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A statistical study of sport concerning the affective factors of resilience

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Abstract. Research on the resilience of athletes has attracted the attention of scholars in the last three decades. The incorporation of statistics has led to rapid advances in sports research, with a major focus on the factors that influence resilience, such as the sport in which the athlete is engaged, the standard of the athlete, the age and the gender, and so on. The methodology of sports statistics is also worth discussing, and the mainstream data analysis methods in the current literature include t-test, ANOVA and linear regression. This paper pulls together a considerable amount of relevant literature at the cutting edge and high academic level and analyzes what they study. We point out recognized findings and contradictions, indicating research directions and academic gaps for future theoretical research.

Keywords: sports statistics; resilience; t-test; ANOVA.

1. Introduction

The research on sports statistics and resilience can be traced back to sports psychology, which is an interdisciplinary field bridging psychology and physical education. The widespread recognition of this discipline spans a little over 30 years, despite the earliest research dating back to the work of Anshel in 1948. The definition of stress was proposed by Lazarus and Folkman in 1984 [17]. Stress factors are commonly present in sports competition, such as issues in preparation, on-field mistakes, success of competitors, and coach expectations. Stress represents the connection between individuals and their environment, thereby introducing the concept of resilience [4]. According to Hawley, resilience refers to adaptive capacity of humans in the face of difficulties and adversity, enabling them to overcome challenges and even enhance their capabilities [14].

Some scholars have conducted relevant research indicating a positive correlation between sports proficiency and resilience. Moderate engagement in sports activities has been shown to foster resilience [7,15,22]. After reaching conclusions regarding the overall population, scholars became interested in exploring potential differences in resilience among athletes participating in various sports disciplines. For instance, Chacon-cuberos and colleagues analyzed the recovery levels of athletes engaged in three different sports: soccer, handball, and skiing. However, they did not discover statistically significant differences [6]. Others have found that athletes in combat sports exhibit significantly higher levels of resilience compared to individuals participating in other individual or team sports.

Regarding the relationship between gender, age and resilience, both aspects have stirred significant debate within the current body of research. Scholars such as Cecilia Blanco- Garcia, Codonhato, and Rodriguez-Rey have suggested a positive correlation between age and resilience [3,8,21]. Their argument stems from the notion the resilience develops as an adaptive enhancement process over times. However, there is an equally substantial number of researchers who have analyzed the data and found no statistically significant correlation between age and resilience [6,20,25]. Regarding the relationship between gender and resilience levels, studies [2,3,19] have investigated athletes participating in different sports, the athletes from specific sport and university students. The consistent conclusion drawn is that male athletes exhibit significantly higher levels of resilience than female athletes. However, there are still compelling studies that indicate no significant correlation between the gender of athletes and their resilience recovery levels, as shown in studies [1,6,16].

Further attention from scholars is warranted in the research on the interplay between age, gender and recovery capabilities.

In the experimental sections of previous research, the majority of scholarly works have utilized statistical inference methods [2,3,4,19]. For our study, we have chosen to extensively elaborate on two of the most widely favored analytical approaches: the t-test and Analysis of Variance (ANOVA). Additionally, in the "Methods" section of this paper, we introduce other equally valuable approaches, including sampling methods.

The "t" in "t-test" stans for "Students t", which is named after William Sealy Gosset, who published under the pseudonym "Student" [24]. Gosset developed the t-test as a statistical method to work with small sample sizes when the population standard deviation is unknown. The t-test has since become a fundamental tool in hypothesis testing and statistical analysis, allowing researchers to assess whether the means of two independent groups are significantly different from each other [10].

ANOVA, devised by the statistician Ronald Fisher [23], encompasses a set of statistical models along with their corresponding estimation methods, encompassing factors like "variation" both within and between groups. This analytical tool is harnessed to scrutinize disparities in means. Anchored in the law of total variance, ANOVA partition s the observed variance of a given variable into distinct components stemming from disparate sources of variation [11]. In its elementary rendition, ANOVA extends the t-test's scope beyond two means, serving as a statistical assessment for determining equality among two or more population means.

The primary objective of this paper is to organize and synthesize the essential existing literature in the field of sports statistics, extracting viewpoints and evidence. It involves a comprehensive review of research conclusions and accomplishments pertaining to factors like resilience among athletes engaged in different sports disciplines and varying levels of athletic performance. Our emphasis lies in identifying gaps in prior research, such as the influence of coaches and training environments on the resilience of athletes. Furthermore, certain contentious viewpoints also necessitate discussion, such as the significance of correlations between resilience levels and gender or age. This paper serves to underscore the research value of sports statistics and provides a necessary research foundation for future scholarly writing, particularly in the context of research-oriented papers.

The structure of this paper is as follows: In the first section, we introduce the research background of sports statistics, statistical analysis methods, and previous study achievements. In the second section, we provide a detailed exposition of the t-test and ANOVA, two widely applied data analysis methods, while briefly outlining distinctive research methods employed by other studies. The third section delves into a discussion of considerable existing research conclusions and explores possible reasons for both aligned and conflicting viewpoints. In the fourth section, we highlight the limitations and potential of current research, offering insights for future scholars.

2. Methods

In this section, we aim to introduce several recent cutting-edge analytical approaches employed in high-quality research [2,3,4,19]. The subject matter of their studies is broadly similar, and the methodologies employed are diverse and contribute to the innovation within sport statistics. Their purpose is to analyze the relationship between the level of resilience in competitive athletes and the sport performed, the gender of the player, the age and the level of the competitiveness. Most of studies have employed t-test and analysis of variance (ANOVA) methods, when comparing age, gender exercise levels and the types of sports. These approaches are prevalent in statistical analysis and, therefore, in this section, we primarily focus on elaborating the theoretical principles underlying these two data analysis methods.

2.1 t-test

The statistical method named "t-test" is utilized to determine whether there exists a significant difference in the means of two independent groups. In the realm of sports statistics, it is commonly applied to compare a variety of factors, such as exercise levels, age groups, or gender differences. The underlying principle of the t-test is to calculate the t-statistic, which measures the difference between the means of two groups relative to the variability within each group. The larger the t-statistic, the more significant the difference between the groups. t-statistic is then compared to a critical value based on the degrees of freedom and the desired level of significance. If the calculated t-statistic exceeds the critical value, it indicates that the difference between the groups is statistically significant. As an example, in the one-sample t-test

$$t = \frac{Z}{s} = \frac{\bar{X}-\mu}{\hat{\sigma}/\sqrt{n}},$$

where $\bar{X}$ is the sample mean for the sample $\{X_1, X_2, \dots, X_n\}$ with size n, s is the standard error, $\hat{\sigma}$ is the estimate of the standard deviation, and μ is the population mean.

2.2 ANOVA

The ANOVA is used to test the difference between two or more means. It helps determine if there are any statistically significant differences among those groups. The fundamental concept behind ANOVA is to partition the total variance in the data into two components: variance due to differences between the groups and variance due to individual variability within the groups. By comparing the ratio of between-group variance to within-group variance, ANOVA calculates an F-statistic. This F-statistic is then compared to a critical value from an F-distribution to determine whether the observed differences among the groups are statistically significant. In sports statistics, ANVOA can be used to assess differences between multiple exercise levels, various age groups, or different types of sports.

2.3 Others

For accurate reliable results, ANOVA relies on certain assumptions to be met. The key assumptions for performing ANOVA are:

The data within each group should follow a normal distribution.

Observations within each group should be independent of each other.

The data should be collected through random sampling to ensure that the results can be generalized to the entire population from which the sample were drawn.

The variability or spread of data should be roughly the same across all groups. That is, the error ε are independent and $\varepsilon \sim N(0, \sigma^2)$. The definitional equation for sample variance is represented as:

$$S^2 = \frac{1}{n-1}\sum_i (y_i - \bar{y})^2.$$

In terms of statistical methodology, the K-S test is also employed to evaluate the normal distribution of variables. To determine the effect of this variable on the Brief Resilience Scale, a linear regression was performed. In addition, ANCOVA could also be employed to assess resilience disparities between sample groups based on physical activity, gender, type of exercise, and level of exercise.

Similarly, numerous scholarly articles employ various kinds of sampling technique, wherein samples are selected through non-probability and incidental means, obtained through a well-structured survey questionnaire.

3. Discussion

In summary, the research findings exhibit intricacy and heterogeneity. Consistent with pertinent investigations [1,3,4,5,9], it is evident that the restorative capacity does not exhibit significant discrepancies attributed to specific exercise modalities or levels of physical activity. However, resilience appears to be associated with the gender and age of the athletes; male athletes show higher

levels of adversity resistance compared to female athletes, with a positive correlation observed between resilience and age.

Regarding the relationship between resilience levels and the sports disciplines athletes are engaged in, the finding from [3] align with the results obtained from studies [1,4,9], indicating that there is no significant correlation between these two factors. Nonetheless, a recent investigation led by Reche-Garcia et al. unveiled a notable discrepancy in resilience levels among athletes engaged in individual, team, and combat sports. Notably, participants involved in combat sports exhibited considerably higher levels of resilience, and there is no difference between individual and team sports [20]. The underlying reason for this trend may stem from other distinctive situational factors that arise during the competition, where the mental and personality traits and cognitive abilities of the athletes may significantly influence their performance. Several factors contributing to this phenomenon include: physical contact and direct engagement with bodies of opponents, common pre-competition weight reduction practices, exposure to pain and potential injury risks, and the enduring fear of failure when facing opponents.

The literature generally suggests a positive correlation between resilience and athletic performance [12,13,16,18,26]. However, the results from study [3,5] do not support this conclusion. Potential reason for this discrepancy could be that, regardless of the category or level of athletes, the ability to efficiently utilize the skills and resources to achieve optimal athletic performance might be more influential [3,19]. Supporting evidence for this rationale can be found in research such as that of Patsiaouras, who conducted a survey of the volleyball athletes. The study revealed that athletes with higher levels of proficiency in sports were better at focusing their attention on finding solutions and overcoming challenges, compared to their less skilled counterparts [19].

Scholars in the research community appear to have engaged in substantial debates regarding the correlation between age and psychological recovery capacity. Scholars such as Cecilia Blanco-García, Codonhato have suggested that older athletes tend to possess stronger psychological recovery capabilities [3,8]. Even those conducted with non-athlete populations, Rodríguez-Rey have confirmed a positive correlation between age and resilience [21]. These researchers propose that the fundamental reason behind this phenomenon lies in the concept of resilience, which is likely to develop over time as a process of increasing adaptability, possibly enriched by life experiences. Contrastingly, scholars like Chacon Cuberos, Reche-García, and Tutte have arrived at opposing conclusions; their studies did not identify a correlation between resilience levels and age [6,20,25]. Hence, further in-depth research might be necessary to explore this aspect comprehensively.

As with age, there is debate surrounding the conclusions of the study regarding gender and resilience. Literature [2,3,19] suggests, through analysis of various athletes, sports university students, and volley Patsiaouras provides potential reasons in their work, suggesting that women tend to demonstrate lower determination in overcoming obstacles during competitions compared to men. In other words, men might be more adept at dispelling negative thoughts and cultivating problem-solving thinking. While previous studies have attributed this to psychological factors, we believe there are deeper underlying causes that still deserve to be explored. Because in several other significant studies, such as [1,4,16], it is indicated that there is no significant correlation between the gender of athletes and their recovery ability, based on their credible analytical results. While some scholars have pointed out that the core of this contradiction lies in the issue of data selection – that is, the limited and homogeneous nature of the samples in the study – clearer information has not been provided. We maintain a reserved perspective on this matter and eagerly anticipate further research delving in this direction, aiming to go beyond the limitations of sports statistics.

4. Limitations

In the studies mentioned above, we have extracted certain trends, while also acknowledging certain limitations. These observations are worthy of being highlighted, as they can offer valuable insights for future researchers.

Limited scholars have considered the two factors of coaches and training environments. It is widely recognized that both coaches and training environments play a crucial role in influencing athletes, impacting both their physical and psychological aspects. Further research in this area could expand to examine the connection between athleres performance and training environments in both developed and underdeveloped regions.

Similar to previous debates regarding outcomes, certain studies have exhibited accurate methodologies, yet yielded contradictory results. The underlying reasons could lie within the processes of data collection and selection, such as utilizing data from the same population to compare inter-group differences, or inadvertently removing substantial valid information during data refinement.

In contemporary statistics, specialized techniques have been developed for various industries. However, tailored analytical tools for sports scenarios have yet to be fully realized. To this day, scholars in this field largely adhere to traditional principles of statistical analysis. Looking ahead, it is hoped that profound theories from statistics, probability theory, and mathematics will be integrated, such as advanced mathematical statistics, stochastic analysis, and partial differential equations. This integration could potentially pave the way for new breakthroughs in the realm of sports statistics research.

5. Conclusion

The research in this paper can be summarized as follows. We provided a comprehensive overview of commonly used statistical methods in sports statistics research, including the t-test and ANOVA, while also briefly indicating other effective analytical approaches in this field. Concerning the research findings, several studies suggested an insignificant correlation between recovery level, athletic performance, and specific sports disciplines. A positive correlation trend between psychological resilience level and age was observed, in alignment with the concept of resilience. However, the existing literature on the relationship between recovery level and gender remains contradictory, demanding further analysis and assessment.

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