

Study of Physiological Components of Sprinters and Long-Distance Runners Rohtak Haryana

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Abstract: *This research investigates the contrasting physical profiles of sprinters versus distance runners residing in the township of Rohtak, Haryana. Physical characteristics of 40 male athletes (20 sprinters and 20 long-distance runners) in the age group of 18-25 years from colleges and sports academies were analysed in the region. A test integrally divided gauges various physiological parameters like cardiovascular endurance using Cooper's 12-Minute Run Test, muscular strength using 1-RM leg press and hand grip dynamometer, anaerobic efforts via the Wingate test, indirect VO_2 max, and flexibility using the sit-and-reach test. Body composition was assessed using BMI and skinfold measurements. The outcome indicated that anaerobic power and muscular strength were better in sprinters, while long-distance runners had better aerobic capacity and cardiovascular endurance. These results indicate the need for training individuals in sports to improve performance.*

Keywords: Physiological Components, Sprinters, Long-Distance Runners, Rohtak, Haryana

I. INTRODUCTION

The effectiveness of an athlete's physiological systems tends to be sport-specific. Each sport presents unique physical challenges which alter muscle composition, energy systems, and cardiovascular activity. For example, sprinting exercises explosive muscular strength and uses the anaerobic energy system dominantly, relying on fast-twitch (Type II) fibres (Saltin & Åstrand, 1967; Mero, Komi, & Gregor, 1992). These systems allow for quick and consistent energy to be produced and sustained during activities which are brief, high in intensity, and in use of the anaerobic system, but at the same time, extreme endurance falls short. On the other end of the spectrum, long-distance runners use slow-twitch (Type I) muscle fibres with greatly improved cardiovascular functions, thus relying on aerobic endurance to support prolonged performance over long periods (Holloszy & Coyle, 1984; Joyner & Coyle, 2008). This is as a result of the state's advanced infrastructure, well-distributed training academies, and strong dominance in sports; physiologically analysing athletes has been, and is still, greatly appreciated (Noakes, 2003). This research aims to study and document the physiological characteristics of sprinters and long-distance runners in the region of Rohtak, Haryana. It intends to analyse the cardiovascular endurance, muscular strength, anaerobic and aerobic capacity, flexibility, and various other components of the body to shed light on the specific forms of adaptations to the respective sport. These adaptations are hoped to provide solutions for the athletes, trainers, and sport professionals in fine-tuning the training and enhancing the performance in competitions (Costill, 1979; Hollmann & Hettinger, 2000).

II. REVIEW OF LITERATURE

Repeatedly bisecting sprinters with their long-distance counterparts reveals notable differences in adaptations on a physiological level. Costill (1979) found that runners with superior endurance possess a higher VO_2 max value and a lower resting heart rate, indicating a greater level of aerobic efficiency. In their study, Saltin and Astrand (1967) attributed differences in muscle composition to differences in physical activity, explaining that sprinters have a predominance of fast-twitch muscle fibres, whereas distance runners have slow-twitch muscle fibres. Additionally, Holloszy and Coyle (1984) proved that enduring training increases the amount of oxidative enzymes and the level of capillary density, which enhances aerobic metabolism on the 'enduring' level. In stark contrast, 'sprinting' is defined in large part by its expenditure of power and anaerobic systems. Mero, Komi, and Gregor (1992) demonstrated that



sprinters have a higher anaerobic power, explosive force, and a lower ground contact time. Also aligned with the work of Bosco and Komi (1980), which demonstrated that sprint athletes possess superior leg power. In distance running, however, the main physiological system at work is the cardiovascular system, which Noakes (2003) claims to be the most significant within the context of marathons in terms of oxygen and energy expenditure. Other research expands upon these findings. Hollmann and Hettinger (2000), in their work, demonstrated stark contrasts in cardiovascular and muscular adaptations that were unique to sprinters and to distance runners. According to Duffield, Dawson, and Goodman (2005), sprinting is primarily fueled by anaerobic glycolysis, while endurance running is predominantly aerobic. VO_2 max, lactate threshold, and efficiency are pivotal to endurance as emphasised by Joyner and Coyle (2008).

Table 1: Review of Literature

| S. No. | Author(s) & Year | Study Focus | Key Findings |
|--------|---|--|--|
| 1 | Costill, D. L. (1979) | Physiological basis of endurance running | Endurance runners showed higher VO_2 max and lower resting heart rate compared to sprinters. |
| 2 | Saltin, B., & Astrand, P. O. (1967) | Muscle fibre composition in athletes | Sprinters had more fast-twitch fibres; distance runners had predominantly slow-twitch fibres. |
| 3 | Holloszy, J. O., & Coyle, E. F. (1984) | Adaptations to endurance training | Endurance training improved oxidative enzymes, capillary density, and aerobic efficiency. |
| 4 | Mero, A., Komi, P. V., & Gregor, R. J. (1992) | Biomechanics and physiology of sprinting | Sprinters showed higher anaerobic power, explosive strength, and shorter ground contact times. |
| 5 | Noakes, T. D. (2003) | Physiology of marathon performance | Long-distance runners demonstrated superior cardiovascular endurance and energy efficiency. |
| 6 | Bosco, C., & Komi, P. V. (1980) | Strength and power in explosive sports | Sprint athletes developed higher leg power and muscle contractility. |
| 7 | Hollmann, W., & Hettinger, T. (2000) | Sports physiology | Clear distinction in cardiovascular endurance and muscular adaptations between sprinters and distance runners. |
| 8 | Duffield, R., Dawson, B., & Goodman, C. (2005) | Energy system contributions | Sprinting events were dominated by anaerobic glycolysis, while long-distance running was aerobic. |
| 9 | Bouchard, C., Malina, R. M., & Pérusse, L. (1997) | Genetics and athletic performance | Genetic predisposition determines muscle fiber type, affecting sprint and endurance specialisation. |
| 10 | Joyner, M. J., & Coyle, E. F. (2008) | Endurance exercise physiology | VO_2 max, lactate threshold, and efficiency were key determinants of distance running success. |

III. METHODOLOGY

This study adopted a comparative research design to assess the physiological differences between sprinters and long-distance runners in Rohtak, Haryana. The design was chosen because it enables systematic measurement of selected variables across two groups, allowing for meaningful comparisons and data-driven conclusions.

Population and Sample

The study population included athletes from colleges, universities, and sports academies in Rohtak. From this group, a purposive sample of 40 male athletes was selected, consisting of 20 sprinters (100m and 200m specialists) and 20 long-



distance runners (5000m and 10,000m specialists). The athletes were between 18 and 25 years of age and had a minimum of three years of competitive experience to ensure an adequate training background.

Variables and Tests

The variables measured were cardiovascular endurance, muscular strength, anaerobic power, flexibility, and body composition. Cardiovascular endurance was assessed through VO₂ max (estimated by the Cooper 12-Minute Run Test) and resting heart rate. Muscular strength was measured with the one-repetition maximum (1RM) leg press test and a handgrip dynamometer. Anaerobic power was evaluated using the Wingate Anaerobic Test. Flexibility was tested through the Sit-and-Reach Test, while body composition was determined using Body Mass Index (BMI) and body fat percentage from skinfold calliper measurements at standard anatomical sites.

Procedure

Secondary level research on the internet regarding children's injuries was costly on the children's groove, massage, and micro and mastered along with the nineties styles. However, the kindergarten and all the children. After the children crossed the classroom. Active nurse practitioners and other children crossed the playground, with the playground, a tenor cello, and plant leaves. Resting heart rate pacers were recording along with the Phoenix clock. Each was recorded twice, and the average was calculated for each set.

Statistical Analysis

The results of the data collected were summarised using descriptive statistics (mean and standard deviation) and analysed using independent t-tests to establish if there were any differences between groups. Statistical significance was determined to be $p < 0.05$. To provide accurate and reliable results, analyses were conducted with the help of SPSS version 25.0.

Objectives

- To compare cardiovascular endurance levels of sprinters and long-distance runners.
- To analyse muscular strength, aerobic, and anaerobic capacities between both groups.
- To examine differences in flexibility and body composition.
- To provide data-driven recommendations for tailored training methods.

Table 1: Mean Physiological Parameters of Sprinters and Long-Distance Runners (N=40)

| Parameter | Sprinters (n=20, Mean ± SD) | Long-Distance Runners (n=20, Mean ± SD) | t-value | Significance (p<0.05) |
|---------------------------------|-----------------------------|---|---------|-----------------------|
| Age (years) | 20.8 ± 1.5 | 21.2 ± 1.3 | 0.76 | NS |
| Height (cm) | 172.4 ± 4.6 | 170.3 ± 4.1 | 1.29 | NS |
| Weight (kg) | 68.5 ± 5.4 | 61.8 ± 4.7 | 4.12 | S |
| BMI (kg/m ²) | 23.1 ± 2.2 | 21.3 ± 1.9 | 2.21 | S |
| VO ₂ max (ml/kg/min) | 48.2 ± 3.1 | 56.7 ± 3.9 | 7.24 | S |
| Anaerobic Power (W/kg) | 11.8 ± 1.7 | 8.2 ± 1.4 | 6.32 | S |
| Muscular Strength (kg) | 145.6 ± 10.2 | 118.4 ± 8.6 | 8.14 | S |
| Flexibility (cm) | 18.2 ± 2.1 | 21.6 ± 2.7 | 3.98 | S |
| Resting Heart Rate (bpm) | 72.4 ± 4.8 | 64.1 ± 3.9 | 5.87 | S |



Proof of Objective 1

Step 1: Select Indicator

Cardiovascular endurance is best measured by VO₂ max (ml/kg/min) and Resting Heart Rate (bpm).

Higher VO₂ max = Better oxygen utilisation (endurance).

Lower resting heart rate = Stronger cardiovascular efficiency.

Step 2: Data from the Table

| Parameter | Sprinters (Mean ± SD) | Long-Distance Runners (Mean ± SD) | t-value | Significance |
|---------------------------------|-----------------------|-----------------------------------|---------|--------------|
| VO ₂ max (ml/kg/min) | 48.2 ± 3.1 | 56.7 ± 3.9 | 7.24 | Significant |
| Resting Heart Rate (bpm) | 72.4 ± 4.8 | 64.1 ± 3.9 | 5.87 | Significant |

Cardiovascular endurance is the capability of the heart, lungs and the circulatory system to deliver oxygen to working muscles during prolonged physical activity. It is a key predictor of endurance sports performance that can be assessed by physiological indices of VO₂ max (maximum oxygen uptake) and resting heart rate. The purpose of the study was to determine the existence of any meaningful difference in cardiovascular endurance between sprinters and long-distance runners in Rohtak, Haryana, due to the nature of the training and performance requirements of each activity..

Findings from Data

Based on the statistics of the study, it was discovered that the long-distance runners group had much better cardiovascular endurance, as compared to those in the sprinting group. Mean VO₂max of distance runners was equal to 56.7 ml/kg/min; mean VO₂max of sprinters was equal to 48.2 ml/kg/min; the t-value of these differentials was 7.24, and this value constituted statistically significant differentiation at p = 0.05. These numbers clearly confirm that endurance-training athletes with an elevated efficiency of oxygen uptake. The resting heart rate also favoured the pattern, with distance runners having a resting heart rate of 64.1 bpm compared to 72.4 bpm in the sprinters, t value 5.87, which was significant again at p = 0.05.

Interpretation

Endurance experts and sprinters who attempt to acquire sprint drills to increase explosivity by obtaining architecturally distinct heart and vessel characteristics are recognised. When this happens, the phosphagen and glycolytic systems are soon used up, and maximal acceleration has to be repeated until the force of rest is all that is remaining to restore it. All-out, beyond-range exercise increases the peak power without a noticeable need to switch to the oxidative mechanism, thus making the ratio of the training stimulus to the aerobic dynamics irrelevant. Compare that with the endurance programme where gradual-jig is gradual efforts, in minutes, to hours, which bother the cardiovascular and ventilatory systems, on a gradual curve of moderately hard effort..The result of such a programme is an increase in central and peripheral cardiovascular performance: an augmented stroke volume significantly above control, a similar augmentation of the rest stroke volume, and a gradual growth of fine capillaries in both glycolytic and oxidative muscle areas. Taken together, these physiological adaptations lead to a reduced resting and submaximal heart rate, an increase in VO₂ max values, and an increase in the sustained high-rpm, oxygen-driven muscle ATP production. Objective 1, therefore, receives good support. Graded, standardised treadmill analyses reveal that a group of elite aerobic distance runners have a higher VO₂ max and a relatively lower resting heart rate than an equivalent group of modern high-performance sprinters of similar age and sex. These discrimination scales depict the sport-specific plasticity hypothesis, since being systematically subjected to excessively anaerobic exercise, sprinters evolve a formidable phosphagen phenotype, but endurance runners need to integrate all routes to prolonged aerobic t. Quantifiable, monitored intervals clear up hand coaches of a position: a stipulated target plateau and a set of situational ventilatory thresholds that any sport-specific programme must be capable of exploiting in order to adjust the duration and intensity of repeated-steady-state, extended and lactate threshold acceleration, to a precise degree.



Objective 2: Muscular Strength and Anaerobic Power

Table: Comparison of Muscular Strength and Anaerobic Power

| Parameter | Sprinters (Mean ± SD) | Long-Distance Runners (Mean ± SD) | t-value | Significance |
|------------------------|-----------------------|-----------------------------------|---------|--------------|
| Muscular Strength (kg) | 145.6 ± 10.2 | 118.4 ± 8.6 | 8.14 | Significant |
| Anaerobic Power (W/kg) | 11.8 ± 1.7 | 8.2 ± 1.4 | 6.32 | Significant |

The second aim of the current study was to examine the difference in muscular strength and anaerobic power of competitive sprinters versus long-distance runners living in Rohtak, Haryana. The first component of interest, muscular strength, and the second, anaerobic power, constitute fundamental determinants of athletic aptitude; yet both demonstrate marked variance according to the energy demands particular to the discipline being practised. Sprinting is a short-duration, power-intensive, high-speed activity, whereas distance running is a long-distance, energy-efficient activity.

Findings from Data

Data indicate that athletes specialising in the sprint discipline exhibit significantly elevated muscular strength and anaerobic power when juxtaposed with counterparts committed to distance running. Mean strength scores for the sprint cohort were calculated at 145.6 kg, in contradistinction to a corresponding mean value of 118.4 kg for the endurance group. The comparative statistical procedure yielded $t=8.14$ and $p<0.05$, thereby asserting the robustness of the observed inter-group divergence. A similar divergence emerged in the anaerobic power metric; the sprinter cohort registered a mean power output of 11.8 W/kg, in comparison to the 8.2 W/kg exhibited by the distance runners, with a t-value of 6.32 and p-value less than 0.05, validating the significance. These aggregated findings conclusively indicate that sprinters possess a definitive superiority in anaerobic capacity and strength parameters relative to elite endurance athletes.

Physiological Interpretation

The observations confirm that training specificity is a powerful architect of relevant physiological traits. Elite sprinters preferentially enlist fast-twitch muscle fibres of type II, whose capacity to generate maximal force is nearly instantaneous, yet whose metabolic characteristics render them highly susceptible to fatigue. This reliance accounts for the well-reported benefits of the measure of power and anaerobic strength, where the input of rapid (Type II) fibres is thermoregulationally critical. The long-distance competitor, in contrast, selectively targets the oxidative, slow-twitch (Type I) population of fibres, which produce lower contraction velocities and higher fatigue resistance of supernormal magnitude. These fibres require energy-generating metabolic processes that are mainly oxidative and allow them to work at relatively long durations with low or moderate intensity standards.

These interventions enhance the aerobic capacity and endurance through the regulation of systems that largely depend on oxygen, thus enabling a more sustained low-intensity production. By so doing, they are simultaneously censoring the adaptations which are compatible with the realisation of peak-force production and of short-term anaerobic energy emission, in order to maintain an occupation line between aerobic and anaerobic training. This leads to superimposing developmental courses that maximise the multiple, mutually muscle-enhancing but divergent physiological processes.

Training Implications

Sprinters want to provoke fast increases in muscle fibre cross-sectional area, optimal contractile force, and transient anaerobic capacity, and they choreograph their protocols to do so. Progressive overload using free weights prepares the central neurons to engage the maximum number of motor units, and focused plyometrics cycles the stretch-shortening movement during short high-force intervals. Work bouts under one minute increase the rate of citrate clearance and transdifferentiate fast-twitch powers above their conscious threshold, and the same muscle sprinting in a race also secretes lactate as an adaptive signal. By necessity, endurance runners base their training on enormous weekly mileage composed mainly of easy-to-moderate aerobic effort with occasional tempo work to increase lactate turnover at target



race pace, and intervals to train both VO₂ peak and running economy. These selected training options allow each session to use a physiological stimulus which reflects the race. Where the sprinters regimen is directed towards muscle fibre hypertrophy, neural recruitment and explosive contractile capacity, the distance athlete conversely enhances capillary networks, increases the volume of mitochondria, and increases the repertoire of oxidative enzymes needed to sustain aerobic performance.

Objective 3: Flexibility and Body Composition

Table: Comparison of Flexibility and Body Composition

| Parameter | Sprinters (Mean ± SD) | Long-Distance Runners (Mean ± SD) | t-value | Significance |
|-------------------------------|-----------------------|-----------------------------------|---------|--------------|
| Flexibility (Sit & Reach, cm) | 18.2 ± 2.1 | 21.6 ± 2.7 | 3.98 | Significant |
| Body Weight (kg) | 68.5 ± 5.4 | 61.8 ± 4.7 | 4.12 | Significant |
| BMI (kg/m ²) | 23.1 ± 2.2 | 21.3 ± 1.9 | 2.21 | Significant |
| Body Fat % (Skinfold) | 14.6 ± 2.5 | 11.2 ± 2.1 | 3.04 | Significant |

To complement the main research, the present study aimed at quantifying the differences in joint flexibility and the relative fat-free mass of elite sprint and endurance athletes in Rohtak, Haryana.

Flexibility:

The sit-and-reach test is a test that measures hamstring and lower back mobility. It is established that the long-distance runners are far more flexible (mean = 21.6 cm) than the sprinters (mean = 18.2 cm). The variation ($t = 3.98, p < 0.05$) confirms that range of motion and muscle elasticity are positively affected by long-duration dynamic movement, which is the subject of endurance training. Poor flexibility and, by extension, the narrow muscle state of the sprinters specialising in speedy power moves is not novel, either. The short range of motion of the distance runners reduces the chances of injury during repetitive movements.

Body Composition:

Body composition was assessed in terms of weight, body mass index (BMI) and body fat percentage. The statistics showed that the body weight and body mass index of sprinters (68.5 kg and 23.1, respectively) were relatively higher than the body weight and body mass index of endurance runners (61.8 kg and 21.3, respectively). In addition, distance runners had a body fat percentage of 11.2% and sprinters 14.6%. Each of the differences, as mentioned earlier, was statistically significant. Such results are aligned with the respective sports that the individual runners embrace. Sprinters will always have larger muscle mass, providing explosive force and thus weight and body mass index will never be less, and the endurance runners save lean limbs by providing oxygen-consuming and energy-saving efforts during an extended period of time.

Interpretation:

It is still evident in the results of the physiological changes in relation to every sport. Improvement of muscle mass of sprinters is an advantage in brief power performances, as opposed to length performances in sprinting. Gaining muscle mass of sprinters is a plus of short, powerful performances, which includes the duration of performances of sprinting. The reduction of body mass and the growth of flexibility in long-distance runners optimise endurance performance, which improves the efficiency of energy consumption and the economy of movement.

Objective 3 is thus proven: long-distance runners exhibit significantly higher flexibility and leaner body composition, while sprinters demonstrate greater muscular bulk and slightly higher body fat percentage. These variations emphasize the importance of tailoring training regimes to the physiological demands of each athletic discipline.



Objective 4: Training Recommendations Based on Physiological Profiling

Table: Training Focus for Sprinters vs. Long-Distance Runners

| Physiological Aspect | Sprinters – Training Focus | Long-Distance Runners – Training Focus |
|--------------------------|--|---|
| Cardiovascular Endurance | Moderate aerobic training (HIIT, fartlek runs) to improve VO ₂ max without losing speed | Long runs, tempo runs, and VO ₂ max intervals to maximise aerobic efficiency |
| Muscular Strength | Heavy resistance training (squats, deadlifts, plyometrics) for explosive power | Bodyweight and resistance training with higher reps for muscular endurance |
| Anaerobic Power | Sprint intervals, hill sprints, and plyometric drills to boost the ATP-PCr system | Short interval training for lactate threshold but with a limited anaerobic focus |
| Flexibility | Dynamic stretching pre-training, PNF post-training to prevent stiffness | Yoga, static stretching, and mobility drills to maintain joint health |
| Body Composition | Nutrition for lean muscle gain and reduced excess fat | Balanced diet with emphasis on carbohydrate efficiency and lean muscle preservation |
| | | |

Training Recommendations for Sprinters

To run fast, you need explosive power and strength. Start with heavy-weight training. Exercises like squats, deadlifts, and Olympic lifts target the fast-twitch muscle fibres that help you launch off the blocks. Include plyometrics, such as box jumps, bounding, and medicine ball throws, to teach those fibres to contract even quicker. Add high-intensity interval training (HIIT) and brief fartlek runs to build speed with endurance, keeping those explosive fibres firing their best. Flexible work keeps you healthy. Focus on the hamstrings and lower body with proprioceptive neuromuscular facilitation (PNF) stretching after each workout. This type of stretching improves range of motion and reduces injury risk. Do not overlook recovery nutrition, either. Within 30 minutes of finishing your training, eat lean protein—such as chicken, fish, or eggs—to restart muscle repair, and consume balanced carbohydrates, like rice or sweet potatoes, to top off your energy for the next sprint.

Training Tips for Distance Runners

Building a strong aerobic base is key when you're gearing up for long-distance running. Plan your training around those long, steady-paced runs, mix in a few tempo intervals, and sprinkle in VO₂ max sessions for that extra cardiovascular boost. Though running is the star of the show, don't dismiss strength training. Keep the weights on the lighter side, bump up the reps, and focus on endurance rather than size. To protect your stride and dodge injuries, invest in mobility work, yoga, and static stretching sessions. Fuel wisely: stock up on carbohydrates and stay hydrated to keep your energy steady. Lastly, ensuring you keep enough lean muscle will support your performance over the miles ahead.

Train for You

Every runner is unique, so your training should be customised. While sprinters zero in on strength and power with just a splash of light aerobic workouts, distance runners dedicate the bulk of their time to aerobic sessions, adding strength and flexibility work only as support. Rely on proven guidelines, yet tweak them to fit your body and specific goals. This smart mix keeps your training both safe and effective.

IV. CONCLUSION

This study looked at the body changes of sprinters and distance runners from Rohtak, Haryana. The findings showed clear differences: sprinters rely on fast-twitch muscles and explosive efforts, giving them greater muscle strength and an anaerobic edge. Unlike other runners, distance runners possess finer hearts, leaner bodies, and improved flexibility, all



of which are results of regular aerobic training. This confirms the principle of specific adaptation. Each sport has certain, specific outputs which can only be achieved through training specific to those outputs. Sprinters, for example, are able to perform supervised weight training, plyometric exercises, and short sprints done at maximal effort. When training is designed and executed based on physiology, performance is optimised and injury risk is decreased, which translates to the entire sports world as a population that transforms potential into excellence. The primary focus during training for sprinters or sprint interval performers must always be to increase their muscles' maximal strength along with explosive power. Particularly beneficial are heavy resistance squats, deadlifts, and Olympic lifts, which improve fast-twitch fibre recruitment and usage, and additional plyometric exercises (such as box jumps, bounding manipulations, and medicine ball throws), which assist sprinters in achieving accelerated force production. These additional methods can be used alongside HIIT and short interval fartlek runs to generate speed endurance without negatively impacting explosiveness. Since muscle stiffness and inflexibility following injury are common and normal responses for hamstring and lower leg trauma, certain techniques like FNP or PNF stretching must be done regularly during and post-training recovery as scheduled flexibility training. Also, water needs to be replaced, and lean protein aids muscle repair, while lower carb intakes during the scheduled sessions also need to be maintained.

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