

# INJURY PREVENTION AND PERFORMANCE ENHANCEMENT IN TEAM SPORTS

## TRAIN SMARTER *AND* HARDER

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### OVERVIEW

Training for team sports reflects a balance between the minimum training load required to elicit an improvement in fitness and the maximum training load tolerable before sustaining marked increases in injury. Previous studies of team sport athletes have reported a positive relationship between training loads and training injury rates, suggesting that the harder these athletes train the more injuries they will sustain. Consequently, the prevention of training-load related soft-tissue injuries in team sports has been relatively simple: if training loads exceeded a planned 'threshold', athletes were 'managed away' from potential injury. Despite the wealth of studies documenting

the relationship between training load and injuries, there is also emerging evidence to suggest that insufficient training may lead to increased injury risk. It has been shown that team sport athletes who perform less than 18 weeks of pre-season training prior to sustaining an initial injury are at increased risk of sustaining a subsequent injury, while athletes with poorly developed physical qualities are at increased risk of sustaining an injury. While injury prediction models may have sufficient predictive accuracy to warrant systematic use in an elite team sport programme, a fine balance exists between training, detraining and overtraining. These injury prediction framework constrain the amount of physical adaptation permitted

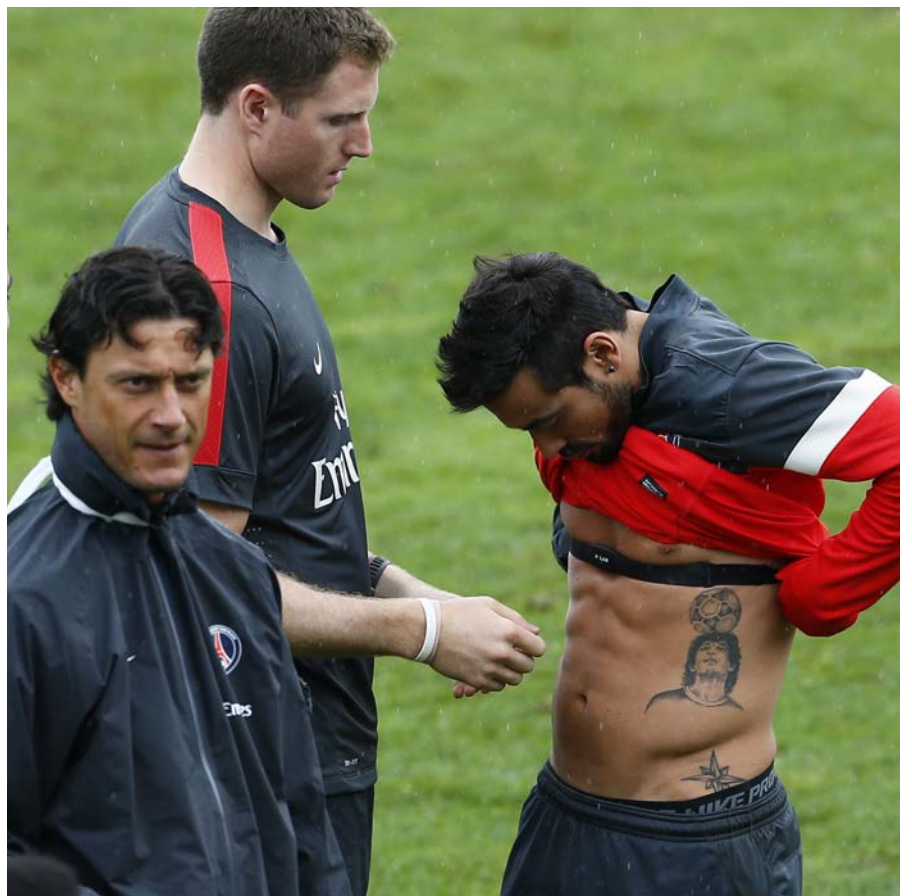
through training, by limiting the amount of physical work that can be performed. While allowing athletes to exert themselves above and beyond the planned training loads could identify those athletes likely to tolerate the intensity and fatigue of competition, the available evidence suggests that soft tissue injury is also likely to occur. Ensuring athletes reach minimum physical fitness standards, coupled with scientific monitoring of training loads to avoid overtraining and excessive fatigue, offers coaches a 'best practice' approach to minimise injuries in team sports.

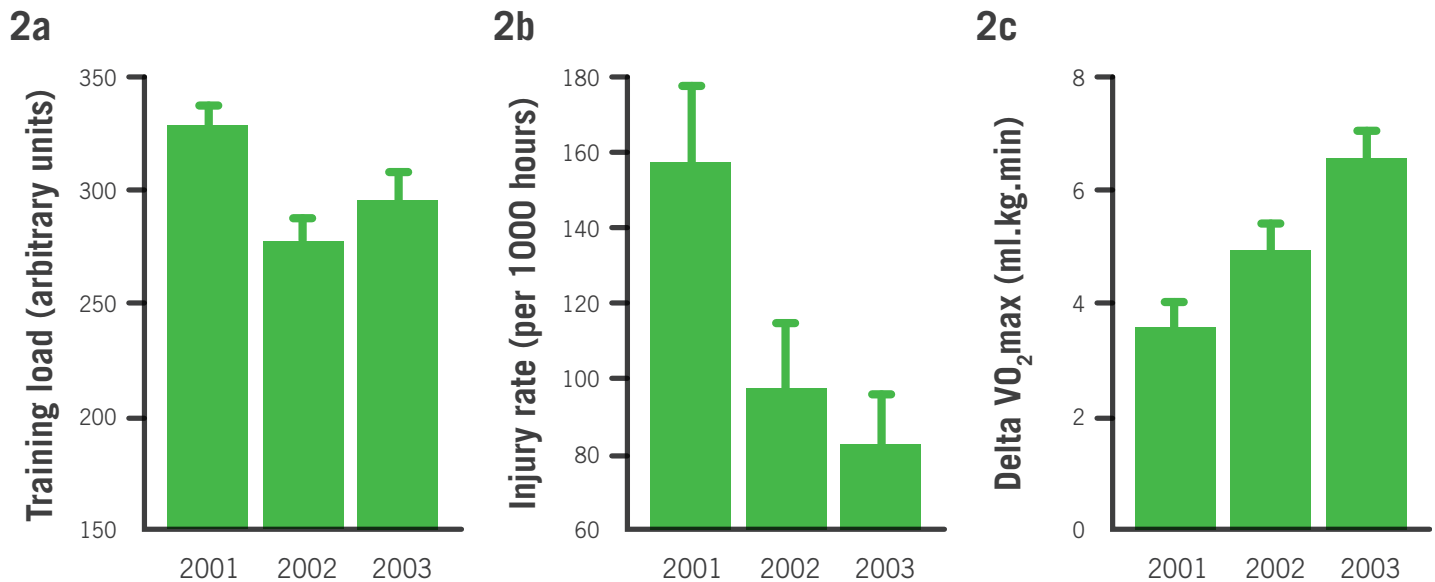
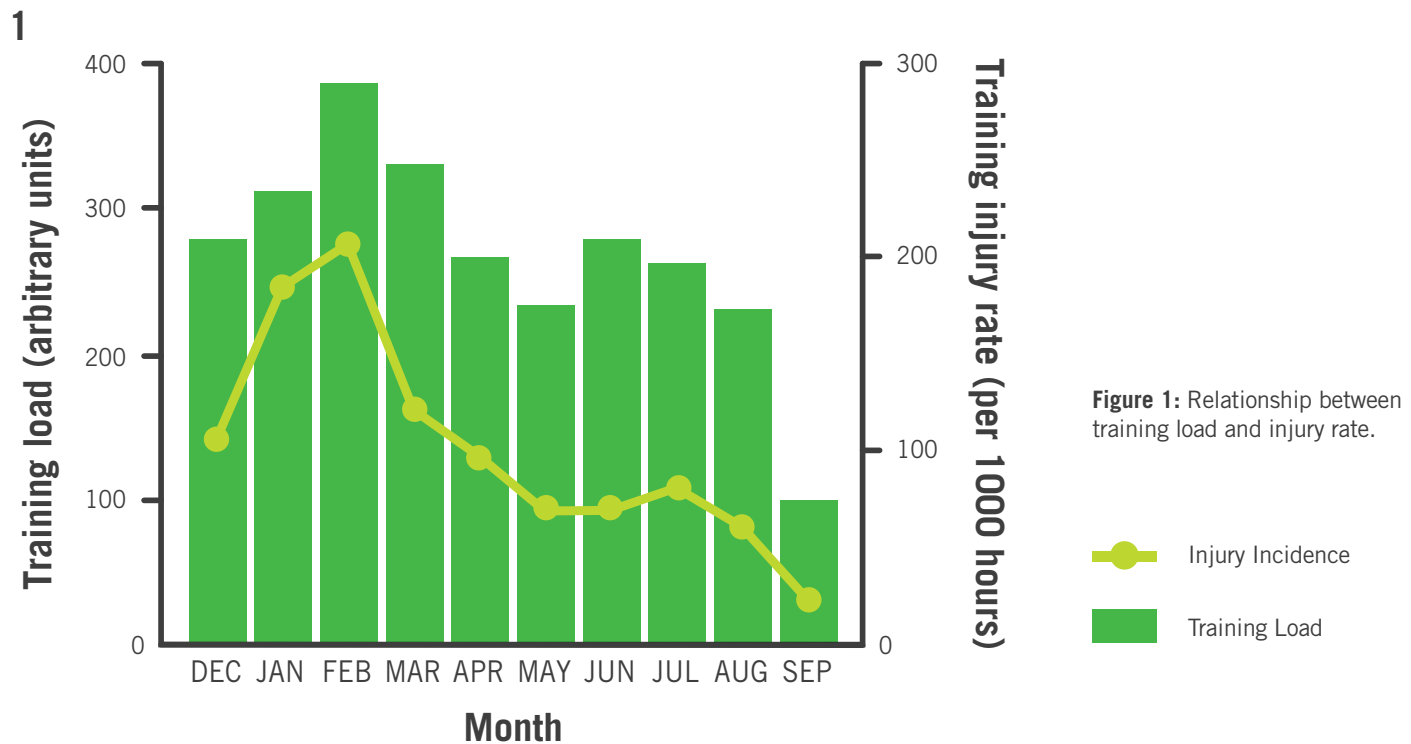
### TRAINING LOADS AND INJURY

Several studies have investigated the influence of training volume, intensity and



frequency on athletic performance, with performance generally improving with increases in training load<sup>1-3</sup>. However, it has also been shown that negative adaptations to exercise training are dose-related, with the highest incidence of illness and injury occurring when training loads are highest<sup>4,5</sup>. Previous studies of team sport athletes have reported a significant relationship ( $r=0.68$  to  $0.86$ ) between training loads and training injury rates<sup>5,6</sup> suggesting that the harder these athletes train, the more injuries they will sustain (Figure 1). Furthermore, reductions in training loads have been shown to reduce training injury rates and result in greater improvements in aerobic power (Figure 2)<sup>7,8</sup>. This evidence, combined with the importance of having





**Figure 2:** Influence of reductions in training loads on injury rates and physical performance.

the maximum number of athletes free from injury and available for selection in as many games as possible throughout the season, has resulted in the development and application of injury prediction neural networks for high performance sport. The use of these neural networks has been well-documented within the media (e.g. AC Milan, Sydney Swans), although the scientific evidence supporting their use

is far from substantive. To date, only one study has been published documenting the use of an injury prediction model for non-contact, soft-tissue injuries in team sport athletes<sup>9</sup>. Athletes who exceeded the training load threshold were 70 times more likely to test positive for non-contact, soft-tissue injury, while athletes who did not exceed the training load threshold were injured 1/10 as often (Table 1)<sup>9</sup>.

Importantly, this study demonstrated that injury prediction models provided greater predictive accuracy than what was available through the 'intuitive expertise' of strength and conditioning staff<sup>9</sup>.

Despite the wealth of studies documenting the relationship between training load and injuries, there is emerging evidence to suggest that insufficient training may lead to increased injury

		ACTUAL STATUS	
		INJURED	NOT INJURED
PREDICTED STATUS	PREDICTED INJURY	<i>True positive</i> <i>n=121</i>	<i>False negative</i> <i>n=20</i>
	PREDICTED NOT INJURY	<i>False positive</i> <i>n=18</i>	<i>True positive</i> <i>n=1589</i>
		<b>SENSITIVITY</b> <b>87.1%</b>	<b>SPECIFICITY</b> <b>98.8%</b>
		<b>LIKELIHOOD RATIO POSITIVE</b> <b>70.0</b>	
		<b>LIKELIHOOD RATIO NEGATIVE</b> <b>0.1</b>	

**Table 1:** Accuracy of a model for predicting non-contact, soft-tissue injuries in team sport athletes (Reproduced from Gabbett<sup>9</sup>.) True positive=predicted injury and athlete sustained injury, false positive=predicted injury but athlete did not sustain injury, false negative=no injury predicted but athlete sustained injury, true negative=no injury predicted and athlete did not sustain injury, sensitivity=proportion of injured athletes who were predicted to be injured, specificity=proportion of uninjured athletes who were predicted to remain injury-free, likelihood ratio positive=sensitivity/(1 - specificity), likelihood ratio negative=(1 - sensitivity)/specificity.

risk. It has been shown that team sport athletes who perform less than 18 weeks of pre-season training prior to sustaining an initial injury are at increased risk of sustaining a subsequent injury, while athletes with poorly developed physical qualities are at increased risk of sustaining an injury<sup>10,11</sup>. Furthermore, data from our laboratory has also shown that athletes with well-developed upper-body strength and prolonged high-intensity intermittent running ability were at reduced risk of sustaining an injury<sup>12</sup>. While injuries are often implicated in reductions in playing performance, it is not clear whether the poor playing performance is the cause or the effect of the high injury rates. Indeed, coaches often lament their high injury tolls when their teams are not playing well and muse over their low injury tolls when their team is winning.

#### THE INJURY PREVENTION AND PERFORMANCE ENHANCEMENT CONTINUUM

Injury prevention and performance enhancement are often viewed as two distinct pursuits at different ends of

a training continuum. Physiotherapy and conditioning staff often appear to have different agendas. On one hand, physiotherapists see the value in monitoring training loads to reduce injuries, while conditioning staff would like athletes performing high training loads to produce positive physical adaptations, and to prepare athletes for the demands of competition. Clearly, training for team sports reflects a balance between the minimum training load required to elicit an improvement in fitness and the maximum training load tolerable before sustaining marked increases in injury rates<sup>5</sup>. This conflict therefore, creates a unique challenge for the applied sport scientist providing advice to coaches to minimise injuries and maximise performance.

To date, the prevention of training-load related soft-tissue injuries in team sports has been relatively simple: if training loads exceeded a planned 'threshold' then athletes were 'managed away' from potential injury. However, it is probable that if training loads are continually reduced to decrease the risk of injury that a secondary complication of detraining may develop. Athletes may

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TIPS FOR PREVENTING TRAINING LOAD RELATED INJURIES	
RESEARCH EVIDENCE	TRAINING TIP
<i>Poor fitness is a risk factor for injury</i>	<i>Ensure athletes reach minimum standards of physical fitness before prescribing intense training loads</i>
<i>Gradually and progressively overload the training of athletes</i>	<i>Monitor both external (i.e. the 'work' performed using distances run or weight lifted) and internal (i.e. the 'response' to that work using heart rate or ratings of perceived exertion) training loads</i>
<i>Well-developed physical fitness protects against injury</i>	<i>Systematically cycle high training loads within the training programme to promote physical resilience in athletes</i>

**Table 2:** Tips for preventing training load related injuries.

not have the required physical qualities to tolerate the physiological demands of competition, playing performance will suffer and, most likely, injury incidence will rise. Equally, given that well-developed physical qualities have been associated with decreased injury risk<sup>10,11</sup>, it is probable that 'managing athletes away' from injury may inadvertently increase the risk of injury.

**'managing athletes away' from injury may inadvertently increase the risk of injury.**

While injury prediction models may have sufficient predictive accuracy to warrant systematic use in an elite team sport programme, a fine balance exists between training, detraining and overtraining. Training programmes must be physiologically and psychologically

appropriate to allow athletes to cope with the demands of competition<sup>13</sup>. Indeed, exposing the brain to hard physical work and fatigue on a regular basis appears to improve the body's ability to cope with fatigue – physically intense training improves physical fitness but, equally as important, it also increases the mental resilience of athletes<sup>14</sup>. Physically (and mentally) unfit athletes are more likely to pace themselves as a self-preservation and protection strategy<sup>14</sup>. If athletes have not been exposed to hard physical work on a regular basis, the brain instructs the body to stop exercise earlier to prevent exhaustion<sup>14</sup>. With this in mind, a growing argument from coaches is that high training loads (note, not excessive) should be prescribed to determine which athletes are most susceptible to injury under physically stressful situations (these athletes most likely won't tolerate the intensity and fatigue of competition), and which athletes are not susceptible to injury under physically stressful situations (these athletes are more likely to tolerate the intensity and fatigue of competition). Most elite sporting teams have a limited number of athletes available in their playing roster. Therefore, the obvious challenge

for high performance staff involved in the development of strength and conditioning programmes (i.e. coaches, applied sport scientists, strength and conditioning staff and physiotherapists) is to design and deliver a training stimulus that is based on sound scientific principles.

#### CONCLUSION

Regular training promotes both physiological and neural adaptations that permit athletes to tolerate the physical and mental demands of regular, intense competition. While recovery is important to physiological adaptation, persistent reductions in training loads is likely to result in detraining, poor playing performance and paradoxical increases in injury rates. Injury prediction models have been shown to be successful in reducing the incidence of soft-tissue injury, however these framework constrain the amount of physical adaptation permitted through training by limiting the amount of physical work that can be performed. While allowing athletes to exert themselves above and beyond the planned training loads could identify those athletes likely to tolerate the intensity and fatigue of competition, the available evidence



suggests that soft tissue injury is also likely to occur. Ensuring athletes reach minimum physical fitness standards, coupled with scientific monitoring of training loads to avoid overtraining and excessive fatigue, offers coaches a 'best practice' approach to minimise soft-tissue injuries in team sports.

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