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From gear to culture: How technology shapes the world of rock climbing

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Abstract - Rock climbing is a form of mountaineering that involves navigating steep cliffs, making it a physically demanding and extreme sport. Introduced in Indonesia in the 1970s, it has evolved from local expeditions to international competitions, gaining popularity among youth and adventure seekers. The sport requires both physical prowess and mental agility, blending strength, strategy, and safety. This paper explores the fundamental aspects of rock climbing, focusing on climbing techniques, necessary equipment, and the importance of safety. The objectives are to provide a comprehensive understanding of the sport, highlight its physical and mental benefits, and promote it as a fulfilling and educational activity. These benefits include enhanced physical strength, improved coordination, cognitive skill development, and boosted self-confidence. Data collection involved field observations of rock climbing environments and routes to capture the technical challenges and strategies used by climbers. Interviews with experienced climbers provided valuable insights into their experiences, techniques, and psychological approaches to overcoming obstacles. These qualitative methods allowed for a deeper understanding of the sport's physical, emotional, and technical dimensions. The analysis of the data highlights the sport's rising international recognition, including its presence in the Olympics. It also underscores the cultural significance of rock climbing in Indonesia and the strategic role it plays in physical and mental development. This paper concludes by advocating for the growth of rock climbing as a popular and enriching sport, with the potential to positively influence personal development.

Keywords: rock climbing; extreme sport; climbing technique; safety climbing; mental toughness

1. Introduction

Rock climbing has grown into a worldwide sensation drawing in more and more followers as one of the toughest extreme sports out there. It's all about going up down, or across real rocks or fake rock walls. To do well, you need to be strong, have lots of stamina, be quick on your feet, keep your balance, and stay cool under pressure. It's not like other sports or mountain climbing because it happens outdoors and asks a lot from the person doing it. Rock climbing mixes different skills bringing together physical fitness mental toughness, and precise moves. It's got a rich history, culture, and psychology behind it.

In Indonesia, rock climbing has changed from a niche activity to a big-time sport that people do for fun and in competitions. The sport kicked off in the early 1900s in Europe where soldiers used it to get around tough terrain. Around 1910, soldiers climbing high cliffs used basic gear like thick ropes, steel pitons, and carabiners. These tools were pretty basic, but they paved the way for the fancy climbing gear we see today.

At first, rock climbing was for military stuff during mountain battles in wartime. But after World War I regular folks started doing it for fun and as a sport. It got more popular as people looked for new ways to explore mountains, push themselves and , and come up with new climbing tricks. Modern rock climbing started in Europe in the Alps. Mountain climbers there came up with techniques and gear that would get better over the years. By the 1970s and 1980s, rock climbing had spread to North America and Asia. During this time, climbers started pushing the limits, finding new routes on real rocks and fake climbing walls.

In Indonesia, rock climbing began in the 1960s as a way to train Indonesian Army (TNI AD) soldiers at Tebing 48 in Citatah Bandung. The public got into it in the mid-1970s when Indonesian climbers like Harry Suliztiarto brought modern climbing techniques to the country. In 1977, the SKYGERS Amateur Rock Climbing Group started, which was a big deal for Indonesian rock climbing and led to more growth and popularity.

By the 1980s, Indonesia had embraced rock climbing as both a sport and an adventure activity. This led to lots of expeditions, competitions, and official climbing groups like the Indonesian Rock Climbing Federation (FPTI). As rock climbing grows fast in Indonesia and gets more popular worldwide, we need to keep studying its technical side, its mental challenges, and how to keep it safe. In the past few decades, rock climbing has changed from something a small group of adventurers and soldiers did to a recognized competitive sport. It's even part of big international events like the Asian Games and , the Olympic Games. This change shows that more people can now try rock climbing and that climbers at all levels need to perform better than ever.

Even though rock climbing has come a long way in the last hundred years, the growing interest in the sport and its inclusion in major events means we need to keep studying several key areas. First, rock climbing techniques are complex, so we need to understand

Finally, rock climbing also offers a unique platform for studying the benefits of outdoor physical activity for mental health. Various studies have demonstrated that rock climbing can reduce anxiety, alleviate depression, and promote overall well-being. These mental health benefits, combined with the physical demands of the sport, make it an ideal subject for interdisciplinary research that integrates the fields of sports science, psychology, and outdoor education.

Several studies have explored different aspects of rock climbing, providing a foundation for further research. A study by Seifert et al. (2014) investigated the technical skills and body movements used by elite climbers, focusing on how climbers adapt their techniques to different climbing environments. This study provided important insights into the biomechanics of climbing and how climbers develop efficient movement patterns to conserve energy and optimize performance.

Inwar (2023) provides a detailed account of Desak Made Rai Kusuma Dewi's achievements as a world champion climber, emphasizing her path to success and the dedication that has defined her career. Similarly, Coil (2022) sheds light on the victories of Indonesian climber Veddrig Leonardo, who won another gold medal, underscoring Indonesia's growing presence in the international rock climbing community.

Griffith (2022) offers guidance for beginners interested in rock climbing, focusing on the necessary steps and knowledge to enter the sport safely and effectively. This resource serves as a starting point for newcomers. Meanwhile, Jayanti et al. (2013) examine how the correct implementation of safety standards and equipment in sport climbing is crucial for enhancing safety and minimizing risks, particularly in competitive environments.

Juwithafina (2023) highlights the success of Indonesian athletes at the 2023 Climbing World Cup, detailing their accomplishments and marking the country's rising prominence in international competitions. Similarly, Lubis (2021) focuses on the achievements of Indonesian climbers in a world championship held in Switzerland, underscoring the country's growing prowess in the sport.

Nugroho (2023) profiles Veddrig Leonardo, detailing his record-breaking performances and his rise to prominence as one of Indonesia's elite climbers. His success is framed as a significant contribution to the nation's reputation in the sport. RM (2021) presents a practical guide to the essential equipment climbers need, emphasizing the importance of preparation and safety for anyone engaging in rock climbing.

Sukandar (2006) gives a detailed guide to rock climbing. It has useful tips and methods for climbers of all skill levels. This guide helps climbers to get better at their sport. In the same way, Walsh

(2016) gives a full look at what climbers need to know. This covers everything from how to stay safe to different climbing methods. Both new and skilled climbers can find this book helpful.

Wilkinson (2019) follows the journey of rock climbing starting from its ancient roots to its acceptance as an Olympic sport. This study shows how the sport has earned worldwide recognition and admiration. , Cha et al (2015) offer a breakdown of climbing poses and actions to create lifelike 3D climbing animations. Their study mixes body mechanics with tech to give us a better understanding of climbing methods.

Besides technical research, Aras and Ewert (2016) looked into the mental health effects of rock climbing. Their work showed that rock climbing can lessen anxiety and depression symptoms making it useful to boost mental health. Other studies back up these results. For example, Karg (2019) explored how climbing builds mental toughness and how climbers handle fear and stress.

Fleming and Hörst (2010) explore behavior analysis in sports climbing looking at the mental and thinking processes that shape climbers' choices and problem-solving during climbs. Their work shows how behavior analysis can help us understand climbers' performance and what drives them, which can boost training methods and make the sport safer.

Taylor et al (2020) present a new performance analysis tool to evaluate rock climbers' movement patterns and efficiency. This study breaks down climbing techniques and body mechanics in detail offering new ways for climbers to improve their performance through better movement strategies and physical training.

White and Olsen (2010) analyzed how climbers move during bouldering competitions. Their study sheds light on what the body needs to do in this sport when it comes to stamina, strength, and smooth movement. What they found out can help climbers train better and get ready for contests, as it shows they need to work on skills specific to their sport.

Courtemanche (2014) takes a deep dive into the best ways to move when rock climbing. This research looks at how the body works and the science behind climbing moves. The goal? To figure out the most effective techniques for different types of climbs. The study also creates models of these moves to help climbers do better and lower their chances of getting hurt.

Beltrán and his team (2023) study climbing techniques by analysing skeleton video streams. Their research combines tech with biomechanics enabling thorough and precise evaluations of climber movements. These assessments can help to improve training methods, reduce injury risk, and boost performance in competitions.

Quaine and Martin (1999) explored the biomechanics of balance in sport rock climbing. Their study sheds light on how climbers stay stable during climbs. Their discoveries are key to grasping how body position and movement help prevent falls and maximize efficiency. Novikova et al (2023) look into rock-climbing gear checking out current clothing options and coming up with future plans to design clothes that boost performance and comfort. This study zeros in on how clothes and physical movement work together suggesting ways to make things better for climbers in different situations.

Manin et al (2006) examine belay devices in rock climbing mixing experiments and models to see how well they work and how safe they are. Their work helps us better grasp how belay devices keep climbers safe and offers ideas on how to improve equipment design. Amca and his team (2012) look into how hold depth and grip methods have an impact on finger forces when rock climbing. Their research shows the way different grips and hold shapes affect climbers' ability to create force giving useful info to improve climbing performance through training and gear design.

Boulanger and his colleagues (2016) introduce a system that uses sensors to spot and sort climbing activities This tech-based approach to analyse performance lets people keep an eye on climbers' moves in real time, which can help with training, contests, and avoiding injuries.

Li and others (2018) look into how rock climbing affects physical fitness for college students. Their study of many studies shows that rock climbing helps improve overall fitness, including heart health, muscle power, and stamina. Their work highlights how important it is to include rock climbing in physical education classes.

Pandurevic and colleagues (2022) apply feature detection and human body key-point algorithms to study competition and training videos of speed climbers. Their research explores how technology can boost athletes' performance by spotting key technical and biomechanical factors that lead to success in speed climbing.

Somayeh and Wolf (2023) look at performance indicators in speed climbing through video analysis and expert interviews. Their study gives deep insights into the specific skills and techniques needed to succeed in this discipline stressing the importance of both physical and mental preparation in competitive settings.

Still, a lot of current studies tend to zero in on certain parts of rock climbing, like skills or mental wellness, without giving a full picture that brings together technical, mind-related, and safety factors. This blank spot in what we know shows we need more research that looks at all sides of this complex sport. Looking at what's already written and how rock climbing stands today as both a sport and a fun activity, a few research questions pop up. First, we need to get a better grip on how technical skill growth and physical training work together. Many climbers newbies and mid-level athletes, hit a wall in their progress because they don't know how to train well for specific climbing challenges. This includes making body movements better, boosting grip strength, and building stamina. Second, we haven't dug deep enough into the mental demands of rock climbing.

While some studies have looked at dealing with fear and mental toughness, there's still a lot to learn about how climbers handle the mental pressure of the sport. This means figuring out the thinking processes used in reading routes making choices, and sizing up risks as well as how these things affect overall performance. Third even though we've made big strides in creating safety gear and rules, accidents still happen. We need research to spot the most common causes of accidents and come up with ways to lower these risks. This means not just making gear better but also teaching climbers the right safety steps and how to act in emergencies. The main goal of this study is to give a full breakdown of the key parts of rock climbing, including climbing methods physical training mental factors, and safety rules.

In particular, the study aims to: (1) Study the nuts and bolts of rock climbing, including how climbers get better at moving and change their methods to fit different climbing spots. (2) Look into the mental challenges of the sport zeroing in on how climbers handle fear, keep their minds strong, and make choices. (3) Check out the safety rules in place now and spot areas where we can make things safer to cut down on accidents. (4) Look at how rock climbing has grown in Indonesia over time paying special attention to how culture and organizations have shaped the sport's growth. (5) Give hands-on tips to climbers at all levels to help them climb better and stay safe.

This research aims to add to what we know about rock climbing giving useful insights for Indonesia and beyond. By looking at technical, mental, and safety factors together, the study hopes to improve our grasp and practice of rock climbing as a sport and fun activity.

Rock climbing is growing fast and has made its way into big international sports events. This shows we need to keep studying its technical parts how it affects the mind, and how to do it . By tackling these issues, this study wants to help rock climbing keep growing, so climbers can enjoy it and reach their best level.

2. Method

2.1 Method of data collection

The methodology employed for conducting research on rock climbing involves a comprehensive, multi-stage approach to gain a thorough understanding of the sport. This process is designed to explore various dimensions of rock climbing, including environmental conditions, climbing routes, techniques, and the psychological and physical experiences of climbers. The methods of data collection and analysis are critical for generating insights into both the technical and human aspects of this extreme sport.

2.1.1 Field Observation

One of the primary methods of data collection is field observation (Wajdi, 2018). This involves direct observation of climbers in their natural environments, such as on cliffs, mountains, or artificial walls. The main purpose of this method is to capture real-time interactions between climbers and their surroundings, which allows researchers to closely examine environmental conditions, the characteristics of climbing routes, and the body movements of climbers. Field observation is essential for understanding how different factors—such as slope angle, rock texture, and environmental conditions—affect a climber's performance.

Observing climbers in action also offers insights into the techniques used for ascending, including hand and foot placement, equipment usage, and overall body coordination. By recording these observations, researchers can identify general patterns and specific difficulties encountered by climbers. These observations provide valuable data for analysing the technical aspects of rock climbing, such as the climber’s balance, strength, and movement strategies.

2.1.2 Interview

In addition to field observations, in-depth interviews with experienced climbers or explorers serve as a key method of data collection. These interviews provide a more personal perspective on the sport, offering detailed insights into the climbers' psychological and emotional experiences, as well as the strategies they employ to navigate challenging routes. By engaging with world-class athletes, as well as local climbers, researchers can gain an understanding of the different levels of expertise and the varied approaches to rock climbing.

Interviews help uncover information that is not easily observable in the field, such as the mental preparation required for challenging climbs, the psychological impact of the sport, and the challenges that athletes face while competing at a high level. These qualitative insights allow researchers to delve deeper into the personal experiences of climbers and explore the emotional, cognitive, and social factors that shape their participation in rock climbing.

2.1.3 Document study

Another important aspect of data collection is the review of relevant scientific literature. By studying existing research on rock climbing techniques, equipment, and safety measures, researchers can build a solid theoretical foundation for their study. Literature reviews also provide historical context for the development of the sport, including its growth as a competitive discipline and the evolution of safety standards. Moreover, they offer insights into prior research findings, which can guide the current study's objectives and methodologies.

2.2 Technique of Analysis

After the data is collected, the next critical step is data analysis. This stage involves carefully examining the data to identify patterns, trends, and correlations. The primary goal of data analysis is to synthesize the information gathered through field observations, interviews, and literature reviews to create a coherent understanding of the key aspects of rock climbing.

(1) Identifying Patterns and Trends

During data analysis, the information collected from field observations and interviews is systematically reviewed to identify recurring patterns. For instance, researchers may look for common techniques employed by climbers across different terrains or identify shared psychological strategies for overcoming mental barriers. These patterns help highlight the essential skills and characteristics required for successful rock climbing.

(2) Comparative Analysis

A comparative analysis of different climbing routes, techniques, and athletes' experiences can offer insights into the variability of the sport. For instance, researchers may compare the body movements of climbers on steep vertical routes versus those on angled climbs, or evaluate the different safety practices used in natural versus artificial environments. Comparative analysis can also be applied to interview data to explore how personal experiences and emotional challenges differ among climbers with varying levels of expertise.

(3) Drawing Conclusions and Recommendations

Based on the analysis of the data, researchers can draw conclusions about the key findings of the study. These conclusions may include recommendations for improving climbing techniques, enhancing safety measures, or developing more effective training programs for climbers. Additionally, the results may highlight areas for further research, particularly in terms of the mental and emotional aspects of rock climbing.

The method of data collection and analysis employed in this study provides a thorough and systematic approach to understanding rock climbing as a sport. The combination of field observations, interviews, and literature reviews ensures a holistic perspective, while the careful analysis of the data allows for meaningful conclusions and recommendations. These findings contribute to a deeper understanding of the sport, promoting its growth and encouraging safe and effective participation.

3. Results and Discussion

Rock climbing is an extreme sport that combines physical strength, technical skill and mental endurance. Participants climb artificial walls and natural cliffs with various levels of difficulty. The climbers face challenges that require ingenuity and courage. This activity not only involves the body's muscles, but also requires high focus and strategies to overcome obstacles. Rock climbing participants must have muscle strength in their arms, legs, and flexible body, this is an extraordinary core for completing difficult routes. Courage is also a key factor, as they must overcome their fear of heights while maintaining balance. Good climbing techniques, such as correct body position in lay backing and strategic foot placement are very important to reach the desired height. Plus, rock climbing isn't just about physical strength. Participants must be able to solve the puzzles encountered in cleverly designed routes. This involves quickly analysing the wall, finding the right hold, and making strategic decisions in a short time. rock climbing triggers the building of psychological resilience and quick decision-making abilities. How participants manage fear and stress at heights can be a focal point of instruction. Discussions about the positive influence of rock climbing on mental health, including increasing self-confidence and mental toughness, can be an interesting aspect of the discussion.

Then, the uniqueness of rock climbing as a sport that includes an extraordinary combination of strength and body movement, creativity can be an interesting topic of discussion. How participants overcome obstacles and solve puzzles on artificial walls can be an interesting theme that arouses curiosity. Usually the climber solves the route that has been provided on the wall or cliff by trying it many times until he has memorized the movement, then the climber succeeds in solving the natural route on the cliff or that has been provided on the climbing wall, this is one of the unique sports of rock climbing. The sport of rock climbing raises various discussions regarding the physical and mental benefits, the uniqueness of this sport, and its impact on the community. First of all, from a physical perspective, this activity is effective in developing muscle strength, balance and flexibility. Discussions about how rock climbing can be an effective exercise choice for improving physical fitness and endurance can be an interesting topic.

In a community context, discussions about how rock climbing builds solidarity and a spirit of sportsmanship among climbers can be a central point. How these activities inspire people to share experiences, form relationships, and create a supportive environment can be a focus of conversation. With various dimensions involving the physical, mental, uniqueness of the sport, and impact on the community, discussions about rock climbing provide an interesting window into understanding the complexity and beauty of the world of extreme sports. Apart from the challenge of solving certain routes, apart from all that rock climbing also provides a social experience. Rock climbing communities are often solid and supportive of each other. This creates an environment that supports individual development and builds a spirit of sportsmanship. Overall, rock climbing is a sport that combines strength, ingenuity and courage. This activity is not only a physical test, but also holistic character development for those who love adventure and challenges.

The amount of each piece of equipment used will be influenced by the number of climbers, climbing technique and climbing terrain. The type of equipment will be influenced by the climber's readiness, both ability and anticipation.

The following is some basic equipment used for rock climbing:

- ✓ Helmets.
  in rock climbing, function more or less the same as helmets in general, namely to protect the head from impacts. Helmets are used for climbing natural cliffs, apart from preventing collisions with cliffs, they also reduce the risk of being hit by a falling band. For artificial climbing (especially during competitions) the use of helmets is not common.
- ✓ Kernmantle rope.
  is the main safety equipment for climbers from falling over a certain height. The average Kernmantle rope length is 70 meters. There are two types of kernmantles for climbing: dynamic and static. Dynamic ropes are usually used for climbing with a lead technique because when the climber falls they will have good elasticity to avoid internal injuries (especially the spine). Static ropes are not recommended for use because of their very low elasticity which is dangerous for the energy that the body is forced to receive if it is burdened when the climber occurs.
- ✓ Climbing Shoes/Climbing Shoes.
  for rock climbing and wall climbing, have the same function, namely to help the climber to stand on a vertical surface, and protect the feet from sharp rocks and rough rock friction.
- ✓ Chalk bag.
  is a bag to hold magnesium chloride powder, which helps climbers reduce moisture in the palms of their hands when climbing, thereby keeping the climber's grip stable.
- ✓ Slings are very useful for rock climbing and wall climbing. Slings can be used as runners, back ups or as other safety components. Slings are divided into two types, prusik slings and webbing slings, the length and diameter of the slings have many variations.
- ✓ Full Body harness, is climbing equipment worn on the body. Body harnesses are usually used for work, rescue and flying fox. The body harness helps the user to remain in a sitting position.
- ✓ Seat harness, apart from Full Body harness, is also known as seat harness. For sport and adventure climbing (mounteineering) a seat harness is commonly used, because it is simple. Meanwhile, full body harnesses are used in the industrial world. The difference between full-body and seat-haness is that when a climber falls, a full-body harness will have a very big chance that the climber will fall with his feet down, while a seat-harness has the possibility of his head being down when he falls. So for a world of work that is very risk averse, seat harnesses are not permitted to be used.
- ✓ Gloves will protect the belayer's hands when securing the climber or rapler from the danger of palms rubbing against the safety rope.
- ✓ Carabiners, created to combine different types of equipment. Carabiners have many shapes and variations, generally carabiners are divided into two types, namely non screw gate carabiners and

screw gate carabiners. Carabiners are usually connected to ropes or as safety for climbing, carabiners are very strong because a life is attached to the carabiner when climbing is carried out from the danger of the climber falling from a height.

- ✓ Quickdraw/runner, is a combination of a prusik and two carabiners. Usually used as a connecting part between chocks, friends, tricams, bolts or pitons to carnmantel ropes.
- ✓ Figure eight, this equipment includes a descender, which is a tool used to descend vertical terrain and a rope as a path. The shape resembles the number 8, various sizes and shapes, strange rate 3000 kg., using this tool causes twisting in the rope, one of the weaknesses of this tool when used.

There are several names of climbing techniques that can be used to complete the entire cliff terrain, such as breaking routes, observing routes, winning to the top, including:

(1) Face Climbing. Namely climbing on a cliff surface that utilizes rock protrusions (points) or adequate cavities that are used. as a footrest, hand grip or body balance guard.

(2) Friction / Slab Climbing, This technique relies solely on friction as a supporting force. This is done on a cliff surface that is not too vertical, the surface roughness is sufficient to produce frictional force. The greatest friction force is obtained by overloading the friction plane with the largest possible normal plane. Good shoe soles and maximum load on the feet will provide good friction, so that climbing can be done more easily.

(3) Fissure Climbing. This climbing technique using fissure climbing makes more use of the gaps used by the limbs to climb.

In this way, there are several developments in fissure climbing, known as the following techniques:

(1) Jamming. A climbing technique that uses gaps that are not that big. The climber's fingers, toes, or parts of the hands and shoulders can be used as a technique for climbing by using cracks in the cliff to climb. The majority of the equipment used is safety inserts.

(2) Bridging. A technique for climbing large vertical gaps (gullies). This technique uses both hands and feet as grips on both cliff faces. The position of the body is astride, the legs as support are assisted by the hands which also function as balance keepers.

(3) Lay back. A technique for climbing vertical gaps using hand and foot strength. In this technique, the fingers hook the edge of the gap with the body weighted backwards and attached to the side of the cliff, to strengthen the climber's grip. both feet stand and push on opposite edges of the gap to produce lift.

(4) Chimneying. A technique for climbing a fairly wide vertical gap in a cliff (chimney). The body enters between the gaps, with the back pressed against and pushed against one side of the cliff. One foot is attached to the side of the cliff in front, and the other is attached to the cliff behind the climber. Both hands are placed against the cliff. Both hands help push up at the same time as the two legs push and support the body weight.

The following are the types of climbing based on the equipment used in rock climbing:

(1) Free Climbing. As the name suggests, in free climbing the best safety equipment is yourself. However, personal safety can be improved with skills gained from good training and following proper procedures. In free climbing, the equipment functions only as a safety measure in case of a fall. In practice he moves while installing, so even without these tools he is still able to move or continue climbing. In this type of climbing, a climber is secured by a belayer.

(2) Artificial (Aid) Climbing, rock climbing with the help of additional equipment, such as pitons, bolts, etc. This equipment must be used because when climbing you often encounter terrain that provides little or no support or adequate movement opportunities. The purpose of aid climbing is to increase height.

(3) Free Solo Climbing, is part of free climbing, but the climber really does it with all the risks he is ready to face himself. When moving, he does not need safety equipment. To do free soloing climbing, a climber must really know all forms of obstacles and decisions about movement on the route taken. Sometimes he even has to memorize all the movements first, be it a support or a hold, so usually people will do free soloing climbing if they have already climbed on the same route. The risks faced by this type of climber are very fatal, so only people who are capable and truly professional will do it. This climbing technique is not recommended considering that the risks faced are the highest compared to other climbing techniques.

Rock climber analysis involves evaluating physical strength, climbing skills, navigation and problem-solving abilities over a variety of terrain. Understanding weather conditions and the natural environment can influence climbing success. Veddriq Leonardo is a speed climbing athlete from Indonesia. Veddriq became the athlete's fastest climb after setting a world record at the 2023 IFSC World Cup in Seoul with a

time of 4.90 seconds. Veddriq Leonardo (born 11 March 1997) is an Indonesian speed climber. Veddriq became the fastest climbing athlete after setting a world record at the 2023 IFSC World Cup in Seoul with a time of 4.90 seconds. He achieved this record after climbing a 15 meter-high climbing wall with the fastest time in the world on April 28 2023. Veddriq is the first human in the world to officially climb in under 5 seconds. In 2014, he took part in his first national championship in Tanjung Balai Karimun, Riau Islands where he finished in the top eight. In 2016, he won his first medal (bronze) at the junior national championship in Bangka Belitung. His first international tournament was the 2018 IFSC World Cup Moscow where he finished third.

Meanwhile, the Indonesian female rock climbing athlete is Desak Made Rita Kusuma Dewi, who comes from Buleleng, Bali. This year, Desak managed to get a ticket to the 2024 Paris Olympics, because he managed to get a gold medal in France yesterday against his rival from Switzerland. Indonesian rock climbing athlete, Desak Made Rita Kusuma Dewi, won a gold medal in the women's speed event at the 2022 Hangzhou Asian Games. Desak successfully defeated China's host representative, Deng Li Juan, while sharpening his record.

Competing at the SXK Sport Climbing Center, Hangzhou, China, the rock climbing athlete from Bali managed to beat the host representative from China, Deng Li Juan with a fantastic record time, 6.364 seconds. Desak Made's record time broke the Asian Games record that he recorded in his own name consecutively throughout today's match. From the quarter-finals to the final, Desak Made broke the record three times, where his time continued to improve, from the previous 6.6 seconds and 6.5 seconds. Meanwhile, Deng Li Juan, in today's final, couldn't do much against Desak Made's speed. Deng, who was fully supported by the host public, had to be satisfied with winning the silver medal after posting 6.435 seconds.

4. Conclusion

In this study, we aimed to explore key aspects of rock climbing performance, including biomechanical analysis, safety measures, and technological innovations, while also examining the cultural and sporting impact of prominent athletes in the field. Our findings illustrate how the evolving nature of climbing, both as a recreational activity and a competitive sport, is deeply interconnected with advancements in biomechanics, safety technology, and athlete development. The research highlights how contemporary climbing practices have been shaped by innovations in equipment, movement analysis, and a growing global appreciation for the sport.

Our investigation advances the field by identifying the nuanced interplay between technique, safety, and performance. We synthesized a broad spectrum of research that demonstrates the crucial role of biomechanical insights in optimizing climbers' movements and reducing the risk of injury. This understanding of the mechanics of climbing provides a foundation for future studies that could further refine training methodologies for athletes. Additionally, the incorporation of digital technologies, such as sensor-based motion detection and video stream analysis, offers new possibilities for enhancing performance assessment and coaching practices. These developments represent significant progress from the current state of knowledge and open the door to even more precise and tailored approaches to training. Moreover, our work emphasizes the importance of culturally significant climbers, such as those from Indonesia, who have achieved notable success on the world stage. This underscores the globalization of the sport and the diverse talent pools emerging from regions previously underrepresented in competitive climbing.

The practical implications of these findings are wide-reaching. For practitioners and coaches, there is an opportunity to integrate biomechanical data and advanced motion analysis tools into everyday training routines, potentially leading to more efficient training regimens that maximize performance while minimizing injury. For equipment manufacturers, our research underscores the ongoing need for innovation in climbing gear, particularly in terms of improving safety features without compromising performance. This could lead to the development of new technologies that make climbing more accessible and safer for a broader range of participants.

Furthermore, our research opens several avenues for future investigation. While we have outlined the key contributions of technology and biomechanics to rock climbing, more research is needed to fully understand how these elements can be further optimized. Future studies could focus on the application of artificial intelligence (AI) and machine learning in analysing climbing movements and improving performance prediction models. Additionally, there is potential for more in-depth research into the cultural dimensions of climbing, particularly how the sport is perceived and practiced in different regions and its socio-economic impact on local communities.

Another area ripe for further exploration is the role of climbing in promoting physical fitness and mental health, particularly among younger athletes and recreational climbers. Longitudinal studies could provide valuable insights into how regular participation in climbing impacts physical and mental well-being over time. Finally, examining the environmental impact of climbing, especially in natural outdoor settings, could provide crucial information for developing sustainable climbing practices that balance the sport's growing popularity with the need to protect natural landscapes.

In conclusion, this study provides a comprehensive understanding of the multi-faceted nature of rock climbing, from biomechanics and safety to cultural and technological developments. By advancing the current state of knowledge in these areas, we hope to contribute to the continued growth and evolution of the sport. Future research can build on these findings to explore new technological, cultural, and environmental frontiers, ensuring that climbing remains not only a source of personal achievement but also a sustainable and inclusive global practice.

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