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SOMATOTYPE-BASED TRAINING INTERVENTION FOR PERFORMANCE ENHANCEMENT IN FEMALE SPORT CLIMBERS

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ABSTRACT
Sport climbing has developed into a globally recognized competitive activity that demands a combination of strength, muscular endurance, flexibility, coordination, and technical proficiency. Body composition and anthropometric features significantly influence climbing performance, as climbers are required to continuously support and move their body weight during vertical ascent. The present study aimed to design and implement a somatotype-based training intervention specifically for female sport climbers and to examine its effect on selected performance variables. Thirty female climbers aged between 18 and 25 years participated in the study. Participants were categorized into endomorphic, mesomorphic, and ectomorphic body types using the Heath–Carter somatotype assessment method. A structured 10-week training program tailored to the physiological characteristics of each somatotype group was conducted with four training sessions per week. Key performance variables such as grip strength, upper-body endurance, climbing time, and flexibility were assessed before and after the training intervention. Statistical evaluation conducted through paired sample t-tests demonstrated significant improvements in all measured variables at the 0.05 level of significance. The results indicate that training programs structured according to somatotype characteristics can contribute to enhanced climbing performance among female athletes. This study highlights the importance of individualized training strategies and provides a practical framework for integrating anthropometric profiling into sport climbing training programs.

Keywords: *sport climbing, somatotype, female athletes, training intervention, climbing performance*

1. INTRODUCTION
Over the past few decades, sport climbing has evolved from a recreational outdoor activity into a highly competitive international sport and is now included in the Olympic Games. The sport requires a combination of physical fitness, technical skills, coordination, and mental focus. Climbers are required to continuously lift and control their body weight against gravity while maintaining stability and accuracy during each movement.

Physical attributes such as muscular strength, endurance, flexibility, and body composition are considered critical determinants of climbing performance. Earlier research indicates that elite climbers typically exhibit lower body fat percentages, high levels of grip strength, and an advantageous strength-to-body-weight ratio, which facilitates efficient movement on vertical climbing surfaces.

Somatotype classification offers a scientific method for describing body structure and composition. The Heath–Carter somatotype method categorizes individuals into three primary components:

- **Endomorphy – relative fat accumulation**
- **Mesomorphy – muscular development**
- **Ectomorphy – linear body structure**

Understanding these body types allows coaches and sports scientists to design more effective and individualized training programs based on the physical characteristics of athletes. Despite increasing scientific interest in climbing performance, limited research has focused on somatotype-based training interventions for female sport climbers. Therefore, the present study attempts to examine how training programs tailored to different body types influence performance outcomes in female climbers.

2. LITERATURE REVIEW
Earlier studies in sport climbing have emphasized the important role of physiological and anthropometric factors in influencing climbing performance. Research findings indicate that proficient climbers usually display greater hand grip strength, improved forearm muscular endurance, and higher levels of flexibility compared with individuals who do not participate in climbing activities. In addition, anthropometric evaluation has frequently been applied to analyze the body composition characteristics of elite athletes. Research findings suggest that climbers often display mesomorphic and ectomorphic characteristics, which support muscular strength development while maintaining a relatively low body mass. Recent advances in sports science highlight the value of individualized training methods instead of applying the same training program to all athletes.

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Designing training plans based on an athlete's physical characteristics, fitness capacity, and body composition can improve performance outcomes and may also help minimize the likelihood of injury. Despite this progress, limited research has specifically explored the effects of somatotype-based training programs on the physical performance of female sport climbers, indicating the need for further investigation in this area.

3. OBJECTIVES OF THE STUDY

1. To determine the somatotype profiles of female sport climbers.

2. To develop a somatotype-based training program for female climbers.

3. To evaluate the effect of the training program on selected physical performance variables.

4. HYPOTHESES

H1: There will be significant improvement in physical performance variables after the intervention.

H2: Somatotype-specific training will positively influence climbing performance.

5. METHODOLOGY

The research utilized an experimental design with pre-test and post-test measurements to assess the effectiveness of the training program. A total of 30 female sport climbers aged between 18 and 25 years, each with a minimum of two years of climbing experience, were selected as participants.

The somatotype classification of participants was determined using the Heath–Carter anthropometric method, which evaluates body composition based on standardized anthropometric measurements. Based on the assessment, participants were grouped into endomorphic, mesomorphic, and ectomorphic categories.

A structured training program lasting ten weeks was implemented, with four training sessions conducted each week. The program was carefully designed to meet the physiological characteristics and performance requirements of each somatotype group.

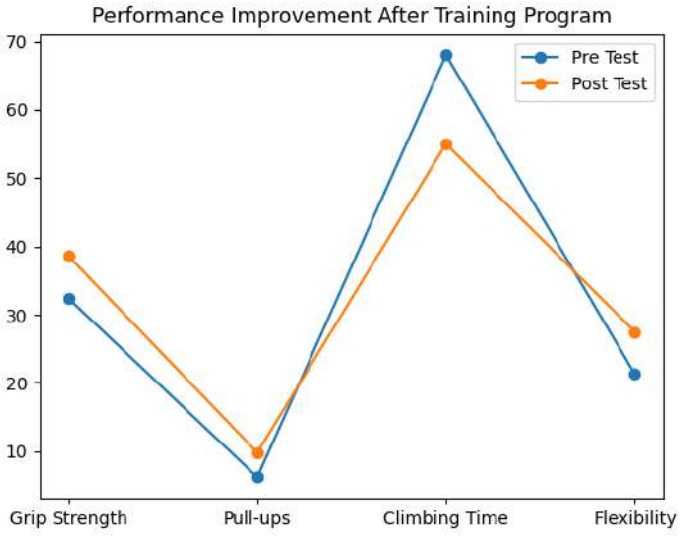
Selected performance variables, including grip strength, upper-body endurance, climbing time, and flexibility, were assessed before and after the intervention to determine the effectiveness of the training program.

6. TRAINING PROGRAM

Somatotype	Training Focus	Exercises
Endomorph	Fat reduction and endurance	Interval climbing, cardio, core training
Mesomorph	Strength and power	Campus board, pull-ups, power drills
Ectomorph	Strength development	Resistance training, finger strength exercises

7. RESULTS

The comparison of pre-test and post-test scores indicated noticeable improvements in all selected performance variables following the 10-week training intervention. Statistical analysis revealed that the training program produced significant enhancements in grip strength, upper-body endurance, climbing efficiency, and flexibility among the participants.



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8. DISCUSSION

The results of the present investigation indicate that training programs tailored according to somatotype characteristics can effectively improve the physical performance of female sport climbers. Climbers categorized as endomorphic benefited primarily from endurance-oriented exercises and conditioning activities aimed at improving body composition.

Participants with mesomorphic characteristics demonstrated greater improvements in strength and power-related activities, likely due to their naturally higher muscular development. On the other hand, ectomorphic climbers showed improvements in muscular strength after participating in resistance-based training exercises.

These findings reinforce the growing recognition of personalized training approaches in modern sports science, suggesting that training strategies need to be tailored to the physiological attributes of each athlete.

9. CONCLUSION

The findings of the present study indicate that somatotype-based training interventions can significantly enhance the performance of female sport climbers. Training programs designed according to body type characteristics contribute to improvements in grip strength, muscular endurance, climbing efficiency, and flexibility.

The results emphasize the importance of incorporating anthropometric assessment and individualized training strategies in the preparation of sport climbers. Coaches and sports scientists can utilize somatotype analysis to design more effective and targeted training programs.

10. RECOMMENDATIONS

- Coaches and trainers should incorporate somatotype assessment using the Heath–Carter Somatotype Method when designing training programs for female sport climbers to ensure training is aligned with individual physiological characteristics.
- Sport climbing training programs should adopt individualized training strategies rather than generalized conditioning programs, as personalized training based on somatotype characteristics can significantly enhance performance outcomes.
- Strength development, particularly upper-body and finger strength, should be emphasized in training programs because these factors play a critical role in improving climbing performance.
- Female climbers with higher endomorphic characteristics should focus more on aerobic conditioning and body composition management, while mesomorphic and ectomorphic climbers should prioritize strength and power training.
- Sports academies and climbing clubs should incorporate anthropometric profiling and physical fitness assessment as part of talent identification and athlete development programs.
- Future studies should include larger sample populations and extended training durations to further examine and confirm the effectiveness of somatotype-based training programs.
- Further studies may also explore the relationship between somatotype characteristics and injury prevention, recovery strategies, and long-term athlete development in sport climbing.
- Researchers should investigate the integration of modern sports science techniques such as biomechanical analysis and physiological monitoring to further enhance training program effectiveness for climbers.

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