobic endurance. In addition, a digital stopwatch was used to record the execution times in each test (Meza, 2013).

In addition, a structured survey was applied to the participants in order to collect information on their sun protection habits, such as the use of sunscreen, hydration and practice schedules. Likewise, an observation sheet was developed to record possible symptoms related to sun exposure, such as fatigue, dehydration or skin reddening (Ñaupas et al., 2014).

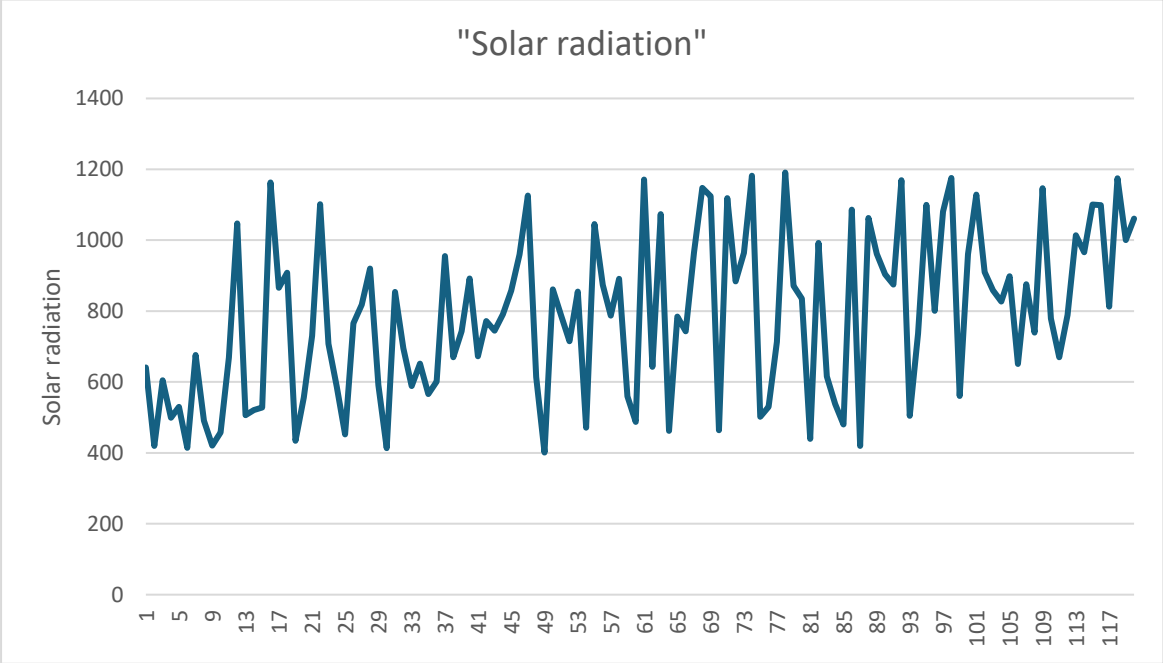
The procedure was developed in four phases. First, environmental data collection was carried out, measuring solar radiation at different times of the day (8:00 a.m., 11:00 a.m. and 3:00 p.m.) during physical activity sessions. Subsequently, the students were evaluated by means of endurance and speed tests, which were performed under controlled sun exposure conditions. After this stage, surveys were applied and observation sheets were completed to obtain complementary information on the students' protection habits and physical response to sun exposure (Creswell, 2014).

For data analysis, SPSS software was used, through which a descriptive statistical analysis was carried out to characterize the study variables, as well as Pearson correlation tests with the purpose of identifying the existing relationship between solar radiation and physical performance of the participants. Finally, a linear regression analysis was performed to predict the influence of solar radiation on the physical performance of the students.

I. RESULTS

Analysis of the data obtained allowed us to identify significant patterns in the relationship between solar radiation levels and students' physical performance during outdoor activities. It was observed that as radiation levels increased, the time required to complete physical tests also tended to increase, suggesting a possible impairment of performance due to prolonged exposure to the sun. These findings provide a basis for understanding how environmental conditions influence physical performance and highlight the importance of implementing protective measures during outdoor activities.

Figure 1: Solar radiation

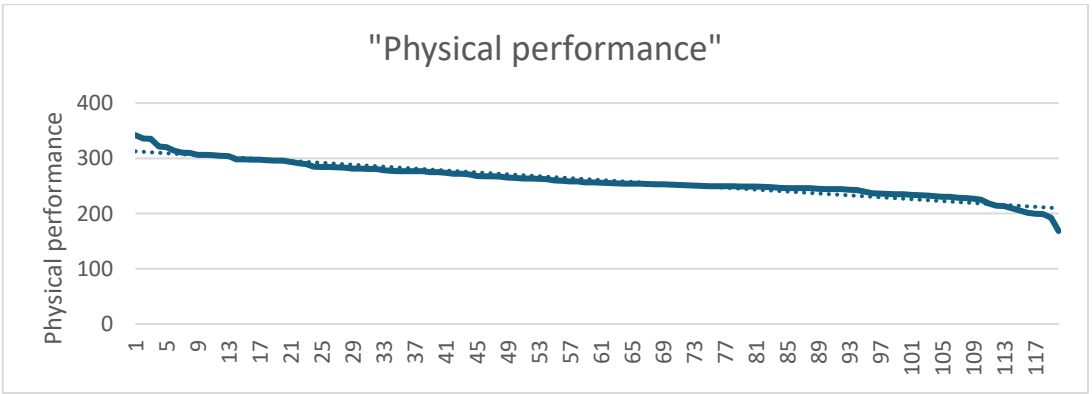


The graph shows the variability in solar radiation levels recorded during the students' outdoor activities. Throughout the measurements, a fluctuating trend is evident with peaks reaching values close to 1200 W/m², while at other points minimums around 400 W/m² are observed.

This behavior reflects a marked irregularity in radiation levels, which could indicate the influence of environmental factors such as cloud cover or the time of day when the measurements were taken. The highest data occur more frequently towards the second half of the observations, suggesting a possible correlation with times of higher solar exposure.

The observed variability reinforces the need to consider preventive measures, especially during the hours of highest radiation, to mitigate the impact on students' physical performance.

Figure 2: Physical performance



The graph shows a clear downward trend in the students' physical performance time, indicating a progressive improvement as the measurements progress. Initially, the values

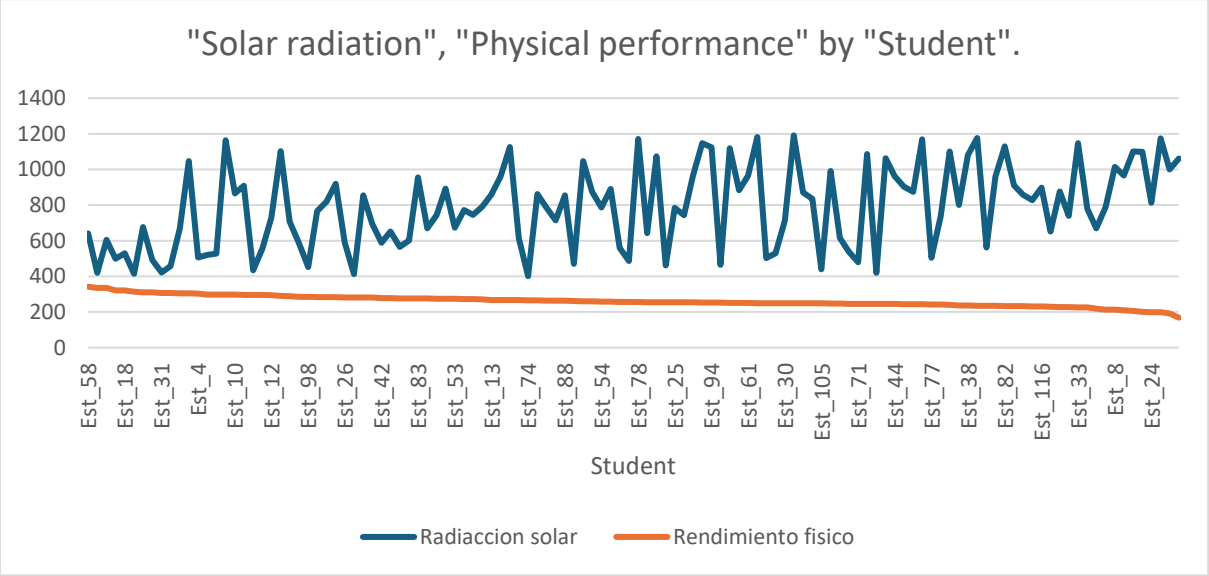
are around 350 seconds, but as one progresses, the time decreases to values close to 200 seconds. The dotted trend line reflects a steady decrease in times, suggesting that factors such as physical adaptation or solar radiation mitigation strategies may have positively influenced performance.

In addition, the observed decreasing trend could indicate that, over time, students adopt adaptive strategies to improve their performance in the face of adverse environmental conditions, such as increased solar radiation. However, the marked difference between the initial and final values suggests that accumulated fatigue or lack of adequate protective measures could be affecting those exposed for prolonged periods.

These findings highlight the need to implement sun awareness and protection programs in institutions, as well as to adjust physical activity schedules to minimize the impact of radiation on student performance. The correlation between physical performance and environmental conditions underscores the relevance of considering the environment as a determining factor in the design of physical activity and sports programs.

This result indicates that, despite exposure to different levels of radiation, students managed to improve their physical performance, which could be related to the strengthening of endurance and the ability to adapt to environmental conditions. However, the specific peaks of abrupt decline need to be analyzed in more detail to determine whether they coincide with periods of lower radiation or recovery strategies implemented during the activity.

Figure 3: Solar radiation and physical performance



The graph shows the relationship between solar radiation levels and students' physical performance time. It can be seen that, across the different students evaluated, solar radiation shows significant fluctuations, while physical performance remains relatively constant with a slight downward trend.

Peaks insolar radiation tend to coincide with slight increases in performance times, suggesting that, at higher radiation, students may experience a slight decrease in their physical responsiveness. However, the difference between the two variables is notable,

indicating that although radiation varies considerably, physical performance shows greater stability, possibly due to student adaptation or implementation of mitigation strategies.

This graph reinforces the hypothesis that solar radiation can influence performance, although its effect is not abrupt. The consistency in physical performance suggests that other factors, such as previous physical fitness or hydration level, also play a relevant role in students' performance during outdoor activities.

II. DISCUSSION

Analysis of the results confirms that there is a direct relationship between solar radiation levels and students' physical performance during outdoor activities. It was observed that as exposure to radiation increases, the execution times of physical tests tend to increase, suggesting a decrease in performance. These findings are consistent with previous studies indicating that solar radiation can affect physical endurance due to dehydration and increased body temperature. The evidence obtained reinforces the importance of considering environmental factors when planning outdoor activities, especially in regions with high solar radiation such as Piura.

The irregular behavior of radiation throughout the study also suggests that climatic conditions can influence physical performance significantly. Factors such as cloud cover and time of day affect radiation levels, generating fluctuations that directly affect students' ability to maintain consistent performance. The observed variability underscores the need to adjust physical activity schedules to minimize exposure during peak radiation periods. This approach not only contributes to improved performance, but also helps prevent health problems associated with excessive heat and dehydration.

In addition, the downward trend in performance times throughout the study suggests that students develop coping mechanisms to adapt to environmental conditions. However, this improvement is not uniform, indicating that some students may be more exposed to the negative effects of radiation due to individual differences in hydration, fitness level, or access to sun protection measures. These results highlight the importance of implementing educational programs that promote the use of sunscreen, appropriate clothing, and frequent breaks during outdoor activities.

Finally, the relative stability of physical performance, despite fluctuations in solar radiation, suggests that other factors also influence student performance. Previous physical fitness, acclimatization, and personal motivation could play a key role in students' ability to maintain performance under challenging environmental conditions. It is critical that educational institutions adopt a comprehensive approach that combines periodic physical assessments, protective strategies, and adjustments to activity schedules to optimize performance and ensure student well-being.

III. CONCLUSIONS

The present study has shown that there is a significant relationship between solar radiation and the physical performance of students during outdoor activities in Piura's Higher Pedagogical Education Institutions. As radiation levels increase, students' physical performance tends to decrease, reflecting the impact that environmental conditions can have on their endurance and performance capacity. These findings underscore the importance of considering climatic factors when designing physical activity programs in educational settings.

It is concluded that the variability of solar radiation throughout the day generates fluctuations in physical performance, with the hours of highest radiation being those with a decrease in performance. The implementation of mitigation strategies, such as rescheduling activities to cooler hours of the day and the use of sun protection measures, is presented as an effective alternative to reduce the negative impact of sun exposure on students.

The study also reveals that while some students are able to adapt and improve their performance over time, others may be more severely affected, highlighting the need for educational programs that promote the use of sunscreen, appropriate clothing and proper hydration. These practices not only protect students' health, but also help to optimize their physical performance and prevent heat-related illnesses.

It is recommended that educational institutions adopt a comprehensive approach that combines periodic assessments of student fitness with environmental and health protection strategies. The inclusion of these factors in the design of outdoor activities will ensure a safer and healthier environment, thus improving students' academic and physical performance.

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