

Wearable Devices and Sports Nutrition: Optimising Recovery and Performance in Professional Athletes

Anusha Ganeshan¹, Arya Sarasan², Preeti Mange³, Aditya Bidkar⁴,
Digvijay Jadhav⁵

^{1,2,3,4,5}Student, Institute of Management Development and Research (IMDR), Pune

ABSTRACT

Sports has evolved from a past-time to a profession that requires great dedication and hard work. For athletes, maintaining their mental and physical well-being is of the greatest importance. The advancement in technology has allowed professional athletes to train and develop their skills in a strategic and systematic manner. Using trackers and wearable devices, they are able to utilise the real-time data for understanding their capabilities and enhancing them with sound scientific backing. These devices provide support not only for training but also for recovery of those athletes who have suffered injuries. It allows them to plan and prepare a nutritional diet and workout based upon their individual requirements. While major countries have already incorporated technological devices into athletes' training programs, India needs to understand the importance of such scientific methodology in order to provide its athletes with the best training for improving their performance and morale.

Keywords - Sports nutrition, wearable devices, sports technology, athlete performance and recovery

1. INTRODUCTION

1.1 CONCEPTUAL FRAMEWORK OF STUDY

The advent of technology has brought about major developments in all aspects of man's life. From everyday life to industries, technology has opened doors for better and more comfortable life. The field of Sports has also seen a massive impact of technology. Athlete training has become more rigorous and innovative. The advancements in technology have had a good effect on athletic performance. For athletes, the most important thing is ensuring that they always perform to the best of their abilities. In order to do so, they must maintain good health through exercise and diet. This is where technology has brought about positive changes to tracking athletes' performance. The cloud based technology (Internet of Things) makes it possible to use wearable devices during training and even while sleeping. This helps the athletes to understand their abilities and limitations in order to optimise their activities for the best possible performance. With player tracking having taken up such an important position in sports, more research is being done to understand and develop a better device for obtaining accurate and reliable results.

Key concepts:

a. Internet of Things (IoT) : It is a network of physical devices, vehicles, appliances, and other physical

objects that are embedded with sensors, software, and network connectivity, allowing them to collect and share data.

- b. **Smart wearable devices** : IoT devices—also known as “smart objects”—can range from simple “smart home” devices like smart thermostats, to wearables like smartwatches (*What Is the Internet of Things (IoT)?* | IBM, n.d.)
- c. **Sports Performance**: Sports performance is the pursuit of excellence where a sportsman measures his or her performance quantitatively or qualitatively to move towards his or her desired goal. (Chuckravanen et al., 2019)
- d. **Recovery**: Recovery is regarded as a multifaceted (eg. Physiological, psychological) restorative process relative to time. In case an individual’s recovery status (ie, his or her biopsychosocial balance) is disturbed by external or internal factors, fatigue as a condition of augmented tiredness due to physical and mental effort develops. (Kellmann et al., 2018)
- e. **Sports Nutrition**: Sports nutrition is the study and practice of optimizing dietary intake to enhance athleticism, recovery, and overall fitness. Sports nutrition differs from general nutrition, because it addresses the unique energy demands of athletes, recognizing that their caloric and nutrient requirements differ significantly from non-athletes. (*What Is Sports Nutrition? Why It Should Matter to Athletes* | American Public University, n.d.)

1.2 APPLICATION IN SPORTS

Nutrition plays an important role in Sporting performance. The definition of proper nutrition varies from one athlete to another since every athlete has a different physique, capacity and tolerance level. Hence, it is pertinent to keep track of the fitness level of athlete to determine the areas where they are lacking in order to improve them. By using wearable devices (which utilise IoT), it is relatively easier to understand the physiological conditions of athletes and customise a diet plan for them. Even during recovery, it is crucial to monitor the condition of the athlete to help increase the pace of recovery without compromising the health.

2. LITERATURE REVIEW

2.1 EMPIRICAL STUDIES

The adoption and usage of wearable tracking devices among athletes presents a complex picture of dependency and preference variation. Mopas and Huybregts (2020) conducted a study on 16 athletes to understand the level of dependency of athletes on the usage of wearable devices, finding that while certain athletes still preferred the conventional method of 'feeling' their condition, most preferred to wear their tracker for even short periods of time. Building on this, Diotaiuti et al. (2020) evaluated the use of wearable tracking devices by runners with varying levels of competitive experience and found that competitive experience was a variable factor which affects the dependency of the athletes on the use of devices. Notably, the more experienced runners used the devices wisely and were not only able to find the defects in the devices, but also highlighted the presence of such defects.

The application of wearable technology across different sports reveals both extensive usage and underutilization challenges. Latino and Tafuri (2024) studied the impact of wearable devices on performance of athletes playing field hockey and found that while wearable technology is being extensively used in field hockey, it is still not being utilised effectively. More broadly, Prosad (2020) reviewed the impact of modern technology on the way sports is played, examining various devices used for tracking player movements and reducing injuries, thereby helping us understand the usefulness of

various devices on various types of sport. Additionally, Farrokhi et al. (2021) explored the application of Internet of Things for 'smart fitness', demonstrating how fitness trackers, AI powered cameras and mobile applications have made it possible to track health and fitness easily, highlighting how Internet of Things has brought about a positive impact on tracking performance and fitness.

Performance measurement and tracking methodology are critical considerations in wearable technology implementation. Buchheit and Simpson (2017) reviewed the tracking of various parameters and tried to understand the importance of measuring those parameters, emphasizing the importance of level of accuracy of the data measured. Sri Harsha Vardhan Goud et al. (2019) reviewed the role of machine learning and wearable devices on sports performance, highlighting that different sports require different performance metrics, meaning that for different types of sports, the importance of each activity varies, while noting that managing data and maintain accuracy is a challenge.

Recovery and sleep management represent important dimensions of athlete performance optimization. Kellmann et al. (2018) explored the importance of recovery in sports, noting that people often do not fully understand the importance of recovery with respect to performance of the athlete. This study explored the parameters measured to understand the method of assessment of recovery and evaluated the time required for recovery. Jakowski (2022) further examined the role of self-tracking smartphone applications and wearable devices in helping athletes manage their recovery and sleep quality, investigating how athletes use these technologies, their impact on sleep habits, and the possible benefits and drawbacks of relying on such tools.

Nutrition represents a specialized yet essential component of athlete performance management. Collins et al. (2021), in a study of footballers participating in the Champions League, gave detailed instructions on the intake of carbohydrates, fat, vitamins, iron and other supplements, while stressing on the importance of personalised nutrition by use of biomarker testing.

The broader context of technological advancement in sports reveals long-term patterns of impact. Haake (2009) used data from 1890s to 2000s to analyse the impact of technology on evolution of sports, analyzing sports performance over the given period and seeing the impact of nutrition, technology, training and coaching on the same.

2.2 RESEARCH GAPS IDENTIFIED

There is a lack of research on the implementation of diet based on results obtained from monitoring the performance of athletes. There is also a significant lacunae of research in India specifically in terms of impact of technology on sports performance. There are very few studies highlighting the importance of Sports Nutrition and player tracking in India.

3. OBJECTIVE OF THE STUDY

3.1 SIGNIFICANCE OF THE STUDY

This study will help us understand the impact of wearable devices on individual athlete's performance. By monitoring the physiological condition of the athlete during training and recovery, it becomes possible to understand the areas which require more attention. This allows tailoring a diet plan and exercise regime for each athlete. By optimising the nutrition plan for every athlete, it ensures that they are healthy throughout the play season and are able to perform at the highest possible level.

3.3 PROBLEM STATEMENT

The main issue associated with wearable technology is that it is quite difficult to interpret and implement a plan based on the results obtained during monitoring the training and/or recovery of the athlete.

3.4 OBJECTIVES OF THE STUDY

The objectives of this study is to understand:

- Impact of device/ trackers on athletes’ performance
- Impact of device/ trackers on athletes’ recovery
- Future prospects of using wearable device on athlete performance

3.5 SCOPE OF THE STUDY

The study is confined to the impact of technology on Sports Nutrition and ultimately, on performance. Insights from Sports Nutritionists and athletes were obtained to understand the same.

3.6 LIMITATIONS OF THE STUDY

This study is limited to athletes only and not regular people.

4. METHODOLOGY

4.1 RESEARCH DESIGN

This study includes both Primary and Secondary data.

4.2 SOURCE OF DATA

The secondary data was collected from previously conducted studies (research and review articles). For the primary data, Sports Nutritionist and Sportspersons were contacted. The data was collected through a questionnaire circulated to both group as a Google Form.

4.3 SAMPLING TECHNIQUE

Since our study is specific to the impact of technology on sports nutrition, therefore, we collected data only from Sports Nutritionists and Athletes. Hence, we chose the Non-probability sampling technique, specifically, the Judgement sampling technique.

Sampling unit: Individual. Each participant responded to the questionnaire individually. This allowed us to collect data from athletes playing different types of sports namely – Weightlifting, Football and Basketball.

Sample size: Due to very specific set of characteristics required for the sample, we were able to collect data from a relatively small sample size. It included: 3 Sports Nutritionists and 6 Athletes.

5. FINDINGS

The data was collected by survey from six athletes and three sport nutritionist. Out of the six athletes five athletes were involved in strength based individual sports and one was in team sports. Additionally with respect to the level of competition, three were at professional level, one in elite level, one in semi-professional level and one in amateur level. The three sports nutritionist had an experience ranging from 2-10 years.

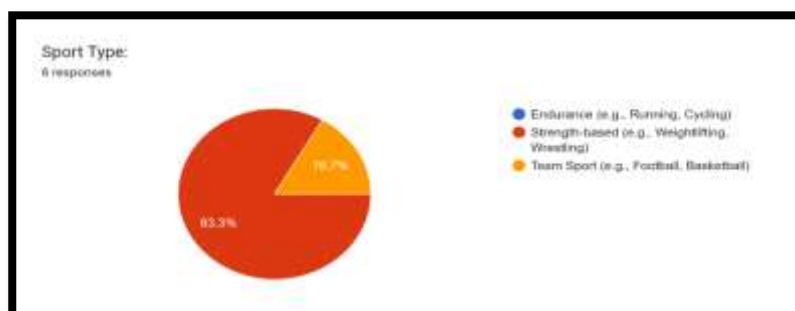


Fig. 1 – Type of Sports the athletes play

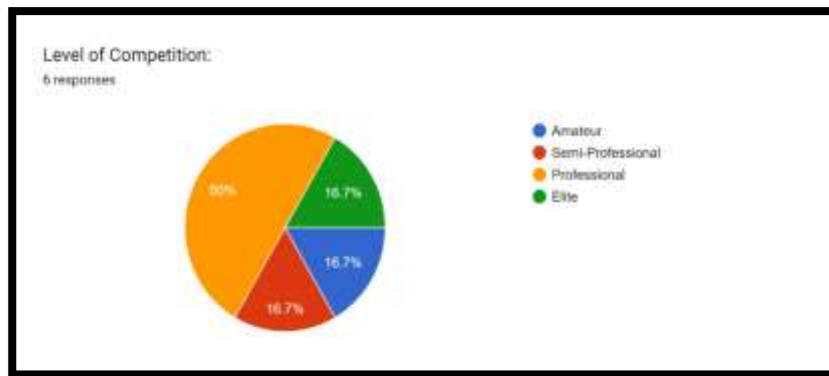


Fig. 2 – Level of Competition of athletes

[The images were auto-generated by Google Analytics as a part of the Google Form]

5.1.1 KEY FINDINGS FROM ATHLETES' RESPONSE

- Adoption of Fitness Trackers: A mix of usage, with some athletes using trackers while others do not. Athletes engaged in professional or elite-level sports were more likely to use fitness tracking technology
- Tracked Nutrition Metrics: Commonly tracked metrics include calories, macronutrients (protein, carbs, fats), hydration, and meal timing. Some athletes wish to track data but struggle with implementation
- Impact on Eating Habits: Majority reported improved nutrition choices due to tracking while some found difficulty in implementing tracker data into real dietary changes
- Recovery Tracking and Perceived Effectiveness: Muscle recovery and sleep quality are the most tracked metrics. However, there were mixed responses on effectiveness – some saw significant improvements, while others reported only slight improvements in recovery
- Accuracy of Trackers: On a scale of 0-10, most athletes rated tracker accuracy between 6 and 10. Interestingly, some stated that they had not used recovery trackers

5.1.2 KEY FINDINGS FROM SPORTS NUTRITIONISTS' RESPONSES

- Perception of Fitness Trackers in Nutrition Monitoring: There were mixed opinions with respect to the application of fitness trackers in nutrition monitoring. One Sports Nutritionist always recommended their use, while the other two did so occasionally due to limitations. On a scale of 0-5, they rated effectiveness of trackers in nutrition between 2 and 4, indicating some concerns over accuracy
- Limitations Identified: There are major concerns regarding the fitness trackers due to - limited food database, athlete compliance issues, hassle of wearing devices, and data inaccuracy
- Recovery Tracking Reliability: With respect to recovery, the reliability of fitness trackers was rated between 2 and 4 (on a scale from 0-5), indicating that the fitness trackers was perceived to be low to moderately reliable
- Most Useful Recovery Metrics: Sleep monitoring, HRV (Heart Rate Variability), muscle recovery, and resting heart rate.
- Integration into Nutrition Plans: One nutritionist adjust plans based on fitness tracker data. One does so only sometimes. One does it rarely due to reliability concerns
- Future of Fitness Trackers in Sports: There were contrasting views on the future usage of fitness trackers. Only one believed they will be essential for performance optimization while the other two think their impact will be limited due to accuracy concerns

- g. Desired Improvements: More accurate nutrition tracking, personalized recommendations, and better integration with athlete training data
- h. Role of AI and Data Analytics: All three believe that AI will enhance fitness tracking for nutrition and recovery.

6. DISCUSSION AND RECOMMENDATION

6.1 DISCUSSION

6.1.1 ADOPTION OF WEARABLE DEVICES

Majority of data points towards the positive impact of wearable devices (and IoTs). Athletes prefer using these devices during training and practice sessions. For many athletes, the wearable devices were more than just a piece of equipment; they were a vital component to their training process itself. While these devices are used for obtaining the quantitative data of the athletes' condition, they also have a significant psychological impact (placebo-like effect) on the athletes' training, which is highly relevant since psychological conditions have an equally great amount of impact on the athletes' performance. (Mopas & Huybregts, 2020) Using this data, their coaches and sports nutritionists plan a diet chart and exercise routine. But these devices do not just give quantifiable data. They also serve as a means of achieving set targets. Thus, the athletes feel a sense of accomplishment upon achieving their set target and are motivated. Therefore, it seems that the wearable technology has a significant effect on the physiology and psychology of athletes.

However, this is not the case in India. There is a severe lack of application of wearable devices. Even though the sports nutritionists recommend their use, the athletes find that it hinders their training.

6.1.2 IMPLEMENTATION OF DATA OBTAINED FROM WEARABLE DEVICES

The data obtained from these devices are used to customise a nutritional diet plan for each athlete. It is essential to monitor the intake of protein, carbohydrates and fat. A properly planned diet customised for each individual athlete should be done for optimum performance and quick recovery. Thus, a highly sophisticated dietary plan is required for elite athletes to stay fit throughout the year. (Collins et al., 2021) Though it is tedious work, it has been seen to have significant impact on the fitness of the athlete. In certain cases, it seems that because of monitoring of exertion levels in athletes using wearable devices, it has been possible to determine the level of performance and therefore change the strategy of the play.

The level of dependency on technology varies based on the level of competition. The highest level of dependency was found in runners of competitive experience between 4 and 6 years while the lowest was found in those with competitive experience greater than 10 years. The low level of dependency indicates more self-awareness of one's own performance and that the athletes prefer using the devices to achieve and improve their performance. (Diotaiuti et al., 2020) It is also understood that in terms of recovery, the usage of devices and rate of recovery were inversely proportional. It means that while devices are an important part of athletes' training, they understand the importance of not being overpowered by the numbers. Instead, they focus on using them to improve their performance.

In India, it seems that there are concerns regarding the accuracy of the data. Therefore, the reliability on the usage of wearable devices is less.

6.1.3 IMPROVEMENT IN PERFORMANCE

The implementation of customised diet and exercise plan for each athlete enhances their performance and hence, their quality of play. The combination of different functions of a tracking device can also help improve the game strategy in terms of player positions and competition levels. Monitoring the heart rate

helps understand the rate of perceived exertion which is compared for athletes of different ages in the team. There is a great potential in application of wearable devices for improving not only the performance of an individual athlete but also that of the team. (Latino & Tafuri, 2024) Certain wearable devices are used to track the hydration levels of athletes in the field based on temperature readings, which prevents any illness or injuries during training or practice sessions. (Sri Harsha Vardhan Goud et al., 2019)

It has been seen over the years in most of the sporting events that with the advancement of technology, the performance of athletes has improved greatly. There has been a positive impact of technology on tracking and analysing athlete's condition. It has given room for better understanding of factors affecting the performance. Sports nutritionists have been able to tailor diet and exercise regime based on every athlete's individual needs. It has allowed athletes to be fit throughout the year. (Farrokhi et al., 2021) (Haake, 2009) Even with events throughout the year, the athletes manage to perform at their best level as a result of a highly individualistic nutritional plan.

In India, the lack of use of wearable devices does not give much detail about the improvement in performance.

6.1.4 IMPACT ON RECOVERY

The recovery metrics mostly includes 'sleep' as a major parameter. Wearable devices have made it easier to monitor sleep quality. It is often difficult to monitor fatigue and recovery in athletes. High level of expertise in physiology, psychology and sport science is required to analyse the data obtained through such monitoring. The athlete must be consulted throughout the monitoring process; each athlete's case must be taken as an 'individual' case (even though two players from the same team sport may have the same or similar injury). Therefore, by tracking each athlete, we can understand their condition better and cater to their needs accordingly. Systematically monitoring recovery and implementing recovery methods influences the rate of recovery and aims at maximising performance. (Kellmann et al., 2018)

Most athletes are comfortable wearing these devices to sleep. The wearable devices and mobile applications also make it possible for athletes to track their own condition such as sleep quality which provides them the essential data for recovery. (Jakowski, 2022) Monitoring recovery helps in quickening the pace while preventing conditions like overtraining syndrome and underrecovery.

In India, athletes feel that use of wearable devices has improved the recovery rate.

6.2 RECOMMENDATIONS

Introduction of wearable devices to all sports in India is vital for ensuring that India catches up with the rest of the world in terms of usage of wearable devices for performance monitoring. However, most of these devices fall under a high price range, most Indian athletes are unable to afford it. Even the well-funded athletes and clubs are unwilling to purchase these devices. A locally manufactured device will attract more athletes and Sportspersons to these devices. Therefore, it is essential that manufacturing of wearable devices in India should be encouraged. Additionally, there is a serious lack of research work on studies pertaining to sports and technology in India. Either due to lack of funding or simply interest, there is not much data regarding the impact of wearable devices on performance monitoring of athletes in India. Hence, it is advisable to encourage research work on sports in Indian institutions.

7. CONCLUSION

Technology has succeeded in making sports more advanced than what it was before. From monitoring athletes' performance to rules of a game, technology has caused crucial transformation in all sports. It is

clear that it has had a major impact on how sports performance was perceived and the methods used for improvement. Now, performance monitoring and wearable devices go hand-in-hand. It has made data collection easier, faster and more efficient. Although there are still concerns regarding the accuracy of the data given by these wearable devices, continuous progress in the field of technology promises to rectify this issue in the future. In India, the promising results obtained from the implementation of data from these devices in most sports (i.e. improvement in performance of athletes playing football, hockey and also from other sports) are encouraging Indian sportspersons to utilise these devices to try and do the same. Thus, the future promises a rise in demand for such devices in India and a monumental increase in the performance of its athletes.

SCOPE OF WEARABLE DEVICE AND FUTURE RESEARCH

With every technological breakthrough, athletes and sports nutritionists alike are hopeful of the future. With the advent of AI, there is expectations of revolution in the field of sports. The changes are set to improve the face of sports in India. With increased awareness, more and more athletes have started preferring wearable devices for monitoring performance over the traditional methods. Although, some believe that even though the accuracy and reliability of the data may increase with AI usage, it will cause irreparable damage to the privacy aspect of it.

With increase in demand for more sophisticated monitoring methods, there will be more opportunities to do an in-depth study on the performance of athletes in India. In terms of team sports and individual sports, gathering data of the athletes' Olympic training will give essential and important insights into Indian sports culture.

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