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Tracking Training Load and Its Implementation in Tactical Populations: A Narrative Review

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Key Words: Police, Military, Firefighters, Injury Prevention, Overload

Abstract: Tactical populations often participate in demanding physical training and perform strenuous workplace tasks, increasing injury risk. Mitigating injury risk is vital for maintaining trained personnel and should be a focus for tactical populations. One such method, tracking training load, has not been studied in-depth in tactical populations, despite documented effectiveness in elite sport. Most injuries to tactical personnel are overuse in nature and therefore may be prevented by optimizing training load.

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Introduction

Tactical populations are inclusive of, but not limited to, firefighters, police officers, and military personnel. Despite intermittent sedentary occupational tasks, especially police, (e.g. sitting in a patrol car [1]), tactical populations are required to perform tasks in stressful, and physically demanding situations [1]. This requirement often occurs while these personnel are carrying external loads, such as body armor and other personnel protection equipment [2]. Externals loads often vary and can range from 10kg in general police units [2], to 22kg in firefighters [3], while military personnel can carry average loads of 45 kg [4]. The addition of these loads not only causes an increase in metabolic demand [5], but can also lead to an increased risk of injury [6]. In police in particular, these loads further increase upon admission to specialist units [7,8]. Specialist police units, due to the requirement to carry additional equipment, such as riot shields and more substantial body armor, can be required to carry loads ranging from around 20kg [9] to 40 kg [10], which can cause even greater metabolic demands and higher risk of injury [6,11].

While each tactical population undergoes high physical stress that increases the risk of injury , the stresses placed on each of these tactical populations vary. Firefighters are typically faced with significant environmental hazards [12], military personnel are more likely to carry considerably heavier loads [13], and police officers are more likely to encounter resistant and uncooperative suspects [14]. Furthermore, and apart from the nature of the occupation itself, sport and physical training can be a leading source of injury in tactical populations [15]. However, sport and physical conditioning are integral to many tactical populations, with appropriate physical training required to increase occupational capability either directly (increased task performance) or indirectly (improved general health) [2,16].

Given the high injury risk of tactical populations [6], it is vital that injury mitigation strategies are researched. One such strategy that has not been explored in depth is the monitoring and optimization of training load (TL), despite documented effectiveness in elite sport [17]. The purpose of this narrative review is to explore the potential benefits and limitations of tracking TL in tactical populations with the intent of reducing injury risk while maintaining or increasing fitness. This review will summarize information regarding injuries in tactical populations, and the potential usefulness of optimizing training loads. Information regarding training load, how it can be measured, as well as previous research examining the relationship between training load and injuries, fitness, and performance will also be presented.

Injuries in Tactical Populations

With differing occupational and physical training demands, the location and incidence of injuries experienced can vary; however, injury types are known to be similar across these populations [18]. In a study by Taylor et al. [19] it was found that firefighters suffered injuries at a rate of 177 per 1000 full-time employees per annum. Firefighters were most likely to suffer joint sprains and muscle strains, accounting for 66.5% of all injuries, followed by contusion/crush injuries, mental disorders, and open wounds. The most common sites of injury being the knee, lower back, shoulder and ankle [19].

In law enforcement, a critical review [18] found injury rates ranging from 240 to 2500 per 1000 personnel per annum, with multiple articles reviewed reporting the most common region of injury being the upper extremity (32.95% to 43.42% of injuries), while another stated the most common site was Other Unspecified sites (63.41%), followed by torso and back (20.49%). This review found the most common injury type to be sprains and strains (42.36% to 94.59%), followed by Other Muscle pains and Other Natures of injury [18].

With regards to military, incidence rates have been reported to range from 23 incidents, for active duty personnel, to 34 incidents, for reserve personnel, per 100 person-years of active service, with "minor personal injury" being the most common for both groups [20]. Their injuries were found to most commonly be overuse or stress syndrome, muscle strains, ankle sprains, and stress fractures which typically occurred at or below the knee [21].

Injuries in these populations can have serious downstream effects, such as a temporary or permanent loss of experience and skills, or even worse, higher workforce strain due to the requirement of covering injured personnel [22,23]. Injuries to tactical populations can also result in high monetary costs to treat and, if needed, replace (e.g. temporarily or permanently) injured personnel, placing an increased financial burden on the organization [22,23]. For example, the financial cost for medical care and salaries of soldiers in the United States (U.S) Army is estimated to be about $1.5 billion (USD) per year [23]. By exploring causative factors for these injuries, and implementing programs to reduce these injuries, some of these negative effects may be mitigated.

Numerous causative factors have been studied in tactical populations, such as poor metabolic fitness levels [24], high body mass index (BMI) [25], history of previous injury [26], and smoking [27]. In 2000, Kaufman et al. [21] discussed how training load (TL) could potentially be another causative factor, and how optimizing TL may decrease injury risk while promoting fitness in a military population. Previous research has shown that an excessive increase in physical activity is linked with an increased injury risk [26,28]. In a study by Trank et al. [28], it was found that U.S. Navy Recruits who completed the highest running mileage (>25 miles (40.23 km)) also had a significantly higher risk of injury, with no significant change in 1.5 mile (2.41 km) run performance. While the need to track TL is evident, a cursory search of the literature shows that little research has been performed to date with regards to quantifying TL in tactical populations. In fact, a systematic review found only two articles regarding TL tactical populations, but these articles focused mainly on increases in physical activity [29]. Despite minimal information pertaining to the tactical environment, it has become a popular tool in elite sporting teams. Similar to the study by Trank et al. [28], a medium effect size (r = 0.59; CI and *p* not reported) was found between higher running distances during a given month in endurance runners and number of injury days the following month [30]. By implementing methods that track TL, sporting teams are able to adjust training stimuli at an individual level, and on a weekly basis to reduce injury risk and also increase performance [17]. Given the significant costs associated with injuries, and the increased risk of injury in tactical populations caused by higher physical loads, a means of monitoring TL and their associated effects on injury risk could prove beneficial for tactical populations [26,28].

Training Load

The International Olympic Committee consensus statement defines TL as a cumulative amount of stress on an individual from single, or multiple, training sessions over time [31]. TL is typically measured using either external methods (e.g. total distance run, or speed) or internal methods (e.g. heart rate or rating of perceived exertion) [17]. External load (EL) has previously been defined as "any external stimulus applied to the athlete that is measured independently of their internal characteristics" , while internal load (IL) is "load measurable by assessing internal response factors within the biological system, which may be physiological, psychological, or other" [31]. Tracking EL can communicate the total amount of work completed, while information yielded from IL typically conveys how the individual is adapting physiologically [31]. Emphasis is placed upon the importance of utilizing both measures, as together they provide a more comprehensive view of the physical stress an individual is experiencing [17]. For example, an individual may perform the same overall output (as measured by EL, such as distance) on two different days, however their ability to respond to this output (as measured by IL, such as heart rate) may have changed. Potential differences between responses to training may provide insights as to whether the individual is in a state of 'readiness' and able to tolerate high TL or 'fatigue' and potentially at an increased risk of both injury and decreased performance [32].

Rapid changes in both EL and IL have previously been linked to higher risk of injury in the literature [17]. One example shows 40% of injuries were the result of a rapid change in TL in the preceding week in Australian football [33]. Factors further compounding the issue were proposed by Gabbett that athletes who over-train or under-train are at higher injury risks [17]. These issues have led to the development of monitoring both IL and EL over the short-term (acute, typically 1 week) and long-term (chronic, 3-6 weeks) periods, and weekly changes to track overall and rapid changes in workload [17]. There are various methods of measuring TL reported in the literature, each of which have benefits and limitations; the following sections will explore these various methods.

External Measurements of Training Load

EL is measured in an attempt to define the total work completed [31]. EL measurements can include distance run, tracking volume-load during strength training sessions, and number of sprints completed, among others [17]. Measuring EL has been aided with the advent of Global Positioning System (GPS) devices and the subsequent accessibility of these relatively low cost devices, which allow for accurate measurement of the above variables [34]. The use of GPS to measure EL is common practice in many professional sports including Australian Football League (AFL), rugby league, and soccer [34]. Research has shown the effectiveness and validity of GPS to measure EL in these sports [35,36]. However, there are concerns of the precision of GPS with regards to high rates of change in velocity and while GPS technology has seen an increase in data accuracy, there are still some limitations in regards to very high speed running (>20 km/hr) [37]. While there may be potential validity issues at high speed, has been estimated that the speed of military marches while on level ground is 5.3 km/h [38], which may allow GPS devices to accurately record data. Practitioners and clinicians may be able to utilize these devices effectively during training stations and while personnel are on duty and be able to record distance covered.

Another concern with GPS units is the high cost associated with them [39]. Research has shown that utilizing GPS on a cellular phone may provide an alternate way to measure distance, as the accuracy between the two was comparable with an approximately 3% variation identified when measuring distance and average speed [40]. Of importance, this study compared the cellular device to GPS devices with lower sampling rates and more limited accuracy, therefore more variation may exist when comparing cellular devices to GPS devices with higher sampling rates [40]. Utilizing cellular phones or fitness watches may be an alternative tool for tactical practitioners to pursue if the acquisition of GPS units proves too costly. One key area of difference between tactical populations and athletics may be potential security concerns and GPS units. Recently data collected by a wearable GPS unit showed the location of a secure U.S. military facility as discussed in an article published by Liz Sly in the Washington Post on January 29th, 2018. Tactical personnel will need to ensure that the devices they are using are secure and will not lead to similar issues.

Apart from GPS devices to track EL, there are other, more cost-effective methods. One such method is utilizing volume-load per the NSCA's definition (number of repetitions x external load [kg]), a convenient method as it does not require any additional equipment [41]. Whereas repetition-volume is the total number of repetitions performed during a workout, volume-load also incorporates the weight lifted and is likely better at quantifying the total amount of work completed [41]. For example, if a police officer completes 4 sets of 12 repetitions of bench press at 100 kg, their volume load will be 4800 "work units", while their repletion-volume will be 48. Volume-load can be used during physical training sessions, when tactical personnel are participating in strength training, to track and adjust based on previous and future loads. More complex methods have that determine mechanical work during resistance exercises may be utilized during strength sessions; however these require additional devices, such as force places, accelerometers, and inertial sensors [39]. While these devices have been shown to have good reliability and validity, they are expensive methods to implement and may not be accessible in all populations [39].

Another method track TL that may be of benefit when training large groups include measuring total running distance, or weight lifted utilizing subjective measures [39]. This method may be particularly useful in military populations upon return from patrol, due to their ability and operational requirement in tracking distances covered. In support of subjective measures, a systematic review on endurance athletes [30] on endurance runners found a medium effect size ($r=0.59$; CI and p not reported) [42] ($r^2=0.36$, CI and $p=0.001$) [43] between subjective reports of high total training distance and rates of injury or pain.

Lastly, there are other methods which have been used to track TL, though these are unlikely to be used in tactical populations due to logistical concerns and time constraints [39]. For example, despite time motion analysis being found to be effective in tracking fatigue in professional soccer players [44], it is unlikely that tactical populations would have the time or resources to record and perform film review of all training and occupational settings. Similarly, despite training diaries being used to track load, concern exists with regards to the accuracy of self-reporting [45]; especially if trying to recall events that occurred at the beginning of long hours of training [46].

Internal Measurements of Training Load

While EL measurements attempt to measure the amount of work done, IL measurements are more focused on the individual's response to the TL [17]. Numerous methods to track IL including heart rate (HR), session Rating of Perceived Exertion (sRPE), and questionnaires. Historically heart rate (HR) has been used to track IL due to an almost linear relationship with VO_{2max} [47]. This allows practitioners to quantify how each individual is responding to the imposed work load [48]. Likewise, blood lactate is related to VO_{2Max} and may be used to track training load and intensity [49]. As this measure has also been linked to load carriage performance in soldiers [50], it may be a useful tool to track intensity and performance. While these methods are accurate, they can be invasive and may require a high level of technical skill or the necessary technology to be performed, and therefore may not be feasible in a tactical population. As an example, while measuring HR at one set point is a simple task, requiring only a stopwatch, measuring and recording HR consistently over a period time may require more sophisticated technology, such as HR chest straps [39]. Utilizing fitness watches to measure heart rate may be an alternative; however, research has shown that these devices are less accurate at higher heart rates compared to chest straps [47]. Incorporating the Rating of Perceived Exertion (RPE) scale may be useful, as it is both low cost and easy to administer, especially to larger groups [48].

The RPE scale (Figure 1) was designed by Borg [51], as an attempt to measure the level of physical strain during activity. It was proposed by Foster et al. [52], that the this scale can be modified to a 0-10 scale (Figure 2), and a score given at the end of activity. This score can then be multiplied by the duration of the session for a measure of TL, called session RPE or sRPE [52]. For example, if an athlete completed a 60-minute weight lifting session, and reported the session was a 6 on the modified RPE, the athlete would have a sRPE of 360 (60 x 6) arbitrary units (AU). Previous research has shown that this method correlates well with blood lactate concentration and heart rate after exercise [53,54]. In a study by Gabbet et al. [53] the correlations between sRPE and both heart rate and blood lactate concentration were found to be r=0.89 and r=0.86 respectively, showing a high correlation between measures. These results suggest sRPE, using the modified scale, can be used to accurately measure IL by tactical practitioners after a variety of activities, such as physical training sessions. While tactical personnel do tend to perform physical activity throughout the day, previous research has confined the “session duration” to fixed training hours experienced each day (0600 – 2200), allowing comparison of RPE scores across days [55]. There was good agreement between RPE and recorded training impulse (TRIMP) scores (R^2= 0.57-0.77), showing that this may be a valid method to compare RPE scores in tactical populations though further research will be necessary [55].

Training impulse (TRIMP) was developed by Bannister et al. [56] as a method of quantifying a training session. This method is calculated by using training duration, maximal heart rate, resting heart rate, average heart rate, and a sex-dependent exponential coefficient [56]. This equation was further modified by Manzi et al. [57], by introducing an individual based exponential factor. The modification was done in attempts to better determine individual physiological response to exercise [57]. The use of this equation, $TRIMP_i$, has been shown to be a valid method to track fitness and performance changes in long distance runners [57] as well as aerobic fitness in team sport [58]. Another method of calculating TRIMP, Edward's TRIMP, multiples the duration accumulated in five HR zones (zone 1 = 50-60% HR_{Max}, zone 2 = 60-70%, zone 3 = 70-80%, zone 4 = 80-90%, and zone 5 = 90-100%) by a coefficient for each zone and then sums the result [59]. This equation was utilized in military training and found agreement (R^2= 0.34-0.49) between TRIMP and distance, suggesting this may be a valid method to calculate internal load, though it may be limited due to the variable training activities and prolonged time frames found in military populations [55]. Utilizing TRIMP may be an effective means track IL over time in tactical populations, particularly Edward's TRIMP as an individual factor will not need to be calculated and it accounts for activity completed in various HR zones.

Heart rate variability (HRV), the beat-to-beat fluctuation of resting HR, is another measure of IL [60]. The autonomic nervous system (ANS) plays a crucial and complex role in maintaining the body's homeostasis [60]. While the ANS is involved in many different mechanisms, its ability to control HR and role in overuse injuries is a key factor when it comes to monitoring TL [60]. Examining the physiology of this relationship is beyond the scope of this article, but to paraphrase, using the parasympathetic and sympathetic nervous systems, the ANS is able to increase and decrease HR, and release chemical mediators in response to injuries, including overuse injuries [61]. HRV aims to indirectly measure the ANS by analyzing the change in time between heart beats during resting HR [60]. Significant changes from an individual's baseline may show that the ANS is under stress, potentially due to overtraining or the onset of an overuse injury [60]. Given the many roles of ANS, changes in HRV may be indicative of other types of stress than overuse injuries. However, this may be beneficial to those working with tactical populations given the amount of non-physical stress, such as psychological, that are experienced [62,63]. Currently, research is inconclusive about the relationship between HRV and overtraining, with evidence both for and against [63-65], but this may be a valuable tool to measure the amount of stress, both physical and other, that are being experienced by tactical personnel.

Various wellness questionnaires, which examine factors such as sleep quantity and sleep quality, feelings of fatigue and soreness, have also been used in an attempt to measure IL [39]. One such survey, the Recovery-Stress Questionnaire for Athletes (RSQ), was created to identify the extent of an athlete's physical and mental exhaustion and recoverability [66]. This questionnaire consists of 19 subscales that discuss various topics such as general and emotional stress, burnout, physical complaints and physical recovery among others [66]. The survey is periodically given out, with one study administering the survey four times during a three week period [67]. It has previously been shown to be able to track the general parameters of training stress of athletes across multiple sports [66], though it is unknown how this scale will apply to those in tactical populations or if they will require a more specific questionnaire for their demands. However, given the high amounts of psychological stress experienced by tactical populations [62], the RSQ may be provide useful information regarding not only the physical, but emotional state of personnel.

Another questionnaire that attempts to quantify recovery is the total quality recovery process (TQR) [68]. This process is divided into two parts, the first being a perceived recovery scale (TQR perceived) (Figure

1). Structured like the Borg RPE Scale, this 6-20 scale attempts to measure an individual's perceived recovery at the end of the day [68]. The second aspect of TQR (TQR action) is a more objective measure of recovery where individuals earn recovery points (20 points maximum) based on nutrition and hydration (10 points maximum), sleep and rest (4 points), and relaxation and emotional support (3 points) (Figure 3) [68,69]. As this method combines both perceived and an objective score for recovery, it may be useful in tactical populations, though future research will be needed to validate this process.

Insert Figure 1 Here

Insert Figure 2 Here

Insert Figure 3 Here

Lastly, while the above methods may be more complex, previous research in military populations has examined muscle soreness and physical fatigue using 0-10 scales [55]. While this study, did not examine these measures in relation to injury, these simple questions may be able track how tactical personnel are managing their current TL [55]. Various questionnaires exist that track both the physical and psychological stress and recovery experienced by individuals [66,68]. Tactical practitioners can utilize these measures periodically to track their personnel. If measures such as these prove to be too time-consuming implementing muscle soreness and physical fatigue scales may be an alternative method to track IL [55].

Insert Table 1 Here

Acute:Chronic Workload Ratio

Acute:Chronic Workload Ratio (ACWR) is an attempt to provide a more complete picture of an individual's cumulative load by comparing an acute workload to a chronic workload and quantifying the changes over time [17]. As mentioned above, it may be the rate of change in load, more than the absolute load, that relates to injury risk [31]. The importance of rate of change in load can be historically seen through the 10% rule which states that increases in exercise frequency, duration, or intensity should be limited to 10% of the previous week [70]. While the timeframes may vary, in sports the acute workload is typically represented by one week, while the chronic load is a summation of the previous 3-6 weeks [17]. If the acute workload is greater than the chronic workload (signifying increases in training load), the ratio will be greater than one, and the individual will be in a fatigued state [17]. Conversely, if the acute workload is less than chronic workload, the ratio will less than one, and injury may be less likely however performance may plateau or decline with inadequate stimulus [17]. The chronic workload has also been called 'fitness' in the literature, while the acute workload has been called 'fatigue' [17]. Evidence shows that high chronic workload or 'fitness', may protect against spikes in acute workload or 'fatigue' [17,71,72]. In a study by Malone et al., it was found that a high chronic TL (4750 AU) measured by sRPE protected against injury from maximal velocity running [71]. In another study by Hulin et al. [72], it was found that a high chronic workload (>16095 meters covered) combined with a moderate ACWR (1.03-1.38; Relative Risk (RR)=6.2±2.2) resulted in a lower injury risk than low chronic workload (<16095 meters covered) combined with a moderate ACWR (1.03-1.38; RR=9.3±2.2). RR states how many times more likely an outcome will occur in an exposed group compared to a non-exposure group [73]. In the case of the Hulin et al. article [72], those who experienced a high chronic workload were 6.2 times more likely to experience an injury, while those in the low chronic workload were 9.3 times more likely to experience an injury. ACWR may be more appropriate to utilize than the 10% rule, as it is not a rigid law, but can be adjusted based on past training.

One limitation of the ACWR model is that it does not account for the decaying effects of fatigue and fitness over time, and therefore may be able to be improved [39,74]. A new method utilizing exponential weighted moving averages (EWMA), instead of rolling averages, was recently put forward by Williams et al [75]. This method attempts to account for the decaying effects by assigning a decreasing weighting for older values [75]. A study by Murray et al. [74] compared EWMA ACWR to rolling average ACWR and found that, while both models showed a significant increase in injury risk with high ACWR, EWMA was more sensitive to detect increases in injury likelihood at higher ACWRs. When compared with an ACWR of 1.0-1.49, a rolling average ACWR of 2.0 was shown to have a relative injury risk of 6.52 [4.83-8.80], a statistically significant finding. Utilizing the same comparison, but with EWMA, the relative risk increased to 21.28 [20.02-22.62] - demonstrating a much higher relative injury risk. Incorporating an EWMA ACWR over a rolling average ACWR may be a more sensitive and advantageous method [75].

Clinicians and practitioners can utilize ACWR with any of the above-mentioned variables. By incorporating ACWR with measures such as a total distance, sRPE, or volume load, practitioners may be better able to predict how well their personnel will respond to future programs. If knowing that over the last 3 weeks, personnel have only covered an average of 2000m per week, practitioners can calculate that covering 4000m will result in an ACWR of 2.00 and therefore increase injury risk (acute load divided by chronic load, or 4000m divided by 2000m). Practitioners can adjust their scheduled training sessions either based off previous work load or off current occupational demands (e.g. dismounted patrols) to keep personnel within a safe range.

While ACWR may be a useful tool for predicting injury risk, there are potential limitations affecting its validity. One such issue is the potential spurious correlations that may exist between ACWR and injury risk [76]. This is likely due to the fact that the acute load is used in the calculation of the chronic load, as the acute load is on both sides of the equation [76]. A second impacting factor is the confounding effect training schedule has on the ability of ACWR to predict injury risk [77]. This was calculated with regards to sporting teams, so it remains to be seen if this relationship exists in tactical population. However, though ACWR may be an effective method to calculate injury risk, it should not be solely relied upon by clinicians and practitioners.

The Association of Training Load and Injuries

Research has hypothesized that musculoskeletal injuries may be linked to adverse responses in TL [60], while specifically researched targets regarding TL and injury in the athletic domain have been studied. Research has shown that two week cumulative sRPE loads >3700 AU [78], and high three week running distances (73721 – 86662 meters) [36] are likely to increase injury risk in Australian Rules football players while studies across multiple sports have shown that ACWR ratios ranging from 0.8 – 1.3 may minimize injury risk while ensuring increases in fitness [35,72]. Utilizing either cumulative loads or ACWR provides information to medical staff and strength and conditioning (S&C) coaches which may assist with reducing injury risk and maximizing performance in tactical environments. It is unlikely that these numbers will be directly transferable given the differences that exist between the tactical and athletic domain, though it should be noted that members of tactical population regularly play sport [79,80].

The Associations of Training Load and Fitness and Performance

While TL may assist with mitigating injury risk, it also is related to fitness and performance. Fitness is a key requirement for tactical personnel and is associated with successful occupational task performance [2], reduced injury risk, [81] and mental health benefits [16]. However, while training to increase fitness is needed, it may pose a risk if not monitored correctly, as supported by findings that in military personnel, physical training and sports participation are leading causes of injuries [15]. Tracking TL may be able to ensure that tactical populations are training at a high enough intensity to increase fitness while not unnecessarily increasing risk of injury [17]. In AFL players, it was found that those who had completed high TL (1600-2000 AU per week) increased their 2km time trial compared to those who completed very high (>2000 AU per week), moderate (1250-1599 AU per week), and low (<1250 AU per week) TL as measured by sRPE [78]. In a study by Gabbett et al. [53], it was found that while increases in TL of 175 to 620

AU, as measured by sRPE, did not result in any increase risk of injury, it did result in decreased performances in agility. These results provide evidence that tracking TL cannot only influence injury risk, but fitness and performance as well. Given the inherent dangers tactical populations can encounter [7,82], decreases in performance or losses of fitness do not simply result in a lost game, but can have life and death consequences. By implementing a method of monitoring TL tactical populations can aim for, and train at a level that maximizes performance gains while minimizing injury risk [39,83].

While there are notable differences between tactical populations and elite athletes, the TL methodology used in elite sport may provide a template for tactical personnel. Preliminary studies in military populations show the associated increase in injury risk with increase in physical activity [26,28]. While these studies have shown the potential harmful impacts of excessive physical activity, modern methods such as sRPE, ACWR or any of the other various methods to track EL and IL used in elite sports [39], appear to be suitable to implement to track and adjust TL [17].

Practitioners must recognize that excessive TL is just one potential causative factor of injury in tactical populations. While there are various other causative factors, i.e. smoking [27,81], previous injury [26,27], and poor fitness [81], little research has been performed regarding monitoring TL, especially using the methods seen in elite sport [17,39]. The current depth of research is lacking given the impact overloading or underloading has on injuries in tactical populations. Multiple studies have shown the impact of high physical activity and repetitive microtrauma has on musculoskeletal injuries in tactical populations [28,84]. A large amount of these injuries are due to repetitive microtrauma, or overuse, accounting for almost 4 times as many injuries as acute trauma [84]. Military recruits especially are at risk for injury due to sudden and large increases in TL due to high amounts of running and other physical activity with possibly little to no prior training [85,86]. Given the impact injuries have on both institutional costs, approximately $1.5 billion (USD) per year in United States Army [22,23], and organizational workload, it is vital that tactical populations begin to research and implement these practices.

Conclusion

Given both the high physical workload and injury rate within tactical populations, it is important that steps are put in to place to maximize performance in decrease injury risk. A wide range of variables including HR, sRPE, HRV, distance covered, volume-load among others may allow practitioners to monitor TL within their personnel. In addition, ACWRs could be devised to minimize any spikes in training load which may increase injury risk. A comprehensive understanding of TL may allow for optimizing the programming of activities such as pack marches and patrols, to allow for the addition of, or reduction of training where required. For example, if a military unit is planning to complete a 5 km dismounted patrol in 4 weeks, a S&C coach can analyze the distance covered previously during field and physical training sessions. Due to the minimal research performed within the tactical domain to date, specific ratios are not currently available, however evidence from elite sport highlights that ACWRs from 0.8-1.3 may be optimal for both performance gains and injury reduction.

Figure 1. Borg RPE Scale and Total Quality Recovery Scale. Reproduced from Kentta and Hassmen (48)

Figure 2. Modified Borg RPE Scale. Reproduced from Foster et al. (25)

Figure 3. TQR Action Scoring Guide. Reproduced from Kentta and Hassmen (49)

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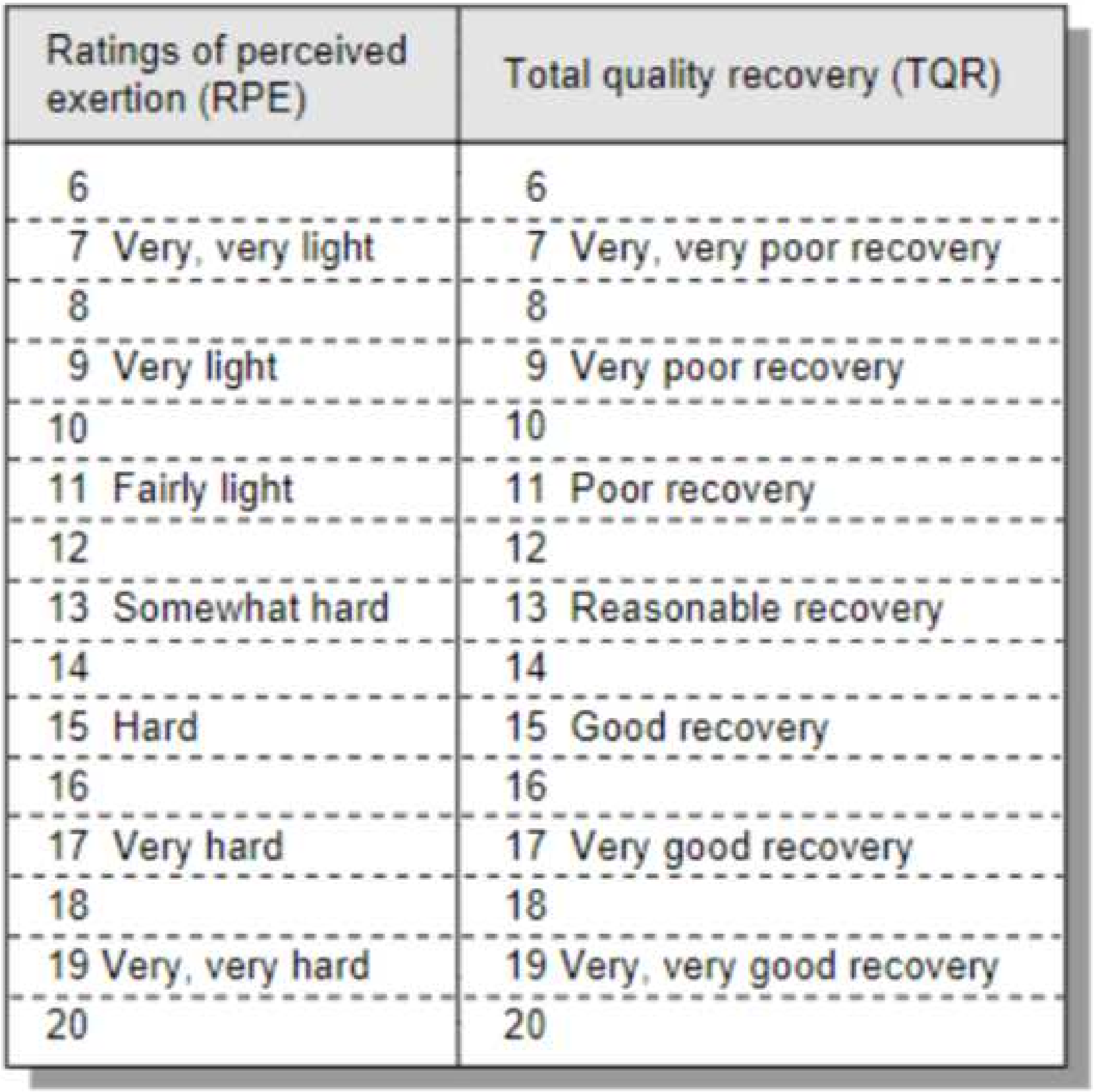
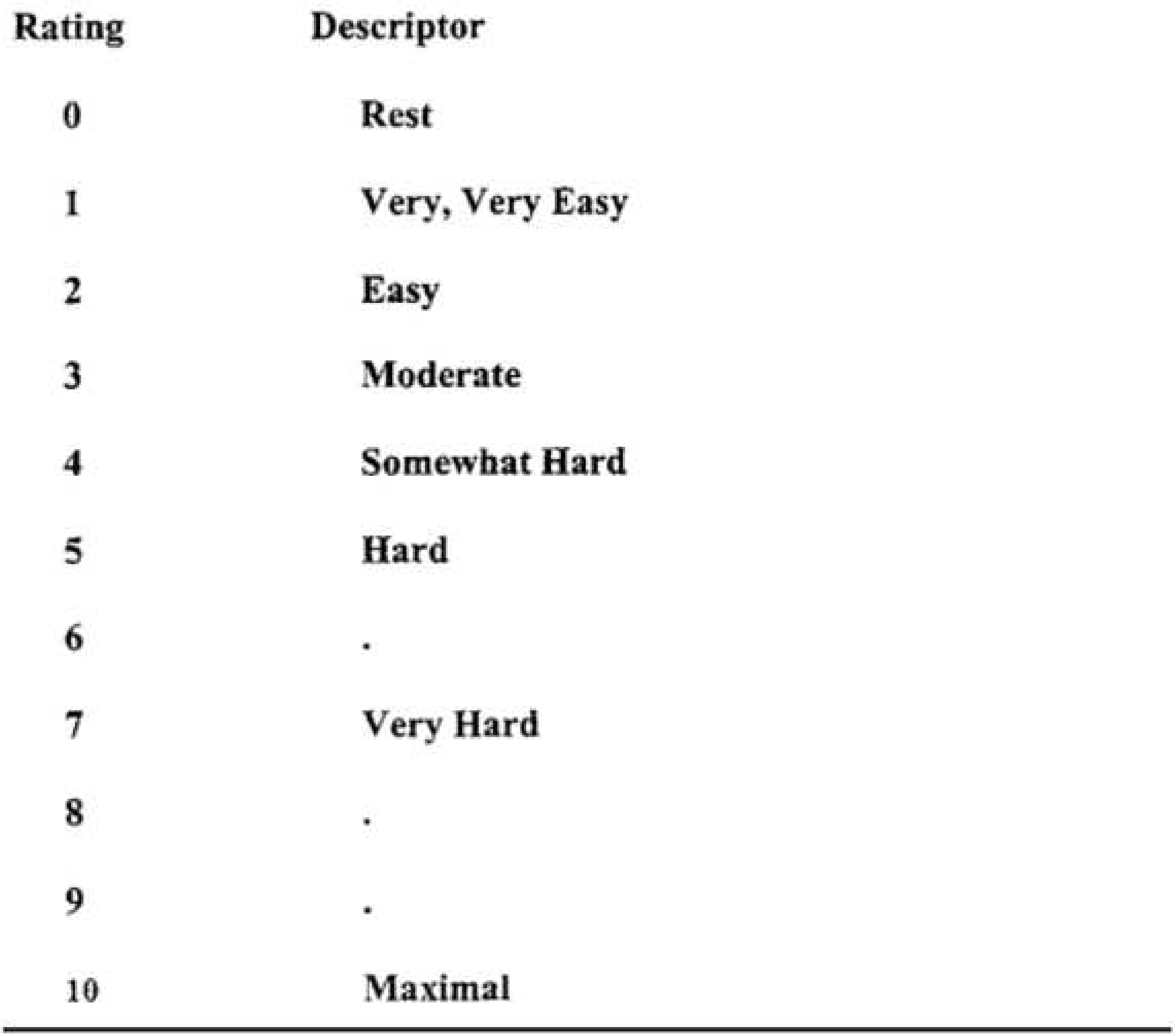
Figure 1



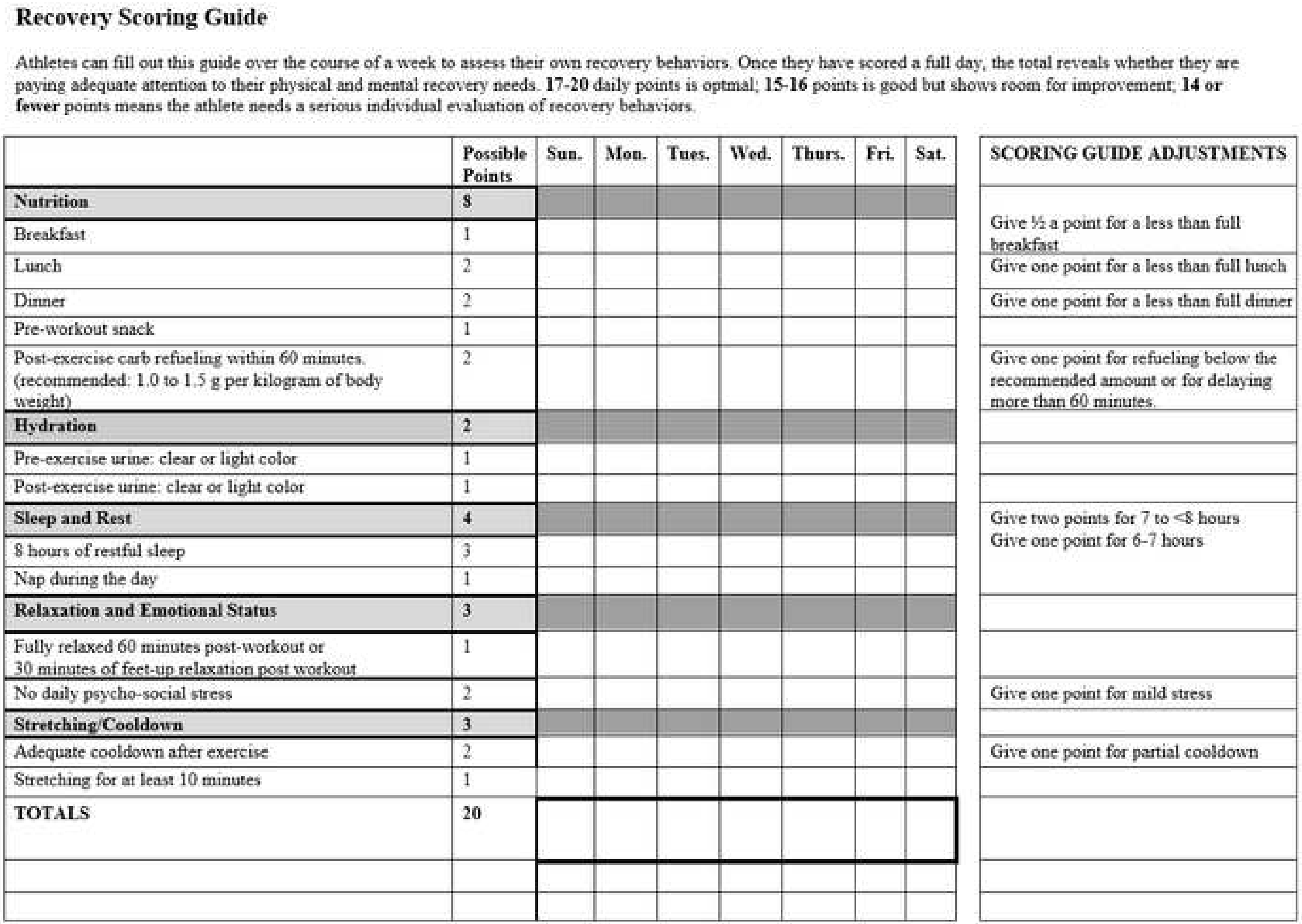
Ratings of perceived exertion (RPE)	Total quality recovery (TQR)
6	6
7 Very, very light	7 Very, very poor recovery
8	8
9 Very light	9 Very poor recovery
10	10
11 Fairly light	11 Poor recovery
12	12
13 Somewhat hard	13 Reasonable recovery
14	14
15 Hard	15 Good recovery
16	16
17 Very hard	17 Very good recovery
18	18
19 Very, very hard	19 Very, very good recovery
20	20

Figure 2



Rating	Descriptor
0	Rest
1	Very, Very Easy
2	Easy
3	Moderate
4	Somewhat Hard
5	Hard
6	.
7	Very Hard
8	.
9	.
10	Maximal

Figure 3



Recovery Scoring Guide

Athletes can fill out this guide over the course of a week to assess their own recovery behaviors. Once they have scored a full day, the total reveals whether they are paying adequate attention to their physical and mental recovery needs. **17-20** daily points is optmal; **15-16** points is good but shows room for improvement; **14 or fewer** points means the athlete needs a serious individual evaluation of recovery behaviors.

	Possible Points	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	SCORING GUIDE ADJUSTMENTS
Nutrition	**8**								
Breakfast	1								Give ½ a point for a less than full breakfast
Lunch	2								Give one point for a less than full lunch
Dinner	2								Give one point for a less than full dinner
Pre-workout snack	1								
Post-exercise carb refueling within 60 minutes. (recommended: 1.0 to 1.5 g per kilogram of body weight)	2								Give one point for refueling below the recommended amount or for delaying more than 60 minutes.
Hydration	**2**								
Pre-exercise urine: clear or light color	1								
Post-exercise urine: clear or light color	1								
Sleep and Rest	**4**								Give two points for 7 to <8 hours Give one point for 6-7 hours
8 hours of restful sleep	3								
Nap during the day	1								
Relaxation and Emotional Status	**3**								
Fully relaxed 60 minutes post-workout or 30 minutes of feet-up relaxation post workout	1								
No daily psycho-social stress	2								Give one point for mild stress
Stretching/Cooldown	**3**								
Adequate cooldown after exercise	2								Give one point for partial cooldown
Stretching for at least 10 minutes	1								
TOTALS	**20**								