AUCTORES
Globalize your Research

International Journal of BioMed Research

Benjamín Ruiz Loyola*

Open Access

Review Article

Science and Pole Vaulting

Benjamín Ruiz Loyola

Department of Organic Chemistry, Faculty of Chemistry, Unam

***Corresponding Author:** Benjamín Ruiz Loyola, Department Of Organic Chemistry, Faculty of Chemistry, Unam

Received date: June 06, 2021; **Accepted date:** July 10, 2021; **Published date:** September 03, 2021

Citation: Benjamín Ruiz Loyola. (2021) Science and Pole Vaulting, *International J. Biomed Research* 1(5); DOI: 10.31579/IJBR-2021/021

Abstract

Using long poles to jump over obstacles has had several historical applications, such as passing over rivers to avoid having to go around them or invading enemy fortifications by passing over their walls. In the middle Ages there were messengers who ran cross country instead of going on horseback to avoid the roads (and bandits), they carried a pole with them to avoid all kinds of terrain.

Key Words

pole; science

History

We believe that the Celts of ancient Ireland pole vaulted over streams for fun and challenge one another about 3800 years ago. We know that this competition was part of their Tailtean Games (somewhat like the Olympics, but for Celtic clans), which began sometime between 1829 and 1600 BC. Bullfighting has also involved polecats, which were used by matadors or picadors to jump over the bull. In ancient Greece, the pole vault was part of the Olympic Games since they were held for the first time, in 776 BC. For this reason, they have also been part of all the Olympic Games of the modern era, from 1896 to the present day.

Objectives and Rules

The objective of the pole vault is to jump a bar placed above ground level. The bar is placed higher than anyone could jump with the sheer force of their muscles (the world record is 6.18 meters, more than double the record of .45 meters for the high jump), so to reach it you need the pole, a flexible, strong and light rod that the athlete uses to push himself up. To achieve this jump you have to run with the pole in your hands on a track. At the end of the track there is a special anchor box in which the athlete jams the pole and uses the momentum of the race to bend it like a spring, which when straightening propels it upwards to jump the bar. If you manage to do it without knocking it down, the jump is valid; otherwise, it is marked missing. The athlete decides the height at which the bar is placed and has three attempts to jump it; the highest that he reaches after accumulating three fouls is the one that competes against those of the other athletes. The International Association of Athletics Federations (IAAF) sets the rules for most athletic competitions, including the pole vault. It establishes, for example, that the track on which the athletes run must be 1.22 meters wide and if possible 45 meters long, although a minimum of 40 meters is acceptable. It also determines the dimensions of the anchor box, bar, posts, brackets, and landing zone. The pole, however, can be of any material, weight, and size, as long as its surface is smooth and has the same diameter throughout its length. The athlete will be fouled: if the bar falls during or after the jump; if the athlete touches the ground or the landing area without having jumped over the bar; if when taking off from the ground, he tries to use his hands to climb the pole; or if, during the jump, you try to accommodate the bar on its supports. Participants can use any substance to gain a better grip, such as wearing gloves or putting tape on the pole. Tape can also be used to protect the tip of the pole.

Science in motion

All sports depend on the transfer and transformation of energy, in particular kinetic energy, which is that of motion. In particular, pole vaulting depends on the elasticity of the pole, which allows it to store energy like a spring when bending and release it when it is straightened again. When the athlete runs on the track with the pole in his hands, he is working to reach a certain speed; which means that it has kinetic energy, or of movement. When he reaches the anchor box and lowers the pole, his movement stops and his energy has to go somewhere. Thus, it transforms from kinetic to potential when the pole is bent. However, the pole quickly recovers its original shape, releasing its elastic potential energy; and since the point that is anchored in the ground cannot move, the one that receives the kinetic energy is the other one, the one that the athlete has in his hands, who has nowhere else to go but up. In short, the athlete transfers kinetic energy to the pole, which bends and briefly stores the energy, converting it to potential, to transfer it back to the athlete as kinetic energy. If the pole were completely rigid, the only thing that would happen at the moment of anchoring it is that the athlete would roll over on his back when braking hard and would take a good blow. On the contrary, if the pole were not rigid enough, it would bend but would not regain its original shape, so our poor athlete would continue on with a useless pole in his hands and failing his jump. But the pole is elastic, that is, it allows it to bend to a certain point but seeks to regain its original shape.

TERM	MEANING
Energy	A property of matter. Equivalent to the ability to perform work, such as moving an object.
Kinetic energy	The energy of a moving object.
Potential energy	The energy stored in an object, such as a stretched spring or a bent pole.
Elasticity	The tendency of a solid body to return to its original shape after being deformed.
Stiffness	The resistance of an object to be deformed when force is applied to it.
Spring	Mechanism used to store mechanical energy in the form of tension (potential energy).

TABLE 1. *Physics terms used in pole vaulting*

When running, the athlete carries a uniform movement in a straight line. By nailing the pole and deforming it, a pendulum movement begins with a center at the low point of the pole that raises the athlete, who, in turn, performs a new pendulum movement that allows him to rise above the pole and jump the bar without knocking it down. The weight of the pole varies between 1.5 and 3 kilograms, which may seem small, but since the jumper carries the pole by holding it at one end, it unbalances him (or her) more than if it were holding it in the middle (although in this case they could not use its total length to help in the jump). The athlete's speed, then, is diminished by loading the pole; however, this has been resolved by the technique of the jumper holding the pole upright when starting and lowering it slowly when approaching the anchor box. This greatly reduces the distortion in the athlete's running and allows him to transfer the maximum of his energy to the elastic deformation of the pole. Of course, a pole that has less weight with the same elastic capacity will always be welcome; hence the importance of improving carbon fiber pole, which can weigh between 15% and 25% less than a fiberglass pole.

Equipment, Uniforms, and Other Materials

Pole

The first poles were made of sturdy woods, such as ash or walnut. However, the internal structure of the wood makes it resistant but not very flexible. This was, for example, the pole used in the first modern Olympiad, in 1896, when the Olympic record was set at 3.3 meters.

Later, bamboo was used, more flexible than those woods. The internal structure of bamboo allows it to have a resistance equal to or greater than that of wood, while increasing its flexibility due to its internal holes; In addition, those same gaps make a bamboo pole lighter than a conventional wooden pole of the same size. With the use of bamboo the record increased to more than 4 meters.

As the plastics or polymer industry developed, fiberglass began to be used, which is a mixture of glass in a polymer; this results in a material with the hardness of glass and the flexibility of plastic. This era began around 1950; the 1952 Olympic record with this kind of pole was set at 4.55 meters.

At some point metal poles was tested, starting with steel and continuing with aluminum. In 1957, American Bob Gutowski used an aluminum pole for the first time and set a world record by jumping 4.78 m. That same year, a new world record was set with 4.80 m. using a steel pole. However, continuous advances in polymer production technology soon outpaced these materials.

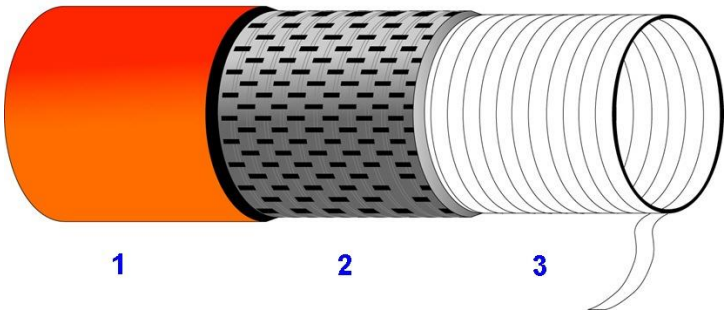
This is how we continue until we reach our days, in which the poles are made with an extremely flexible and resistant material that is also extremely light: carbon fiber. This polymer has several advantages, but it has not been universally adopted by all athletes, which means that in the present fiberglass pole and carbon fiber pole coexist, still with a predominance of the former, but with trends to the change. Using fiberglass an Olympic record was set in 2012, jumping 5.97 meters.

Carbon fiber is widely used, for example, in aviation, because it makes airplanes lighter and stronger, which helps to control corrosion processes in metal parts and allows fuel consumption to be lower by reducing the final weight of the aircraft (thereby reducing environmental pollution); For this reason, it is also widely used in the design and construction of spacecraft, in such a way that aerospace technology has a significant impact on sport. This fiber is the basis for the construction of the so-called invisible planes, which eliminate the echo produced by a radar or reduce its size so that it can be confused with that of a bird; is the technology known as stealth. It should be emphasized that the main virtue of the materials has been the increase in the flexibility of the pole, which together with the changes in jumping techniques, has been reflected in the increase in the distance that establishes world or Olympic records.

RECORD	GENDER	ATHLETE	COUNTRY	DATE	HEIGTH
WORLD	WOMEN	YELENA ISINBAYEVA	RUSSIA	8/28/2009	5.06 m
WORLD	MEN	ARMAND DUPLANTIS	SWEDEN	2/15/2020	6.18 m
OLYMPIC	WOMEN	YELENA ISINBAYEVA	RUSSIA	2008	5.05 m
OLYMPIC	MEN	THIAGO BRAZ DA SILVA	BRAZIL	2016	6.03 m

TABLE 2. *World and Olympic Records on Pole Vaulting*

A fiberglass pole can be bent up to 170° without breaking and can store as elastic potential energy up to 50% of the kinetic energy developed by the athlete in the race. Most jumpers choose the pole according to their physical condition, the condition of the track and environmental conditions such as rain, wind, etc. Pole lengths vary, in the case of men, between 4.90 and 5.40 meters, while for women they are between 4.30 and 4.60 meters. On the other hand, its weight ranges between .5 and kg, as was stated before.



Sectional view of a modern pole. The center (3) is made with thin layers of fiberglass that are mounted on a steel tube, first in one direction and then in the opposite direction, so that its resistance is reinforced with a kind of interwoven fabric. The second layer (2) can be made with a fiberglass or carbon fiber mesh, joining the mesh with epoxy resin; this network is longitudinal. Finally the outer layer (1) is formed with fiberglass or linear carbon fiber bonded with resin or epoxy glue, so that there are no ridges.

http://wwwchem.uwimona.edu.jm/courses/CHEM2402/Sport/Equipment.html

As we mentioned before, the change from fiberglass to carbon fiber has been gradual. A recent history tells us about these perspectives. American Jenn Suhr won the gold medal at the 2012 London Olympics with a jump of 4.75 m. In 2013 she set a new record for indoor competition at 5.02 m. Elena Isinbayeva had the previous marks with 5.00 and 5.01 m. Suhr participated in the indoor world championships in Sopot, Poland, in March 2014, earning a disappointing fifth place for her, jumping 4.65m. She spoke with her coach, who is also her husband, and they decided to make a momentous switch to carbon fiber pole. In his first competition with this new pole, she jumped 4.70 m. and came in second place.

The poles tend to deteriorate from the tip when they come into contact with the anchor box, which is currently prevented by using a protector, usually made of vulcanized rubber.

Protective equipment

The first pole vaulters landed on their feet. This meant that all energy was absorbed by his body; particularly the discs in his spine, which deteriorated over time, causing back problems. Later, they landed on their side, inside pits filled with sawdust or fine sand. When reaching greater heights, it was necessary to fall on surfaces that better absorb shocks to mitigate the effects of falls, which has been achieved with the use of high-strength polymers that absorb the energy of falls so that the jumper don't be afraid of an injury. After all, heights greater than 5.50 meters are equivalent to a fall from a second story. Currently, to reduce the risks in the fall, plastic foam mattresses with vinyl covers are used, which reduce the impact by up to 70%, giving the competitor more security for their performance.

Computers provide a series of information of great importance for athletes, their coaches and their medical assistants, such as the way in which the pole is held at each moment of the jump process, the length of the running steps, respiratory rate and frequency. Cardiac. This allows making the necessary adjustments to the athlete's technique to optimize it; however, the performance of the jump will always depend on the athletes, their will, preparation and commitment. For its part, the evolution of materials is not over. The development of graphene, which can have the strength of steel and the weight of a feather, could in the future produce even more flexible and lighter poles, perhaps setting new standards.

Conclusion

Behind this showy sport, various sciences are mixed, intimately linked to each other. Physics, medicine, computers and, above all, chemistry, provide the athlete with ever better opportunities. For its part, psychology helps the athlete prepare mentally to be a fighter and a winner. Sport is more than just fun.

References

1. Física del salto con garrocha - Vox Populi de la Ciencia
2. What is the maximum height a human can jump?
3. Guia-deportiva-el-salto-con-garrocha-en-detall
4. Bermejo F. J. Y Palao J. M., Lecturas: Educación Física y Deportes, Revista Digital. Buenos Aires, Año 17, Nº 168, Mayo de 2012.
5. Physics Of Pole Vaulting
6. How it Works: The Pole Vault
7. olympics-physics-pole-vault
8. large.stanford
9. pole-vault
10. EnergyInteractions(Linthorne)
11. Mechanics_of_Pole_Vaulting_A_Review