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Research Article

Designing an Effective Warm-up Protocol for Competitive Badminton Players to Enhance Performance and Prevent Injuries

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Abstract

This study aims to define a proper process of a Badminton-specific warm-up, which helps a player perform well in tournaments and achieve better results with appropriate injury management. Badminton players need speed, agility, endurance, and strength to cover the court quickly, react to shots, and maintain a high level of play throughout a match. This analysis reviews the player's performance with a designed warm-up process. A well-planned warm-up has the potential to not only prepare athletes physically and mentally but also possess the ability to reduce the likelihood of injury and improve performance, highlighting its significant importance in athletic development. General warm-up specifically targets increasing body temperature and heart rate, which only involves basic body movements. Specific warm-ups target a particular muscle group and movements related to the activity. Concisely, a general warm-up is a broader preparation, while a specific warm-up is tailored to a certain activity. So, there is a need for sports specific warm-up programs. This approach of defined step-by-step warm-up procedures will help players in their performance and develop a standard procedure for the warm-up. As per the data collected during the analysis, the designed warm-up program showed better results in the performance of badminton players.

Keywords

Physical Conditioning, Dynamic Stretching, Specific Warm-up, Reaction Time

1. Introduction

1.1. Why Warm-up Is Essential

The concept of warming up before physical activity has ancient roots, with civilizations like the Greeks and Romans recognizing its benefits. Early civilizations like the Greeks and Romans understood the importance of preparing the body for physical activity, suggesting an early recognition of the benefits of warming up. The practice has become formalized in sports and fitness, with a focus on increasing body temperature and blood flow. A proper warm-up is essential before engaging in any physical activity, including badminton. A good warm-up routine helps prepare your body for the demands of the sport, reduces the risk of injury, and improves performance [2]. By following a comprehensive warm-up routine, the player will effectively prepare his body

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and mind for the challenges faced in the badminton match, reducing the risk of injury and maximizing your performance on the court. Performing warm-ups increases muscle temperature and blood flow, which contributes to improved exercise performance and reduced risk of injuries [1].

1.2. Components of Warm-Up

A warm-up program includes the following two components.

1) General Warm-Up consist of slow activity, such as jogging or skipping. Alternatively, low-intensity sport-specific actions can be performed. The warm-up provides a sport-specific general warm-up that aids skill development and raises body temperature. This period aims to increase heart rate, blood flow, deep muscle temperature, respiration rate, and perspiration and decrease the viscosity of joint fluids [6].
2) A Specific Warm-Up incorporates movements similar to those of the athlete's sport. It involves dynamic stretching that focuses on movements that work through the range of motion required for the sport. The more power necessary for the sport or activity, the more essential the warm-up becomes. A warm-up should progress gradually and provide sufficient intensity to increase muscle and core temperatures without causing fatigue or reducing energy stores [8].

Arrangement of exercises: The proper sequential arrangement of physical exercise is the first and foremost principle that helps attain the highest performance and quick recovery from fatigue after training.

2. Materials and Methods

2.1. Data Collection

Table 1. *Weight & Height Classification of players.*

Gender	Weight (in Kg)	Frequency	Height (cm)	Frequency
Male	Below 40 kg	11	Below 145 cm	2
	40-50 kg	18	146-155 cm	4
	51-60 kg	12	156-165 cm	15
	61-70 kg	9	166-175 cm	20
	Above 70 kg	10	Above 175 cm	19
Female	Below 40 kg	6	Below 145 cm	1
	40-50 kg	8	146-155 cm	8
	51-60 kg	9	156-165 cm	15
	61-70 kg	10	166-175 cm	14
	Above 70 kg	7	Above 75 cm	2

A total of 100 badminton players were chosen from clubs and professional players playing at different levels from professional badminton coaching centers. The players aged between 18 to 45 years were considered as a sample. The mean age was 25.96 ± 2.50 years; there were 60 males and 40 female players. The mean height of the players is 171.058 ± 5.50 cm, and the mean weight is 68.36 ± 10.50 kg. The players responded to questionnaires, which shows that warm-up procedures had significant positive effects on the performance of participants. Warm-up activities mentally prepare players for competition and enhance their confidence levels. The data was obtained through athlete demographics and a self-description questionnaire. The criteria defined for the selection of the samples are as follows:

1) Both genders
2) Aged between 18 and 45 years
3) Players who plays recreational and competitive badminton
4) Players who play a minimum of two days a week for at least 90 mins per day

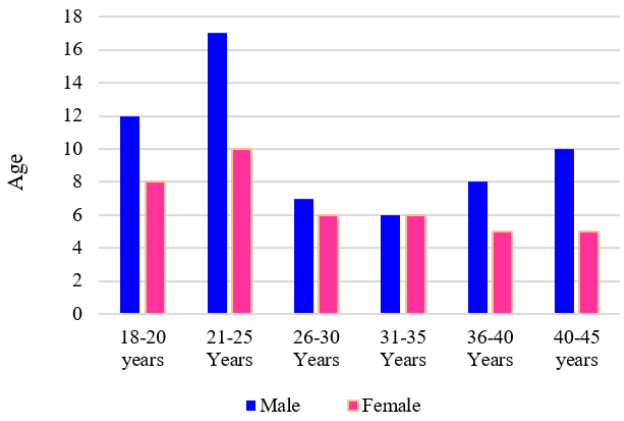

Figure 1. Age & Gender Classification.

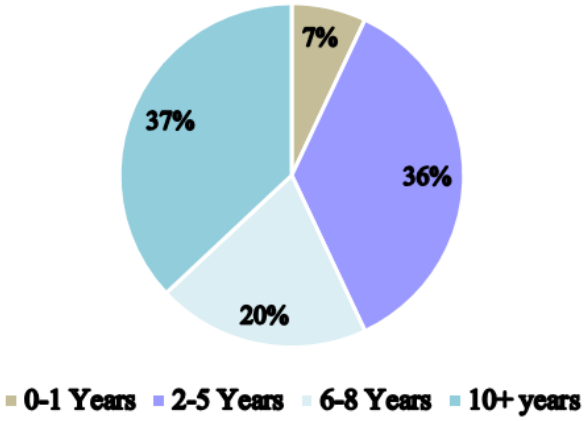

Figure 2. Playing Experience.

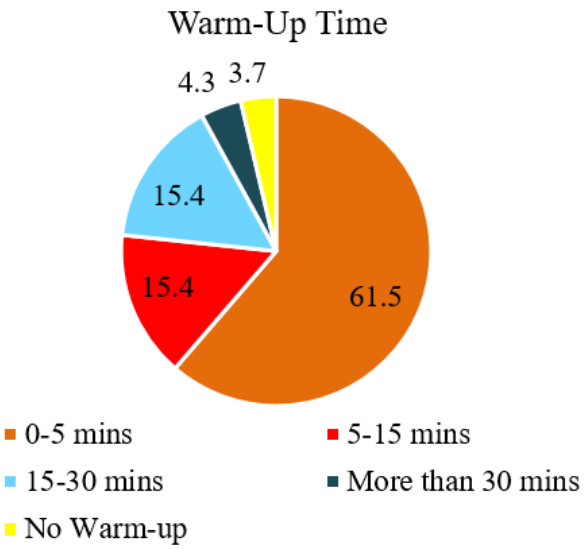

Figure 3. Warm time of Players earlie. r.

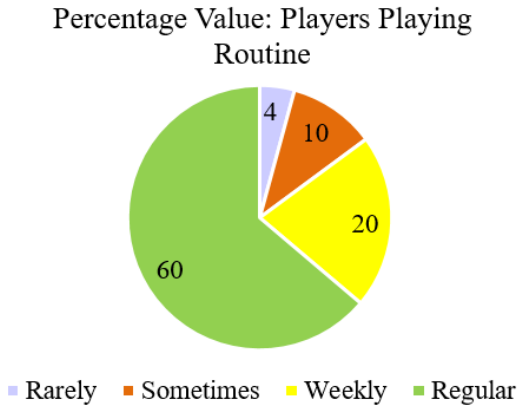

Figure 4. Players playing Routine.

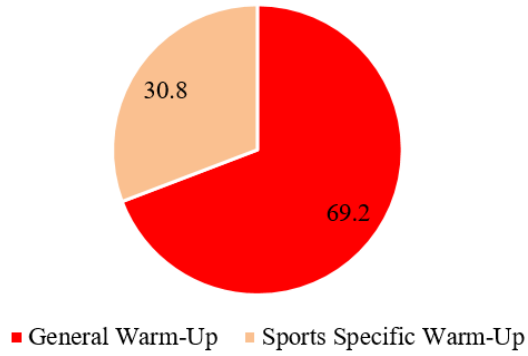

Figure 5. Players Preference on General Vs Sports Specific Warm-Up.

2.2. Procedure

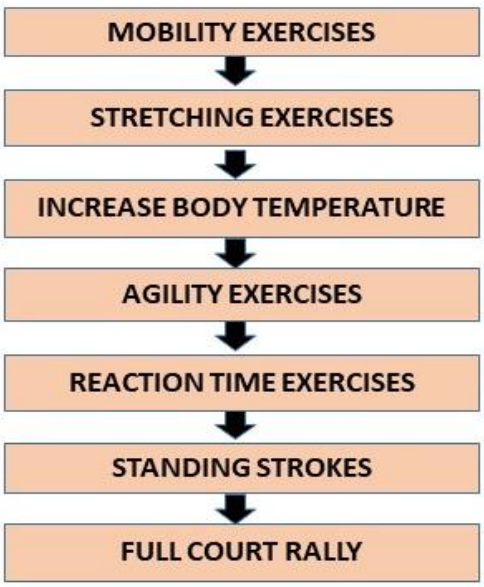

Figure 6. Flow chart for warm-up exercises.

The designed warm up process was clearly explained to the selected players, demonstrated and queries were addressed [7]. The players were instructed to follow the proper technique of the exercises [4]. This study lasted 90 days.

3. Warm up Protocol

The warm-up protocol consists of exercises that must be followed step by step for the best performance during the play.

3.1. Mobility Exercises

Preparing the body to move naturally with control but without noticeable effort, as the body seamlessly responds to the player's intentions occasionally. Mobility exercises improve muscle strength, flexibility, joint health, motor control, body awareness and coordination. They explicitly focus on shoulders, pelvis, Back, hip, Wrist, Knees and toes with all necessary movements (Supination, Pronation, Extension, Flexion, Lunar) [9].

3.2. Stretching

Hip Flexor Stretch, Butterfly stretch, Thoracic Spine Rotation, Leg Swings, Cat cow stretch, Ankle circles, Doorway stretch. The time duration will be 15-20 mins [3, 5].

3.3. Increase Body Temperature

Body temperature can be increased through a systematic process that includes walking, jogging, and slow running. The whole process should be followed with the phenomena of Slow to Moderate to Heavy. Playing small games or slow-running drills may be more appropriate. The time duration will be 15-20 mins.

3.4. Agility Exercises

Figure 7. *Mobility exercise.*

Agility is the ability to change body direction and accelerate or decelerate rapidly.

Exercises: Side Run, back run, Side Shuffle Run, L-Z-V-T shape run, front-back movements, shuttle run, High Knee, Carioca run, Exercise with agility ladder. The duration will be 15-20 minutes.

3.5. Reaction Time Exercises

Reaction time refers to the connection between your vision system and movement. In other words, you can move quickly and precisely in response to what you see. The time duration will be 15-20 mins. Exercise: Ball drop & catch, Ball Tossing, shadow training.

3.6. Standing Strokes

This is the first stage of the warm-up process on the court. This involves the practice of all the strokes from the corners in a standing position to mobilize the specific muscles used in the match for the particular stroke. A player can practice tosses, drops, lifts, drives, and smashes while standing from the end of a court.

Figure 8. *Reaction Time Exercise.*

3.7. Full-court Rally

Players can exchange the shots while the shuttle is in play, keeping the body active on the full court and trying all the strokes randomly from any position. Players can do full-court rallies with modifications like known or unknown shot play.

4. Result

The study was performed on 100 players (60 Male and 40 Female). Based on the data collected, all the players were instructed to perform a warm-up process daily before a practice session. The majority of the players were found to be

physically fit, having no injuries, besides a few players having minor niggles. The data was collected through a self-description questionnaire from the players. After following all the warm processes, it was found that all the players had a significant positive effect on their performance. As feedback from players, the warm-up process has mentally prepared the players for competition and enhanced their confidence level. After implementing a specific warm-up process, the set of collected data showed better improvement in preventing injuries and performance implementation.

To find out the possible effects of warm up exercises on performance of badminton players through self-Questionnaire in which N= Total Players. Components such as Reflexes Coordination, Sprain, Strain, Injury, Flexibility recovery and confidence are compared. Result shows significant positive effect on performance of participants after impletion of effective warmup process. A structured self-report questionnaire was administered using a 5-point Likert scale to evaluate the perceived effectiveness of the warm-up process across six performance-related components.

Table 2. *Frequency & percentage comparison of Male players.*

Male (N=60)	VE		E		A		RE		NE	
	F	%	F	%	F	%	F	%	F	%
Reflexes	10	16.6	12	20	16	26.6	12	20	10	16.6
Coordination	10	16.6	12	20	12	20	14	23.3	12	20
Injury	20	33.3	12	20	10	16.6	10	16.6	12	20
Flexibility	10	16.6	10	16.6	16	26.6	12	20	12	20
Recovery	10	16.6	12	20	14	23.3	18	30	12	20
Confidence	16	26.6	14	23.3	10	16.6	10	16.6	12	20

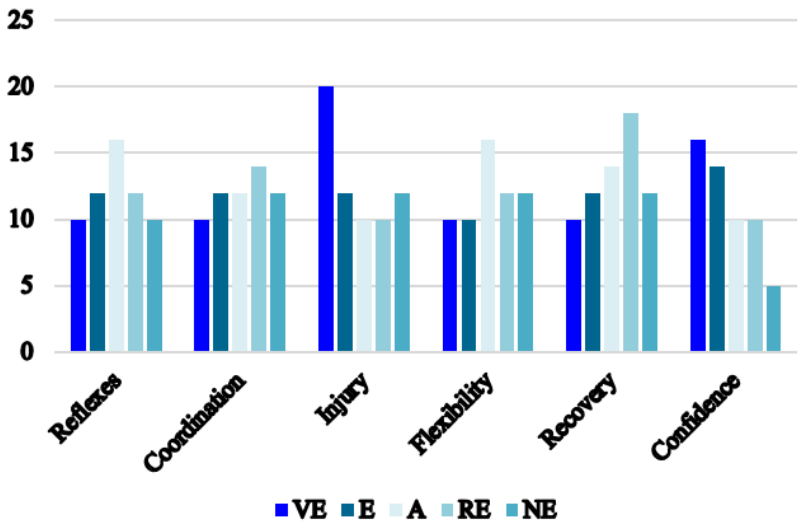

Figure 9. *Component Comparison for Male Players.*

Table 3. *Frequency-Percentage comparison of Female players.*

Female (N=40)	VE		E		A		RE		NE	
	F	%	F	%	F	%	F	%	F	%
Reflexes	6	15	8	20	10	25	8	20	8	20

Female (N=40)	VE		E		A		RE		NE	
	F	%	F	%	F	%	F	%	F	%
Coordination	8	20	8	20	10	25	8	20	6	15
Injury	16	40	8	20	6	15	4	10	10	25
Flexibility	12	30	8	20	6	15	4	10	10	25
Recovery	8	20	10	25	6	15	8	20	8	20
Confidence	8	20	12	30	6	15	6	30	8	20

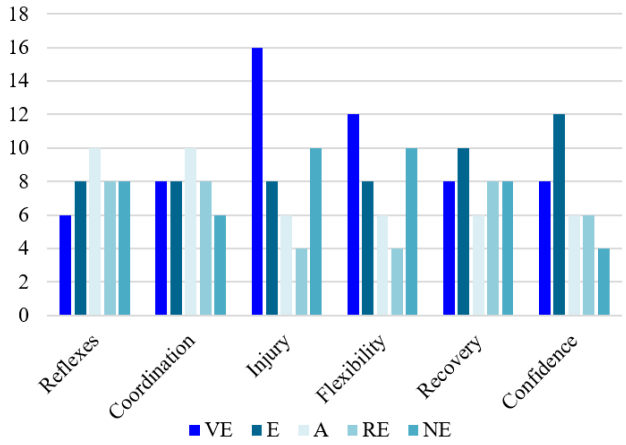

Figure 10. *Component Comparison for female Players.*

Tables 1 & 2 present the frequency and percentage data of males and female's based on Reflexes, coordination, Injury, Flexibility, Recovery, Confidence, where self-description Questionnaire categorizes as VE=Very Effective, E=Effective, A= Average, RE= Rarely Effective, NE=No Effect where F=Value of response and%= percent.

Table 4. *Mean & SD comparison of male and female.*

Participant (N=100)	Very Effective (VE)		
	N	Mean	±SD
Reflexes	16	8	2.8
Coordination	18	9	1.4
Injury	36	18	2.8
Flexibility	22	11	1.4
Recovery	18	9	1.4
Confidence	24	12	5.6

Table 5. *Mean & SD comparison of male and female.*

Participant (N=50)	Effective (E)		
	N	Mean	±SD
Reflexes	20	10	2.88
Coordination	20	10	2.88
Injury	20	10	2.88
Flexibility	18	9	1.4
Recovery	22	11	1.4
Confidence	26	13	1.4

Table 6. *Mean & SD comparison of male and female.*

Participant (N=50)	Average (A)		
	N	M	±SD
Reflexes	26	13	4.2
Coordination	22	11	1.44
Injury	16	8	2.8
Flexibility	22	11	7.07
Recovery	20	10	5.6
Confidence	16	8	2.8

Table 7. *Mean & SD comparison of male and female.*

Participant (N=50)	Rarely Effective (RE)		
	N	Mean	±SD
Reflexes	20	10	2.8

Participant (N=50)	Rarely Effective (RE)		
	N	Mean	±SD
Coordination	22	11	4.2
Injury	14	7	4
Flexibility	16	8	5.6
Recovery	26	13	7.0
Confidence	16	8	2.8

Table 8. *Mean & SD comparison of male and female.*

Participant (N=50)	No Effect (NE)		
	N	Mean	±SD
Reflexes	18	9	1.4
Coordination	18	9	4.2
Injury	22	11	1.4
Flexibility	22	11	1.4
Recovery	20	10	2.8
Confidence	20	10	2.8

Statistical analysis shows N=100 (M=60 & F= 40), mean and ±SD values are VE= 11.16±2.56, E=10.5±2.14, A=10.1±3.97, RE=9.5±2.33, NE=10±2.33. All six domains of Physical self-description Questionnaire score shows majority of the participants were in the Very Effective and effective category which means that warm-up process had significant positive effects on performance of participants. Warm-up activities mentally prepare players for competition and enhance confidence level.

Anova single factor test used to find out comparison results between the samples of component comparison of male and female players.

Table 9. *Anova Single Factor Summary.*

SUMMARY				
Groups	**Count**	**Sum**	**Average**	**Variance**
VE	6	134	22.333333	53.466667
E	6	126	21	7.6
A	6	122	20.333333	15.066667
RE	6	114	19	20.4
NE	6	120	20	3.2

Table 10. *Anova test values.*

ANOVA						
Source of Variation	**SS**	**df**	**MS**	**F**	**P-value**	**F crit**
Between Groups	36.8	4	9.2	0.46123	0.763428	2.75871
Within Groups	498.6667	25	19.94667			
Total	535.4667	29				

5. Conclusion

Warm-up exercises are crucial to any sport or fitness training program. Structured warm-up procedures should be considered when it comes to the prevention of sports injuries. A proper warm-up has several vital components or parts that should all work together to prepare the individuals for sports performance and minimize the likelihood of sports injury from physical activity. Through specific warm-up protocol, the athlete is specifically preparing their body for the demands of their sport. Activity should reflect the movement and actions required during the sporting event, including sports-specific and technical drills.

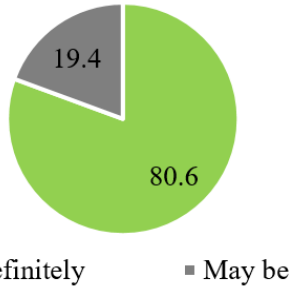

Figure 11. *Players interest in learning new was of Warm-up techniques.*

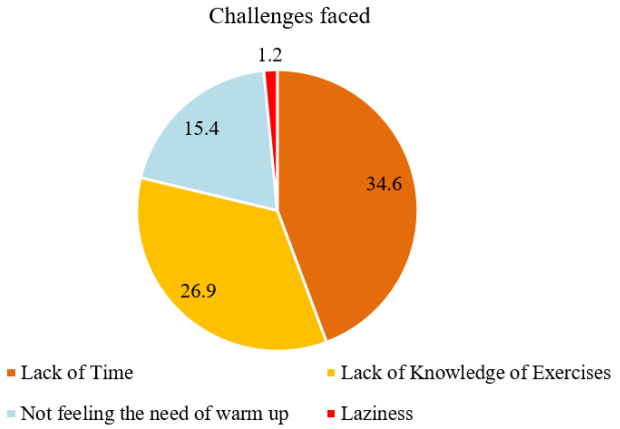

Figure 12. *Challenges Faced in a consistent warm-up routine.*

Abbreviations

HR	Hear Rate
RT	Reaction Time
VE	Very Effective
E	Effective
A	Average
RE	Rarely effective
NE	No Effect

Author Contributions

Ujjawal Bahuguna: Conceptualization, Data curation, Investigation, Methodology, Resources, Validation, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Ujjawal Bahuguna is a dedicated professional in the field of sports, currently serving as a Badminton Coach at Shiv Nadar Institution of Eminence, Delhi-NCR. Ujjawal Bahuguna holds a Bachelor of Physical Education (BPED) and a Master of Physical Education (MPED) degree, which laid a solid foundation for his expertise in sports science, training methods, and athlete development. In addition to his academic qualifications, Bahuguna has earned world-level sports certifications, enhancing his credibility and knowledge as a high-performance badminton coach. With a vision to elevate the standard of badminton coaching in India, Ujjawal continues to contribute to the sports ecosystem through mentorship, skill-building workshops, and continuous learning. His commitment to excellence and passion for badminton makes him a respected figure in the sports community.

Amrish Tony is a distinguished sports education professional and currently serves as the Director of Sports at the University of Petroleum and Energy Studies (UPES), Dehradun. With over 15 years of experience in sports administration, coaching, and athlete development, Dr. Tony has made significant contributions to enhancing university-level sports in India. He holds a Ph. D. in Physical Education and Sports Science, along with an M. Phil., M. P. Ed. and B. P. Ed., reflecting his deep academic grounding in the discipline. He is also a certified Professional Swimming Coach, accredited by the Sports Authority of India, and has successfully trained age-group, elite, and master-level athletes. Before joining UPES, Dr. Tony held leadership positions at premier institutions such as Shiv Nadar University and SRM University, where he was instrumental in structuring competitive sports programs and expanding student participation. His international exposure across reputed sports academies and his strong industry network have enabled him to bring a global perspective to the university sports ecosystem.