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Thermal load and physical mobility implications of body armour systems with different levels of protection

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Thermal Load and Physical Mobility Implications of Body Armour Systems with Different Levels of Protection

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ABSTRACT

Current military operations involve complex omnipresent threats, resulting in the need for all soldiers, regardless of occupational speciality, to wear body armour during operational deployment. Body armour is typically comprised of both hard and soft armour and is designed to provide ballistic, fragmentation and stab protection. The mass and bulk of body armour systems (BAS), which are influenced by the design, materials and extent of hard and soft armour coverage, can affect both the thermal load and physical mobility of the soldier.

This research investigated the trade-off between the level of protection and its adverse impact on performance. Thermal loading and physical mobility were evaluated in two experiments, across four torso BAS conditions (Tiers 1-4) and a control state (Tier 0), which provided no protection. For Tiers 1 to 4, there was a gradual increase in hard and soft armour coverage, which also increased mass.

For the thermal load study (n=8) a patrol simulation followed by a section attack simulation was conducted on a treadmill in a climate controlled chamber, set to simulate the hot-dry conditions common to the Afghanistan summer. The mechanism driving thermal loading was the surface area coverage of the BAS which impeded evaporative cooling and increased heat storage. Those BAS with less surface area coverage (Tiers 0-2) facilitated greater evaporation leading to reduced heat storage when compared to Tiers 3 and 4. Ultimately, a reduced thermal load will increase sustainability, and will allow soldiers to retain their operational capability for longer, giving more tactical options.

For the physical mobility study (n=34) soldiers completed a series of battlefield mobility assessments designed to simulate the principal physical mobility challenges encountered during tactical movement of dismounted soldiers. Physical mobility was reduced as external load increased. This effect was manifested in slower movement speeds, reduced ability to generate power from a stationary posture, earlier fatigue onset during repetitive movements and a reduced ability to quickly negotiate obstacles. Three equally stressful groups, clustered around mass, were identified: Tiers 0 and 1; Tiers 2 and 3; and Tier 4. Minimising the physical mobility impediment decreases exposure time and reduces target acquisition by the enemy.

When viewed collectively, theses studies present some potentially contradictory outcomes. For example, while the thermal burden of Tier 2 was less than Tier 3, Tiers 2 and 3 induced similar impacts on mobility. Consequently, Tier 3 would be preferred to maximise protection if physical mobility was the sole consideration. Yet this would significantly elevate thermal strain, and potentially compromise operational capability. Such contradicting outcomes highlight the importance of taking a holistic approach to BAS evaluation and selection.