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How Much? How Fast? How Soon? Three Simple Concepts for Progressing Training Loads to Minimize Injury Risk and Enhance Performance

Overload is a key principle of training—load must exceed capacity to improve performance. Small, systematic increases in load that are slightly greater than load capacity will improve tolerance of further load.¹⁶ However, if the applied load greatly exceeds load capacity, then tissue tolerance is exceeded and injury may occur.² This clinical commentary addresses key considerations for rehabilitation practitioners when helping an athlete prepare for the demands of competition.

Clinical Questions: How Much? How Fast? How Soon?

Sports medicine practitioners play a role in maximizing the positive and minimizing

the negative adaptations to training—too much training may result in excessive fatigue; too little training may mean athletes are underprepared for competition. Clearly, a balance exists between providing an adequate training stimulus to elicit performance benefits and minimizing the risk of injury. How can practitioners determine

how much training is too much? Following injury, how soon can training loads be progressed? How quickly can athletes return to competition?

The Floor, the Ceiling, and Time

When developing rehabilitation or performance programs, 3 key concepts are critical: the “floor,” the “ceiling,” and time. The floor represents the athlete’s current capacity, whereas the ceiling represents the capacity needed to perform the specific activities of the sport. It is possible to safely progress an athlete from the floor to the ceiling, as long as the athlete is afforded adequate time (**FIGURE** panel A).

The Challenges of Getting the Preseason Right

A challenge in most sporting environments is the time required to progress from the floor to the ceiling. If athletes’ training loads are progressed too rapidly, they will be at increased risk of injury.⁶ This scenario occurs all too frequently. Consider athletes who enter a very short training camp (or preseason period), or who have sustained an injury. If the gap between the current capacity and the required capacity is large, then the only way to progress from the floor to the ceiling is to rapidly increase training load to ensure that the athletes are prepared for the first competition game or return to play. Not-

• **BACKGROUND:** When progressing an athlete from rehabilitation to peak performance, load must exceed load capacity. When gradual, systematic increases in load are applied, load capacity will improve. However, if the applied load greatly exceeds load capacity, then tissue tolerance is exceeded and injury may occur.

• **CLINICAL QUESTION:** It is well established that a balance exists between providing an adequate training stimulus to elicit performance benefits and minimizing the risk of injury. How can practitioners determine how much training is too much? Following injury, how soon can training loads be progressed? How quickly can athletes return to competition?

• **KEY RESULTS:** When developing rehabilitation or performance programs, 3 concepts are critical: the “floor,” the “ceiling,” and time. The floor represents the athlete’s current capacity, whereas the ceiling represents the capacity needed to perform the

specific activities of the sport. A challenge in most sporting environments is the time required to progress from the floor to the ceiling. If athletes’ training loads are progressed too rapidly, they will be at increased risk of injury and underperformance.

• **CLINICAL APPLICATION:** Rehabilitation practitioners should consider and plan the appropriate amount of time required to progress from the floor (eg, rehabilitation) to the ceiling (eg, return to performance). The resilience and robustness that come from training take time, and different physical capacities will adapt at different rates. Progressive, gradual, and systematic increases in training load allow athletes to safely progress to the ceiling, reducing injury risk, improving availability, and enhancing performance. *J Orthop Sports Phys Ther* 2020;50(10):570-573. Epub 15 Nov 2019. doi:10.2519/jospt.2020.9256

• **KEY WORDS:** injury prevention, load, rehabilitation, strength and conditioning, training, workload

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withstanding the fact that athletes with poorer physical capacities^{9,11} and musculoskeletal dysfunction¹⁴ are at increased risk of injury, training in this manner is associated with a high risk of injury⁶ and poor performance¹⁰ (FIGURE panel B). Coaches can take more time to safely progress athletes to higher training loads and prepare them for the ceiling, but coaches do not have infinite time. Equally, if an inadequate training stimulus is applied, then the athlete is at risk of being underprepared, underperforming, and reinjury.

How Does One Help Athletes Safely Progress From the Floor to the Ceiling?

The demands of elite performance are constantly evolving; in general, the complexity and physicality are increasing every year.¹ Reducing the ceiling is not a realistic option to help athletes avoid injury and perform well. One option is to take more time to bridge the gap between the floor and the ceiling, although most coaches will be less than impressed if their best athletes are not fit enough to compete in the first game of the season or spend extended periods of time in rehabilitation

(FIGURE panel C). What if we could buy more time prior to the official start of the preseason? If athletes performed a minimum volume of training prior to returning from an extended break, this would have the effect of artificially increasing the length of the preseason period, minimizing the detraining effect induced by the offseason, thereby ensuring that progression to the ceiling was gradual and systematic (FIGURE panel D).

Progressing athletes, of any performance level, from the floor to the ceiling is further complicated when the athlete returns to preseason training in a severely deconditioned state or following offseason surgery. In these examples, the athlete's current capacity is inadequate to sustain normal training loads; rather than having an adequate floor, the athlete's capacity is more like "the basement" (FIGURE panel E). This situation can also occur when athletes are injured; local tissue capacity can immediately decrease, resulting in a reduction in the floor. In this respect, given the same amount of time, progressing the athlete from his or her current capacity to the ceiling would

require rapid changes in training load, in turn increasing injury risk.

Another solution to ensure that athletes are safely progressed from the floor to the ceiling is to raise the floor (FIGURE panel F)—to ensure that when athletes are taking an extended break or enter rehabilitation, they do not allow their physical capacity to fall to the basement. The benefit of raising the floor is that it also provides athletes the opportunity to develop greater load capacity than previously may have been possible (perhaps reaching "the penthouse") (FIGURE panel F). Preparation for sporting activities involves year-round management, monitoring, and manipulation of training load, with an understanding that the ceiling is somewhat of a "moving target"²—different capacities will require development depending on the specific phase of the season and on the factors limiting performance for individual athletes.

What Can Rehabilitation and Performance Staff Do to Help Athletes Achieve Their Performance Goals?

Athletes participate in sport for many reasons, which may differ between elite and

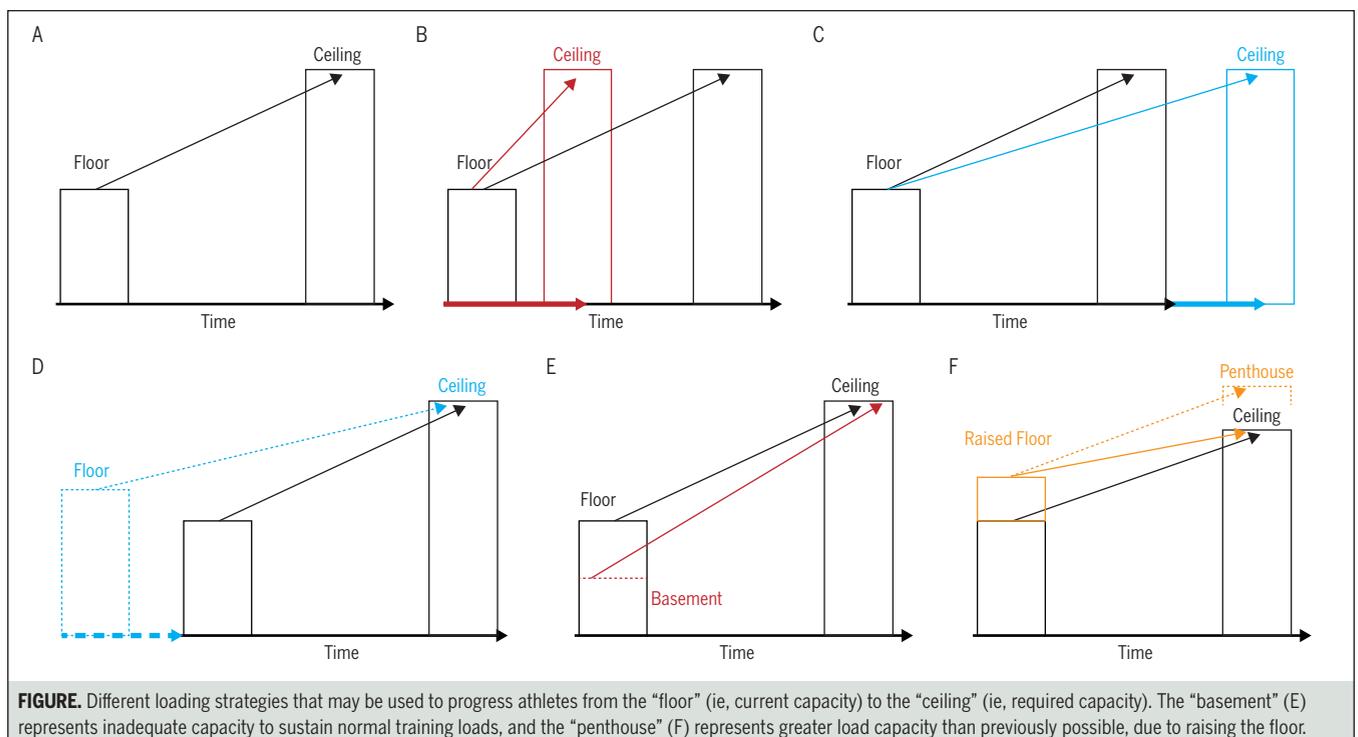


FIGURE. Different loading strategies that may be used to progress athletes from the "floor" (ie, current capacity) to the "ceiling" (ie, required capacity). The "basement" (E) represents inadequate capacity to sustain normal training loads, and the "penthouse" (F) represents greater load capacity than previously possible, due to raising the floor.

[CLINICAL COMMENTARY]

nonelite competitors. Whether competing at an elite or nonelite level, athletes strive for continual improvement and to achieve their personal best performances. To achieve high-level performance, the load capacity of athletes must be adequate to meet the demands required of competition. Athletes cannot perform if their current capacity is well below the capacity required of their sport. Equally, athletes cannot perform if they are injured.

Taking the concepts of the floor, ceiling, and time, there are at least 5 simple ways rehabilitation and performance staff can minimize the risk of injury and give athletes the best chance of achieving their performance goals (TABLE).

Summary: From Risk to Resilience

Training loads can have positive and negative effects. The risk of injury increases with rapid changes in training load. However, not all training load is bad—when prescribed appropriately, it can create resilient and robust athletes, capable of withstanding the high loads of competition and thriving in the most de-

manding passages of play. Systematically increasing training loads, and identifying factors related to load tolerance, not only lowers the risk of injury but also allows athletes to progress to higher training loads typical of those required for elite performance.¹² Importantly, once athletes have reached these high training loads, they are at reduced risk of injury and have greater likelihood of achieving their performance goals—loading allows athletes to withstand further load. ●

KEY POINTS

FINDINGS: This clinical commentary addresses key considerations for rehabilitation practitioners when helping an athlete prepare for the demands of competition. Rehabilitation and reconditioning programs should prepare athletes for the most demanding passages of competition. This will ensure that (1) athletes are able to perform the high-intensity tasks that often determine the outcome of the game, and (2) athletes are at lower injury risk when performing these activities.

IMPLICATIONS: These findings highlight the importance of maintaining an adequate training load (floor) during the offseason and while injured. Preparation for sporting activities involves year-round management, monitoring, and manipulation of training load, with an understanding that the ceiling is somewhat of a “moving target”—different capacities will require development depending on the specific phase of the season and on the factors limiting performance for individual athletes.

CAUTION: Very young and older athletes, and those with a long injury history, poor training history, musculoskeletal deficiencies, and lower strength and aerobic fitness, may have poorer tolerance of rapid increases in training load, while other biomechanical and psychosocial factors can also impact load capacity. Along with gradual loading progressions, a comprehensive assessment of the sport-specific (eg, strength, aerobic fitness) and tissue-specific (eg, musculoskeletal) capacities is required to ensure training loads are progressed on an individual basis.

TABLE

FIVE WAYS TO ENSURE ATHLETES ARE WELL PREPARED FOR THE DEMANDS OF COMPETITION

Description

- 1 Maintain an adequate training load during the offseason³ and while injured. Loading during these periods raises the floor (or, alternatively, ensures athletes avoid the basement) and improves athletes' ability to tolerate load during the preseason and on return to competition
- 2 Identify the ceiling and ensure that training load is proportionate to competition demands.³ Various methodologies (including the use of wearable and video technologies) have been used to assess the sport-specific demands required at the ceiling.^{4,7,8,15} These may include (but are not necessarily limited to) peak running intensities,⁴ longest ball-in-play periods,⁷ and repeated-sprint¹⁵ and repeated-effort activity.⁸ If expensive technology is not available, practitioners are encouraged to access sport-specific literature to inform their training programs. The individual load capacities and the absolute competition demands will differ between elite and nonelite, adult and adolescent, and male and female athletes; training demands should also reflect these differences
- 3 Assess individual differences in training tolerance among athletes. Very young and older athletes¹⁴ and those with a long injury history,⁵ poor training history,¹⁰ musculoskeletal deficiencies,¹² and lower strength¹¹ and aerobic fitness¹³ may have poorer tolerance of rapid increases in training load. Furthermore, other physical (eg, biomechanical, movement patterns) and psychosocial (eg, emotional, lifestyle) factors can impact load capacity.⁵ It might be tempting to rapidly increase training loads in less fit athletes and those with musculoskeletal deficiencies. However, these are the athletes who are least likely to tolerate this type of training progression, and in turn most likely to sustain injury in response to this loading pattern. Along with gradual loading progressions, a comprehensive assessment of the sport-specific (eg, strength, aerobic fitness) and tissue-specific (eg, musculoskeletal) capacities is required to ensure training loads are progressed on an individual basis. It is here that sports medicine professionals (eg, physical therapists and strength-and-conditioning coaches) play a critical role
- 4 Identify and prepare for the most demanding passages of play. Training for the average demands of competition may mean that athletes are underprepared for the “worst-case scenario.”^{8,15} This may trigger at least 2 consequences: (1) athletes are unable to perform the high-intensity tasks that often determine the outcome of the game,¹⁵ and (2) athletes are at greater injury risk when attempting to perform these activities
- 5 Training programs require an understanding of the (1) physical demands of the sport, (2) physical capacities required to perform these activities, and (3) factors that limit performance on an individual basis. Coaches should consider and plan the appropriate amount of time required to progress from the floor to the ceiling. The resilience and robustness that come from training take time, and different physical capacities will adapt at different rates. Progressive, gradual, and systematic increases in training load allow athletes to safely progress to the ceiling, reducing injury risk, improving availability, and enhancing performance

STUDY DETAILS

AUTHOR CONTRIBUTIONS: Professor Gabbett is responsible for all concepts, practical applications, and conclusions presented in this paper.

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