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Tracking Physical Effort Before and After Effects of a Structured Training Program on Master's Students in Sports Training: Cardiorespiratory and Physical Indicators

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Abstract :
In order to assess the impact of a structured training program on these indicators as well as overall physical performance, this study monitored cardiorespiratory and physical indicators before and after physical exertion among Master's students specialising in Sports Training (Physical Culture). A one-group pre-test/post-test design was used in the experimental approach. Purposive sampling was used to choose 20 students—10 men and 10 females—for the research sample. Anthropometric measures, cardiac and respiratory indicator evaluations (heart rate, blood pressure, FVC, FEV1, and FEV1/FVC ratio), and standardised physical fitness tests (Bronco test, 30-m sprint, T-agility test, Sargent jump, 30-second push-up, flexibility, and balance) were used to gather data. For statistical analysis, the Wilcoxon Signed Ranks Test and the Paired Samples T-test were used. The success of the training program in enhancing cardiorespiratory efficiency and physical capacity was demonstrated by the results, which showed statistically significant changes between pre- and post-test measures favouring the post-test across all studied variables ($p < 0.05$). In order to maximise performance and encourage good response to physical effort, it is advised that university sports education implement scientifically planned training programs with frequent physiological indicator monitoring.
Keywords: Cardiorespiratory Indicators; Physical Capacities; Training Program; Sports Training; Master's Students; Physical Culture; Exercise Physiology

1. Introduction :

The assessment of physiological and physical reactions to exercise has become a crucial part of sports science in order to comprehend human performance and maximise training methods. Cardiorespiratory and physical markers are among the most pertinent aspects of athletic adaptation as they offer objective assessments of a person's functional ability, state of health, and preparedness for physical exertion. Researchers and practitioners can evaluate the efficacy of training programs and determine the degree of physiological adaptation brought about by systematic practice by keeping an eye on these factors both before and after exercise (ACSM, 2021). It is commonly acknowledged that cardiorespiratory fitness plays a significant role in determining both long-term health and sports performance. Research has shown that increases in cardiorespiratory fitness are closely linked to improved overall health outcomes, decreased cardiovascular risk, and improved physical performance (McArdle et al., 2015). Additionally, it has been demonstrated that organised exercise programs greatly enhance physiological parameters as blood pressure, heart rate, and oxygen consumption (World Health Organization, 2020). Athletic skill is mostly determined by physical markers including strength, speed, agility, flexibility, balance, and endurance. Targeted and well-structured training programs may greatly improve these physical capacities while also enhancing overall functional performance, as research has repeatedly shown (Bompa & Buzzichelli, 2019). Monitoring these variables is much more crucial for students who specialise in physical culture and sports training. This cohort is perfect for researching the effects of organised training programs because they integrate academic knowledge with real-world physical activity. Studies concentrating on university-level athletes are still needed, despite the acknowledged significance of tracking athletic performance. Thus, the goal of the current study was to examine and track cardiorespiratory and physical markers prior to and during a structured training program for Master's students in Sports Training with a focus on Physical Culture.

2. Problem Statement and Research Questions :

A particular demographic that combines theoretical understanding with real-world application is represented by master's students in sports training. There aren't many empirical studies that particularly look at their physical and cardiorespiratory reactions to organised training regimens, despite their expertise in exercise science. It becomes challenging to effectively assess the efficacy of training loads and comprehend how the body adjusts to recurrent physical stress over time without careful and methodical monitoring of these signs before and after exercise.
This background led to the formulation of the following main research question: What effect will a suggested training program have on improving the physical and physiological markers of Master's students in physical culture-focused sports training?

Three sub-questions were addressed:

1- Are there statistically significant differences between pre- and post-test measurements in cardiovascular indicators (heart rate and blood pressure)?

2- Are there statistically significant differences in respiratory indicators (respiratory rate and maximum vital capacity)?

3- Are there statistically significant differences in physical qualities (speed, strength, agility, flexibility, balance, and endurance)?

3. Research Hypotheses :

H1: There are statistically significant differences between pre- and post-measurements in favor of the post-test regarding the improvement of cardiac indicators (reduction in heart rate and blood pressure).

H2: There are statistically significant differences between pre- and post-measurements in favor of the post-test regarding the improvement of respiratory functions.

H3: There are statistically significant differences between pre- and post-tests in favor of the post-test, regarding the development of physical qualities (speed, strength, agility, balance, flexibility, and endurance).

4. Methodology :

4.1 Research Design :

The experimental method was adopted as the most appropriate approach for the nature of this research. A one-group pre-test/post-test design was used. The main study lasted approximately 20 weeks, from October 2025 to April 2026, with all tests and measurements conducted at the University of Science and Technology Mohamed Boudiaf stadium.

4.2 Participants :

A purposive sample of 20 Master's students specializing in Sports Training (Physical Education) was selected from the research population, comprising 10 males and 10 females. The mean age was 22.30 ± 0.98 years, mean height 1.72 ± 0.09 m, and mean body weight 68.40 ± 7.28 kg (BMI = 23.05 ± 1.51 kg/m²). All participants attended and participated regularly in training sessions throughout the study period.

4.3 Instruments and Measurements :

The following instruments were used:

• Spirometer (Sibel Group) for respiratory function assessment.
• Electronic blood pressure monitor (Rossmax) for cardiac indicator measurement.
• Stopwatch, measuring ruler, and electronic medical scale for anthropometric data.

Cardiorespiratory measurements included: Resting Heart Rate (HR rest, bpm), Resting Respiratory Rate (RR rest, c/min), Systolic and Diastolic Blood Pressure (mmHg), Forced Vital Capacity (FVC, L), Forced Expiratory Volume in the first second (FEV1, L), and the FEV1/FVC ratio (%).

Physical fitness tests included: the Bronco Test (aerobic endurance), 30-meter Sprint Test (speed), T-Test Agility (agility), Sargent Jump Test (explosive leg power), 30-Second Push-Up Test (upper-body muscular endurance), Sit-and-Reach Flexibility Test (spinal and hamstring flexibility), and a Single-Leg Balance Test (static and dynamic balance).

4.4 Pilot Study :

A pilot study was conducted from October 11–21, 2025, on a sample of five students selected from outside the main study sample. Test–retest reliability was assessed using the Pearson correlation coefficient at df = 3 and $\alpha = 0.05$ (tabulated r = 0.878). All calculated r values exceeded the tabulated value, confirming high reliability (r = 0.89–0.99) and validity (r = 0.93–0.99) across all measurements. Results are presented in Tables 1–3.

Table 1. Reliability and Validity of Anthropometric Measurements (Pilot Study, n = 5)

Measurement	Pre-test M	Pre-test SD	Post-test M	Post-test SD	Reliability	Validity
Height (cm)	175.20	8.50	175.20	8.50	0.99	0.99
Weight (kg)	69.80	6.20	69.10	6.00	0.98	0.99
BMI (kg/m²)	22.70	1.80	22.40	1.70	0.97	0.98

Table 2. Reliability and Validity of Physical and Physiological Measurements (Pilot Study, n = 5)

Measurement	Pre-test M	Pre-test SD	Post-test M	Post-test SD	Reliability	Validity

Bronco Test (min)	5.60	0.10	5.41	0.09	0.94	0.96
Agility (s)	11.20	0.60	10.60	0.55	0.92	0.95
Sargent Jump (cm)	30.00	3.50	34.80	3.20	0.94	0.97
30-m Sprint (s)	5.48	0.29	5.16	0.30	0.95	0.96
Push-ups (30 s)	20.00	3.00	23.80	3.12	0.91	0.95
Flexibility (cm)	10.50	2.00	11.54	1.92	0.90	0.95
Balance (s)	60.00	15.00	75.12	18.00	0.89	0.93

Table 3. Reliability and Validity of Cardiorespiratory Measurements (Pilot Study, n = 5)

Measurement	Pre-test M	Pre-test SD	Post-test M	Post-test SD	Reliability	Validity
HR Rest (bpm)	70.00	5.00	61.88	6.50	0.93	0.96
RR Rest (c/min)	15.00	1.50	12.80	1.10	0.91	0.95
Systolic (mmHg)	115.00	10.00	101.60	8.00	0.94	0.97
Diastolic (mmHg)	70.00	6.00	65.44	5.00	0.92	0.96
FVC (L)	5.48	0.90	6.04	0.96	0.94	0.97
FEV1 (L)	4.54	0.88	5.04	0.95	0.93	0.96
FEV1/FVC (%)	77.23	7.50	83.53	8.70	0.91	0.95

4.5 Statistical Analysis :

Data were analyzed using SPSS. Descriptive statistics (mean, standard deviation, skewness) were computed for all variables. Normality was assessed using the Shapiro–Wilk test (appropriate for $N < 50$). For normally distributed variables, the Paired Samples T-test was applied (tabulated $t = 2.093$, $df = 19$, $\alpha = 0.05$, two-tailed). For variables deviating from normality (Sargent Jump and Balance, $p < 0.05$), the Wilcoxon Signed Ranks Test was used. Effect size was calculated as $r = Z / \sqrt{N}$.

5. Results :

5.1 Pre-test Descriptive Statistics and Baseline Characteristics :

Table 4 presents the baseline descriptive statistics for all variables. The sample demonstrated high homogeneity in anthropometric variables (low SDs). Baseline physiological values were within normal ranges: HR rest = 68.65 ± 9.03 bpm, Systolic BP = 120.35 ± 12.03 mmHg, Diastolic BP = 67.85 ± 6.13 mmHg, FVC = 4.56 ± 1.25 L, and FEV1 = 3.87 ± 0.96 L. The Shapiro–Wilk test confirmed normal distribution for most variables ($p > 0.05$), with the exception of Age ($p = 0.017$), Sargent Jump (p = 0.004), and Balance (p = 0.010), justifying the use of parametric statistics for the principal dependent variables.

Table 4. Pre-test Descriptive Statistics for All Study Variables (N = 20)

Variable	N	Min	Max	Mean	SD	Variance	Skewness
Age (years)	20	21.00	24.00	22.30	0.98	0.96	0.07
Height (m)	20	1.55	1.88	1.72	0.09	0.01	0.14
Body Weight (kg)	20	55.00	83.00	68.40	7.28	52.99	-0.02
BMI (kg/m²)	20	20.68	26.67	23.05	1.51	2.28	0.51
HR Rest (bpm)	20	52.00	84.00	68.65	9.03	81.50	-0.14
RR Rest (c/min)	20	14.00	20.00	16.45	1.79	3.21	0.34
Systolic (mmHg)	20	99.00	145.00	120.35	12.03	144.66	0.23
Diastolic (mmHg)	20	57.00	83.00	67.85	6.13	37.61	0.72
FVC (L)	20	2.84	6.96	4.56	1.25	1.55	0.48
FEV1 (L)	20	2.49	5.86	3.87	0.96	0.92	0.67
FEV1/FVC (%)	20	68.30	99.40	85.30	8.94	79.84	-0.19
Sprint (s)	20	4.64	7.20	5.82	0.74	0.54	0.14
Push-ups (30 s)	20	6.00	25.00	15.80	6.29	39.54	0.04
Flexibility (cm)	20	8.50	21.00	13.50	3.95	15.62	0.49
Balance (s)	20	15.07	236.35	80.25	54.39	2958.59	1.51
Bronco (min)	20	5.07	7.36	6.19	0.73	0.54	-0.11
Agility (s)	20	10.33	13.40	11.84	1.02	1.03	-0.10
Sargent Jump (cm)	20	23.00	56.00	31.96	8.12	65.92	1.68

5.2 Paired Samples T-test Results (Pre-test vs. Post-test) :

Table 5 presents the results of the Paired Samples T-test comparing pre- and post-test measurements for all parametric variables (N = 20, df = 19, tabulated t = 2.093). All calculated t-values exceeded the tabulated value and all p-values were below the 0.05 threshold, confirming statistically significant differences across all measured parameters. Negative t-values for FVC, FEV1, Push-ups, and Flexibility indicate that post-test values were higher than pre-test values (i.e., improvement). * $p < 0.05$; ** $p < 0.01$.

Table 5. Results of the Paired Samples T-test (Pre-test vs. Post-test, N = 20)

Variable Pair	Mean Diff.	SD	95% CI Lower	95% CI Upper	t (df=19)	p-value

Body Weight (kg)	1.75	1.02	1.27	2.23	7.68	0.000**
BMI (kg/m²)	0.59	0.35	0.43	0.76	7.65	0.000**
Bronco Test (min)	0.52	0.41	0.33	0.71	5.74	0.000**
Agility (s)	0.69	0.45	0.48	0.90	6.87	0.000**
30-m Sprint (s)	0.24	0.49	0.02	0.47	2.23	0.038*
Push-ups (30 s)	-2.45	1.00	-2.92	-1.98	-10.97	0.000**
Flexibility (cm)	-1.23	0.61	-1.51	-0.94	-8.91	0.000**
HR Rest (bpm)	3.90	2.86	2.56	5.24	6.09	0.000**
RR Rest (c/min)	2.15	0.75	1.80	2.50	12.90	0.000**
Systolic BP (mmHg)	8.60	1.23	8.02	9.18	31.24	0.000**
Diastolic BP (mmHg)	4.45	0.76	4.09	4.81	26.22	0.000**
FVC (L)	-0.53	0.31	-0.68	-0.39	-7.74	0.000**
FEV1 (L)	-0.19	0.06	-0.22	-0.16	-14.95	0.000**
FEV1/FVC (%)	5.19	5.97	2.40	7.98	3.89	0.001**

5.3 Wilcoxon Signed Ranks Test Results :

For the two variables that violated normality assumptions — the Sargent Jump Test and the Balance Test — the Wilcoxon Signed Ranks Test was applied. Both variables showed highly significant improvements post-intervention (Table 6), with large effect sizes ($r \approx 0.88$ and $r \approx 0.87$, respectively), confirming the practical significance of the training program on explosive power and balance.

Table 6. Results of the Wilcoxon Signed Ranks Test (N = 20)

Variable	Z-value	Asymp. Sig. (2-tailed)	Effect Size (r)
Sargent Jump (Vertical Jump)	-3.935	0.000**	≈ 0.88 (Large)
Balance Test	-3.920	0.000**	≈ 0.87 (Large)

6. Discussion :

6.1 Cardiac Indicators (H1 Accepted) :

The first hypothesis was fully supported. Resting heart rate decreased significantly ($t = 6.09$, $p = 0.000$), and both systolic ($t = 31.24$, $p = 0.000$) and diastolic blood pressure ($t = 26.22$, $p = 0.000$) were significantly reduced following the training program. These findings are consistent with established physiological principles: systematic aerobic training induces cardiac remodeling characterized by increased stroke volume, enhanced autonomic regulation (increased vagal tone), and improved circulatory efficiency, collectively leading to lower resting heart rate and blood pressure

(Sayed, 2014; McArdle et al., 2015). These results align with the findings of Baghirova and Guliyeva (2025), who demonstrated favorable cardiorespiratory recovery patterns following physical load in trained athletes, and with Merabet et al. (2021), who highlighted differential cardiovascular indicator values between pre- and post-effort periods. The magnitude of the blood pressure reductions observed in the present study (Systolic: 8.60 mmHg; Diastolic: 4.45 mmHg) is clinically significant and suggests meaningful cardiovascular health benefits for this population.

6.2 Respiratory Functions (H2 Accepted) :

The second hypothesis was confirmed. Significant improvements were observed in FVC ($t = -7.74$, $p = 0.000$), FEV1 ($t = -14.95$, $p = 0.000$), and the FEV1/FVC ratio ($t = 3.89$, $p = 0.001$). The negative t-values indicate that post-test pulmonary function values were higher than pre-test values, reflecting genuine improvements in lung capacity and airway efficiency. These adaptations are attributable to strengthened respiratory muscles, increased pulmonary ventilation efficiency, and enhanced gas exchange capacity induced by systematic exercise training (NASER, 2008; Flandrois & Mondo, 2003). The present findings are consistent with Shareef and Danoon (2025), who reported significant improvements in VO2max and cardiovascular efficiency in football players following HIIT, and with Bekhtaoui et al. (2022), who demonstrated that structured sports programs substantially improved cardiorespiratory fitness in school-aged girls. The improvement in the FEV1/FVC ratio is particularly noteworthy, as it reflects better airway patency and is an important indicator of respiratory health (Hall, 2016).

6.3 Physical Qualities (H3 Accepted) :

The third hypothesis was supported across all physical fitness components. In the parametric analysis: agility improved significantly ($t = 6.87$, $p = 0.000$), 30-m sprint time decreased ($t = 2.23$, $p = 0.038$), muscular endurance (push-ups) increased markedly ($t = -10.97$, $p = 0.000$), flexibility improved ($t = -8.91$, $p = 0.000$), and aerobic endurance (Bronco test) showed significant gains ($t = 5.74$, $p = 0.000$). The non-parametric Wilcoxon analysis confirmed significant improvements in explosive power (Sargent Jump, $Z = -3.935$, $p = 0.000$, $r \approx 0.88$) and balance ($Z = -3.920$, $p = 0.000$, $r \approx 0.87$), both with large effect sizes.

These improvements reflect the multifaceted effectiveness of the training protocol in developing diverse physical capacities simultaneously. Enhanced sprint and agility performance indicates improved neuromuscular coordination and movement efficiency. Increased push-up scores reflect adaptations in muscular endurance and upper-body strength. Improved flexibility reflects enhanced joint mobility, while superior balance performance indicates refined postural control. These findings are consistent with the conclusions of Düking et al. (2021), who reported that training monitoring based on physiological parameters leads to more favorable responses, and with Yu et al. (2024), who confirmed the importance of exercise type and internal load monitoring in optimizing cardiorespiratory and perceptual adaptations in sedentary youth.

7. Conclusion :

The findings of this study provide robust statistical evidence that a 20-week structured training program led to statistically significant and practically meaningful improvements in cardiorespiratory efficiency (reduced resting heart rate, blood pressure; improved FVC, FEV1, FEV1/FVC ratio) and across all measured physical qualities (speed, agility, muscular endurance, flexibility, balance, and aerobic endurance) among Master's students in Sports Training. All three research hypotheses were accepted. The consistency of results across both parametric and non-parametric tests strengthens the validity of these conclusions.

These findings contribute to the growing evidence base supporting the integration of scientifically structured training programs and continuous physiological assessment in university sports education. Systematic monitoring of physiological indicators is essential not only for evaluating training effectiveness but also for guiding evidence-based adjustments in training design and preventing overtraining.

7.1 Study Limitations :

The following limitations should be acknowledged: (1) the relatively small sample size (N = 20) may limit the statistical power and generalizability of the findings; (2) the single-group design without a control group precludes full causal inference regarding the training program's exclusive effect; (3) the 20-week duration may not fully capture long-term physiological adaptations; and (4) the study did not control for dietary habits, sleep quality, or external physical activities outside the program.

7.2 Recommendations and Future Research :

Based on the results, the following recommendations are made: integrate regular monitoring of cardiorespiratory and physical indicators into university sports programs; design training interventions based on scientific evidence and individualized physiological responses; and adopt long-term training plans addressing both functional health and athletic performance.

Future research should: (1) employ randomized controlled designs with larger and more diverse samples; (2) conduct gender-comparative analyses to identify differential responses; (3) investigate the long-term sustainability of adaptations; (4) examine the role of psychological factors and recovery strategies on training outcomes; and (5) explore the efficacy of individualized versus standardized group-based training programs.

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