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SCIENTIFIC FOUNDATIONS FOR ADVANCING ENDURANCE TRAINING STRATEGIES IN ADOLESCENT FEMALE WRESTLERS

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Abstract: Endurance is essential for competitive success in wrestling, particularly among adolescent female athletes who are experiencing critical phases of physical and hormonal development. This study aims to evaluate and enhance existing endurance training methods for young female wrestlers by integrating sport-specific conditioning, functional testing, and periodized load management. A 10-week intervention was carried out involving 28 athletes, comparing conventional endurance training with an optimized, multidimensional protocol. The findings support the use of tailored, stage-sensitive programs to achieve substantial improvements in aerobic capacity and match-related work efficiency without compromising athlete health.

Keywords:female wrestlers, adolescent training, endurance adaptation, periodization, sport-specific conditioning, physiological development

Introduction

The development of endurance is a foundational aspect of training in wrestling, a sport that requires sustained physical and mental output under high-stress conditions. For adolescent female wrestlers, optimizing endurance is particularly challenging due to ongoing musculoskeletal growth, hormonal fluctuations, and psychological sensitivity associated with puberty. These factors necessitate an approach that differs significantly from adult training methodologies.

Conventional endurance training often applies generalized methods such as continuous running or circuit training, which may neglect individual variability and the specific demands of wrestling. Overreliance on these methods may lead to stagnation, overtraining, or adverse health outcomes—particularly in female athletes whose metabolic and hormonal profiles differ significantly from their male counterparts.

Given the increasing participation of girls in competitive wrestling globally, there is a pressing need to refine endurance training strategies based on scientific principles of developmental physiology, motor learning, and workload recovery balance. This study was designed to explore the effectiveness of a periodized endurance training model that aligns with the athletic, biological, and psychological characteristics of adolescent female wrestlers.

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Methods
This quasi-experimental study involved 28 adolescent female wrestlers aged 12 to 16 years from a regional sports school. Participants were matched for age, wrestling experience (minimum 2 years), and weight category, and randomly assigned to two groups: a traditional training group (TTG, n=14) and an experimental group (EG, n=14) that received an enhanced endurance development program.

Baseline testing included:

- Resting and exercise heart rate monitoring
- VO_2 max estimation via the Yo-Yo Intermittent Recovery Test
- Lactate threshold approximation using submaximal running
- Wrestling-specific endurance test (takedown volume over 5-minute bouts)

The experimental program, conducted over 10 weeks, incorporated:

- Wrestling-based endurance circuits (takedown repetitions, positional isometrics)
- High-intensity interval training (HIIT) adjusted to age-predicted HR zones
- Recovery sessions using low-impact aerobic activities and breathing drills
- Monitoring via session RPE (Rate of Perceived Exertion) and wellness questionnaires

Both groups trained five days a week under the supervision of certified coaches and sports scientists. Final testing mirrored the baseline to evaluate improvements. Data were analyzed using ANOVA to determine statistical significance between and within groups.

Results
Initial assessments indicated similar endurance levels between the two groups. After the 10-week intervention:

- The experimental group showed a 17.3% increase in estimated VO_2 max, compared to 8.9% in the traditional group ($p < 0.01$).
- Time to fatigue in wrestling-specific endurance tests increased by 23% in EG and 11% in TTG ($p = 0.018$).
- Lactate tolerance improved in the EG, with significantly lower perceived exertion scores following simulated matches.
- No participants in either group exhibited signs of overtraining or injury during the study period.
- The EG athletes reported higher motivation and enjoyment levels during training, attributed to task variety and sport-specific relevance.

Discussion
The findings of this study underscore the importance of using sport-specific, individualized endurance training protocols for adolescent female wrestlers. The improvements observed in the experimental group reflect not only physiological adaptation but also enhanced neuromuscular efficiency and motivation—factors closely linked with athlete engagement and long-term development.

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The combination of wrestling-specific drills and targeted cardiovascular conditioning in the experimental model allowed for more relevant stimulus-response cycles, mimicking the actual demands of competition. Moreover, age-adjusted recovery strategies proved effective in maintaining training consistency without triggering excessive fatigue or hormonal disturbance.

This supports broader recommendations in sports science that advocate for periodized, athlete-centered training frameworks during puberty, particularly for female athletes who require closer monitoring due to menstrual cycle influences and hormonal sensitivity.

The study also highlights the limitations of traditional endurance methods, which often fail to stimulate adaptation specific to wrestling demands. Static aerobic activities alone are insufficient for athletes competing in a sport that demands explosive energy release and sustained effort under variable intensities.

Conclusion

Effective endurance development in adolescent female wrestlers requires more than conventional aerobic conditioning. This study demonstrates that integrating sport-specific endurance protocols with physiological monitoring and individualized progression significantly enhances both performance outcomes and athlete well-being. Coaches and trainers should adopt periodized, scientifically informed training strategies that reflect the biological maturity, motivational profile, and competitive goals of young female athletes. Such methodologies not only improve athletic readiness but also contribute to injury prevention, hormonal balance, and long-term sport participation.

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