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Physiological parameters response to the effect of different stretching among school football players

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Abstract
Stretching is an important component of warm-up and training programmes in football, as it directly influences performance, flexibility, and injury prevention. Different types of stretching methods, such as static stretching, dynamic stretching, and proprioceptive neuromuscular facilitation (PNF), produce varied physiological responses including changes in heart rate, blood pressure, respiratory rate, muscle temperature, flexibility, and neuromuscular activation. The purpose of this study was to find out the effect of different stretching on selected physiological parameters among school football players. The selected subjects (N=45) were divided into three equal groups each consisting of 15 (n-15) football ball players. Experimental group I (N=15) underwent Dynamic Stretching (DST), Experimental group –II (N=15) underwent) Static Stretching (SST), and the Group-III (N=15) acted as control group (CG). All the selected subjects were given proper orientation about the purpose of the study, testing and training procedures. The selected subjects were initially tested on criterion variables used in this study and this was considered as the pre-test data and recorded for analysis. The Experimental groups were given respective training for a period of 12 weeks. After twelve weeks of their training program again the subjects were tested on the same criterion variables as such in the pre-test and considered this as the post-test data for the analysis. Vo2 Max was assessed by 20m multi stage fitness test and the unit of measure was in ml/kg/lit and breath holding time was assessed by breath holding fitness test and unit of measure was in seconds, Descriptive statistics such as mean and standard deviation are found in order to get the basic idea of the data distribution "t" test was done for finding whether there is any statistically significant pre-test to post-test mean differences in their respective variables of each groups. ANCOVA tests the significance of "adjusted post test mean" differences between the experimental and control groups for each variable. Whenever the "F" ratio for adjusted post test was found to be significant, Scheffee's post hoc test was applied to test the significant difference between the paired adjusted means.0.05 level of confidence was fixed for speed and endurance parameters to test the level of significance.

Keywords: Dynamic stretching, Static training, Football Players, Physiological, Breath Holding Time, Vo2 Max

Introduction

Metabolic-based dynamic and static stretching exercises were selected in the present study because football is a high-intensity intermittent sport that requires well-developed physical fitness, physiological efficiency, coordinative abilities, and technical skill performance. Football players frequently perform sprinting, jumping, kicking, dribbling, passing, and rapid changes of direction, which demand efficient functioning of both aerobic and anaerobic energy systems. Dynamic stretching was selected as it increases muscle temperature, enhances blood circulation, improves neuromuscular activation, and prepares the body for high metabolic demandsMetabolic training refers to a form of high-efficiency physical training that targets the body's energy systems—specifically, how efficiently the body generates and uses energy during physical activity. It involves structured exercises designed to improve the performance and capacity of metabolic pathways: phosphagen (ATP-PCr), glycolytic (anaerobic), and oxidative (aerobic) systems (Baechle & Earle, 2008).

According to Kraemer & Ratamess (2004), metabolic training is "a type of exercise program that targets the body's metabolism by increasing the energy demand of the muscles to improve efficiency and performance of the cardiovascular and muscular systems."

The aerobic system is the body's primary energ system for producing ATP (adenosine triphosphate)—the energy currency of the body—during long-duration, low- to moderate-intensity activities that require oxygen. It operates through the oxidation of carbohydrates, fats, and (to a lesser extent) proteins to generate ATP.

According to Wilmore and Costill (2004), the aerobic energy system "uses oxygen to metabolize substrates from food and provides the bulk of energy required during prolonged physical activity."

It becomes the dominant energy system during activities such as long-distance running, cycling, swimming, and football when players are jogging or walking between sprints.

Methodology

The purpose of this study was to find out the effect of different stretching on selected physiological parameters among school football players. The selected subjects (N=45) were divided into three equal groups each consisting of 15 (n-15) football ball players. Experimental group I (N=15) underwent Dynamic Stretching (DST), Experimental group –II (N=15) underwent) Static Stretching (SST), and the Group-III (N=15) acted as control group (CG). All the selected subjects were given proper orientation about the purpose of the study, testing and training procedures. The selected subjects were initially tested on criterion variables used in this study and this was considered as the pre-test data and recorded for analysis. The Experimental groups were given respective training for a period of 12 weeks. After twelve weeks of their training program again the subjects were tested on the same criterion variables as such in the pre-test and considered this as the post-test data for the analysis. Vo2 Max was assessed by 20m multi stage fitness test and the unit of measure was in ml/kg/lit and breath holding time was assessed by breath holding fitness test and unit of measure was in seconds.

Descriptive statistics such as mean and standard deviation are found in order to get the basic idea of the data distribution "t" test was done for finding whether th ere is any statistically significant pre-test to post-test mean differences in their respective variables of each groups. ANCOVA tests the significance of "adjusted post test mean" differences between the experimental and control groups for each variable. Whenever the "F" ratio for adjusted post test was found to be significant, Scheffee's post hoc test was applied to test the significant difference between the paired adjusted means.0.05 level of confidence was fixed for Vo21 max and breath holding time parameters to test the level of significance.

Table 1: Computation of 't' ratio on Vo2 max of experimental and control groups (Scores in Ml/kg/lits)

Groups	Pre–test mean	Pre–test S. D (±)	Post-test mean	Post–test S. D (±)	't' ratio
Metabolic Based Dynamic stretching Training Group	42.52	1.25	45.94	1.45	15.43*
Metabolic Based Static stretching Training Group	42.44	1.30	44.02	1.72	8.06*
Control Group	42.49	0.54	42.43	0.87	0.49

*Significant at 0.05 level for the degrees of freedom 1 and 14, (2.15)

Table 4.16 shows that the 't' ratios on Vo_2 Max of MBDSTG and MBSSTG 15.49 and 8.06 respectively. Since, these values were higher than the required table value of 2.145, it was found to be statistically significant at 0.05 level of confidence for degrees of freedom 1 and 14. Further, the obtained 't' ratio between pre and post test of the control group 0.49 was lesser than the required table value of 2.14, and it was found to be not statistically significant

From the results it was inferred that, MBDSTG and MBSSTG produced a significant improvement in Vo_2 Max of school level football players

Table 2: Analysis of covariance on pre, post and adjusted post test means on Vo2 max of experimental and control groups (Scores in ml/kg/min)

Test	Metabolic Based Dynamic stretching Training	Metabolic Based Static stretching Training	Control Group	Source of variance	Df	Sum of square	Mean square	F-ratio
Pre-test mean	42.52	42.44	42.49	B / S	2	0.13	0.07	0.17
				W / S	42	40.65	0.71	
Post-test mean	45.94	44.02	42.43	B / S	2	6.25	3.12	9.94*
				W / S	42	45.13	0.79	
Adjusted post-test mean	45.95	44.03	42.42	B / S	2	4.76	2.38	11.29*
				W / S	41	16.09	0.28	

*Significant at 0.05 level for the degrees of freedom (2, 42) and (2, 43), 3.21

Table 4.17 reveals the computation of 'F' ratios on pre test, post test and adjusted post test means of MBDSTG, MBSSTG and CG on Vo_2 Max.

The obtained 'F' ratio for the pre test means of MBDSTG, MBSSTG and CG on Vo_2 Max was 0.17. Since, the 'F' value was less than the required table value of 3.21 for the degrees of freedom 2 and 42, it was found to be not significant at 0.05 level of confidence.

Further, the 'F' ratio for post test means of MBDSTG, MBSSTG and CG on Vo_2 Max was 9.94. Since, the 'F' value was higher than the required table value of 3.21 for the degrees of freedom 2 and 42, hence it was found to be statistically significant at 0.05 level of confidence.

The obtained 'F' ratio for the adjusted post test means of MBDSTG, MBSSTG and CG on Vo_2 Max was 11.29. Since, the 'F' value was higher than the required table value of 3.16 for the degrees of freedom 2 and 56, it was found to be statistically significant at 0.05 level of confidence. The results revealed that there was a significant difference in post-test means among MBDSTG, MBSSTG and CG in Vo_2 Max of football players.

Table 3: Scheffe's post hoc test for the differences between thepaired adjusted post-test means of Vo2 max

Metabolic Based Dynamic stretching Training Group	Metabolic Static stretching Training Group	Control Group	Mean difference	Confidence Interval
45.95	44.03		1.92*	0.86
45.95		42.42	3.53*	
	44.03	42.42	1.62*	

*Significant at 0.05 level

Table 4.18 revealed that the mean differences between the paired adjusted post test means of all groups.

The mean difference between MBDSTG and MBSSTG, MBDSTG and CG, MBSSTG and CG, were 1.92, 3.53 and 1.62 respectively. The values of mean difference of adjusted post-test means were higher than the required confidence interval value of 0.86 and it was found to be significant at 0.05 level of confidence.

From these results, it was inferred that twelve weeks of MBDSTG produced significant improvement in Vo_2 Max of school level football players than MBSSTG and control group.

Mean values of pre, post and adjusted post test of DSTG, SSTG and CG on Vo_2 Max are presented in Figure 1.

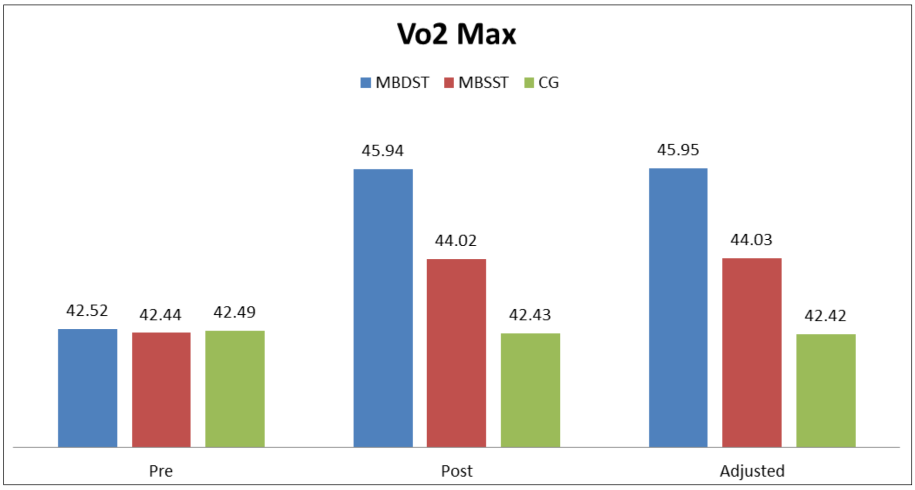

Fig 1: Bar diagram showing pre, post and adjusted post test means of tabata training group and control group on agility (Scores in Seconds)

Table 4: Computation of 't' ratio on breath holding time of experimental and control groups (Scores in seconds)

Groups	Pre – test mean	Pre – test S. D (±)	Post - test mean	Post – test S. D (±)	't' ratio
Metabolic Based Dynamic stretching Training Group	29.50	1.50	35.99	0.92	14.90*
Metabolic Based Static stretching Training Group	29.52	2.78	34.76	1.90	13.62*
Control Group	29.52	1.12	29.60	0.78	0.78

*Significant at 0.05 level for the degrees of freedom 1 and 14, (2.15)

Table 4.22 shows that the 't' ratios on breath holding time of MBDSTG and MBSSTG 14.90 and 13.62 respectively. Since, these values were higher than the required table value of 2.145, it was found to be statistically significant at 0.05 level of confidence for degrees of freedom 1 and 14. Further, the obtained 't' ratio between pre and post test of the control group 0.78 was lesser than the required table value of 2.14, and it was found to be not statistically significant

From the results it was inferred that, MBDSTG and MBSSTG produced a significant improvement in breath holding time of school level football players.

Table 5: Analysis of covariance on pre, post and adjusted post test means on breath holding time of experimental and control groups (Scores in Seconds)

Test	Metabolic Based Dynamic stretching Training	Metabolic Based Static stretching Training	Control Group	Source of variance	Df	Sum of square	Mean square	F-ratio
Pre-test mean	29.50	29.52	29.52	B / S	2	1.03	0.51	0.84
				W / S	42	352.79	6.18	
Post-test mean	35.99	34.76	29.60	B / S	2	81.28	40.64	21.44*
				W / S	42	108.00	1.89	
Adjusted post-test mean	35.99	34.75	29.60	B / S	2	75.09	37.54	30.80*
				W / S	41	68.24	1.21	

*Significant at 0.05 level for the degrees of freedom (2, 42) and (2, 43), 3.21

Table 4.23 reveals the computation of 'F' ratios on pre test, post test and adjusted post test means of MBDSTG, MBSSTG and CG on breath holding time.

The obtained 'F' ratio for the pre test means of MBDSTG, MBSSTG and CG on breath holding time was 0.84. Since, the 'F' value was less than the required table value of 3.21 for the degrees of freedom 2 and 42, it was found to be not significant at 0.05 level of confidence.

Further, the 'F' ratio for post test means of MBDSTG, MBSSTG and CG on breath holding time was 21.44. Since, the 'F' value was higher than the required table value of 12.41 for the degrees of freedom 2 and 42, hence it was found to be statistically significant at 0.05 level of confidence.

The obtained 'F' ratio for the adjusted post test means of MBDSTG, MBSSTG and CG on breath holding time was 30.80 Since, the 'F' value was higher than the required table value of 3.16 for the degrees of freedom 2 and 56, it was found to be statistically significant at 0.05 level of confidence. The results revealed that there was a significant difference in post-test means among MBDSTG, MBSSTG and CG in breath holding time of football players.

Table 6: Scheffe's post hoc test for the differences between thepaired adjusted post-test means of breath holding time

Metabolic Based Dynamic stretching Training Group	Metabolic Static stretching Training Group	Control Group	Mean difference	Confidence Interval
35.99	34.75		1.24*	0.99
35.99		29.60	6.39*	
	34.75	29.60	5.15*	

* Significant at 0.05 level

Table 4.24 revealed that the mean differences between the paired adjusted post test means of all groups.

The mean difference between MBDSTG and MBSSTG, MBDSTG and CG, MBSSTG and CG, were 1.24, 6.39 and 5.15 respectively. The values of mean difference of adjusted post-test means were higher than the required confidence interval value of 0.99 and it was found to be significant at 0.05 level of confidence.

From these results, it was inferred that twelve weeks of MBDSTG produced significant improvement in breath holding time of school level football players than MBSSTG and control group.

Mean values of pre, post and adjusted post test of DSTG, SSTG and CG on breath holding time are presented in Figure 2.

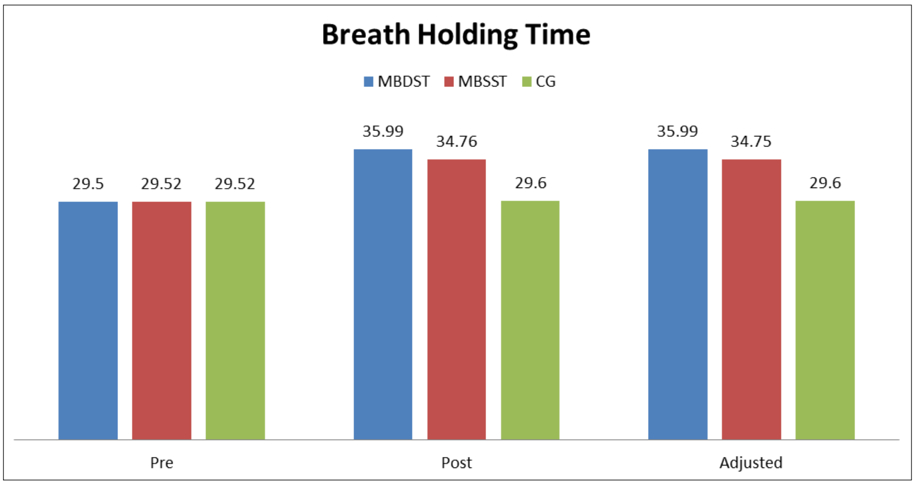

Fig 2: Bar diagram showing pre, post and adjusted post test means of tabata training group and control group on dribbling (Scores in Seconds)

Discussion on Findings

Football is a fast, dynamic, and physically demanding sport that requires a high level of physical fitness, physiological efficiency, coordinative abilities, and technical skill performance. (Worthington, 1980). Elite and school-level football players must possess essential physical fitness qualities such as speed, agility, flexibility, leg explosive power, and cardiorespiratory endurance to meet the continuous and intermittent demands of the game.

Metabolic based sports specific training has emerged as an effective scientific training approach designed to improve the metabolic efficiency, physical fitness, physiological functioning, coordinative abilities, and skill performance of football players. This type of training enhances the ability of players to perform repeated high-intensity efforts while maintaining technical efficiency. The inclusion of different stretching methods further supports muscular flexibility, reduces injury risk, improves movement efficiency, and enhances overall performance readiness. Stretching interventions contribute to improved neuromuscular coordination, joint mobility, and recovery, which are essential for sustaining optimal performance during training and competition. (Raven *et al.*, 1976).

Physiological Variables

In the present study, maximal oxygen uptake (VO_2 max) and breath holding time were selected as physiological variables to examine the effect of metabolic based sports specific training combined with dynamic stretching and static stretching among school level football players.

The results of the study indicated that the metabolic based dynamic stretching group (MBDSG) showed significant improvement in VO_2 max and breath holding time by 3.60%, and 3.40% respectively, when compared between baseline and post-test. Similarly, the metabolic based static stretching group (MBSSG) also showed significant improvement in VO_2 max and breath holding time by 2.40% and 2.75% respectively, when compared between baseline and post-test.

On comparison between the groups, it was observed that the metabolic based dynamic stretching group showed greater improvement in VO_2 max (3.60% vs 2.40%) and breath holding time (3.40% vs 2.75%) than the metabolic based static stretching group. This indicates that metabolic based dynamic stretching is more effective in improving cardiovascular and respiratory efficiency due to its ability to enhance oxygen uptake, lung function, and physiological adaptation to exercise.

The metabolic based static stretching group also demonstrated significant improvement in all selected physiological variables; however, the percentage of improvement was comparatively lower than that of the metabolic based dynamic stretching group. These findings clearly indicate that metabolic based sports specific training combined with stretching methods significantly enhances physiological variables among school level football players.

The results confirm that metabolic based dynamic stretching is more effective than metabolic based static stretching in improving physiological variables such as VO_2 max, vital capacity, and breath holding time.

Metabolic based sports specific training combined with dynamic stretching significantly improves physiological variables such as VO_2 max, vital capacity, and breath holding time due to improved cardiovascular efficiency and oxygen utilization.

Dynamic stretching enhances blood circulation, increases oxygen delivery to working muscles, and improves aerobic efficiency.

Helgerud *et al.* (2001) [7] reported that sports specific aerobic training significantly improves VO_2 max and cardiovascular performance in football players. McMillian *et al.* (2006) found that dynamic warm-up protocols improved physiological readiness and oxygen utilization more effectively than static stretching. Additionally, Bishop (2003) reported that dynamic warm-up enhances cardiovascular function and improves exercise performance by increasing oxygen uptake kinetics. Kodeeswaran, N. (2025) [5] Physiological changes on the vital capacity and breath holding time due to the effect of metabolic based specific skill training. These physiological adaptations improve respiratory efficiency, lung function, and endurance capacity, which are essential for football performance.

Conclusion

1. Within the limitations and on the basis of the findings, it was very clear that 12 weeks of metabolic based sports specific training with dynamic stretching (MBDST) produces significant changes in the physiological variables among school level football players.
2. It was very clear that 12 weeks of metabolic based sports specific training with static stretching (MBSST) produces significant changes in the physiological variables, among school level football players.
3. The findings of this research clearly demonstrate that 12 weeks of metabolic-based sport-specific training with dynamic stretching produces the most comprehensive and significant improvements in the physiological of school-level football players. Therefore, this training approach can be confidently recommended for coaches, physical educators, and trainers seeking to optimize performance in school level football players.
4. It is concluded that the metabolic based dynamic and static training need to be incorporated in the training protocol to enhance the overall performance of team sports.

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