SPORT gericht

The term 'mobility' is recently thrown at all sorts of exercises and training sessions targeting flexibility, athletic capabilities, range of motion, freedom of movement and injury prevention.

Mobility: the road to efficient, controlled and pain free movement

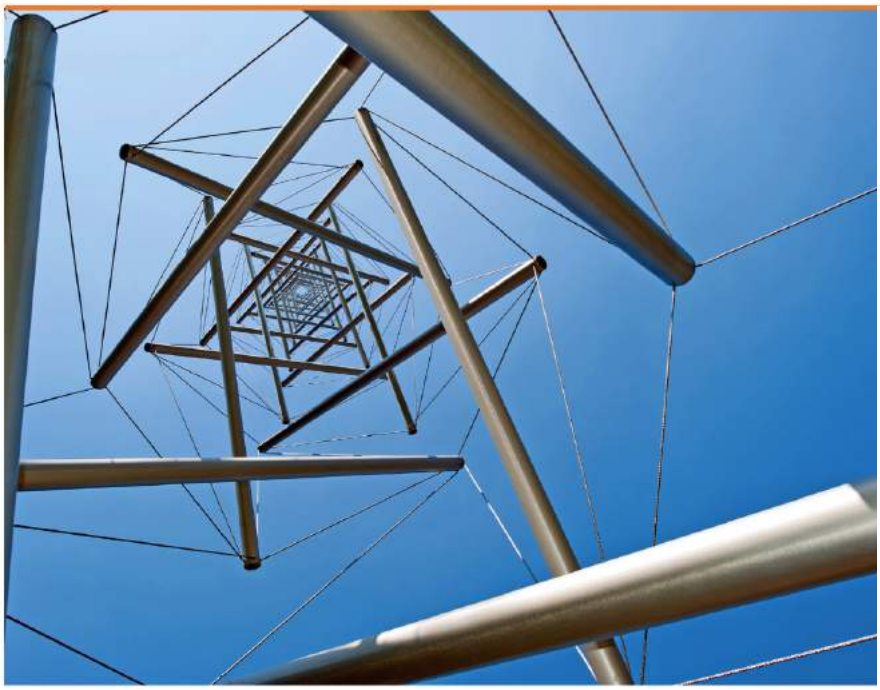
Nathalie Jeras

In articles the terms mobility and flexibility are being used interchangeably and with certain overlap. In this article the term mobility will be used in the broadest sense of the word (see above). How does mobility 'work' and how to best apply it into physical training?

Importance

In the context of sports performance mobility can be seen as the ability to use the right amount of movement, in the right (series of) joints, in the right position, in the right direction, with the right timing and necessary control.[1,2]

Image 1



The addition of the components timing and control make that mobility is more than just lengthening of muscles and moving joints. Mobility is also a skill. The flexibility and elegance that are needed in aesthetic sports are also a part of mobility. Reaching extreme ranges of motion is a performance determining factor in these sports and therefore an important goal of the mobility training. Injury prevention and sufficient freedom of movement form the most important goals of mobility training in other sports. With more range of motion the time of force production and receiving (the mechanic impuls) can be increased.[2] For example, a baseball thrower and judoka winding up for a throw by turning the body away from the target. With good mobility the distance and time of force application can be increased resulting in a higher speed of the object or person being thrown.[1,2] Having good mobility is therefore important in both aesthetic and non-aesthetic sports.

Mechanics behind mobility

The mobility of a certain joint is determined by the extend to which surrounding muscles and tissues can lengthen and shorten.

Where the mechanics behind the shortening of muscles are known for a long time[3], the mechanics behind the lengthening of muscles is not yet fully investigated and understood.[1]
The lengthening of muscles can be trained through multiple forms of stretching. The thought that muscles and associated structures are permanently becoming longer because os this, is often disputed over the last years. It seems like they don't permanently change shape, but the central en peripheral nervous system (CNS and PNS) play a large role in the lengthening of muscles and reaching large ranges of motion. This is shown, among other things, by a temporary increase in muscle length as the range of motion increases in a dynamic movement. When gymnasts and dancers bring their leg next to their ipsilateral ear, the length of the hamstrings can increase by up to 20 centimeters compared to a standing starting position.[1] Nothing weird or crazy to be seen at the hamstrings once the leg is back in starting position. This shows that muscles and associated structures do not permanently stretch. After all, the entire leg did not suddenly become 20 centimeters longer. So there must be another mechanism lying behind the lengthening and shortening again of muscles. The ability of muscles to lengthen and returning to original shape is based on 1) elasticity and 2) het ability of the structures to slide over each other.[1,4] When a muscle shortens there is energy, ATP, needed to let the structures slide over each other. When a muscle lengthens however, it seems like the structures are sliding in the opposite direction influenced by an external force. This could be gravity, resistance of the ground or a partner, but this could also be contractions of the agonist.

How far the structures can slide over each other is largely determined by the CNS and PNS. The role the nervous system plays becomes particularly clear when its influence is eliminated. When someone is anesthetized their leg can be brought into a much larger range of motion than before and after the anesthesia.[5] The hamstrings can apparently lengthen further when the CNS and PNS can no longer send and receive signals, compared to when the movement is being inhibited by neural signals. The CNS and PNS will sooner inhibit a movement when necessary stability and control is lacking in the specific joint.[6] The brain will so to speak hit the brakes and limit the range of motion. Therefore, stability and control form an important aspect of mobility as a lack of it could induce limited range of motion and freedom of movement.

Methods to increase range of motion

The range of motion of a certain sport specific movement can be increased in different ways. A distinction can be made between passive and active methods. Massage, foam rolling and trigger point rolling are methods to decrease tension on muscles, fascia and other soft tissues and can lead to an (generally acute) increase in range of motion.[7] Static stretching, in which a lengthening of a muscle and corresponding tissues is being held or slowly enlarged, is another passive method shown to be effective for increasing range of motion. Nevertheless, more and more researches and elite coaches are questioning this method.[2] With good reason it seems. Static stretching seems to negatively effect sports performance which makes this method not suitable to use prior to training or competition of almost all sports. Sprinting, jumping, throwing, maximum strength, maximum power output, muscular endurance and maximum isometric strength are all negatively effected by static stretching beforehand.[1,8,9]
When static stretches are not held for too long there can be a place for them in the warming-up. For example, when great ranges of motion must be achieved like in aesthetic sports it totally makes sense to practice and get a feel for these extreme positions in the warming-up. A static stretch does not have to be held for longer than 10 to 30 seconds to achieve the aspired range of motion. Holding the stretch for longer than 30 seconds will weaken tendons and ligaments and increase the negative side effects on sports performance.[8,10]

PNF

Proprioceptive neuromuscular facilitation **(PNF) is another stretching method to increase range of motion. PNF includes the following stretches:**

1. **Contraction of the agonist muscle for a longer period of time. This is thought to lead to reciprocal inhibition of the antagonist muscle. However, whether the contraction of a muscle actually leads to relaxation of the antagonist muscle is not been scientifically proven[4];**
2. **Contraction of the antagonist muscle to thereafter relax this muscle by the activity of Golgi tendon organs. This mechanism only lasts for one second however and does not seem to be effective during PNF stretching[4];**
3. **Isometric contraction of the antagonist (often against resistance provided by a partner)**

followed by relaxation of the muscle and further increasing of the range of motion (with help of a partner). The help of a partner here is up for debate. It seems to be better to let the athlete acquire a greater range of motion himself so that the required strength and skill to control the extreme range of motion are also being trained.[1]

The different PNF stretches are being used in multiple sports while underlying mechanisms are pretty unclear. PNF has shown to be effective in increasing range of motion, but more research is needed to determine and understand underlying mechanisms and to apply it intensionally.

Dynamic and ballistic stretching

Dynamic and ballistic ('bouncing') stretching seem to be just as effective as static stretching and PNF stretching but, when applied correctly, do not negatively effect sports performance. The difference between these two stretches is control in the end range. The fast and springy moment in ballistic stretching is missing control in the end range. This immediately ensures that ballistic stretching must always be performed with the necessary caution, in order to prevent damage of the structures. The use of small ankle weights in ballistic stretching is therefore strongly discouraged. Firstly, this disrupts the skill acquisition aspect of the dynamic movement; secondly, the impact on the structures around the hip and pelvis can be much greater than previously estimated. Even with the use of small weights, the long lever from hip to ankle creates a relatively large momentum on the small and fragile structures.

Dynamic stretching is seen as the most optimal method to improve mobility for sports performance.[1-3,7] The necessary strength and coordination of the agonists muscle ensure a good transfer to dynamic movements in sports situations. Challenging these agonist muscles some more seems to lead to more lengthening of the antagonist muscles and thus to more improvement in range of motion. Sands & McNeal[11] conducted a test period with gymnasts of Team USA which included the addition of elastic bands to their flexibility training. By performing split jumps with an elastic band attached to both ankles even more strength, coordination and control is required from the agonist muscles to achieve a greater range of motion. The increasing resistance of the elastic band towards the end ranges prevents an uncontrolled springy moment. After four weeks the gymnasts showed a five degree improvement in range of motion, what the authors state to be the difference between first and 20th place at the World Championship Gymnastics of that year.[11]

Vibration

Another innovative method to increase range of motion is the addition of vibration. Holding different stretch positions on a vibrating surface resulted in a 40% improvement after four minutes and a 100% improvement after one week in young gymnasts of Team USA.[12]

More and more research shows that the addition of vibration can result in extra range of motion in elite athletes.[13] Just by standing on a vibrating surface you could improve your mobility.[14] Underlying mechanisms that could be responsible for these promising results are a reduction in pain sensation, increased muscle blood flow, increased muscle temperature, altered proprioceptive feedback and a possible decrease in muscle viscosity (thixotropic function).[1] However, vibration training should always be performed with caution. For example, long-term vibration could pose an increased risk of thrombosis and vibration around the neck and head should always be avoided.

Tensegrity

So static stretching is by no means the only way to get more range of motion. Adding dynamic exercises seems to be the best way to improve mobility for sports performance. This is acknowledged by Scott[7], who describes the body as a *tensegrity model.* This refers to a combination of tension and integrity, where a floating structure is kept in equilibrium by the correct tension around it, such as the construction of the artwork in image 1. In the body this tension is provided by muscles and by the fascia, which hold the bones, muscles and other structures in place.

Image 3

Image 2

Practical application

Mobility exercises can easily be incorporated into a warming-up because of their dynamic character. By activating agonist muscles in dynamic warming-up exercises you can create an acute improvement in range of motion diminish potential movement faults. Mobility exercises can also be applied 1) as part of supersets to improve technique, 2) as a standalone exercise or session and 3) at the end of the physical training.

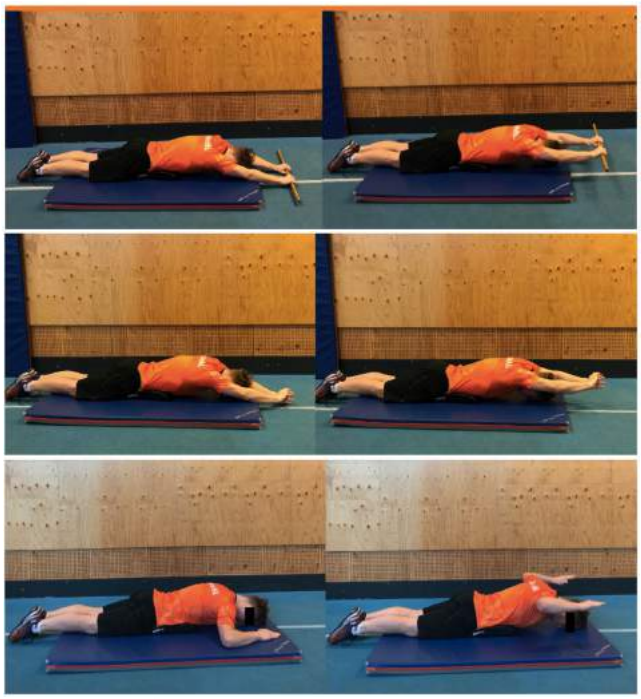


Image 4a, b and c (top to bottom)

Mobility exercises can be used to bring an imbalance in tension back to an equilibrium. Passive mobility exercises can reduce tension on the one hand, while active mobility exercises and targeted strength exercises increase tension on the other hand. In this way, the imbalance in tension is brought back towards an equilibrium giving the athlete more freedom to move. The importance of active mobility exercises targeting the agonist muscles is further emphasized here. Passive mobilization alone is not enough to bring the imbalance in tension around a joint back to an equilibrium.

By choosing slow dynamic exercises the athlete learns to control the entire range of motion. The focus in the exercises is on the correct execution of the movement, with as little compensation as possible in position (leaning or collapsing) and execution (not performing the movement through the full range of motion). When an athlete shows a limited mobility, both general mobility exercises through the full range of motion of a joint and specific exercises targeting strength and coordination of the specific muscle in the desired movement direction are effective. For example, an athlete is showing limited mobility in thoracic extension and retraction and flexion of the shoulders (image 2). To increase range of motion movements through the full range of motion of the shoulders can be performed (image 3), as well as isolated exercises targeting the agonist muscles of the aspired movement (image 4a). The exercises can be adjusted to the specific needs of the athlete and the ultimate target movement.


Image 5a


Image 5b



Image 6



Image 7



Image 8



Image 9

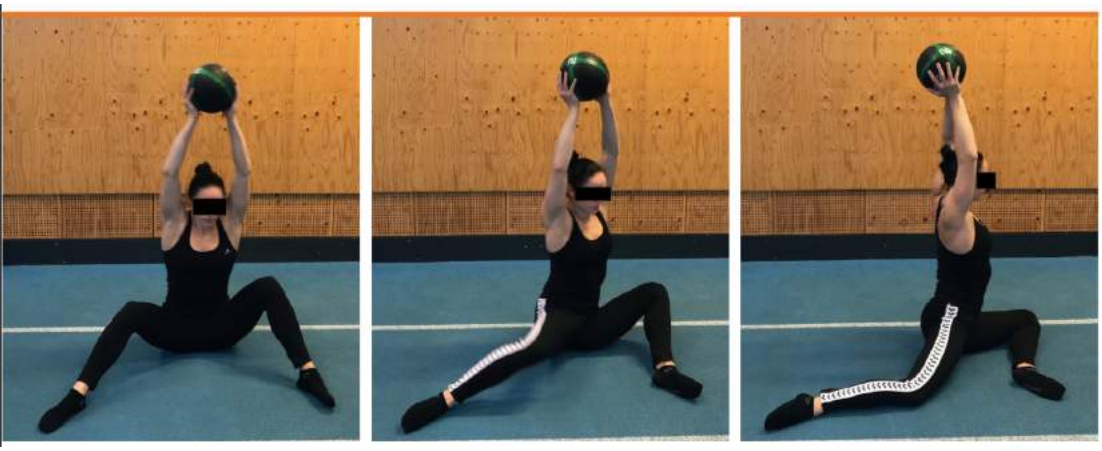


Image 10

Examples are a more narrow overhead grip for divers (image 4a) and extra attention for exorotation of the shoulders in an abducted position for judo, baseball and waterpolo (image 4c). Image 5 shows an example of an athlete with limited mobility in exorotation and flexion of the hips. This limitation also can be improved by performing exercises through the full range of motion of the hips (image 6) and specific exercises targeting the agonist muscles combined (image 7) or isolated (image 8). Addressing multiple joints in one mobility exercise makes the exercise more challenging. See image 9 and 10 for exercises addressing hip- thoracic spine- and shoulder mobility simultaneously.

About the author

Nathalie Jeras is a strength & conditioning coach at TeamNL, where she among other other sports is working within diving and gymnastics. Besides this she coaches CrossFit classes and mobility classes to non elite athletes. She created the online platform MoveXcellent which helps athletes to work on their mobility. Website: www.movexcellent.com



2023

Nathalie left TeamNL to start her own CrossFit Affiliate: CrossFit Down to Earth. She currently coaches both elite and non-elite athletes in the field of CrossFit, strength & conditioning and mobility.

1. Sands WA & McNeal JR (2016). Flexibility: developing effective movement. In: Jeffreys I & Moody J, Strength and Conditioning for Sports Performance, pp. 387- 403. New York: Routledge.
2. McNeal JR & Sands WA (2006). Stretching for performance enhancement. Current Sports Medicine Reports, 5, 141-146.
3. Willmore JH, Costill DL & Kenney WL (2009). Inspannings- en sportfysiologie. Elsevier.
4. Chalmers G (2004). Re-examination of the possible role of golgi-tendon organ and muscle spindle re exes in proprioceptive neuromuscular facilitation muscle stretching. Sports Biomechanics, 3 (1), 159-183.
5. Krabak BJ et al. (2001). Neurophysiological in uences on hamstring exibility: a pilot study. Clinical Journal of Sport Medicine, 11, 241-246.
6. Swinnen B (2016). Strength training for soccer. New York: Routledge.
7. Scott D (2019). Mobility training: debunking the myth. The Journal of the UK Strength & Conditioning Association, 54, 7-18.
8. Moeskops S et al. (2019). The physiological demands of youth artistic gymnastics: applications to strength and conditioning. Strength and Conditioning Journal, 41 (1), 1-13.
9. Knudson D (2006). The biomechanics of stretching. Journal of Exercise Science & Physiotherapy, 2, 3-12.
10. Marina M & Rodriguez FA (2014). Physiological demands of young women's competitive gymnastics routine. Biology of Sport, 31, 217-222.
11. Sands WA & McNeal JR (2000). Enhancing exibility in gymnastics. Technique, 20 (5), 6-9.
12. Sands WA et al. (2006). Flexibility enhancement with vibration: acute and long- term. Medicine & Science in Sports & Exercise, 38 (4), 720-725.
13. Kinser AM et al. (2008). Vibration and stretching effects on exibility and explosive strength in young gymnasts. Medicine & Science in Sports & Exercise, 40 (1), 133-140.
14. Tillaar R van den (2006). Will whole-body vibration training help increase the range of motion of the hamstrings? Journal of Strength & Conditioning Research, 20 (1), 192-196.