

3. Pathways for Understanding Pain and Fatigue

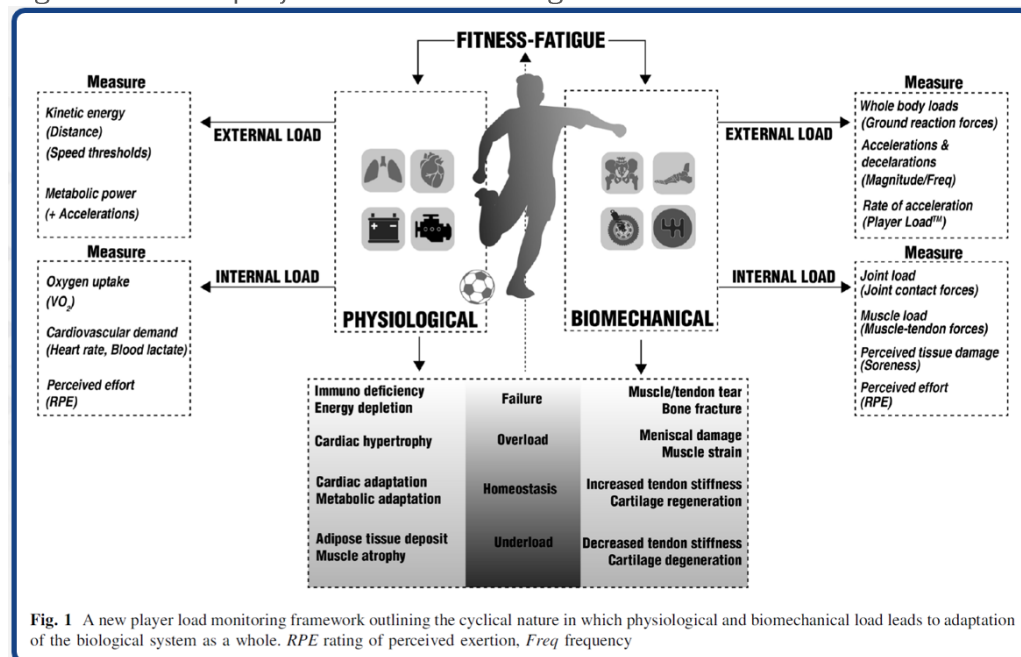
We've focused a lot on the fitness-fatigue model and the physiological effects of workload monitoring. It is a really important part of what we do, in monitoring the physiological responses to workloads. However, it is not just physiological factors that we need to monitor; load capacity involves factors other than "physiology". We've discussed external load and internal load.

Biomechanical load examines forces acting upon the body (e.g. accelerations and decelerations). We can measure these external loads. However, biomechanics can also be used to explain internal loads.

We can measure variables like joint loads, and muscle loads. When the load that is placed on the tissue exceeds the capacity of the tissue to tolerate that load, this is an example of a breakdown in the "stress-strain" model (comprehensively described by biomechanists). In these situations, injuries such as tendon rupture, muscle strain, meniscus tear or broken bone may occur.

So, all of these are examples from a biomechanical point of view with a load placed on the tissue exceeding the capacity of the tissue to tolerate it. This is what we refer to when we talk about the fitness-fatigue model applied to biomechanics. This is about the athlete's ability to tolerate load. The final piece of the puzzle here though is that it is not all about physiology or biomechanics, there is also a psychological element to how athletes and patients tolerate load.

Figure 1: A new player load-monitoring framework



Source: Vanrenterghem et al., 2017, p. 2136.

The biomechanical component of training load (Fig. 1, right-hand side) depends largely on propulsive and breaking forces against the ground. It has been recognized that players in team sports undertake some 500 rapid accelerations and decelerations in a single match. The mechanical stresses on soft tissues (internal load) come from these external kinetic demands of absorbing high forces from the impact with the environment and generating high forces to push off against the ground (remember the car suspension analogy). Directly measuring these external forces is possible but difficult outside of a laboratory. Instead, measuring the accelerations based on Newton's second law (with a certain mass, accelerations are proportional to the external forces acting on the body) is more feasible. (Vanrenterghem, Nedergaard, Robinson, & Drust, 2017, p. 2137).

When we expose our athletes to a physical training stimulus, the goal is to induce some physiological adaptations. We are either trying to build muscle, lose body fat, make some changes in the cardiovascular system or the muscular system - to improve the players ability to tolerate the demands of competition.

Nevertheless it is important to keep in mind that we are not training our players to “look good in the mirror”. Every time we expose our athletes to a physical training stimulus, we are also training the brain. We are attempting to place athletes in situations where it they may not have been before, and to tolerate that particular moment of competition.

When we exercise, the brain sets a certain pacing strategy. Thus, we set that pacing strategy largely according to our experiences, and it will be based on the anticipated end point of the exercise (i.e. “the finish line”).

So, if we have a very short session planned then our brain sets a much higher pacing strategy because we know it’s going to be short duration session, therefore we can exercise at a higher intensity. But if we are about to do a marathon, a very long exercise duration, then the brain sets a lower pacing strategy in order for us to get the “finish line” of the marathon without failure of any individual physiological system. Much of this pacing strategy is based on our experiences of that activity. This happens in running and in cycling but it also happens in team sports. For example, the substitutes in a football match will come onto the field and they will set a higher pacing strategy than someone who has played the entire game.

When that pacing strategy is set, there are receptors in the muscles, in the heart and the lungs that receive information. They sense information that we are either exercising at an intensity that is too high or too low. If the intensity is too high, our muscles become acidic, our heart starts to pump very hard, and we start to breath very heavy. This information is sent via afferent pathways to the brain. The brain processes that information concluding, “if I keep exercising at this high intensity with the known end point in mind, then I’m not going to get the finish line in one piece!” Therefore, efferent information travels back to the muscles, the heart, the lungs to lower the intensity.

The same applies if the exercise intensity is too low. Receptors in the muscles, the heart and the lungs provide feedback (via afferent pathways) to the brain, which provides information to the muscles, the heart, and the lungs to increase the intensity. In both examples what we are talking about is not just training the body in isolation, we are training the brain to recognize the cues that are sent from the muscles and from the cardiorespiratory system.

A second point to consider is that in high performance sport, there are practitioners from a wide range of fields. We have physiologists, strength and conditioning staff, biomechanists, doctors, physical therapists, athletic trainers, and psychologists.

Medical and coaching staff need to understand each other's perspectives, and share a common understanding of athletic resilience, to achieve athlete-centred goals. We recommend that clinicians and coaches develop good relationships with their athletes so they can identify the breadth of factors that make athletes vulnerable to reporting these sensations. In conclusion, monitoring perceived training load, pain and fatigue can be useful. However, once serious pathology has been excluded, athletes reporting these sensations should not panic. Instead, this information should be used within a decision-making framework to understand why an athlete is struggling, allowing for identification and management of the relevant modifiable factors underlying these sensations. In this manner, athletes can continue at least some training, without unnecessarily avoiding activity or provoking symptoms. (O'Sullivan, O'Sullivan, & Gabbett, 2017, p. 2.).

Even though we work in different fields with different levels of expertise, we are not actually competing against each other. Therefore, it is important to look at how other people work. You may see, that sometimes the way a psychologist works, or a physiotherapist works, is quite similar to the way that a strength and conditioning coach works.

This brings me to the point of how athletes and patients process pain and fatigue. Pain and injury are not necessarily the same thing and, equally fatigue does not always lead to injury. When we develop our beliefs about training, every person that we train will have their different beliefs. These different beliefs will bring about a certain response that, elicits a certain action and that action always has a consequence. We are talking about beliefs, responses, actions and consequences.

Figure 2: Parallels between the interpretation of pain and fatigue



Source: O'Sullivan et al., 2017, p. 1.

In many ways, athletes can process pain similarly to fatigue. Therefore, it is important to recognize this processing and how we might adjust load according to the different beliefs of the potential consequences of pain and fatigue.

- 1) Previously, it was thought that pain was a sensation that indicated danger to the body. If we have a belief that all pain is a sensation indicating danger, then our response to that is a fear-driven avoidance of those sensations. We will do whatever it takes to avoid those sensations, thus the action in response to those beliefs is to back off training. Essentially, what we believe is that if we do not stop training, the vulnerable athlete will break. The consequence is that we are left with a physically and psychologically vulnerable athlete or patient. They will suffer a deconditioning process, will not be able to handle pain, and they will be unable to handle the demands of the sport.

- 2) However, another pathway is that we believe that these sensations of pain or sensations of fatigue are a sign of psychological or physical weakness. The coach's response to that is to ignore the sensations of pain and punish the athlete, training harder to try to "toughen" them up. In this situation, the outcome is an exacerbation of the sensation, which makes symptoms worse. This may result in the athlete breaking down. Clearly, that is not an ideal way to understand pain or to deal with pain or fatigue.
- 3) There is a third pathway, which I would like you to consider. This pathway recognizes that these sensations of pain and fatigue are associated with multiple factors. The trick with understanding pain and fatigue with your different athletes and patients is to identify which factors underpin those sensations. Sometimes, pain is not due to tissue damage and quite often fatigue does not mean you are leading to injury. These sensations could be due to the athlete's underlying beliefs or stress. As a practitioner, if you can identify where these sensations of fatigue originate, it allows you to educate your athlete. This way you will be able to maintain loads at the highest tolerable level for that individual. This will build an athlete (or patient) who is psychologically and physiologically more resilient and less vulnerable when it comes to load. Therefore, they will be more likely to produce a robust performance.

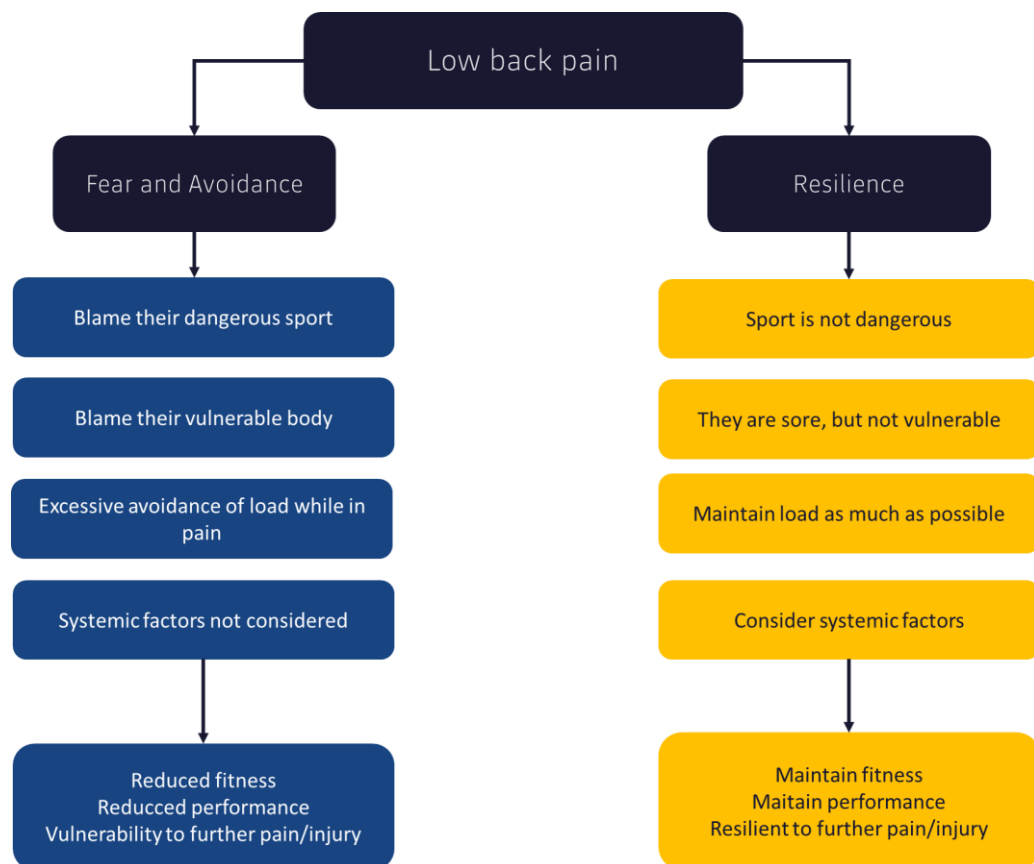
If you are a physical therapist or part of a medical team that has been presented with a certain sensation from a player, I would encourage you to first investigate this pain using a biopsychosocial approach. Try not to just focus on the tissue, use a broader approach that encompasses both a physiological state of your athlete or patient, and some of the social factors that could affect their pain.

Equally, when you are trying to develop resilience through training and you observe an athlete who experiences fatigue quite quickly, it should be considered that the fatigue could arise from factors other than "physical". Consider some of the psychological factors that could be affecting this fatigue, and the ability to tolerate it. If you go down the path where you look at pain as being a sensation driven by a danger, then you are left with a vulnerable and deconditioned athlete. If you go down a path where you believe that these sensations of pain or fatigue are driven by psychological or physical weakness, then you end up with a broken athlete. If you go down a path where you believe that these sensations of pain or fatigue are driven by psychological or physical weakness, then you end up with a broken athlete or thinking the sensations of pain and fatigue are just exacerbated.

From my point of view, go down in a middle pathway, trying to recognize these sensations of pain and fatigue, which can be due to multiple factors. If you follow the process, you end up with an athlete with robust performance who is physically and psychologically resilient.

A similar approach could be used when managing athletes with specific conditions (e.g. low back pain). Keeping athletes as active as possible and monitoring well-being factors (such as sleep, energy, mood and soreness) has been recommended as a method of minimizing the negative effects associated with low back pain in athletes (O'Sullivan et al., 2018).

Figure 3: How responses to managing low back pain in athletes can influence outcomes

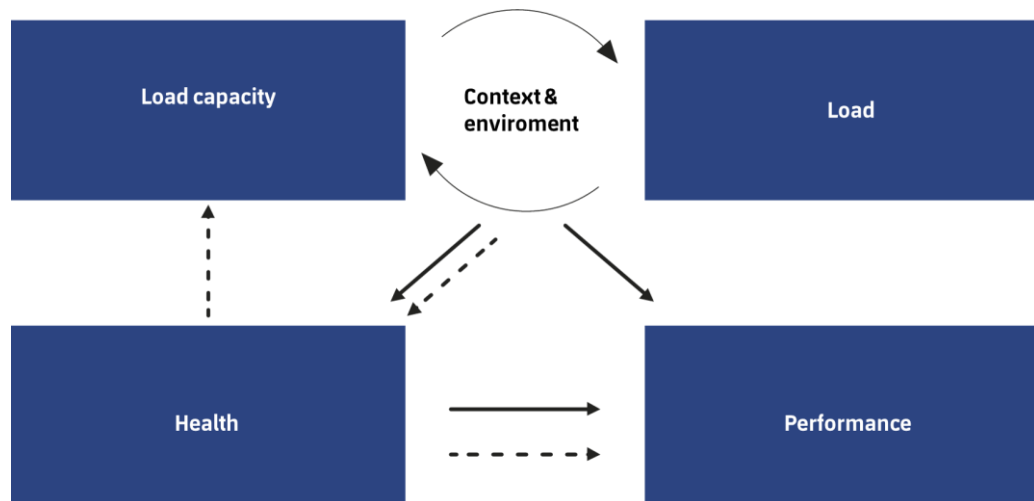


Source: O'Sullivan, O'Sullivan, Gabbett, O'Keeffe, 2018. P.1.

Finally, all sports medicine practitioners wish to develop robust athletes, capable of performing high workloads. In this respect, understanding the workload–capacity relationship is critical.

For every athlete, there is a maximal load that can be handled in a safe way. If load exceeds the athlete's capacity, this may result in injury. The load capacity of an athlete is influenced by age, fitness, and other qualities, and can change from day-to-day (i.e. the load capacity of an athlete is heavily influenced by the health of that athlete) (Figure 3, 4).

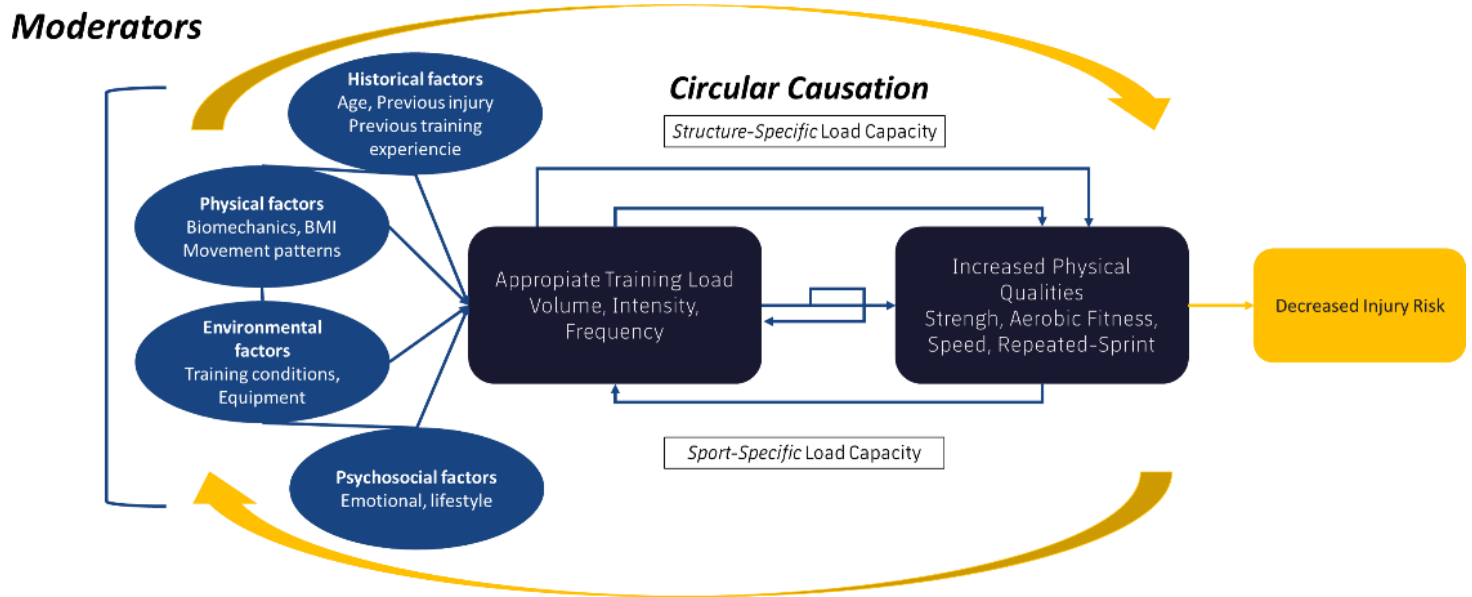
Figure 4: An integrative view on load



Source: Verhagen, Gabbett, 2018, p.1. Dotted lines represent negative relationships and solid lines represent positive relationships.

There are multiple factors determining physical capacity; therefore, in order to determine how much load athletes with different characteristics will tolerate, it is necessary to assess the relevant musculoskeletal system (MSK). In order to achieve high performance, athletes need to tolerate large amounts of training. However, tolerating high training load and improving physical capabilities requires specific capacities that depend on already having robust physical qualities. In this sense, appropriately progressed loading, in consideration of athletes load moderators such as age, stress and training history, provides a pathway for achieving robustness in athletes. (Gabbett, Nielsen, Bertelsen, Bittencourt, Fonseca, Malone, Møller, Oetter, Verhagen, Windt 2018).

Figure 5: Alignment of two different sports injury frameworks



Source: Gabbett, Nielsen, Bertelsen, Bittencourt, Fonseca, Malone, Møller, Oetter, Verhagen, Windt, 2018. p. 2.

The green boxes and arrows demonstrate how the workload–capacity relationship is moderated by historical, physical, psychosocial and environmental factors. The red boxes and circles provide an example of circular causation. Developing physical qualities requires high training loads, but tolerating high training loads requires well-developed physical qualities. BMI, body mass index. (Gabbett et al 2018. p.2)

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