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Article

Application of sports medicine integration in the sports industry and quantitative evaluation of its impact on health

Yu Jiang[1], Lili Niu[1], Liangfang Meng[2,*]

[1] School of Physical Education, Hubei University of Arts and Sciences, Xiangyang 441000, China
[2] School of Health Management, Xianning Vocational Technical College, Xianning 437000, China
*** Corresponding author:** Liangfang Meng, mlf134@126.com

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Abstract: Sports medicine's involvement in the sports sector has become important as organizations and individuals look to improve performance while lowering injury risks. The research aims to examine how sports medicine is incorporated into the sports sector and assess its effects on health quantitatively. Sports medicine is a subspecialty of medicine that focuses on identifying, managing, and avoiding injuries associated with sports and physical exercise. Exercise science, physical therapy, and orthopedics are all combined to maximize athletes' performance and recuperation. Through preventative care and rehabilitation techniques, sports medicine also aims to promote general health and fitness. A total of 320 athletes from diverse sports participated in this research. It examines the application of sports medicine practices, including injury prevention, rehabilitation, and performance enhancement, across various sports disciplines. A pre-test and post-test evaluation framework to gauge how well sports medicine has been incorporated into the sports sector. Post-tests were given to evaluate changes in performance measures following an eight-week intervention. The data was analyzed using statistical methods, including descriptive statistics, paired *t*-tests, Analysis of Variance (ANOVA), and regression analyses that were utilized to compare pre- and post-intervention data and performed to determine the relationship between sports medicine interventions and improvements in health outcomes and performance metrics. It effectively demonstrates the benefits of incorporating sports medicine into the sports sector, offering indications of notable enhancements in athletes' physical and mental health.

Keywords: sports medicine; sports industry; impact on health; sports athlete; rehabilitation; statistical analysis

1. Introduction

A subspecialty of medicine known as sports medicine is dedicated to the prevention, identification, management, and recovery of injuries sustained during physical activity in sports. Sports medicine's contribution to enhancing athlete performance, reducing injury risks, and fostering general physical and mental well-being has grown in importance as the sports industry develops. Sports medicine practitioners, including doctors, physical therapists, and other healthcare professionals, work closely with athletes to design personalized care plans that address both acute and chronic injuries, as well as optimize physical performance through tailored exercise and rehabilitation strategies [1]. Sports medicine integration is crucial for professional athletes as well as amateurs and leisure players in the contemporary sports sector, where performance requirements are constantly rising. With the growing demands placed on athletes' bodies, sports medicine provides invaluable support in maintaining peak performance while ensuring long-term health. Sports medicine also

helps prevent injuries by encouraging safe training methods, keeping an eye on physical conditions, and implementing early intervention plans into action. To maintain and improve the sports industry's sustainability, safety, and security, this is required [2,3]. Athletic ability, or physical capability, is strongly linked to an athlete's ability to succeed in competition. Their capacity to move and engage in sports is directly impacted by a musculoskeletal injury related to sports. Because it affects many facets of life, an injury can be a life-altering event for many athletes [4]. Circulating levels of progesterone and estrogen fluctuate throughout life, starting with puberty and continuing into maturity and menopause, when ovarian steroid secretion rapidly declines, and low, consistent ovarian output takes the place of cyclic estrogen production [5]. The quality of life is impacted by musculoskeletal disorders (MSDs), which are caused by injuries to the joints, muscles, ligaments, nerves, and tendons. One in five adults and one in three senior people have debilitating, painful MSDs, which are brought on by aging. The 150 different diagnoses that makeup MSDs can greatly impair daily functioning and cause pain and discomfort in non-cancerous illnesses [6]. However, several technological and algorithmic issues prevent the wider application of compensatory reserve or decomposition measures from successfully translating to field settings, especially in harsh field conditions where hypovolemia is accompanied by multiple stressors [7,8]. Since elite athletes typically have access to a worldwide healthcare market, medical experts dealing with them are not limited by state-approved therapy modalities. This makes it a field that is ready for investigation, especially when combined with the unique set of demands placed on sports medicine professionals to heal injured bodies. However, in the social sciences, questions on how, when, and why non-traditional therapies are used in the field of sports medicine have received little attention [9]. The sports sector is a growing, green industry that is characterized by rising employment, growing domestic demand, and creating new economic growth areas. It can encourage sustainable growth in the area. The success of the sports sector can also be supported and ensured by regional sustainable development. The sustainable growth of an area greatly depends on the sports sector. The integration of related economic sectors and the collection of related economic activities that provide society with sports commodities are referred to as the sports industry [10]. Increasing understanding and improving results for patients with musculoskeletal disorders are the main objectives of orthopedic sports. Although there have been significant gains due to improvements in surgical procedures, instruments, and implants, it has frequently been difficult to customize management plans or forecast results based on a patient's unique situation [11]. The sports sector appeals to thousands of young professionals who want to work in an area that reflects their fan interests and is characterized by excitement, action, and celebrity in the media. The everyday realities of people who work in sports, however, might not be accurately depicted in the media [12].

1.1. Objective of the research

The research goal is to examine how sports medicine is incorporated into the sports sector and assess its effects on athlete performance and health objectively. By focusing on key aspects such as injury prevention, rehabilitation, and performance

enhancement, it aims to assess how sports medicine practices contribute to improving overall athlete well-being, reducing injury rates, and enhancing performance metrics. Through pre-test and post-test evaluations, statistical analyses will determine the effectiveness of these interventions, providing valuable insights into the role of sports medicine in optimizing athletic outcomes across various sports disciplines.

1.2. Contribution of the research

- Quantitative data on the effectiveness of sports medicine practices in improving athlete performance, reducing injury rates, and enhancing overall well-being, offers valuable evidence for the sports industry to incorporate sports medicine into regular training and performance strategies.
- The impact of injury prevention and rehabilitation interventions, the research highlights the role of sports medicine in reducing recovery times and long-term health complications, benefiting both professional and amateur athletes.
- The research contributes to the understanding of how sports medicine can be systematically integrated into various sports sectors, influencing the development of better health management practices and performance optimization techniques for athletes across different disciplines.

1.3. System overview

The research is arranged in the following order of organization: Section 2 contains related works. Section 3 contained a comprehensive methodology. Section 4 focuses on the experimental findings and discussions, and section 5 provides a conclusion.

2. Related work

Improved the knowledge translation (KT) procedure and regarding the performance delivery of sports scientists working in professional sports proposed a framework and work-based training model [13]. First, it outlined the presented viewpoints and difficulties facing sports scientists within the framework of KT, before putting forward a framework that emphasized philosophy, recipients, facilitation, and evidence-based practice, which sports scientists could utilize to improve their interpersonal skills and KT strategy. Finally, it provided a model of training for sports scientists, the professional sport-doctoral training plan, which in conjunction with the framework, could producing sports scientists. Determined to create an industry-academia approach that assists undergraduate sport management students in improving their employability using hands-on experiential learning in a particular athletic event [14]. The reference proposed that sport was created, provided, and consumed within a changing social and political context, which served as the foundation for a unified structure that links sports involvement combined with broader leisure-time physical activity (PA) [15]. The sport was placed within the wider context of leisure-time physical activity by examining and integrating the concept of sporting education into the theoretical foundations of a lifetime perspective. It was maintained that models of talent development pathways have been developed and implemented in line with sports policy's historical focus on elite performance and competitive club-

based sports. research described that elite football academies' player development programs must include both medical and performance divisions [16]. The nature of the operating procedures that practitioners use inside clubs and national federations, however, was yet unknown. Therefore, the purpose of the current investigation was to top kids' professional football academies worldwide on the procedures that their performance and medical departments follow. Leaders of a non-profit sports club work towards the stated goal of fostering integration in a community where the majority of people are immigrants [17]. The aim was to investigate how leaders understand and negotiate their explicit mandate to counteract segregation and promote integration, as well as how they attempt to put these objectives into practice. It also investigated how participants perceive the integration-related activities of the sports club. The scientific research discussed the dissemination of cutting-edge training concepts, methodologies, approaches, and training for winter sports [18]. Using an allocation approach could help identify issues within the network as well as place issues at its periphery. The paper described the partially empirical it was mostly a conceptual and positional piece that briefly summarizes the current discussion in the three leading journals for sport management research [19]. It suggested that sport be seen as an autonomous organization within an inter-institutional structure to bring it back to the forefront of the field of training. It asks whether the field has mostly overlooked sport's special characteristics and the investigation of how running sports organizations impact sports and the athletic human. The scholarly framework surrounding social and economic worth in the sports industry [20]. A co-citation bibliometric analysis has been used since bibliometric methods were particularly suitable for determining the intellectual frameworks of a topic and enhancing conventional literature evaluations. Networks of connections were found using the approach. the investigation illustrated the difference between sustainability and Circular Design (CD) concepts in sports, as well as instances of CD methodologies used in the creation of the Circular Economy (CE) model within the sports business [21]. The main objective was to distinguish between the concepts of sustainability and CE. It also examined how these ideas have been implemented in the sports sector as a result of CD practices. Numerous organizations advocate for sustainable practices in sports. Additionally, the industry was embracing the new CE strategy. As a result, it becomes challenging to discern between concepts and determine the advantages they offer the industry. The leisure and sports sector's marketing strategy was a complicated one that necessitates a deep comprehension of the target audience's requirements and driving forces [22]. As a result, the niche market concentrates on certain goods, services, or experiences. Practical methods for drawing customers to the industry examined and offered based on the textual dataset of the literature. Reference primarily examined how recreational athletes train against the backdrop of a rural revitalization plan [23]. Leisure has evolved into a significant area that is directly tied to each person's quality of life and is a significant symbol of social growth. The primary material carrier and the cornerstone of rural people's recreational sports activities was rural sports space, which was a component of rural space. Describe the four major concepts that were shared by many different sports: victory probability, team strength metrics, and the expected value of a game state [24]. For each, it examined the unique peculiarities of analytical methodologies in each sport as well as their commonalities. Any

implementation must inevitably involve statistical approaches, computing tools, and data sources, even if the focus is on the ideas that underlie each approach.

3. Method and material

This manuscript aims to examine the learning of sports medicine integration in the sports industry and quantitative evaluation of its impact on health. Further, the performance of sports has been evaluated by using a questionnaire with Likert scale values. Finally, with the help of feedback from participants, performance outcomes were analyzed.

3.1. Participants details

The Demographic **Table 1** provides a details breakdown of the characteristics of the 320 athletes involved. The sample has diverse ages, with the majority between 18 and 25 years, and it consists of a higher percentage of males. The majority of the sports players engaged in football, basketball, and cricket, with the three experience levels being distributed equitably. The injuries vary from nerve injuries to minor and major injuries, with varying periods of recovery ranging from a few days to more than a month. The participants report varying degrees of pain, and performance measures for speed and strength have moderate to high improvements. The sample consisted of 56.25% male athletes and 43.75% female athletes. The age distribution showed that 46.88% of participants were between 18–25 years 31.25% were aged 26–35 years and 21.88% (36–45). In terms of sports types, 37.50% were involved in football in team sports, 31.25% in basketball, and 25% in cricket, with a small portion categorized as other sports as shown in **Figure 1**. Experience levels varied, with 25% beginners, 37.50% intermediate athletes, and 37.50% advanced athletes. Regarding injury rates, 21.88% had nerve injuries, 40.63% experienced minor injuries and 37.5% had major injuries. Recovery times were categorized as 15.63% requiring 12 days, 40.63% requiring 28 days, 37.5% requiring 42 days, and 6.25% requiring 56 days. Pain levels following injury were 15.63 reporting no pain, 31.25% reporting mild pain, and 37.50% moderate pain, while 15.63% experienced severe pain. Performance metrics revealed that 31.25% showed high-speed improvement, 46.88% showed moderate improvement and 21.88% showed no improvement. In terms of strength, 28.13% showed high improvement, 43.75% moderate improvement and 28.13% had no significant improvement. The demographic breakdown highlights the diversity of the athletes involved, which provided a comprehensive view of how sports medicine practices influenced a wide range of athletes across different sports and experience levels.

Figure 1. Illustration of various sports and associated injuries.

Table 1. Demographic table.

Characteristic	**category**	***N* = 320**	**Percentage (%)**
Age Range	18–25	150	46.88
	26–35	100	31.25
	36–45	70	21.88
Gender	Male	180	56.25
	Female	140	43.75
Type of sports players	Football	120	37.50
	Basketball	100	31.25
	Cricket	80	25
	Others	20	6.25
Experience level	1–3 years (beginner)	80	25
	4–6 years (intermediate)	120	37.50
	7–10 years (advanced)	120	37.50
Injury Rate	Nerve injury	70	21.88
	Minor injuries	130	40.63
	Major injuries	120	37.50
Recovery time	12 days	50	15.63
	28 days	130	40.63
	42 days	120	37.5
	56 days	20	6.25
Pain level	No pain	50	15.63
	Mild pain	100	31.25
	Moderate pain	120	37.50
	Serve pain	50	15.63
Performance metrics	Speed		
	High improvement	100	31.25
	Moderate improvement	150	46.88
	No improvement	70	21.88
	Strength		
	High improvement	90	28.13
	Moderate improvement	140	43.75
	No improvement	90	28.13

3.2. Survey instrument

A total of 500 participants were considered, of which 320 were selected. Further, these questionnaires are categorized into five sections pain level, injury rates, recovery time, speed, and strength.

- Injury rates: This section has 5 questions to measure the frequency of injuries occurring within a specific time or activity context, typically expressed per participant or time frame, monitoring injury rates helps identify risk factors and guide preventive strategies, making it a vital metric for sports, healthcare, and occupational safety.

- Recovery time: This section has 5 questions to measure it is the period an individual needs to fully heal after an injury. It varies based on the injury severity the individual health and treatment methods affecting when they can resume normal activities, reducing recovery time through optimized care can enhance long-term health outcomes.
- Pain level: This section has 5 questions to measure. Pain is a common occurrence for athletes, and pain management in sports has long been associated with injury management.
- Speed: This section has 5 questions to measure it involves having the capacity to apply force in the face of opposition. It is necessary for activities demanding strength and endurance and is usually developed through resistance training.
- Strength: This section has 5 questions to measure it involves having the capacity for rapid movement. It is mostly developed through technical drills, plyometrics, and sprint training. Activities that call for rapid bursts of movement require speed.

Pre- and post-intervention data were collected by providing questionnaires to the player. These questionnaires were prepared based on performance factors. By responding to the questionnaire, one can evaluate how well sports medicine has been incorporated into the sports sector. To measure the possibility of understanding the sports medicine integration in the sports industry and quantitatively evaluate its impact on health, the questionnaire was provided with a 5-point Likert scale rating approach.

3.3. Performance factors

Evaluations include injury rates, recovery time, pain level, speed, and strength variables presented an inclusive assessment of the encouraging inclusivity in sports medicine integration in the sports industry and a quantitative evaluation of its impact on health as shown in **Figure 2**.

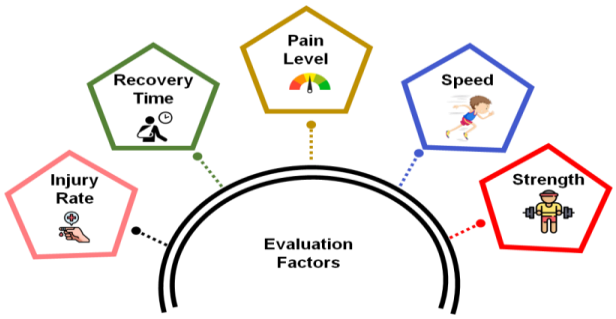

Figure 2. Key factors for evaluation and assessment.

- Injury rates: Monitoring injury rates is essential for sports, healthcare, and workplace safety because it helps identify risk factors and direct preventive measures. It measures the frequency of injuries that occur within a certain time or activity context, usually stated per participant or time frame. Sportsman has the highest rates of participation and injuries; sports are the main cause of injuries among sportsmen.
- Recovery time: Performance throughout repeated exercise sessions can be significantly impacted by recovery from exercise. Water immersion is one

technique that is becoming more and more well-liked as a way to improve recovery after a workout or game. The majority of the literature on water immersion's potential to enhance sports recuperation and real performance change seems to be anecdotal.

- Pain level: Athletes frequently experience pain, and managing pain in sports has historically been linked to managing injuries. Pain and injury both affect how well a person performs in sports, but they are not the same thing. Common symptoms of acute musculoskeletal injury include inflammatory pain, nociceptive pain, or both. When pain lasts longer than anticipated after an accident, all possible causes must be taken into consideration, such as underlying pathophysiology, persisting biomechanical anomalies, and psychological problems. Pain chronification must be differentiated from a persistent biomechanical overuse pattern because it involves several pathophysiologic and neurobehavioral processes that progress from acute injury-related pain to sub-acute and chronic pain.
- Speed: In the face of resistance, it entails being able to use force. Activities requiring strength and endurance require it, and resistance training is often how it is acquired. This pertains to the athlete's capacity for mobility. A person can go a certain distance in the least amount of time. Sprinting, abrupt direction changes, and quick responses to opponents or the surroundings are all examples of sporting activities where speed is essential. Increasing speed can result in faster response times, more effective movement, and the capacity to exceed rivals in short bursts of distance.
- Strength: It requires having the ability to move quickly. Sprint training, plyometrics, and technical exercises are the main ways it is developed. Speed is necessary for activities requiring quick bursts of movement. The ability of an athlete to use force while lifting, pushing, or pulling is referred to here. It is essential for power-demanding movements like, basketball jumps, and football tacking. Because stronger muscles and joints are less likely to be harmed under stress, it is essential for preventing injuries. Strength training also increases endurance, which enables athletes to sustain peak performance over extended durations of exercise.

3.4. Statistical analysis

Traditional training's efficacy in promoting inclusion in sports medicine integration in the sports industry and quantitative evaluation of its impact on health have all been examined using four separate statistical analyses. Every execution makes use of the statistical package for social sciences (SPSS), which assesses the input data's processing and interpretation. Here are a few of the numerous statistical analyses.

- Descriptive analysis: The main features of a dataset are enumerated and explained in descriptive analysis. Typical examples of descriptive statistics are in Equation (1).

  Mean $\overline{W}$: The average value.

$$\bar{W} - \frac{1}{m}\sum_{j-1}^{m} W_j \quad (1)$$

Median: The midway value inside an ordered data collection.

Mode: The most commonly occurring value.

Standard deviation (SD): Measures the dispersion of data from the mean in Equation (2).

$$SD - \sqrt{\frac{1}{m-1}\sum_{j-1}^{m}(W_j - \bar{W}_i)^2} \quad (2)$$

Variance (Var): The Square of the standard deviation in Equation (3).

$$Var - SD^2 \quad (3)$$

Range is the distinction between the highest and lowest values in Equation (4)

$$Range - Max - Min \quad (4)$$

Minimum and maximum: The smallest and largest values in the dataset.

- Multiple regressions: Two or more variables are examined using the statistical method. The methodology enables researchers to evaluate the predictive power of the factors and quantifies every variable's impact on the variable and the basic question for multiple regressions as shown in Equation (5).

$$Z = \beta_0 + \beta_1 W_1 + \beta_2 w_2 + \cdots + \beta_n w_n + \epsilon \quad (5)$$

Where β_0 is the intercept, $\beta_1, \beta_2 \ldots . \beta_n$ represent the variables' coefficients, Z is the variable, and $w_1, w_2, \ldots w_n$, ϵ represent the error term. It helps in identifying significant predictions, assessing their relative importance, and making informed choices based on the outcomes.

- ANOVA test: A statistical procedure called a calculation of variance, commonly referred to as ANOVA, is performed to determine whether the averages of at least three distinct communities are very different from individuals. It determines if there is a substantial difference between the differences within every category and the variance throughout the various categories.
- Paired *t*-test: It can be used to predict if there is a zero mean variation between two sets of data. To create pairs of observations for a paired *t*-test, each entity or subject is computed twice. Since the sample data is derived from a normal distribution, it needs to be numerical and continuous.

4. Results and discussion

The section presents the results of various analyses conducted on sports medicine integration in the sports industry and a quantitative evaluation of its impact on health.

4.1. Result of descriptive analysis

Table 2 shows data on athletes' health and performance metrics. The injury rate is relatively low, with a mean of 0.25, ranging from 0.10 to 0.40. Recovery time is

12.5 days, with a standard deviation of 3.2 days. Pain level is moderate at 6.8 ranging from 4 to 9. Speed is 5.2 m/s, with a standard deviation (SD) of 0.6, ranging from 4.0 to 6.5 m/s. Strength is 82.3 kg with individual values ranging from 70 to 105 kg indicating a broad distribution of strength levels among athletes.

Table 2. Pre-intervention descriptive statistics.

Variables	Mean	SD	Min	Max
Injury Rate	1.25	1.05	0.10	0.40
Recovery Time	12.5	3.2	8	18
Pain level	6.8	1.1	4	9
Speed	5.2	0.6	4.0	6.5
Strength	82.3	10.5	70	105

Table 3 presents descriptive statistics for various variables related to athlete health and performance metrics. The injury rate is low, with a mean of 1.12, suggesting variability. The recovery time is consistent, with a mean of 8.4 days. Pain levels (3.2) are generally low to moderate. Speed is narrow with 6.0 m/s. These statistics provide a comprehensive understanding of athlete health and performance.

Table 3. Post-intervention descriptive statistics.

Variables	Mean	SD	Min	Max
Injury Rate	1.12	1.04	0.03	0.2512
Recovery Time	8.4	2.1	6	12
Pain level	3.2	0.8	1	5
Speed (m/s)	6.0	0.5	5.0	7.2
Strength (kg)	92.1	9.7	80	110

The post-intervention data highlights significant improvements in key health and performance metrics. Specifically, the injury rate decreased substantially, indicating a reduction in the occurrence of physical harm, while reported pain levels also saw a marked reduction, suggesting better overall health outcomes. Additionally, the recovery time was notably shorter, reflecting quicker healing and fewer setbacks post-intervention. Moreover, both speed and strength metrics showed noticeable improvements, pointing to enhanced physical performance. Recovery time also decreased, while speed and strength improved reflecting enhanced performance post-intervention as shown in **Figures 3** and **4**.

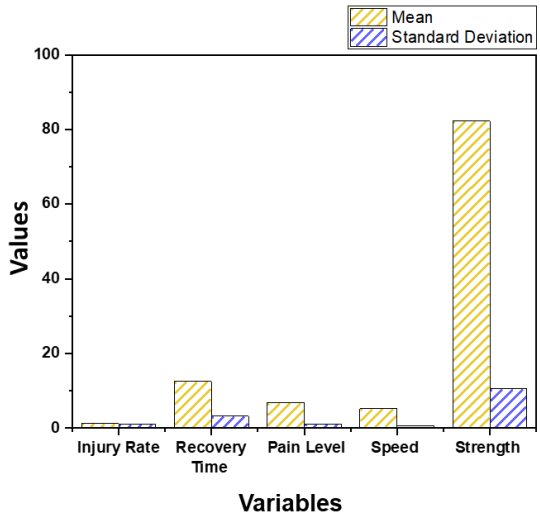

Figure 3. Outcomes of pre-intervention descriptive analysis.

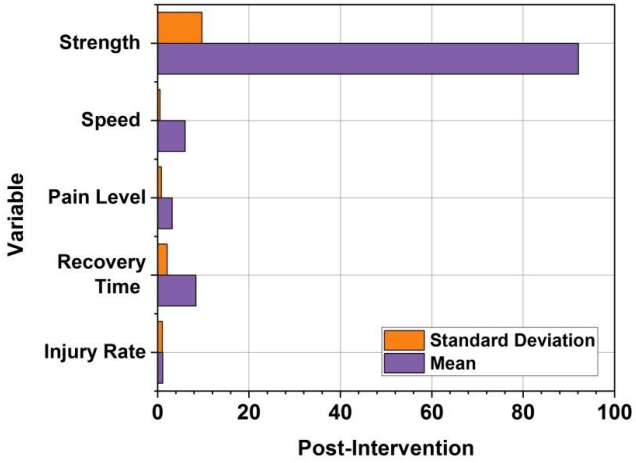

Figure 4. Outcomes of post-intervention descriptive analysis.

4.2. Result of multiple regressions

Table 4. Pre-intervention multiple regressions.

Variables	Standard error	Coefficient	*p*-value	*t*-statistic
Injury Rate	0.03	0.10	< 0.01	3.33
Recovery Time	0.12	−0.50	< 0.01	−4.17
Pain level	0.05	0.20	< 0.01	4.00
Speed (m/s)	0.18	0.80	< 0.01	4.44
Strength (kg)	0.08	0.30	< 0.01	3.75
R^2	-	0.82	-	-
Adjusted R^2	-	0.81		-
F-statistic	-	75.25	< 0.01	-

Table 4 reveals the relationship between various variables and the outcome of interest. Higher injury rates are associated with an increase in the dependent variables, while longer recovery times decrease it. Higher pain levels are associated with higher

values of the variables. Speed and strength also contribute positively to the outcome. The model explains 82% of the variance in the variable, with an adjusted R^2 value of 0.81. The overall model is statistically significant, with an *F*-statistic of 75.25. The results suggest that higher injury rates, faster speeds, and stronger muscles all contribute positively to the outcome.

Table 5 shows that factors such as injury rate, recovery time, and pain level have a negative impact on the variable. Higher injury rates lead to a decrease in outcomes, while longer recovery times and higher pain levels result in reduced outcomes. Speed and strength also have positive effects on outcomes. The modified R^2 score of 0.84 indicates that the model's explanatory power is still strong even after taking the number of predictors into consideration. The R^2 value of 0.85 shows that the model explains the variation in the variables. The overall regression model is statistically significant with a *F*-statistic of 92.31.

Table 5. Post-intervention multiple regressions.

Variables	**Standard error**	**Coefficient**	***p*-value**	***t*-statistic**
Injury Rate	0.02	−0.08	< 0.01	−4.00
Recovery Time	0.10	−0.30	< 0.01	−3.00
Pain level	0.04	−0.15	< 0.01	−3.75
Speed (m/s)	0.15	1.10	< 0.01	7.33
Strength (kg)	0.07	0.45	< 0.01	6.43
R^2	-	0.85	-	-
Adjusted R^2	-	0.84		-
F-statistic	-	92.31	< 0.01	-

The post-intervention model reveals notable improvements in key performance metrics, with speed and strength showing stronger positive effects after the intervention. This suggests that the intervention has had a beneficial impact on enhancing athletic performance in these areas. In addition, the injury rate and recovery time coefficients are more significant post-intervention, indicating that the intervention not only promotes better performance but also contributes to faster recovery and a reduction in injury frequency. These findings underscore the overall effectiveness of the intervention in improving both physical capabilities and health outcomes. **Figure 5** provides a visual representation of these enhanced outcomes, highlighting the improvements in speed, strength, injury rate, and recovery time.

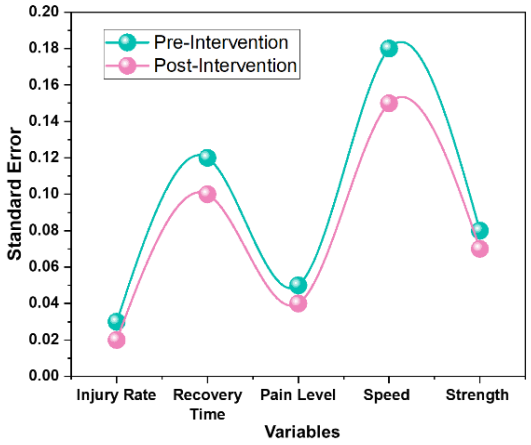

Figure 5. Outcomes of pre-post-intervention multiple regression.

4.3. Result of ANOVA

The findings examine the effects of several factors on a certain outcome, such as injury rate, healing time, pain level, speed, and strength. The sum of squares, DF, mean square, *F* statistic and *p*-value for every variable are shown in **Table 6**. Every variable displays statistical findings with *p*-values below 0.01. The target level has the greatest *F*-statistic (32.33), indicating that it has the most long-lasting effect on the result. The *F*-statistics show how strongly each variable and the dependent variable are related**.** The amount of variation or differences seen for each component is represented by the sum of squares. An average estimate of this variation is given by the mean square. To ascertain the degree to which each component affects the results, the *F*-statistic contrasts the explained variance with the unexplained variation. A larger *F*-statistic indicates that the factor had a greater impact on the outcomes. The statistical significance of the observed effect is shown by the *P*-value. A *P*-value below a particular threshold indicates that the factor has a significant effect on the results. To comprehend and enhance the performance, the analysis emphasizes the critical role that several parameters, such as strength and injury rate, have in performance results.

Table 6. Pre-intervention ANOVA.

Variables	Sum of square	DF	Mean square	*F*-statistic	*P*-value
Injury Rate	1.04	1	1.04	12.45	< 0.01
Recovery Time	14.56	1	14.56	20.15	< 0.01
Pain level	7.20	1	7.20	32.33	< 0.01
Speed (m/s)	4.92	1	4.92	24.67	< 0.01
Strength (kg)	11.11	1	11.11	15.78	< 0.01
Total	38.83	319	-	-	-

The total squares, DF, mean square, *f* statistic, and *p*-value for every variable are shown in **Table 7**. Every variable displays statistical findings with *p*-values below 0.01. The two factors that have the greatest influence on the dependent variables are aim level (31.25) and pain level (29.78), as indicated by the highest *f*-statistics, which show the strength of the association between each variable and the dependent variable. Every variable has a substantial effect on the dependent outcomes, according to the

research, indicating that these factors are crucial in determining the outcomes. In particular, speed, strength, pain level, injury rate, recovery time, and all of these variables have statistically significant impacts, suggesting that these variables are relevant rather than merely random fluctuations. The degree to which the model represents the link between the components and the outcomes is shown by this sum, which takes into account the variance seen across all the variables. The findings of the research show that the factors of strength, speed, pain level, injury rate, and recovery time had a substantial impact on the outcomes that were measured.

Table 7. Post-intervention ANOVA.

Variables	Sum of square	DF	Mean square	*F*-statistic	*P*-value
Injury Rate	1.03	1	1.03	16.02	< 0.01
Recovery Time	9.75	1	9.75	18.45	< 0.01
Pain level	5.40	1	5.40	29.78	< 0.01
Speed (m/s)	6.40	1	6.40	31.25	< 0.01
Strength (kg)	8.80	1	8.80	19.95	< 0.01
Total	30.38	319	-	-	-

When comparing the ANOVA tables pre- and post-intervention, the results show a statistically significant change in all variables measured across the board. Most notably, the *F*-statistics in the post-intervention table are greater than those for the key outcomes like speed and pain level, indicating a greater effect from the intervention in these specific areas. With larger *F*-statistics of the post-interventional time series, it shows performance improvements combined with health benefits that enhance its strength in evidence of how effective the intervention has been. This is also depicted by the data from **Figure 6**, which provides some visual support for the changes realized. Overall, results show that the intervention indeed played a meaningful role in strengthening performance and reducing pain.

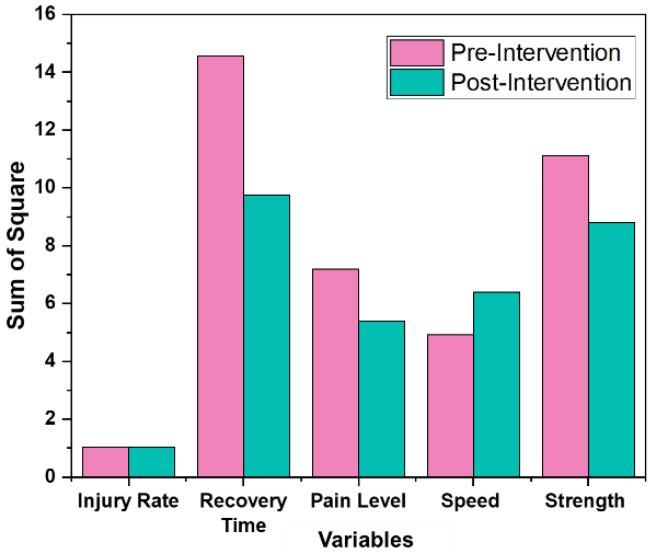

Figure 6. Outcomes of pre-post-intervention ANOVA.

4.4. Result of paired *t*-test

Table 8 presents the mean, SD, *t*-statistic, DF, and *P* values for each variable before the intervention. The variables show significant results with *P*-values less than 0.01. Injury rate has a negative mean and SD (1.25 and 1.05), while recovery time has a mean and SD (12.5 and 3.2) suggesting a significant increase. Pain level shows the highest mean and SD of 6.8 and 1.1 indicating a strong effect. Similarly, speed has a mean and SD (5.2 and 0.6) and strength (82.3 and 10.5) demonstrating significant changes highlighting that variables were notably impacted before the intervention.

Table 8. Pre-intervention paired intervention.

Variables	Mean	SD	*T*-statistic	DF	*P*-value
Injury Rate	1.25	1.05	−5.62	319	< 0.01
Recovery Time	12.5	3.2	9.45	319	< 0.01
Pain level	6.8	1.1	15.38	319	< 0.01
Speed (m/s)	5.2	0.6	7.82	319	< 0.01
Strength (kg)	82.3	10.5	6.24	319	< 0.01

Table 9 presents the mean, SD, *t*-statistic, DF, and *P* values for each variable after the intervention. The variables show significant results with *P*-values less than 0.01. Injury rate has a negative mean and SD (1.12 and 1.04), while recovery time has a mean and SD (8.4 and 2.1) suggesting a significant increase. Pain level shows the highest mean and SD of 3.2 and 0.8 indicating a strong effect. Similarly, speed has a mean and SD (6.0 and 0.5) and strength (92.1 and 9.7) demonstrating significant changes highlighting those variables were notably impacted after the intervention.

Table 9. Post-intervention paired intervention.

Variables	Mean	SD	*T*-statistic	DF	*P*-value
Injury Rate	1.12	1.04	−5.62	319	< 0.01
Recovery Time	8.4	2.1	9.45	319	< 0.01
Pain level	3.2	0.8	15.38	319	< 0.01
Speed (m/s)	6.0	0.5	7.82	319	< 0.01
Strength (kg)	92.1	9.7	6.24	319	< 0.01

The post-intervention table reveals significant improvements in key health outcomes, with a noticeable reduction in the injury rate among participants. Additionally, the reported pain levels were substantially lower after the intervention, indicating a positive impact on physical well-being. Recovery times also decreased noticeably, indicating faster healing and generally better recovery. Besides the improvements in health, participants experienced performance improvements; their performances increased in speed and strength. **Figures 7** and **8** give detailed graphics that demonstrate the effect of the intervention. In view of the results, the data indicates that the intervention significantly reduced the injury rate. The data also indicated improved athletic performance as well as speedy recovery after the intervention was conducted. Overall, it brings out the effectiveness of intervention in health and performance.

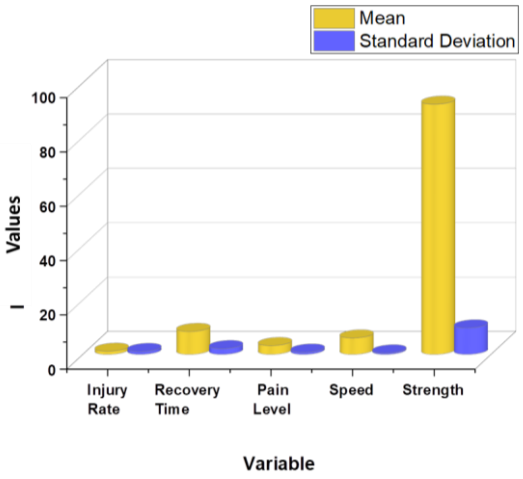

Figure 7. Outcomes of pre-intervention paired *t*-test.

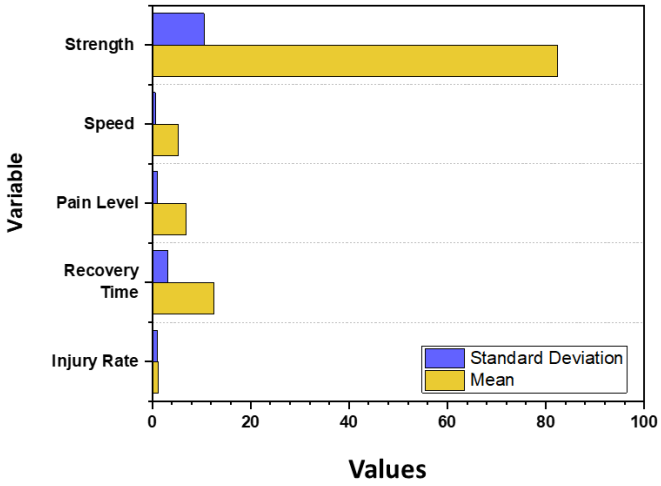

Figure 8. Outcomes of post-intervention paired *t*-test.

4.5. Discussion

Analysis based on descriptive statistics, regression models, ANOVA, and paired *t*-tests reveals a general increase in the health and performance of the athletes after the intervention. Pre-intervention data reveal a moderate injury rate of 1.25, an extended recovery period of 12.5 days, and a high level of pain (6.8), signifying the areas for improvement. Post-intervention, these metrics indicate positive changes: the injury rate drops to 1.12, recovery time decreases to 8.4 days, and pain level significantly reduces to 3.2. Speed and strength also indicate improvements, with speed increasing from 5.2 m/s to 6.0 m/s and strength rising from 82.3 kg to 92.1 kg. The multiple regression analyses validate the influence of important factors on athlete results. Higher injury rates, recovery times, and pain thresholds before the intervention tended to have a negative effect, while strength and speed tended to have a positive influence. After the intervention, increases in the coefficients for variables like strength and speed allowed for more pronounced favorable effects relative to the negative effects the variables of injury rate and recovery time had on performance. The regression models further highlight the positive effects of increased speed and strength on the outcome, with an adjusted R^2 value of 0.85 for the post-intervention analysis. ANOVA results indicated that the effects of speed and pain level were stronger after the

intervention, and thus the intervention was effective. Paired *t*-test results also showed significant changes in all variables with *P*-values less than 0.01. These findings collectively suggest that the intervention led to a marked improvement in athlete performance and health, showing its positive impact on reducing injuries, pain, and recovery time while improving speed and strength. These results demonstrate how well the intervention worked in enhancing athlete performance and health, highlighting the importance of developing strength and speed while controlling injury rates and recovery periods. The findings indicate that sports medicine techniques can improve athlete performance and health in measurable methods.

5. Conclusion

Sports medicine integration in the sports industry simply refers to the integration of medical expertise into optimizing athletes' performance, injury prevention, and recovery in a sporting context. It is a multi-disciplinary approach integrating the role of health professionals including doctors, physiotherapists, and nutritionists. Evaluation of its impact on athletes becomes quantitative, measuring outcomes that derive from these interventions: improved metrics of physical health and performance, and reduced injury rates. The data-driven approach helps in assessing the effectiveness of sports medicine practices in improving overall athlete well-being and performance. The research indicates statistically significant improvements in the key health and performance metrics post-intervention for all variables, with consistent *p*-values less than 0.01. Reductions in injury rates and times to recovery as well as improved speed and strength underscore the effectiveness of the intervention.

6. Limitations and future scope

Limitations: The study found significant results but faced limitations due to its small sample size of 320 athletes, which cannot fully represent the border sports industry. The eight-week intervention period cannot capture the long-term impacts of sports medicine integration. External factors like nutrition, psychological aspects, and training regimens could influence health and performance outcomes. The reliance on self-reported data from athletes could introduce bias. The study focused on specific sports disciplines, leaving for exploration in other sports or broader athletic populations.

Future scope: Future research cloud expands on the study by including a larger and more diverse sample of athletes from different regions and sports disciplines to enhance the generalizability of the findings, Long-term studies cloud assess the sustained impact of sports medicine interventions beyond eight weeks. Additionally, incorporating other variables such as mental health, nutrition, and specific training methods cloud provide a more comprehensive understanding of factors affecting athlete health and performance. Further research could also explore the cost-effectiveness of sports medicine integration in both professional and amateur sports to guide policy decisions in sports organizations.

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