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Relationship analysis and effects of different factors of running on maximum speed

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Abstract
Maximum Speed is mainly depends on stride frequency, stride length, lower limb length, arm length, leg length, build of the body, leg explosive strength etc. The main aim of the present study was to find out the effects of the stride frequency, stride length and the leg explosive strength on maximum speed. Fifteen college girls of 19 to 25 years of age were considered as the subjects. The stride frequency, stride length, explosive length and the maximum speed performance were measured through standard process. It was observed from the study that the stride length was highly negatively and significantly correlated with maximum speed and the stride frequency was highly positively significantly correlated with the maximum speed but the relation between maximum speed and the explosive strength was very moderate. It were concluded from the study that the sprinting speed was significantly and positively influenced by the stride frequency. The maximum speed depends inversely upon the stride length and the influence of the explosive strength on speed was very moderate.

Keywords: speed, stride frequency, stride length, explosive strength

Introductions
Running is a fundamental movement of human being. It demands specific co-ordination between upper and lower extremities. When it executed with maximum speed is called sprint and guided by some rules and regulation under an organization may be considered as a competitive event. In different events of Sport and Game sprint plays an important role. It has firm belief with scientific truth that the speed is a hereditary factor composited by White muscle fiber, less muscle myoglobin, quick sending and receiving functioning of nervous system, different biomechanical functioning etc. These inborn qualities having some specific developmental pattern are not influenced by training system. Speed mainly depends upon the Stride frequency and stride length along with the Lower Limb length, Arm length, Leg Length, Build of the Body, leg explosive strength etc. In sprint the Performer has to cover a specific distance in minimum time. In this case the momentum of the body acted with the coordinated effect of the said different factors. There is specific dependence of running upon the said factors. Among the said factors, stride length is thought to be hereditary whereas stride frequency depends upon factors all of which are not hereditary in nature. So, training for sprinters is mainly aimed at improving stride length with maximum possible stride frequency. Schmolinsky *et al.* (1983) showed that the purpose of sprint training should be to increase leg explosive strength for maximum possible Stride length with increase stride frequency. Rompetti (1957) and Hoffman (1967) [3] analyzed the relation of stride length with body height and leg length and found statistically positive significant correlation. Gundlach (1963) investigated thoroughly regarding stride length during 100m sprint and reported that top sprinters increased their stride length up to 60m whereas poorly trained athletes increased them up to 30m. Saito *et al.* (1975) reported that the sprinters exhibited slight decrease in stride length at the extreme velocity. So it is very clear that among different dependent variables of speed the stride frequency, Stride length and the explosive strength are the three major variables and all they are almost trainable factors. Considering the said view the aim of the present study was to find out the relationship among the stride frequency, stride length, leg explosive strength and the performance.
Running, foot racing over a variety of distances and courses and numbering among the most popular sports in nearly all times and places. Modern competitive running ranges from sprints (dashes), with their emphasis on continuous high speed, to grueling long-distance and marathon races, requiring great endurance. See also athletics; cross-country; hurdling; long-distance running; marathon; middle-distance running; relay race; sprint; steeplechase.

Running is also a popular noncompetitive recreation that can produce important physiological benefits.

Running is a method of terrestrial locomotion allowing humans and other animals to move rapidly on foot. Running is a type of gait characterized by an aerial phase in which all feet are above the ground (though there are exceptions). This is in contrast to walking, where one foot is always in contact with the ground, the legs are kept mostly straight and the center of gravity vaults over the stance leg or legs in an inverted pendulum fashion. A feature of a running body from the viewpoint of spring-mass mechanics is that changes in kinetic and potential energy within a stride occur simultaneously, with energy storage accomplished by springy tendons and passive muscle elasticity. The term running can refer to any of a variety of speeds ranging from jogging to sprinting.

Running in humans is associated with improved health and life expectancy.

It is assumed that the ancestors of humankind developed the ability to run for long distances about 2.6 million years ago, probably in order to hunt animals. Competitive running grew out of religious festivals in various areas. Records of competitive racing date back to the Tailteann Games in Ireland between 632 BCE and 1171 BCE, while the first recorded Olympic Games took place in 776 BCE. Running has been described as the world's most accessible sport.

Running gait can be divided into two phases in regard to the lower extremity: stance and swing. These can be further divided into absorption, propulsion, initial swing and terminal swing. Due to the continuous nature of running gait, no certain point is assumed to be the beginning. However, for simplicity, it will be assumed that absorption and footstrike mark the beginning of the running cycle in a body already in motion.

Footstrike

Footstrike occurs when a plantar portion of the foot makes initial contact with the ground. Common footstrike types include forefoot, midfoot and heel strike types. These are characterized by initial contact of the ball of the foot, ball and heel of the foot simultaneously and heel of the foot respectively. During this time the hip joint is undergoing extension from being in maximal flexion from the previous swing phase. For proper force absorption, the knee joint should be flexed upon footstrike and the ankle should be slightly in front of the body. Footstrike begins the absorption phase as forces from initial contact are attenuated throughout the lower extremity. Absorption of forces continues as the body moves from footstrike to midstance due to vertical propulsion from the toe-off during a previous gait cycle.

Midstance

Midstance is defined as the time at which the lower extremity limb of focus is in knee flexion directly underneath the trunk, pelvis and hips. It is at this point that propulsion begins to occur as the hips undergo hip extension, the knee joint undergoes extension and the ankle undergoes plantar flexion. Propulsion continues until the leg is extended behind the body and toe off occurs. This involves maximal hip extension, knee extension and plantar flexion for the subject, resulting in the body being pushed forward from this motion and the ankle/foot leaves the ground as initial swing begins.

Propulsion phase

Most recent research, particularly regarding the footstrike debate, has focused solely on the absorption phases for injury identification and prevention purposes. The propulsion phase of running involves the movement beginning at midstance until toe off. From a full stride length model however, components of the terminal swing and footstrike can aid in propulsion. Set up for propulsion begins at the end of terminal swing as the hip joint flexes, creating the maximal range of motion for the hip extensors to accelerate through and produce force. As the hip extensors change from respiratory inhibitors to primary muscle movers, the lower extremity is brought back toward the ground, although aided greatly by the stretch reflex and gravity. Footstrike and absorption phases occur next with two types of outcomes. This phase can be only a continuation of momentum from the stretch reflex reaction to hip flexion, gravity and light hip extension with a heel strike, which does little to provide force absorption through the ankle joint. With a mid/forefoot strike, loading of the gastro-soleus complex from shock absorption will serve to aid in plantar flexion from midstance to toe-off. As the lower extremity enters midstance, true propulsion begins. The hip extensors continue contracting along with help from the acceleration of gravity and the stretch reflex left over from maximal hip flexion during the terminal swing phase. Hip extension pulls the ground underneath the body, thereby pulling the runner forward. During midstance, the knee should be in some degree of knee flexion due to elastic loading from the absorption and footstrike phases to preserve forward momentum. The ankle joint is in dorsiflexion at this point underneath the body, either elastically loaded from a mid/forefoot strike or preparing for stand-alone concentric plantar flexion. All three joints perform the final propulsive movements during toe-off. The plantar flexors plantar flex, pushing off from the ground and returning from dorsiflexion in midstance. This can either occur by releasing the elastic load from an earlier mid/forefoot strike or concentrically contracting from a heel strike. With a forefoot strike, both the ankle and knee joints will release their stored elastic energy from the footstrike/absorption phase. The quadriceps group/knee extensors go into full knee extension, pushing the body off of the ground. At the same time, the knee flexors and stretch reflex pull the knee back into flexion, adding to a pulling motion on the ground and beginning the initial swing phase. The hip extensors extend to maximum, adding the forces pulling and pushing off of the ground. The movement and momentum generated by the hip extensors also contributes to knee flexion and the beginning of the initial swing phase.

Swing Phase

Initial swing is the response of both stretch reflexes and concentric movements to the propulsion movements of the body. Hip flexion and knee flexion occur beginning the return of the limb to the starting position and setting up for another footstrike. Initial swing ends at midswing, when the limb is again directly underneath the trunk, pelvis and hip with the knee joint flexed and hip flexion continuing. Terminal swing then begins as hip flexion continues to the point of activation of the stretch reflex of the hip extensors. The knee begins to extend slightly as it swings to the anterior portion of the body. The foot then makes contact with the ground with footstrike, completing the running cycle of one side of the lower extremity. Each limb of the lower extremity works opposite to the other. When one side is in toe-off/propulsion, the other hand is in the swing/recovery phase preparing for footstrike. Following toe-off and the beginning of the initial swing of one side, there is a flight phase where neither extremity is in contact with the ground due to the opposite side finishing terminal swing. As the footstrike of the one hand occurs, initial swing continues. The opposing limbs meet with one in midstance and midswing, beginning the propulsion and terminal swing phases.

Upper extremity function

Upper extremity function serves mainly in providing balance in conjunction with the opposing side of the lower extremity. The movement of each leg is paired with the opposite arm which serves to counterbalance the body, particularly during the stance phase. The arms move most effectively (as seen in elite athletes) with the elbow joint at an approximately 90 degrees or less, the hands swinging from the hips up to mid chest level with the opposite leg, the Humerus moving from being parallel with the trunk to approximately 45 degrees shoulder extension (never passing the trunk in flexion) and with as little movement in the transverse plane as possible. The trunk also rotates in conjunction with arm swing. It mainly serves as a balance point from which the limbs are anchored. Thus trunk motion should remain mostly stable with little motion except for slight rotation as excessive movement would contribute to transverse motion and wasted energy.

Footstrike Debate

Recent research into various forms of running has focused on the differences, in the potential injury risks and shock absorption capabilities between heel and mid/forefoot footstrikes. It has been shown that heel striking is generally associated with higher rates of injury and impact due to inefficient shock absorption and inefficient biomechanical compensations for these forces. This is due to forces from a heel strike traveling through bones for shock absorption rather than being absorbed by muscles. Since bones cannot disperse forces easily, the forces are transmitted to other parts of the body, including ligaments, joints and bones in the rest of the lower extremity all the way up to the lower back. This causes the body to use abnormal compensatory motions in an attempt to avoid serious bone injuries. These compensations include internal rotation of the tibia, knee and hip joints. Excessive amounts of compensation over time have been linked to higher risk of injuries in those joints as well as the muscles involved in those motions. Conversely, amid/ forefoot strike has been associated with greater efficiency and lower injury risk due to the triceps surae being used as a lever system to absorb forces with the muscles eccentrically rather than through the bone. Landing with a mid/forefoot strike has also been shown to not only properly attenuate shock but allows the triceps surae to aid in propulsion via reflexive plantar flexion after stretching to absorb ground contact forces. Thus a mid/forefoot strike may aid in propulsion. However, even among elite athletes there are variations in self-selected footstrike types. This is especially true in longer distance events, where there is a prevalence of heel strikers. There does tend however to be a greater percentage of mid/forefoot striking runners in the elite fields, particularly in the faster racers and the winning individuals or groups. While one could attribute the faster speeds of elite runners compared to recreational runners with similar footstrikes to physiological differences, the hip and joints have been left out of the equation for proper propulsion. This brings up the question as to how heel striking elite distance runners are able to keep up such high paces with a supposedly inefficient and injurious foot strike technique.

Stride length, hip and knee function

Biomechanical factors associated with elite runners include increased hip function, use and stride length over recreational runners. An increase in running speeds causes increased ground reaction forces and elite distance runners must compensate for this to maintain their pace over long distances. These forces are attenuated through increased stride length via increased hip flexion and extension through decreased ground contact time and more force being used in propulsion. With increased propulsion in the horizontal plane, less impact occurs from decreased force in the vertical plane. Increased hip flexion allows for increased use of the hip extensors through midstance and toe-off, allowing for more force production. The difference even between world-class and national-level 1500-m runners has been associated with more efficient hip joint function. The increase in velocity likely comes from the increased range of motion in hip flexion and extension, allowing for greater acceleration and velocity. The hip extensors and hip extension have been linked to more powerful knee extension during toe-off, which contributes to propulsion. Stride length must be properly increased with some degree of knee flexion maintained through the terminal swing phases, as excessive knee extension during this phase along with footstrike has been associated with higher impact forces due to braking and an increased prevalence of heel striking. Elite runners tend to exhibit some degree of knee flexion at footstrike and midstance, which first serves to eccentrically absorb impact forces in the quadriceps muscle group. Secondly it allows for the knee joint to concentrically contract and provides major aid in propulsion during toe-off as the quadriceps group is capable of produce large amounts of force. Recreational runners have been shown to increase stride length through increased knee extension rather than increased hip flexion as exhibited by elite runners, which serves instead to provide an intense braking motion with each step and decrease the rate and efficiency of knee extension during toe-off, slowing down speed. Knee extension however contributes to additional stride length and propulsion during toe-off and is seen more frequently in elite runners as well.

Methodology

Fifteen trainee girls of 19 to 25 years of age of J.S. Post Graduate College, Sikandrabad, Uttar Pradesh, have been selected as the subjects. The subject did not have any earlier experience about organized training except their routine physical education programme in the training college. The stride frequency, stride length, explosive length and speed performance were the measured Variables. For measuring speed, stride length and stride frequency, the subjects were instructed to run 60m sprint. Marble dusts were spreaded on the running surface from 30mt to 60mt of the course to record the foot prints. From the foot print the Stride length and the stride frequency were recorded. Time keepers were posted at the finishing line after 60mt.

The speed performance was measured in between 30-60mt. by a manually operated electronic stop watches with 1/100 sec. calibrations.

Results and Discussion

The Table 1 reveals that the mean values of maximum speed as dependent variable and selected mechanical, anthropometric and motor fitness parameters as independent variables in this study. To find out the relationship among stride length, stride frequency, explosive strength and speed the coefficient of correlation were compute by product–moment method.

Table 1: Anthropometric and Motor Fitness Parameters

Stat.	Max. Speed (Sec)	Stride Length (cm.)	Stride Frequency (No)	Explosive Strength (cm.)
Mean	4.65	177.33	17.17	28.53
S.D	0.42	17.56	1.88	4.10

***Sources*:** Primary Data

Co-efficient of Correlation between different Speed Variables and Performance

Table 2: Co-efficient of Correlation Value

Variables	Stride Length	Stride Frequency	Explosive Strength
Speed	-0.76*	0.68*	0.45

Significance level - 0.05

It was observed from the above table that the stride length was highly negatively Correlated with maximum speed and the Stride frequency was highly positively correlated with the maximum speed. Both the relation has significant. So, increase of stride frequency might reduce the stride length and vice versa during maximum speed.

This result explains the findings of Saito *et al.* (1975). Who noticed small decrease in stride length at maximum speed both in surface running and treadmill running? But as speed is the conjugate effect of said two factors so they must be taken into consideration according to the ability of the respective athlete. The performance was also moderately and negatively correlated with the explosive strength but that was not significant. Schmolinsky *et al.* (1983) showed the same that to increase the maximum speed the leg explosive strength should be increased.

Conclusion

From the results of the present study, following conclusions were drawn: During sprinting speed, stride length varies inversely with stride frequency. Maximum speed directly and positively influenced by stride frequency. Maximum speed depends inversely on the stride length if it considers a single variable only.

References

1. Lamberts RP, Lemmnik KAPM, Durandt JJ, Lambert MI. Variation in heart rate during submaximal exercise: Implications for monitoring training. Journal of Strength and Conditioning Research 2004;18:641-645.
2. Nigg B. Biomechanical considerations on barefoot movement and barefoot shoe concepts. Footwear Sciences 2009;1:73-79.
3. Hoffman K. The Length and Frequency of Stride of the World's Leading Female Sprinters. Treaties, Texts and Document WSWF in Pozman Series. Treaties 1967, 17.
4. Ravindran G, Annida B, Parthiban B, Sekarbabu K. Effects of walking jogging and running program on coronary heart disease risk factors among Lorenzetti S, Gülay T, Stoop M, List R, Gerber H, Schellenberg F, Stüssi E. Comparison of the angles and corresponding moments in the knee and hip during restricted and unrestricted squats. Journal of Strength and Conditioning Research 2010-2012;26:2829-2836.
5. Srivastava AK. How to Play Running, Sports Publication, New Delhi.
6. Novacheck TF. The biomechanics of running. Gait & Posture 1998;7:77-95.
7. Houmard JA, Costill DL, Mitchell JB *et al.* The role of anaerobic ability in middle distance running performance. Eur J Appl Physiol 1991;62(1):40-3.
8. Dettwyler M, Stacoff A, Stüssi E. Static in situ calibration of statically over determined ground reaction force measurement platforms. In P. Milburn, B. Wilson, & T. Yanai (Eds.), 19th international congress of biomechanics. Dunedin: University of Otago 2003, 88.
9. Verma H. Understanding Athletics, Angel Publication, New Delhi.
10. Lieberherr R, Marquis JF, Storni A, Wiedenmayer G. Gesundheit und gesundheitsverhalten in der schweiz. Switzerland: Bundesamt für Statistik (BfS) 2007-2010. ISBN: 978-3-303-14136-6.
11. Dixon SJ. Application of center- of-pressure data to indicate rearfoot inversion-eversion in shod running. Journal of the American Podiatric Medical Association 2006;96:305-312.
12. Stanford C. Rana pretiosa (spotted frog): Toe clipping effects. Herpetological Reviews 1996;27:195-196.