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EXCESSIVE SITTING— A TACTICAL PERFORMANCE PROBLEM

INTRODUCTION

Tactical professions often have heavy physical demands despite frequent periods of inactivity and sedentary off-duty time (1,2). This unique scenario, termed the sedentary-active paradox, is exacerbated by a lack of targeted physical fitness training or tactical occupational tasks that are relatively low in physical demand, such as office work, sitting in a patrol vehicle, or supervising inmates (2,3). Within tactical professions, periods of inactivity, or chronic sitting, are as prevalent as they are in the broader adult population. Research has shown a doubling of obesity rates among military and veteran populations from 2001 – 2007, and obesity rates as high as 40% have been reported among police officers (4,5,6,7). These figures mirror obesity rates among the general adult population in the United States (8). The results of long periods of sedentary time include increased prevalence of health concerns, increased injury risk with physical activity, decreased ability to tolerate occupational demands, and decreased longevity in the profession (9). Because chronic sitting and sedentary time are invariably linked, an understanding of the effects of sitting on the neuromuscular system and occupational task performance is necessary, as is knowledge of practical strategies to minimize the negative impact of chronic sitting for the tactical professional.

MOBILITY AND MUSCULAR RECRUITMENT

Perhaps one of the most performance-limiting effects of chronic sitting is the development of muscular imbalance and limited mobility around major joints. In a seated posture, neuromuscular activation of much of the anterior musculature predominates, while important posterior chain muscles, such as the gluteus maximus, are largely inactive (10). Over time, the anterior musculature becomes chronically contracted, further inhibiting proper recruitment and activation of the posterior chain (11). Unfortunately, these muscular imbalances promote poor static posture and limit mobility, or the ability of a joint to move through its full range of motion (12). As a result, compensatory movement and altered muscle recruitment patterns gradually emerge, which can lead to suboptimal performance and injury (13,14). Muscular imbalances are particularly problematic for tactical athletes whose occupation frequently requires unpredictable quick transition from a sedentary state (seated position) to an active posture or dynamic occupational tasks involving agility or change of direction.

In the upper body, the anterior shoulder musculature is substantially more active when performing tasks in a seated posture as compared to standing, with one study about dentists demonstrating increased activation in the upper trapezius by 82%, the anterior deltoid by 71%, and the pectoralis major by 45% (15). This increased anterior activation causes reciprocal inhibition of the posterior scapular stabilizers, such as the middle and lower trapezius, resulting in rounded shoulders and a forward head posture (16,17). Not only is this posture associated with neck and shoulder pain, but it also contributes to decreased shoulder mobility and irregular movement of the scapulae, known as scapular dyskinesis, especially in overhead activities (18). Similarly, prolonged sitting is known to reduce thoracic spine mobility which further limits full overhead extension (19,20). All of this leads to the fundamental postural deviation of the upper body described by Dr. Vladimir Janda as upper crossed syndrome, in which the anterior muscles of the chest and posterior muscles of the neck become short and tight, while the posterior scapular stabilizers and anterior deep neck flexors become long and weak (21). When viewed from the side or considered in the sagittal plane, the line of short/tight musculature creates an "X" (or cross) with the line of long/weak musculature. Not surprisingly, many studies have linked these limitations to reduced upper body function and increased shoulder pain and injury, with a recent meta-analysis finding a 43% increase in risk of future shoulder pain in currently asymptomatic athletes presenting with shoulder mobility dysfunction (22).

In the lower extremity, a similar dysfunction presents around the pelvic girdle. Although the lower extremity musculature is relatively inactive when sitting, the hip is maintained in a flexed position. Consequently, the iliopsoas, as the predominant hip flexor, is held in a shortened position while the major hip extensor, the gluteus maximus, remains statically lengthened. This contributes to Janda's lower crossed syndrome, in which the superficial lumbar extensors are also tight opposite weakened abdominal muscles (21). Hip mobility and more specifically, hip extension, are key to an individual's ability to develop power, as triple extension is the foundation for many powerful movements and tactical job tasks. Unfortunately, chronic sitting has been shown to decrease hip extension and reduce hamstring flexibility (12,23). Perhaps most problematic is inhibition of the gluteus maximus (10,24). It does not take long for these effects to begin, as just one hour of sitting has been shown to increase lumbar spine stiffness (25). Additionally, multi-site pain in the lower body has been reported after only two hours of sitting in healthy adults (11,25).

OCCUPATIONAL TASK PERFORMANCE

The effect of sitting on mobility is particularly concerning with regards to occupational task performance, especially in tasks requiring overhead movement, rotational movement of the neck and torso, agility, or quick reaction time. Because chronic sitting contributes to weakening of the posterior chain musculature, core strength is negatively impacted as well (24). Importantly, the trunk region must compensate for neuromuscular inhibition or muscular weakness in the posterior chain. Research has shown that core strength and stability are needed for optimal power production (26). Therefore, muscular dysfunction or compensatory patterns in the trunk region, including the abdominals, erector spinae and other contributing musculature, are problematic for occupational task performance. Neuromuscular inhibition or muscular weakness in the posterior chain may predispose the tactical athlete to injury risk when one quickly transitions from sedentary to active positions (23,24). These considerations are often exacerbated by external load wear (e.g., protective equipment such as ballistic vests) during periods of sitting, as external load places additional demand on stabilizing musculature (27). As an example, tactical athletes often wear protective equipment while in a patrol vehicle or during desk duty (28). The addition of external load may not only exacerbate musculoskeletal imbalances and compensatory patterns associated with chronic sitting, but may also contribute to increased overall subjective discomfort (28). Researchers observed this with Swedish police officers wearing duty belts during periods of prolonged sitting (28).

Body position, posture, and associated stress hormone concentrations all impact the tactical athlete's readiness to perform physically demanding occupational tasks. Research has demonstrated the importance of specific warm-up drills to prepare athletes physically and psychologically for athletic tasks, and appropriately designed warm-up drills have been shown to potentiate neuromuscular performance (29,30). Underscoring the importance of neuromuscular activation, a novel investigation by Carney et al. evaluated the effect of posture on stress hormone concentrations (31). The research demonstrated statistically significant increases in testosterone and concomitant decreases in cortisol concentrations when study participants assumed active "power" postures, as compared to passive, anteriorly-contracted postures (31). Although study participants performed no physical activity, when assuming an "active" posture, not only did testosterone concentrations increase, but so did participants' subjective rating of how "powerful" or confident they felt during a brief gambling task (31). The researchers concluded that "by simply changing physical posture, an individual prepares his or her mental and physiological systems to endure difficult and stressful situations," (31).

Because individuals most often sit in passive, anteriorly flexed positions that tend to worsen as time spent in a seated posture progresses, there may be a concerning impact on subsequent occupational performance. For example, research has demonstrated increased subjective discomfort and reduced lower extremity tissue oxygenation in helicopter pilots after a four-hour period of sitting (32). Another study among young active-duty United States Marines found that chronic sitting was not only a major contributor to incidence of low back pain, but that sitting while wearing body armor also resulted in marked differences in lumbar spine posture as compared to standing with and without body armor, as measured by magnetic resonance imaging (33). As described in the sedentary-active paradox, tactical athletes may be required to quickly transition from a seated position to a dynamic occupational task (2,3). A passive, seated posture, as part of an overall increased stress state, may contribute to decreased readiness to perform mission critical tasks when preparatory movements to facilitate passive to active postural transition have not been implemented, as one would do with sport athletes during a dynamic warm-up (9,30).

How well one is able to perform and recover from strenuous occupational or physical training tasks is also linked to cognitive load and accumulated fatigue (psychological or physical). Among military personnel, increased sitting time as a percentage of a 24-hr time period has been associated with increased subjective fatigue (fatigue severity scale) (34). Relatedly, increased sitting time negatively impacted subjective mood (profile of mood states) among office workers, as compared to those who implemented periods of standing during the workday (35). When assessing the impact of increased sitting time on the performance of a cognitive test battery to assess problem solving (ruff figural fluency test) and sustained attention (go/no-go test), researchers found a substantial increase in participants' error count as sitting time increased (11). Participants in this study also reported a significant increase in subjective discomfort and mental fatigue (visual analog scale for fatigue), although no impact on neuromuscular fatigue was observed as measured by surface electromyography (11). Research suggests that pain and discomfort, commonly in the neck, upper back, and lumbar spine regions, associated with prolonged sitting time also impact cognitive load (11,17,36). This is simply to say that increased pain due to chronic sitting may detract from one's ability to perform cognitively demanding tasks requiring problem solving or sustained attention (36). Thus, chronic sitting is clearly detrimental to one's ability to perform optimally.

Inactivity is associated with increased all-cause mortality in a dose-dependent relationship (i.e., the greater the sitting time the greater the negative health implications) (34). Within tactical professions, cardiovascular disease and other health concerns associated with a sedentary lifestyle are equally prevalent as in the general population (5,6,8). In a multi-year cross-sectional study of United States Navy personnel, increased sitting time was associated with decreased mobility (Functional Movement Screen) and greater body mass index (34). Unfortunately, research has shown that an hour of moderate intensity physical activity is not enough to offset the negative effects of inactivity on metabolic markers when the remainder of the day is spent sitting (37). To further contextualize, the metabolic cost of sitting is roughly equivalent to that of being in a prone position (38). Meanwhile, standing results in roughly an 11% increase in caloric expenditure as compared to sitting (38). Given the high obesity prevalence among tactical populations, simply increasing the amount of time spent standing or interspersing periods of sitting with movement throughout the day may have a positive effect on energy expenditure. By extension, this may contribute to maintenance of a healthy muscle mass to fat mass ratio, commonly associated with increased physical fitness and improved occupational task performance (3,8).

PRACTICAL APPLICATIONS

An important takeaway is the understanding that despite best intentions to be physically active, tactical athletes likely spend excessive amounts of time sitting. Research has demonstrated that physical activity of an hour's duration is not enough to offset the metabolic effects of inactivity; likewise, it is not enough to offset the effects of chronic sitting on mobility, musculoskeletal function, and subjective discomfort. Therefore, it is in the tactical athlete's best interest to incorporate periods of movement and strategic mobility interventions daily to mitigate these negative effects. Mobility should be viewed as a continuous progression incorporated throughout the day in preparation for physical activity. A progression from in-place exercise while sitting, to brief mobility exercise, to a specific athletic preparatory protocol, will help ensure the individual is optimally primed for athletic task performance. This approach may also counteract many of the postural disturbances commonly associated with chronic sitting postures. Furthermore, implementing the strategies outlined below can translate to improved readiness to perform physically demanding tasks when required to do so, and will likely reduce the risk of injury commonly associated with poor mobility. Some practical strategies to address mobility, posture, and posterior chain activation follow:

1) **When possible, sit less or vary seated positions**: Periods of sitting are sometimes unavoidable. Some alternatives to seated postures are tall kneeling, half kneeling, or standing positions. Another alternative is to vary the sitting surface (e.g., using an unstable sitting surface or a chair without fixed back support).

2) **When sitting is unavoidable, focus of postural awareness**: An ideal seated posture is with the shoulders down and back (i.e., "shoulders in back pocket"), without compensating for lack of thoracic mobility with thoracic hyperextension. Likewise, an important consideration is proper head and neck positioning. Computer monitors, if in use, should be positioned to allow the individual to look straight ahead, keeping the neck in a neutral position, instead of looking down (i.e., avoiding a flexed neck position). Another common occurrence with sitting is allowing the neck to crane forward, putting shear force on the delicate spinal architecture of the neck, as well as increasing the strain on the posterior neck musculature. Postural awareness of neck positioning (i.e., neutral) will help mitigate this issue. Hips should be positioned neutrally, without anterior or posterior pelvic tilt (i.e., avoiding lumbar hyperextension). Feet should be positioned flat on the floor allowing for an approximately 90-degree angle of flexion at the knee.

3) **Incorporate micro-movements into periods of sitting**: When in a seated position, micro-movements such as scapular protraction/retraction or a series of isometric muscle contractions (e.g., flex/extend the calf muscles, contract/relax the hamstring and gluteal muscles) can be performed. As an alternative, a brief in-place mobility session is included in Table 1.

4) **Intersperse periods of sitting with physical activity**: For every hour of sitting, aim to incorporate 10 – 15 min of movement, such as walking, yoga poses, or specific mobility drills. A sample brief mobility session is outlined in Table 2.

5) **Incorporate mobility and neuromuscular activation as part of physical training**: Mobility is an often-overlooked component in the tactical athlete's training. To better address this, mobility and neuromuscular activation drills should be incorporated as part of the athlete's warm-up protocol. This facilitates passive-to-active postural transition and allows for optional transfer of force onto skeletal muscle and bone and downstream benefits with regards to physical performance. Table 3 outlines a warm-up protocol that can be incorporated as part of a general training session.

In conclusion, maintaining a fixed seated posture for extended periods of time will negatively impact the tactical athlete's neuromuscular system and day-to-day occupational task performance. Luckily, it is possible to mitigate performance and health concerns with a small investment of deliberate mobility work and physical activity interspersed throughout the day. Following the practical strategies outlined in this article will aid the tactical athlete in performing occupational tasks safely while contributing to reduced injury risk in the long term.

TABLE 1. IN-PLACE MOBILITY SESSION

EXERCISE	DETAILS	SETS	TIME (SECONDS)
Tennis Ball Foot Roll	Use a tennis or lacrosse ball, apply gentle downward pressure through foot	1	30 s per side
Calf Stretch	Dorsiflex foot/ankle	1	10 s per side
Half Kneeling Hip Flexor/Quadriceps Stretch	Front leg hip/knee angle at 90 degrees flexion, extend rear leg hip and hold end range (contract rear leg gluteal musculature)	1	10 s per side
Half Kneeling Groin Stretch	Half kneeling position, extend opposite leg laterally, sit back into hips	1	10 s per side
Seated Hip Rotator Stretch	Seated position (90 degrees hip/knee flexion, feet flat on floor), cross leg (ankle over opposite side knee), hold end range	1	10 s per side
Pectorals/Anterior Shoulder – Single-Arm Posterior Reach	Single-arm overhead and posterior reach, retract scapulae (avoid thoracic hyperextension), hold end range	1	10 s per side
Pectorals/Anterior Shoulder – Double-Arm Posterior Reach	Double-arm overhead and posterior reach, retract scapulae (avoid thoracic hyperextension), hold end range	1	10 s
Latissimus Dorsi - Crossbody Reach	Palms down, hold end range	1	10 s
Short Kneeling Sit	Plantarflex feet/ankles	1	20 s
Tall Kneeling Sit	Dorsiflex feet/ankles	1	20 s
Side-Lying Thoracic Spine Rotation	Hold end range for 5 s	1	5 per side

TABLE 2. BRIEF MOBILITY SESSION

EXERCISE	DETAILS	SETS	TIME (SECONDS)
Neck Movement	Look down, look up, laterally flex (left/right), rotate (left/right)	1	10 s each position
Wrist Movement	Flexion and extension	1	10 s each position, per side
Pectorals/Anterior Shoulder – Single-Arm Posterior Reach	Single-arm overhead and posterior reach, retract scapulae (avoid thoracic hyperextension), hold end range	1	10 s per side
Pectorals/Anterior Shoulder – Double-Arm Posterior Reach	Double-arm overhead and posterior reach, retract scapulae (avoid thoracic hyperextension), hold end range	1	10 s
Latissimus Dorsi - Crossbody Reach	Palms down, hold end range	1	10 s
Trunk - Hand Over Head Lean and Rotate	Hold end range	1	10 s
Half Kneeling Hip Flexor/Quadriceps Stretch	Front leg hip/knee angle at 90 degrees flexion, extend rear leg hip and hold end range (contract rear leg gluteal musculature)	1	10 s per side
Seated Hip Rotator Stretch	Seated position (90 degrees hip/knee flexion, feet flat on floor), cross leg (ankle over opposite side knee), hold end range	1	10 s per side
Tennis Ball Foot Roll	Use a tennis or lacrosse ball, apply gentle downward pressure through foot	1	30 s per side
Calf Stretch	Dorsiflex foot/ankle	1	30 s per side

TABLE 3. TRAINING WARM-UP PROTOCOL

EXERCISE	DETAILS	SETS	REPETITIONS
	Perform In-Place Mobility Session First		
Bodyweight (BW) Squat	Maintain neutral pelvis, engage anterior core musculature, hold bottom position for 2 s	1	10
BW Split Squat with Overhead Reach	Maintain scapular retraction on reach (avoid thoracic hyperextension), hold bottom position for 2 s	1	5 each side
BW Reverse Lunge with Scapular Retraction	Maintain scapular retraction (avoid thoracic hyperextension), hold bottom position for 2 s	1	5 each side
BW Lateral Squat with Anterior Reach	Maintain neutral pelvis, engage anterior core musculature, maintain scapular retraction on reach, hold bottom position for 2 s	1	5 each side
BW Romanian Deadlift (RDL) with Anterior Reach	Maintain scapular retraction on reach, hold bottom position for 2 s	1	5 each
BW Single-Leg RDL with Scapular Retraction	Maintain neutral pelvis and scapular retraction, hold bottom position for 2 s	1	5 each side
Push-Up with Scapular Protraction	Maintain neutral pelvis, protract scapulae at top of movement (elbows extended), hold top and bottom positions for 2 s	1	10
Glute Bridge	Maintain neutral pelvis, hold top position (contract gluteal musculature) for 5 s	1	5
Dead Bug	Maintain neutral pelvis, hold end range for 2 s	1	5 each side
BW Squat	Maintain neutral pelvis, engage anterior core musculature, hold bottom position for 2 s	1	10

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