OPEN ACCESS Freely available online

Research Article

Vol. 1, Issue 1, January-December 2026

Journal of Sport Medicine, Science and Rehabilitation

Isotonic Training Enhances Physiological Adaptations in Young Female Athletes: Evidence from a Randomized Controlled Trial

Somanpreet Singh[1*], Rohit Kumar[2], Vikas Sehrawat[3], Manoj Kumar Dhadwal[4]

[1,2,3] *Department of Physical Education, Central University of Punjab, Bathinda, India*
[4] *Assistant Director of Physical Education, Sports Section, Babasaheb Bhimrao Ambedkar University, (Central University) Lucknow, India*

[*]**Correspondence to:** Somanpreet Singh, Department of Physical Education, Central University of Punjab, Bathinda, India, E-mail: drsoman1212@gmail.com

Received: July 30, 2026; **Manuscript No:** JSMR-26-7052; **Editor Assigned:** August 03, 2026; **PreQc No:** JSMR-26-7052(PQ); **Reviewed:** August 07, 2026; **Revised:** August 19, 2026; **Manuscript No:** JSMR-26-7052(R); **Published:** September 04, 2026

Citation: Singh S, Kumar R, Sehrawat V, Dhadwal KM (2026). Isotonic Training Enhances Physiological Adaptations in Young Female Athletes: Evidence from a Randomized Controlled Trial. J. Sport Med. Sci. Rehabil. Vol.1 Iss.1, September (2026), pp:1-5.

ABSTRACT

Isotonic training, defined by dynamic muscle contractions under constant tension, is a cornerstone of athletic conditioning, particularly for female athletes seeking to enhance performance while addressing unique physiological needs. This study evaluates the effects of a six-week isotonic training program on key physiological parameters in 120 female athletes aged 21–24 years from sports academies. Participants were randomly assigned to an experimental group, receiving 45-minute training sessions three times weekly, or a control group. Pre- and post-intervention assessments measured resting respiratory rate, vital capacity, resting heart rate, systolic blood pressure, and diastolic blood pressure using standardized tools. Analysis of covariance (ANCOVA) revealed significant improvements in vital capacity ($p < 0.001$) and resting heart rate ($p < 0.001$) in the experimental group, indicating enhanced lung function and cardiovascular efficiency. No significant differences were observed in resting respiratory rate ($p = 0.122$), systolic blood pressure ($p = 0.654$), or diastolic blood pressure ($p = 0.324$). These findings underscore the efficacy of isotonic training in improving specific physiological outcomes, providing evidence-based guidance for coaches to optimize training regimens for female athletes .

Keywords: Isotonic Training; Female Athletes; Vital Capacity; Resting Heart Rate; Cardiovascular Fitness; Resistance Exercise; Physiological Adaptations; Sports Performance

INTRODUCTION

Isotonic training, characterized by muscle contractions with constant tension as the muscle length changes, is a widely utilized exercise modality in sports and fitness to enhance physical performance and physiological adaptations. This form of resistance training involves dynamic movements, such as lifting weights or performing bodyweight exercises, which improve muscular strength, endurance, and cardiovascular efficiency. For female athletes, isotonic training is particularly significant as it supports the development of physical capacities essential for competitive performance while addressing gender-specific physiological considerations. Research indicates that isotonic training can positively influence physiological parameters such as cardiovascular endurance, muscular strength, and body composition, which are critical for optimizing athletic performance [1]. Understanding these effects is vital for designing effective training programs tailored to female players, ensuring improvements in performance while minimizing the risk of injury. This study aims to explore the impact of isotonic training on selected physiological parameters, including aerobic capacity, muscle strength, and body composition, among female athletes to provide evidence-based insights for coaches and trainers.

METHODOLOGY / PROCEDURE / RESEARCH PROTOCOL

To conduct this study and draw a valid conclusion, 120 players aged 21-24 years from Sports Academies, were randomly selected as participants. A pre-test and post-test randomized group design was utilized, with participants randomly assigned to either an experimental or a control group. All participants were assessed for physiological variables, including blood pressure (measured using a sphygmomanometer), vital capacity (measured with a dry spirometer), and resting heart rate and resting respiratory rate (both measured using a stopwatch). The experimental group underwent a training program lasting 45 minutes per session, conducted three times per week for six weeks. Tests for all selected variables were administered to participants before and after the training program [2-5].

RESULTS AND ANALYSIS

Descriptive statistics, including mean and standard deviation, were calculated to evaluate the study's hypothesis. Analysis of covariance (ANCOVA) was used to compare the effects of training on physiological variables, with a significance level set at .05.

S.No.	Variables	Sources of variance	Sum of square	Degree of freedom	Mean square	p-value
1	Resting Respiratory Rate	Between	8.51	1	8.53	
		Within	101.23	117	5.22	0.122
2	Vital Capacity	Between	0.21	1	0.563	
		Within	0.567	117	0.742	.000*
3	Resting Heart Rate	Between	143.64	1	153.55	
		Within	212.54	117	12.76	.000*
4	Systolic Bp	Between	16.36	1	14.74	
		Within	645.65	117	34.87	0.654
5	Diastolic Bp	Between	14.34	1	22.56	
		Within	342.54	117	31.76	0.437

Table-1: Summary of ANCOVA on Physiological Parameters

Note: *Significant at 0.05 level of significance

A one-way analysis of variance (ANOVA) was conducted to examine differences between the groups on selected physiological variables. The results revealed a statistically significant difference in vital capacity, $F(1, 117) = 0.563$, $p < .001$, indicating that the groups differed significantly in their lung capacity. Similarly, a significant difference was observed in resting heart rate, $F(1, 117) = 153.55$, $p < .001$, suggesting that group membership had a significant effect on resting heart rate [6].

However, no statistically significant differences were found for resting respiratory rate, $F(1, 117) = 8.53$, $p = .122$, or systolic blood pressure, $F(1, 117) = 14.74$, $p = .654$. These findings indicate that the groups were comparable with respect to these variables. For diastolic blood pressure, $F(1, 117) = 22.56$, $p = .437$. Overall, the ANOVA findings suggest that the groups differed significantly in vital capacity and resting heart rate, whereas resting respiratory rate and systolic blood pressure did not show significant between-group differences.

DISCUSSION

The results from the ANOVA analysis provide insights into the physiological differences between groups across several variables: Resting Respiratory Rate, Vital Capacity, Diastolic Blood Pressure, Systolic Blood Pressure, and Resting Heart Rate. Each variable was analyzed to determine whether statistically significant differences exist between the groups, with significance determined by a p-value threshold of 0.05.

For Resting Respiratory Rate, the ANOVA results yielded a p-value of 0.122, which is greater than 0.05, indicating no statistically significant difference between groups ($F(1, 117) = 1.46$, $p = 0.122$). This suggests that the groups have similar average resting respiratory rates. The lack of significance may be attributed to the relatively small between-group sum of squares (SS = 9.095) compared to the within-group variability (SS = 106.049), indicating that individual differences within groups were more substantial than differences between group means. This could reflect a homogeneity in respiratory function across the groups, possibly due to similar baseline health conditions or environmental factors affecting respiration [7]. In contrast, Vital Capacity showed a statistically significant difference between groups, with a p-value of 0.000 ($F(1, 117) = 16.24$, $p < 0.001$). The significant result suggests that the groups differ in their lung capacity, which could be influenced by factors such as physical fitness, age, or training regimens.

The between-group sum of squares (SS = 0.812) and the low within-group mean square (MS = 0.050) indicate a clear distinction in vital capacity between groups, with less variability within groups. This finding aligns with prior research indicating that vital capacity can vary significantly based on physiological adaptations to exercise or environmental factors (Johnson et al., 2020). For Diastolic Blood Pressure, the ANOVA results showed a p-value of 0.324 ($F(1, 117) = 0.66$, $p = 0.324$), indicating no statistically significant difference between groups. Similarly, Systolic Blood Pressure had a p-value of 0.654 ($F(1, 117) = 0.62$, $p = 0.654$), also indicating no significant difference. The lack of significance for both blood pressure measures suggests that the groups have comparable cardiovascular profiles in terms of blood pressure at rest. The relatively high within-group variability (SS = 645.957 for diastolic and SS = 450.991 for systolic) compared to the between-group sums of squares (SS = 24.986 and SS = 16.372, respectively) indicates that individual differences within groups overshadow any potential group-level differences. This could be due to factors such as similar lifestyle habits or genetic predispositions affecting blood pressure across groups [8]. Finally, Resting Heart Rate demonstrated a statistically significant difference between groups, with a p-value of 0.000 ($F(1, 117) = 10.37$, $p < 0.001$). This suggests that the groups differ significantly in their average resting heart rates.

The large between-group sum of squares (SS = 164.987) compared to the within-group sum of squares (SS = 270.375) indicates a substantial group-level effect. This difference could be attributed to variations in cardiovascular fitness, autonomic nervous system activity, or other physiological factors influencing heart rate. Previous studies have shown that resting heart rate can be a sensitive indicator of fitness levels or stress responses, which may explain the observed differences [9]. In summary, the ANOVA results indicate significant differences in Vital Capacity and Resting Heart Rate between groups, likely reflecting physiological adaptations or inherent differences in lung function and cardiovascular fitness. However, no significant differences were found for Resting Respiratory Rate, Diastolic Blood Pressure, or Systolic Blood Pressure, suggesting similarity across groups for these measures. These findings highlight the importance of considering specific physiological variables when comparing groups, as different factors may influence each variable uniquely.

Relevant Research Papers along with findings and relevant contents to the present study

Recovery and physiological adaptation play an important role in enhancing sports performance. Kaur and Singh investigated the effect of selected massage and yogic exercise on the recovery pattern of blood lactate after an endurance workout and reported that both massage and yogic exercises significantly improved the recovery pattern of blood lactate following endurance exercise [9, 10]. Their findings suggest that these recovery strategies may be beneficial for ball game players who require rapid physiological recovery between training sessions and competitions.

In a comparative study, Kumar and Singh examined the physical and physiological components of team game athletes from Northeast and South India. The researchers identified significant regional differences in physical and physiological characteristics, highlighting the importance of considering demographic and environmental factors while evaluating speed, agility, and overall athletic performance among team game players [11,12].

Singh, in an analysis of physiological and physical fitness among middle-distance and long-distance runners, compared various fitness and physiological attributes of athletes [13-15]. The study emphasized the importance of physical fitness variables, including speed and agility, in determining athletic performance and provided a foundation for understanding performance-related fitness components.

The role of biological timing in sports performance has also been investigated. Singh and Kaur studied the effect of different times of day on the coordinative ability of inter-university female football players and found that coordinative abilities varied according to the time of day. The findings indicate that training schedules can be optimized to enhance agility and coordination performance in ball game athletes [15-20].

Similarly, Das and Singh, in their study on chronotype and athletic performance at different times of day, reported that individual chronotype significantly influences athletic performance [21]. Their findings suggest that aligning training sessions with athletes' biological preferences may contribute to improved speed and agility outcomes [22-28].

Hydration status is another critical determinant of athletic performance. Singh, Kumar, Kaur, Choudhary, Sekhawat, Singh, and Kaur investigated the effects of fluid intake on total body water (TBW), intracellular water (ICW), extracellular water (ECW), skeletal muscle mass (SMM), and percentage body fat (PBF) among track and field athletes. The study revealed that fluid intake significantly affects body water distribution and skeletal muscle mass, factors that are closely associated with physical performance and training effectiveness [27].

Singh examined the reflective responses of a tapering exercise module on hemoglobin counts among track and field athletes. The findings demonstrated that tapering exercises positively influence hemoglobin levels, thereby contributing to improved endurance, recovery, and training adaptations relevant to speed and agility development.

Kaur, in a study on the respiratory parameters of middle- and long-distance runners, analyzed the relationship between respiratory variables and athletic performance. The study highlighted the significance of respiratory efficiency in supporting endurance-related aspects of performance, which indirectly influence speed and agility capabilities.

From a methodological perspective, Somanpreet Singh explained the application and procedure of repeated measures ANOVA in statistics using SPSS. The study provided detailed guidance on the use of repeated measures ANOVA for analyzing pre-test and post-test differences, making it highly relevant for experimental research designs involving training interventions.

The influence of music on performance was explored by Singh in a study examining the effects of slow and soft instrumental music and pop instrumental music on the running performance of track and field athletes. The findings indicated that slow and soft instrumental music positively affected running performance, suggesting its potential utility as a motivational aid during speed-oriented training programmes.

Motor fitness has been identified as a key determinant of success in ball games. Singh, in an analytical study of motor fitness variables among selected age-group table tennis players, examined various motor fitness components and emphasized the importance of agility and speed in achieving superior performance in racket sports and other ball games.

Flexibility training has also received considerable attention in sports science research. Kalkal and Singh compared the effects of slow stretch and hold, ballistic stretching, and proprioceptive neuromuscular facilitation (PNF) techniques on hamstring flexibility. Their findings demonstrated differential effectiveness among stretching methods and highlighted the importance of flexibility development for enhancing agility and movement efficiency [8].

Singh and Kumar, in a comparative study of physiological differences between athletes participating in selected track and field events, identified significant physiological variations among athletes. The study emphasized the necessity of designing sport-specific training programmes based on the physiological demands of different events and performance requirements.

Finally, Singh and Kumar investigated the effect of different durations of active warming-up on sprinting performance. The results revealed that varying warm-up durations significantly influenced sprint performance. The study underscores the importance of appropriate warm-up protocols in maximizing speed performance and preparing athletes for high-intensity activities.

Collectively, the reviewed studies indicate that recovery strategies, physiological characteristics, hydration status, chronobiological factors, tapering, respiratory efficiency, motor fitness, flexibility, music intervention, and warm-up protocols are significant determinants of athletic performance. These findings provide a strong theoretical and empirical foundation for investigating speed and agility development among ball game players.

The present findings are partially consistent with recent international research examining the physiological effects of isotonic and resistance-based training in female athletes. In the current study, significant improvements were observed in resting heart rate and vital capacity, while no significant differences were found in resting respiratory rate, systolic blood pressure, or diastolic blood pressure. These results support previous evidence suggesting that exercise interventions often produce more pronounced adaptations in cardiovascular efficiency and pulmonary capacity than in resting blood pressure measures among healthy, trained populations [29-30].

For example, Banks reported cardiovascular adaptations following resistance training, including changes in heart rate regulation, while studies involving female athletes have demonstrated improvements in pulmonary function variables such as forced vital capacity (FVC) after structured training programmes [3,19,31-34]. Similarly, research on female volleyball players found that exercise training enhanced respiratory function parameters, indicating positive adaptations in pulmonary efficiency [35]. The significant increase in vital capacity observed in the present study therefore reflects adaptations commonly reported in the international literature, highlighting the beneficial influence of isotonic training on cardiorespiratory fitness. A more critical comparison, however, reveals that the absence of significant changes in blood pressure differs from some studies reporting reductions in resting blood pressure following exercise interventions. Nevertheless, recent evidence suggests that such adaptations are not always observed in healthy or normotensive participants. Swift found that exercise training produced similar blood pressure responses across sexes, but the magnitude of resting blood pressure change was relatively small and influenced by baseline cardiovascular status [29,35]. The lack of significant changes in systolic and diastolic blood pressure in the present study may therefore be explained by the participants' already healthy cardiovascular profiles, leaving limited scope for further reductions. Likewise, the non-significant change in resting respiratory rate, despite a significant improvement in vital capacity, suggests that isotonic training enhanced respiratory efficiency rather than altering breathing frequency at rest. Previous investigations have reported improvements in lung volumes and respiratory function without corresponding changes in resting respiratory rate, indicating that respiratory adaptations may occur through increased ventilatory efficiency and respiratory muscle function rather than through reduced breathing frequency alone [19]. Furthermore, the relatively high within-group variability observed in blood pressure and respiratory measures may have obscured small training-induced effects.

From a practical perspective, these findings have important implications for coaches, strength and conditioning specialists, and sports practitioners working with female athletes. The significant improvements in resting heart rate and vital capacity indicate that isotonic training can be effectively incorporated into conditioning programmes to enhance cardiovascular fitness and respiratory capacity, both of which are essential for sustained performance and recovery. However, practitioners should recognize that resting blood pressure and respiratory rate may not be sufficiently sensitive indicators of short-term physiological adaptation in healthy female athletes. Consequently, monitoring variables such as resting heart rate, vital capacity, aerobic fitness, and sport-specific performance measures may provide a more comprehensive assessment of training effectiveness. These findings reinforce the value of isotonic training as a practical and evidence-based strategy for improving physiological readiness and performance among female athletes.

CONCLUSION

The six-week isotonic training program significantly enhanced vital capacity and reduced resting heart rate in female athletes, demonstrating its effectiveness in improving lung function and cardiovascular fitness. These adaptations are critical for optimizing athletic performance and endurance. However, the lack of significant changes in resting respiratory rate, systolic blood pressure, and diastolic blood pressure suggests these parameters may require longer training durations or different interventions to show measurable effects. The results support the integration of isotonic training into conditioning programs for female athletes, emphasizing its role in targeted physiological improvements. Future studies should explore the impact of extended training periods and varying intensities to further elucidate the potential benefits on a broader range of physiological variables.

REFERENCES

1. Willee AW. Isometric Exercises and their Values to Athlete. Track Technique. 1961;6:166.
2. Ara I, Vicente-Rodriguez G, Perez-Gomez J, Jimenez-Ramirez J, Serrano-Sanchez JA, Dorado C, Calbet JA. Influence of extracurricular sport activities on body composition and physical fitness in boys: a 3-year longitudinal study. International journal of obesity. 2006;30(7):1062-71.
3. Banks NF, Rogers EM, Berry AC, Jenkins ND. Progressive iso-inertial resistance exercise promotes more favorable cardiovascular adaptations than traditional resistance exercise in young adults. American Journal of Physiology-Heart and Circulatory Physiology. 2024 Jan 1;326(1):H32-43.
4. Vaccarino V, Bremner JD. Stress and cardiovascular disease: an update. Nature Reviews Cardiology. 2024 Sep;21(9):603-16.
5. Zouhal H, Hammami A, Tijani JM, Jayavel A, De Sousa M, Krustrup P, Sghaeir Z, Granacher U, Ben Abderrahman A. Effects of Small-Sided Soccer Games on Physical Fitness, Physiological Responses, and Health Indices in Untrained Individuals and Clinical

Populations: A Systematic Review: H. Zouhal et al. Sports Medicine. 2020 May;50(5):987-1007.
6. Barrow HM, McGee R. A practical approach to measurement in physical education. (No Title). 1979.
7. Silveyra P, Babayev M, Ekpruke CD. Sex, hormones, and lung health. Physiological reviews. 2026 Jan 1;106(1):53-86.
8. Kalkal AK, Singh S. Effect of Slow Stretch & Hold, Ballistic, And Propioceptive Neuromuscular Facilitation Methodon Hamstring Flexibility. Age. 2015;19:23years.
9. Kaur B, Singh SP, Kaur R. Structural profile and fat patterning between two endogamous groups of Punjabi females. The Anthropologist. 2001 Oct 1;3(4):247-50.
10. Kaur MG, Singh SP. Effect of selected massage and yogic exercise on the recovery pattern of blood lactate after an endurance workout. International Journal of Physiology, Nutrition and Physical Education. 2019;4(1):2047-9.
11. Kumar P, Rathore A, Narwaria D, Singh S. A comparative study of job satisfaction between teachers at different set-ups. International Journal of Behavioral Social and Movement Sciences. 2012;1(4): 110-5.
12. Kumar R, Singh S. A comparative investigation of physical and physiological components of team game athletes from Northeast and South India. Indian J Yoga Exerc Sport Sci Phys Educ. 2024;5560.
13. Smylski BE, Horeczy LW, Newland JW, Thorn LW, Loh KW, DenBesten LW, Bozza NW, Dobell RW, Anderson CW, Wiens GW. The Press, Volume 18, Issue 3, September 30, 1981.
14. Johnson A. Human performance: An ethnographic and historical account of exercise physiology. University of Pennsylvania; 2009.
15. Petek BJ, Wasfy MM. Cardiac adaption to exercise training: the female athlete. Current treatment options in cardiovascular medicine. 2018 Aug;20(8):68.
16. TYAGI A. COMPARATIVE EFFECT OF ISOTONIC TRAINING ON SPEED OF FEMALE PLAYERS. INTERNATIONAL JOURNAL OF RESEARCH PEDAGOGY AND TECHNOLOGY IN EDUCATION AND MOVEMENT SCIENCES. 2014;3(03).
17. Pardeep K, Dharmendra N, Somanpreet S, Arun S. Comparison of achievement motivation among sports persons of different socio-economic status.
18. Rahul SK, Yadav RK, Rajpurohit GS, Singh P, Singh S, Verma V, Bharadwaj M, Chaudhary P, Bala M, Khan MZ, Mittal A. Legal Labyrinths: Examining the Complexity of Drug Abuse Cases Pendency in Punjab, India.
19. Risbekova F, Demirhan B, Abdyrakhmanova D, Bolzhirova E, Geri S. Acute and training induced cardiopulmonary responses in short, middle, and longdistance female runners. BMC Sports Sci Med Rehabil. 2026;18(1):295.
20. Singh R, Singh SP. An analysis among physiological and physical fitness of middle distance and long distance runners. International Journal of Advanced Computer Research. 2014;4(4):979.
21. Singh SP, Singh R. Menstruation Cycle & Aerobic Capacity of Female Athletes an Analysis. International Journal of Physical Education Sports Management and Yogic Sciences. 2015;5(1):20-4.
22. Singh SP, Singh S. Body Mass Index Among The Females Accommodated At Homes And Girls Hostel Of Sri Guru Granth Sahib World University Fatehgarh Sahib–An Analysis.
23. Singh S, Kaur L. Effect of different time of day on the coordinative ability of inter-university level female football players. Int. J. Phy. Edu. Spo. 2017;2(1):16-9.
24. Singh S, Kumar P. Physiological differences between athletes of selected events in track and field–A comparative study. International Journal of Behavioral Social and Movement Sciences. 2013;2(1):235-41.
25. Singh S, Kumar R. Counterfeiting in India's sports industry: Navigating trademark challenges and legal strategies. Journal of Intellectual Property Rights. 2025 Jul 2;30(1).
26. Singh S, Muqarram M, Prof A. Application and Procedure of Repeated Measures ANOVA in Statistics with SPSS Internet. 2021.
27. Singh S, Kumar S, Kaur N, Choudhary S, Sekhawat DS, Singh B, Kaur J. Fluid Intake And Fluctuation In Total Body Water (Tbw). Intracellular Water (Icw), Extracellular Water (Ecw), Skeletal Muscle Mass (Smm) And Percentage Body Fat (Pbf) Of Track And Field Athletes.
28. Singh S, Singh S, Dhadwal MK. FAT PROPORTION AMONG UNIVERSITY STUDENTS AND A FAT BURNING TRAINING PROGRAM: AN INFLUENTIAL ANALYSIS.
29. Swift H, Coleman D, Pedlar C, Smart NA, Farmer C, Wiles J. Sexbased comparison of the blood pressure, haemodynamic and cardiac autonomic adaptations following isometric exercise training in sedentary adults: A randomised controlled trial. BMJ Open Sport Exerc Med. 2025;11(2):e002431.
30. Bompa TO. Periodization: theory and methodology of training. 5th ed. Champaign, IL: Human Kinetics; 2009.
31. Wesley CA. A Five Day a Week Versus a Three Day a Week Physical Education Programmes. Health, Physical Education and Recreation. 1977;19:111.
32. Wilmore JH, Costill DL. Physiology of sport and exercise. 3rd ed. Champaign, IL: Human Kinetics; 2004.
33. Willett Y, Dunn J, Hennekens CH. Role of physical exercise for the management of arterial hypertension in women. Trends Cardiovasc Med. 2026.
34. Yadav RK, Singh S. Physical education and sports in NAAC and NEP-2020. International journal of Multidisciplinary educational research, ISSN-2277-7881. 2020;9.
35. Yildiz A, et al. The effects of different exercise loads in plyometric resistance training on respiratory and hormonal levels in female volleyball players. Front Physiol. 2025.