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Projektni rad  
**Predstavljamo vam Trčanje**

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## Introduction

Running is a means of terrestrial locomotion allowing humans and other animals to move rapidly on foot. It is simply defined in athletics terms as a gait in which at regular points during the running cycle both feet are off the ground. 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 characteristic 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.

The ancestors of mankind developed the ability to run for long distances about four and a half million years ago,[citation needed] 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 in 1829 BCE,[citation needed] while the first recorded Olympic Games took place in 776 BCE. Running has been described as the world's most accessible sport.



## History

It is thought that human running evolved at least four and a half million years ago out of the ability of the ape-like Australopithecus, an early ancestor of humans, to walk upright on two legs.[4]

The theory proposed considered to be the most likely evolution of running is of early humans' developing as endurance runners from the practice of persistence hunting of animals, the activity of following and chasing until a prey is too exhausted to flee, succumbing to "chase myopathy" (Sears 2001), and that human features such as the nuchal ligament, abundant sweat glands, the Achilles tendons, big knee joints and muscular glutei maximi, were changes caused by this type of activity (Bramble & Lieberman 2004, et al.).[5][6][7] The theory as first proposed used comparative physiological evidence and the natural habits of animals when running, indicating the likelihood of this activity as a successful hunting method. Further evidence from

observation of modern day hunting practice also indicated this likelihood (Carrier et al. 1984). [7][8] According to Sears (p. 12) scientific investigation (Walker & Leakey 1993) of the Nariokotome Skeleton provided further evidence for the Carrier theory.[9]

Competitive running grew out of religious festivals in various areas such as Greece, Egypt, Asia, and the East African Rift in Africa. The Tailteann Games, an Irish sporting festival in honour of the goddess Tailtiu, dates back to 1829 BCE, and is one of the earliest records of competitive running.[10] The origins of the Olympics and Marathon running are shrouded by myth and legend, though the first recorded game took place in 776 BCE.[11]

## **Running kinematic description**

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.[16][17][18] 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.[19] 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.[13][14][20] From a full stride length model however, components of the terminal swing and footstrike can aid in propulsion.[15][21] 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 reciporatory inhibitors to primary muscle movers, the lower extremity is brought back toward the ground, although aided greatly by the stretch reflex and gravity.[15] 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.[20][22][23] 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.[23][24] As the lower extremity enters midstance, true propulsion begins.[20] 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.[25][26][27] 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.[20][22][23][24] 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.[25][26][27] 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.