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THE FUTURE OF CRICKET COACHING: EFFECT OF 8-WEEK VIRTUAL REALITY SIMULATION INTERVENTION FOR ENHANCING BATTING SKILLS AND MENTAL TOUGHNESS

ARPIT KULSHRESHTHA
HARMANPREET KAUR
LOVELY PROFESSIONAL UNIVERSITY, PUNJAB, INDIA

PAWAN DEEP
GNA UNIVERSITY

Abstract: Cricket coaching has long depended on in-person training and video analysis, but the emergence of Virtual Reality (VR) offers a modern solution to simulate real match scenarios. This study implemented a structured 8-week VR training simulation to improve batting skills and mental toughness in young cricketers. Twenty intentionally selected male right-handed batsmen (16–19 years) from the Under-19 Interstate Championship, Punjab, participated. Using the Cricket Mental Toughness Inventory (CMTI) and IB Cricket software with an Oculus Quest Advance 2.0 headset, each player completed 24 sessions (35 minutes, three sessions per week). Results showed significant improvement in batting skills, with post-training scores **(M = 31.40, SD = 2.97)** outperforming pre-training scores **(M = 27.97, SD = 2.18) (t(19) = 2.27, p < 0.05)**. Mental toughness also improved **(M = 90.10, SD = 4.67) (M = 82.45, SD = 4.02) (t(19) = 2.45, p < 0.05)**. Overall, VR proved effective for enhancing batting ability, muscle activation, and cricket-specific mental toughness.

Keywords: Virtual Reality Training, AI in Sports, Digital Sports Coaching, Innovation in Training, Mantal Toughness Enhancement.

INTRODUCTION

Virtual Reality (VR) has emerged as a promising tool in the field of sports training, offering immersive and interactive environments to simulate real-world scenarios. Casella, A. 2024 demonstrated the effects of a virtual reality reaction training protocol on the physical and cognitive skills of young adults and their neural correlates with potential implications for strengthening mental toughness in high-pressure tasks. Bedir, D. 2021 pointed out that VR training offers the possibility of controlled stress exposure, allowing players to face match-like conditions with less physical risk and develop stronger cricket-specific mental toughness through repeated exposure to stressful scenarios. Almansour, A. M. 2024 found VR allows players to rehearse game-specific tasks, enabling cognitive improvement in areas like pattern recognition and anticipation which form a foundation for mental toughness during competitive gameplay. Yang, J. G. 2022 described the utility of VR in sports such as tennis and soccer for refining these cognitive skills, suggesting similar benefits for cricket players in developing both cognitive sharpness and mental resilience. Krupitzer, C. 2022 explained that it offers an immersive platform where athletes can practice, visualize, and mentally prepare without real-world constraints enhancing psychological readiness and mental toughness. Panchuk, D. 2018 examined the use of VR to improve decision-making skills in cricket and other ball sports. The study concluded that players exposed to VR simulations developed quicker, more accurate responses under pressure compared to traditional training methods indicating improvements in mental toughness levels. Similarly, Neumann, D. L. 2018 reviewed the application of VR to enhance psychological preparation in elite athletes. The authors found that VR contributed to significant improvements in players' stress responses and focus under pressure, enhancing their overall mental toughness. Furthermore, in cricket-specific research, Richlan, F. 2023 observed that immersive VR training enhanced the cognitive and emotional resilience of cricketers, leading to improved on-field performance and stronger mental toughness during competitive play. Research by Radianti, J. 2020 found that players using VR exhibited improved concentration and reduced anxiety during high-stakes matches. The realism and interactivity of VR systems provide players with an engaging way to train their focus, leading to enhanced mental toughness. Tribe, T. N. 2023 explored that this enables cricketers to experience pressure situations repeatedly, helping them to develop coping mechanisms and mental resilience which are central components of cricket mental toughness. Ahir, K. 2020 explains that VRT can be beneficial for psychological training, tactical skill development, training objectives, and technical stimulators to improve training strategy including mental toughness training. Cricket, often referred to as a game of strategy and skill, encompasses various facets that contribute to a team's success. Among these, batting stands as a crucial component, capable of shaping the outcome of a match. Padli, P. 2023 revealed this tool is used by using the sensor from the camera to

see how fast the shots are going in the game of cricket. In cricket, the application of VR technology has the potential to revolutionize training methods, allowing batsmen to practice against diverse bowlers, deliveries, and match situations without the constraints of time, weather, or physical fatigue while simultaneously reinforcing their mental toughness through repeated exposure to competitive scenarios. Kelly, N. 2022 suggests the batting simulator in virtual reality (VR) gives the batter access to bowler run-ups and allows real players to virtually improve their batting technique and psychological preparedness. The proposed VR training schedule incorporates cutting-edge technology to simulate diverse game situations, allowing batsmen to practice against virtual bowlers in realistic cricket environments that help build mental toughness under varying pressures. Nambi, G. 2020 explores Virtual Reality Training is used widely because contributes to the prevention of further injuries. A comprehensive validation process ensures that the VR training effectively mirrors the dynamics of actual gameplay, providing a reliable platform for skill development and mental toughness cultivation. Through the VR training system, the athletes can get better training effects suggests Zhao, K. & Guo, X. 2022. This implementation is complemented by a user-friendly interface, allowing coaches and players to customize training sessions based on individual skill levels, strengths, and weaknesses including personalized mental toughness components. Emre Gurbus and Murat Tas, 2023 evaluated the effectiveness of virtual reality training in 12–13-year-old child football players and improved the heading technical skills of child football players by using virtual reality technology without experiencing any injuries due to heading at a young age in the future. Hawkar Oagaz, Breawn Schoun, and Min-Hyung Choi, 2021 VR skill acquisition and training transfer by using a system that combines realistic audiovisual stimuli and real-time feedback, supports the validity of VR for training and provides a low-cost, accessible, timesaving, and effective system for table tennis training in VR which also contributes to mental toughness development by presenting consistent cognitive challenges. Matthew Buns, 2020 addressed how virtual training can improve the accuracy and velocity of real-world hockey shooting on goal in isolated practice settings, it remains unknown whether such skills would be effectively applied during actual gameplay. Brad Thatcher, Georgi Ivanov, Mihaly Szerovay, and Graham Mills, 2020 analyzed elite coaches' and performance analysts' perceptions of barriers and opportunities for the adaptation of VR technology in football coaching. Rob Gray, 2017 examined the real value of using VE as a training tool for sports, not the ability to create more repetitions of the same types of practice that are used in real training. The presented VR training schedule signifies a paradigm shift in cricket coaching methodologies, providing an immersive and engaging platform for skill enhancement and mental toughness development. Aishwarya Dhawan, Alan Cummins, and Wayne Spratford, 2016 describe illustrate a novel immersive, interactive VR bowling simulator that may be used to assess expertise in cricket batting. This paper contributes to the growing body of research in sports technology, demonstrating the potential of VR in revolutionizing the way cricket batting skills and mental toughness are developed and refined. As the cricketing landscape evolves, embracing innovative technologies like VR can pave the way for a new era of precision, mastery, and mental toughness in the sport.

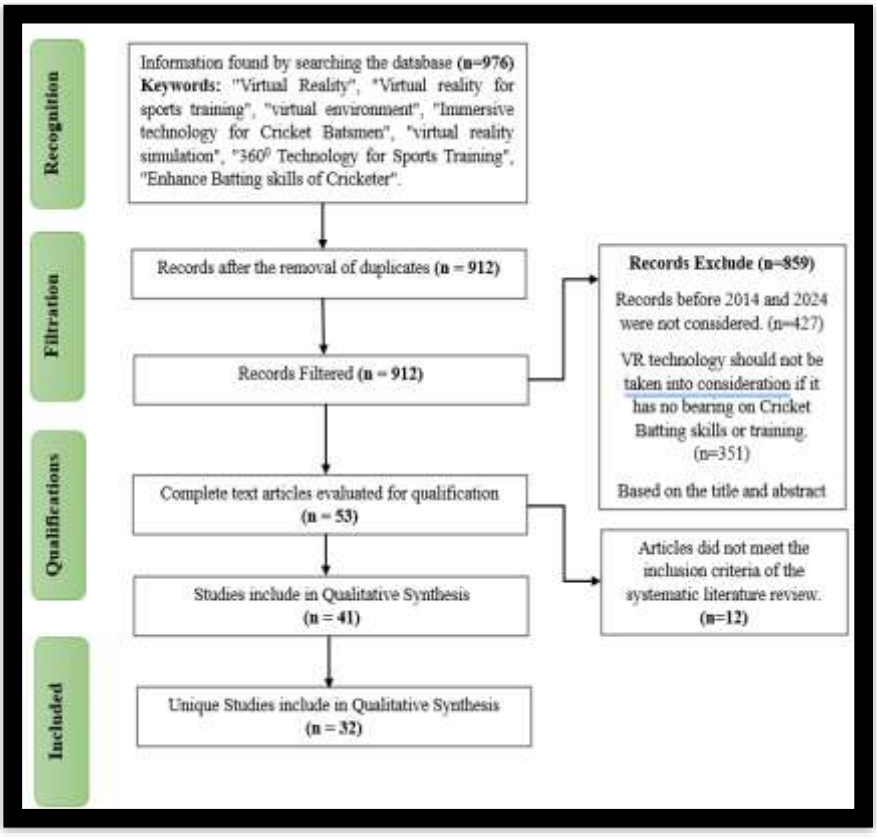

Figure 1 Systematic Selection of Related Works

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METHODOLOGY

The utilization of VR technology directly depends on the complexity of the interaction between the user(s) and the environment system. During this study, the researcher used the Oculus Quest advanced 2.0 device to create a 3D virtual reality environment. In this device, ib Cricket companion software was run for cricket simulation in which many models are available for the enhancement of batting skills as well as for exposing players to pressure-based scenarios to indirectly support mental toughness development. So, the researcher created a Virtual Reality Training Schedule by using virtual reality and machine learning to enhance the batting skills and cricket mental toughness of cricket batsmen. This design was made specifically for right-handed batsmen, in which batsmen were trained through virtual reality for 8 weeks, three sessions each week, and 35 minutes total for each session. After collecting the written consent, a pre-test was conducted in which batsmen assessed their batting skill ability through a Batting Skill Test (Developed by the Cricket Australia Centre of Excellence (COE), 2010) and their psychological resilience and focus levels through the Cricket Mental Toughness Inventory (CMTI), developed by Daniel F. Gucciardi (2009). Then, the researcher randomly created a group VRTG for this study. Participants of the Virtual Reality Training Group (VRTG) participated in 24 practice sessions that were conducted over 8 weeks, each week 3 sessions, and each session was 35 minutes for each batsman. The batsmen were trained through iB Cricket competition software by running the Oculus Quest 2 Advance VR device in fully immersive virtual environments that simulated high-pressure match situations to promote mental toughness. After the intervention, a post-test was conducted to assess the virtual reality training effect on the batting skill and mental toughness of the batsmen. The overall study design is conferred in Figure 2. Equipment: Virtual Reality Headset, Controller, iB Cricket Companion Software, Streaming Software, Laptop, Bat, Batting Glove, Batting Pad, Helmet, Abdo Guard and Net Area.

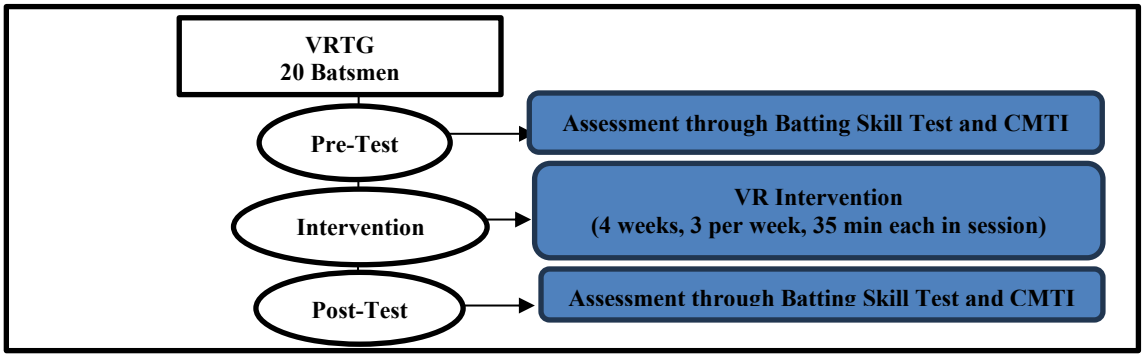

Figure 2Selected Methodology

Participants: The participants in the study were 20 male right-handed cricket batsmen aged 16–19 years old who were recruited from the Under-19 Interstate Championship, Punjab, India. Only participants in this study secured medals (Position) at the Inter-state and State Levels. The sampling frame that was used for this study was self-selected and made only one Virtual Reality Training Group. Before group assignments, batsmen whose association had expressed interest in taking part in the study were screened to confirm that they were willing to participate, once they were informed regarding the study requirements and checked against the inclusion and exclusion criteria. Inclusion criteria were: aged 16–19 years at the beginning of the study, able to use VR cricket simulation, able to attend all the training sessions of the intervention program, have knowledge of cricket, and were psychologically fit to undergo mental toughness assessment as a part of the study's objectives. Exclusion criterion was a current clinically severe health problem or disorder making it not possible to perform the intervention program or that could hinder mental toughness evaluation. Then, the association of the batsmen was asked for a written informed consent statement that the batsmen could participate in the research including both batting skill and cricket mental toughness assessments.

Tool: In this study, the researcher assessed batsmen's batting skill ability through a Batting Skill Test (Developed by the Cricket Australia Centre of Excellence (COE), 2010). The purpose of this test was to quantify the batsman's capability to manipulate the ball around the playing field under varying conditions of speed and length. The objective of the test required batsmen to hit a number of deliveries through specific targets around the field (Figure 13). Each target was assigned a score of '1' or '4', with a greater weight of runs for more accurate strokes. The test allowed researchers to determine each batsman's accuracy of execution according to specific gaps in the field, which is an important skill in order to score runs in cricket. The reliability of the batting skill test tool on Indian participants has been determined by the researcher, whose reliability is 0.90. Similarly, the Cricket Mental Toughness Inventory (CMTI), developed by Daniel F. Gucciardi (2009), was used to assess the mental toughness levels of the batsmen. The CMTI measures key psychological components such as resilience, confidence, attentional control, and coping under pressure, providing a comprehensive evaluation of a player's mental readiness for competitive cricket.

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Figure 3 Cone layout at each target zone (According to the Batting Skill Test developed by CACOE, 2010)

Figure 4 Performing Batting Skill Test (According to Batting Skill Test developed by CACOE, 2010)

Intervention: Before the intervention batsmen need to wear safety gear Batting Gloves, Batting Pads, Abdo Guard, and the Oculus Quest 2 Advance VR device. The virtual reality training group (VRTG) received an introductory tutorial on how to use the iB cricket competition software that runs the Oculus Quest 2 Advance VR device and how to play the games. The frequency of attendance was three times a week, while the session lasted 35 min. An 8-minute warm-up with Slow jogging and warmup exercises, a 5-minute Specific warm-up for joint mobility and dynamic stretching, a 5-minute orientation on VR for familiarity with the VR environment, a 10-minute Main training phase in which batsmen improve their Batting skills and Batsmen usually take 2 shots in 1st week (Off-Drive Shot and Cover-Drive Shot). In which the degree of difficulty is increased in every session. In the 2nd week, the player will again attempt two shots (Square Cut Shot and Late Cul Shot), and the degree of difficulty will increase in each session like in the 1st week. 3rd week player will attempt 3 shots (On Drive Shot, Flick Shot, and Slog Sweep), a 2-minute Discussion, and a 5-minute Cool down for measles relaxing exercises. In particular, in every session, the participants were able to play the games that were based on training and the degree of difficulty will increase in every session like the 1st week. Each batsman follows the 35-minute training intervention to enhance their batting skill in the virtual environment in each session, batsmen attempt to hit 36 balls in the pre-determined area. After hitting the ball batsmen see their mistake on six parameters “Eye Level, Head Status, Watching the impact, Distance between head and impact, Bat impact region, The ball hit into given region”. The level of difficulty for the batsmen increases with each session, specifically in terms of length variation (Full, Good, and Short Length) and balling pace (Pace, Medium pace, and Spin), and also sets the competitive environment according to batting ability of the batsmen. Additionally, throughout these progressive VR-based sessions, the batsmen were also exposed to mentally demanding scenarios designed to enhance cricket-specific mental toughness, such as sustaining focus under time pressure, maintaining composure after performance errors, and adapting to challenging virtual match situations. These elements supported the development of psychological resilience, confidence, and attentional control during the training program.

Figure 5 Cover Drive Performing in Virtual Reality Environment

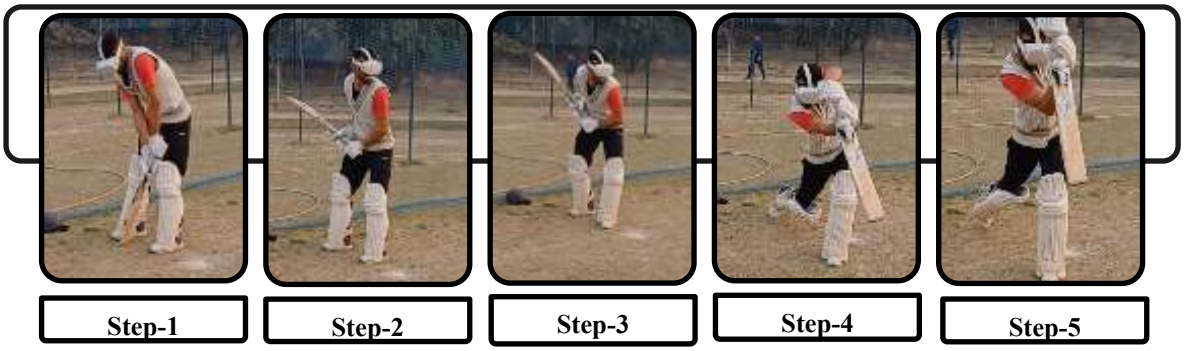

Figure 6 Cover Drive Performing in Real Time

RESULTS

Financial Implications: Implementing an 8-week VR-based cricket coaching program involves initial expenses, including VR hardware (headsets, motion trackers, and controllers), software development, and content creation. Additional costs include maintenance, software updates, and instructor training. In contrast, traditional coaching primarily requires facility rental, equipment, and coaching fees. However, VR training can reduce long-term costs by minimizing travel, optimizing training schedules, and providing scalable training solutions. Furthermore, VR modules designed for cricket mental toughness such as pressure-scenario simulations and stress-management tasks may require additional software upgrades but enhance the overall psychological development of players. Cost-Effectiveness: While VR training has a higher initial investment, its cost-effectiveness improves over time. Players can engage in unlimited, personalized, data-driven practice sessions without requiring physical coaching presence. Studies indicate that skill retention and reaction time improvements from VR training can be comparable or superior to traditional methods, potentially reducing the need for expensive in-person coaching hours. Moreover, VR-based mental toughness training, which exposes players to time pressure, high-stakes simulations, and focus-challenging scenarios, can reduce the long-term expenses associated with separate psychological conditioning programs. Impact on Learning Curve: An 8-week VR training program can accelerate the learning curve by providing consistent and repeatable scenarios that mimic real-match conditions. VR allows instant feedback, biomechanical analysis, and error correction, helping players refine their technique more efficiently than traditional coaching, which may rely on periodic assessments and external feedback. At the same time, VR enhances the mental toughness learning curve by repeatedly placing batsmen in demanding virtual match conditions that develop psychological resilience, decision-making under pressure, and emotional control. Optimal Training Duration: Research suggests that 3-5 sessions per week, each lasting 30–45 minutes, strike a balance between cognitive load and muscle memory development. Excessive VR exposure may lead to mental fatigue and reduced engagement, while insufficient sessions may not provide enough exposure for skill acquisition. For mental toughness development, this duration also ensures adequate exposure to pressure-based tasks without causing cognitive overload, allowing players to gradually adapt to stress and enhance psychological endurance.

Effectiveness in Different Environments: VR-based batting training is highly effective in controlled indoor settings, such as VR labs, where distractions are minimal, and data collection is optimized. However, open-field augmented reality (AR) settings may enhance the realism of training by integrating real-world factors such as wind, lighting, and physical movement. The choice depends on the intended training focus-precision skill development (VR lab) vs. real-game adaptability (AR settings). Similarly, cricket mental toughness can be enhanced in both environments: VR labs for controlled mental-pressure drills and AR setups for practicing focus, composure, and adaptability in more realistic, unpredictable conditions. Infrastructure Requirements: Professional academies require high-end VR systems integrated with motion tracking, AI-driven analytics, and biomechanical assessment tools. These facilities benefit from dedicated VR labs and expert supervision. Grassroots coaching centers, on the other hand, can adopt lower-cost VR solutions, such as standalone VR headsets and pre-programmed training modules, making the technology more accessible without extensive infrastructure investments. Mental toughness modules such as concentration drills, confidence-building simulations, and coping-strategy tasks can be embedded in both high-end and basic systems, ensuring psychological training accessibility across different levels of cricket development. A paired-samples t-test was conducted to assess the impact of the Virtual Reality Training Schedule (VRTS) on batsmen's batting skill ability. The analysis compared the performance scores of batsmen before and after undergoing the VRTS intervention. Results indicated a significant improvement in batting skill following the training. Specifically, the mean score after training ($M = 31.40$, $SD = 2.97$) was higher than the mean score before training ($M = 21.97$, $SD = 2.18$). The difference between the two conditions was statistically significant, $t(19) = 2.27$, $p < .05$. Similarly, a paired-samples t-test was conducted to assess the effect of the VRTS on Cricket Mental Toughness. Results demonstrated a significant improvement in mental toughness after the intervention. The mean post-test score ($M = 90.10$, $SD = 4.67$) was higher than the mean pre-test score ($M = 82.45$, $SD = 4.02$). This difference was statistically significant, $t(19) = 2.45$, $p < .05$, indicating that the VR training schedule not only enhanced batting skill but also improved the mental toughness, resilience and psychological readiness of the batsmen.

TABLE 1 PAIRED SAMPLE T-TEST TO ASSESS THE BATTING SKILL ABILITY AND MENTAL TOUGHNESS OF BATSMEN

Variable	Test Type	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of Difference		t	Sig. (2-tailed)
					Lower	Upper		
Batting Skill Ability	Pre-test	27.40	2.18	2.57	1.69	5.66	**2.27**	19
	Post-test	31.97	2.97					
Cricket Mental Toughness	Pre-test	82.45	4.02	2.53	3.12	12.18	**2.45**	19
	Post-test	90.10	4.67					

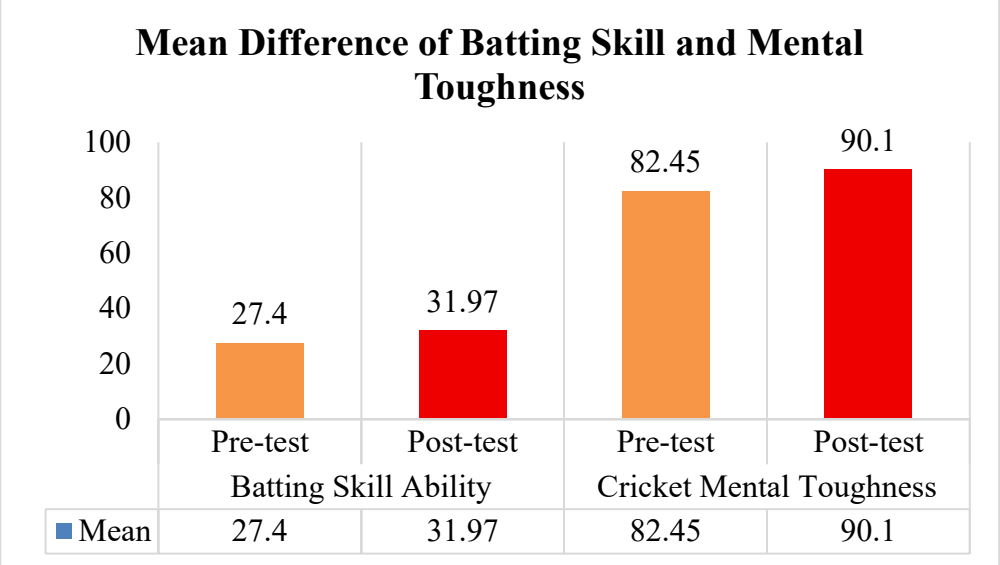

FIGURE 7 Pre-test and post-test of Batting Skill and Mental Toughness Score of Cricket Batsmen

DISCUSSION

The data obtained from the study were analyzed using the Statistical Package for the Social Sciences (SPSS) version 22.0 for Windows. To determine the effect of the Virtual Reality Training Group (VRTG) on participants' batting skill ability and cricket mental toughness, a paired-samples t-test was employed. This statistical procedure was selected because it is appropriate for comparing the mean scores of the same group measured at two different time points (pre-test and post-test), thereby accounting for within-subject variability. The test was conducted to examine whether there was a statistically significant difference in batting skill scores and cricket mental toughness scores of participants before undergoing the virtual reality training and after completing the intervention. The level of statistical significance was set at an alpha value of 0.05, which implies that differences in means with a probability of occurrence less than 5% were considered statistically significant. This ensured a rigorous assessment of whether the observed improvements in batting skill as well as improvements in cricket mental toughness were attributable to the training program rather than to chance variation. The purpose of this study was to investigate the effect of an 8-week virtual reality simulation for cricket batting skills enhancement and cricket mental toughness of right-handed cricket batsmen. Before the virtual reality intervention, batting skill ability and cricket mental toughness were assessed and after 8 weeks of intervention (24 practice sessions) batting skill and mental toughness were measured. Batsmen in experimental groups (VRTG), after the intervention, increased significantly in batting skill ability and demonstrated improvement in cricket mental toughness, that was relevant to Cricket. Furthermore, the research noted that participants, even within the constraints of a limited observation period, demonstrated an enhanced ability to discern characteristic points of skill. Kun Zhao and Xueying Guo (2022) suggested the advantages of VR technology, are that athletes and coaches should get better training to improve their abilities. They exhibited a heightened capacity to extract more nuanced information regarding movement patterns and their consequential effects. Notably, participants refined their focus on key elements of skill execution, including foot movement, bat direction, and forearm turn. Simultaneously, there was an observable enhancement in their ability to concentrate on the outcome of the skill, delving into details such as the direction and depth of the ball's trajectory. Hawkar Oagaz (2021) explored the descriptive training system within VR was designed to provide real-time feedback on posture, technique, and ball returns. This suggests that the virtual reality intervention not only positively influenced overall batting skill but also contributed to a more nuanced and focused understanding of the intricacies of cricketing movements and their outcomes while simultaneously supporting improvements in cricket mental toughness by enabling repeated exposure to decision-making under pressure. Dhawan Aishwar and et.al. (2015) did a pilot experiment on batting skills conducted with a batter to investigate collision detection and

whether the better was able to maintain a high level of task engagement throughout. Future studies should explore further research on the larger sample size of subject professionals in different domains of the coaching sector to provide a more comprehensive evaluation. The primary objective of this research was to examine the effect of this 8-week virtual reality intervention on the batting proficiency and cricket mental toughness of right-handed cricket batsmen. Preceding the introduction of the virtual reality intervention, an assessment of batting skill proficiency and mental toughness was conducted. Following an 8-week intervention comprising 24 practice sessions, a post-intervention evaluation of batting skills and cricket mental toughness was undertaken. Remarkably, the experimental group, those subjected to the VR training regimen (VRTG), exhibited a significant improvement in their batting skill as well as their cricket mental toughness, demonstrating its relevance to the sport of cricket.

CONCLUSION

Overall, the purpose of this investigation was to find the effect of an 8-week virtual reality simulation on cricket batting skills enhancement. Virtual reality training shows a valid effect so by the result of the study, batsmen can use it without any hesitation to improve their batting skills. During this study, practical implementation of the VR training was done on batsmen which yielded positive effective results. The VR training in cricket coaching has proven to be an effective strategy for engaging batsmen and enhancing their batting skill ability. This VR training schedule provides engaging and interactive training opportunities. In addition to batting performance, the 8-week VR intervention also contributed to meaningful improvements in cricket-specific mental toughness, particularly in areas such as concentration, emotional control, confidence, and decision-making under pressure. These enhancements indicate that VR simulation not only strengthens technical execution but also fosters the psychological readiness essential for high-performance cricket. In addition, the greater gains obtained post-virtual reality simulation is a very appealing strategy to further optimize the development of batting skills and mental toughness in young right-handed cricket batsmen.

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