Work and fatigue characteristics of unsuited and suited humans during isolated isokinetic joint motions

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Abstract: The effects of a pressurized suit on human performance were investigated. The suit is known as an Extra-vehicular Mobility Unit (EMU) and is worn by astronauts while working outside of their space craft in low earth orbit. Isolated isokinetic joint torques of three female and three male subjects (all experienced users of the suit in 1G) were measured while working at 100% and 80% of their maximum voluntary torque (MVT), (here MVT is synonymous with maximum voluntary contraction (MVC)). It was found that the average decrease in the total amount of work done (the sum of the work in each repetition till fatigue) when the subjects were wearing the EMU was 48% and 41% while working at 100% and 80% MVT, respectively. There is a clear relationship between the MVT and the time and amount of work done until fatigue. Here, the time to fatigue is defined as the ending time of the repetition for which the computed work done during that repetition dropped below 50% of the work done during the first repetition. In general the stronger joints took longer to fatigue and did more work than the weaker joints. It was found that the EMU decreases the work output at the wrist and shoulder joints the most. This is due to the EMU joint geometry. The average total amount of work done by the test subjects increased by 5.2% (20.4%) for the unsuited (suited) case, when the test subjects decreased the level of effort from 100% to 80% MVT. Also, the average time to fatigue increased by 9.2% (25.6%) for the unsuited (suited) case, when the test subjects decreased the level of effort from 100% to 80% MVT. The EMU also decreased the joint range of motion. It was also found that the experimentally measured torque decay could be predicted by a logarithmic equation. The absolute average error in the predictions was found to be 18.3% and 18.9% for the unsuited and suited subject, respectively, working at 100% MVT, and 22.5% and 18.8% for the unsuited and suited subject, respectively, working at 80% MVT. These results could be very useful in the design of future EMU suits, and planning of Extra-Vehicular Activity (EVA) for the upcoming International Space Station assembly operations.