

INTISARI

Passive lower-limb exoskeleton merupakan perangkat yang dirancang untuk meningkatkan kekuatan manusia dan tergolong sebagai salah satu *personal protective equipment* yang dapat membantu pekerja industri mengurangi risiko *Musculoskeletal Disorders* (MSDs). Penelitian ini bertujuan untuk menyelidiki pengaruh penggunaan *passive lower limb exoskeleton* Noonee Chairless Chair 2.0 terhadap performa, persepsi kesulitan, dan persepsi ketidaknyamanan pada aktivitas kerja statis yang meliputi *wide stance*, *trunk bending*, dan *bolting task* bidang kerja vertikal pada berbagai level ketinggian (level bahu, level siku, dan level lutut).

Sebanyak 17 laki-laki dan 13 perempuan dengan rentang usia 19 hingga 23 tahun berpartisipasi dalam penelitian ini. Masing-masing subjek menjalankan kelima aktivitas kerja statis dengan dua perlakuan, tanpa *exoskeleton* dan dengan *exoskeleton* dengan teknik *half-randomized within subject*. Dilakukan pencatatan data tiga variabel terikat berupa performa yang diukur dengan fleksibilitas dan waktu penyelesaian tugas, serta persepsi tingkat kesulitan dan persepsi ketidaknyamanan. Data performa kemudian diolah menggunakan uji statistik *t* berpasangan atau *Wilcoxon Signed Rank Test* jika data non-parametrik. Sementara data *Perceived Task Difficulty* (PTD) dan *General Discomfort* (GD) yang diukur menggunakan *Visual Analogue Scale* diolah menggunakan *Wilcoxon Signed Rank Test*. Signifikansi yang digunakan 5%.

Hasil penelitian menunjukkan bahwa penggunaan *exoskeleton* memberikan dampak yang bervariasi terhadap performa, PTD, dan GD bergantung pada jenis aktivitas. Pada pengukuran performa, hanya aktivitas *wide stance* ($p < 0,05$) dan *trunk bending* ($p < 0,001$) yang menunjukkan perbedaan signifikan antara kondisi tanpa dan dengan *exoskeleton*, sementara aktivitas lainnya seperti *bolting task* level bahu ($p = 0,686$), *bolting task* level siku ($p = 0,394$), dan *bolting task* level lutut ($p = 0,210$) tidak menunjukkan perbedaan signifikan. Untuk PTD, perbedaan signifikan ditemukan pada *trunk bending* ($p < 0,05$), *bolting task* level siku ($p < 0,05$), dan *bolting task* level lutut ($p < 0,05$), sedangkan *wide stance* ($p = 0,703$) dan *bolting task* level bahu ($p = 0,394$) tidak signifikan. Pada aspek GD, terdapat perbedaan signifikan pada aktivitas *trunk bending* ($p < 0,05$), *bolting task* level siku ($p < 0,05$) dan *bolting task* level lutut ($p < 0,001$), sementara *wide stance* ($p = 0,726$) dan *bolting task* level bahu ($p = 0,609$) tidak menunjukkan perbedaan yang bermakna. Temuan ini menunjukkan bahwa pengaruh *exoskeleton* bersifat kontekstual dan bergantung pada jenis aktivitas kerja yang dilakukan.

Kata kunci: *Lower-limb exoskeleton*, performa, *perceived task difficulty* (PTD), *general discomfort* (GD), aktivitas statis

ABSTRACT

A passive lower-limb exoskeleton is a device designed to enhance human strength and is classified as a type of personal protective equipment that can help industrial workers reduce the risk of Musculoskeletal Disorders (MSDs). This study aims to investigate the effect of using the Noonee Chairless Chair 2.0 passive lower-limb exoskeleton on performance, perceived task difficulty (PTD), and general discomfort (GD) during static work activities, including wide stance, trunk bending, and vertical bolting task at various height levels (shoulder-level, elbow-level, and knee-level).

A total of 17 males and 13 females aged between 19 and 23 years participated in this study. Each subject performed all five static work activities under two conditions: without exoskeleton and with exoskeleton, using a half-randomized within-subject design. Data were collected for three dependent variables: performance (measured by flexibility and task completion time), perceived task difficulty, and general discomfort. Performance data were analyzed using either the dependent t-test or the Wilcoxon Signed Rank Test for nonparametric data. Perceived Task Difficulty (PTD) and General Discomfort (GD) data, measured using a Visual Analogue Scale (VAS), were analyzed using the Wilcoxon Signed Rank Test. A 5% significance level was applied.

The results show that the use of an exoskeleton had varying impacts on performance, PTD, and GD depending on the type of activity. For performance, only wide stance ($p < 0.05$) and trunk bending ($p < 0.001$) showed significant differences between conditions with and without the exoskeleton, while bolting task at shoulder-level ($p = 0.686$), bolting task at elbow-level ($p = 0.394$), and bolting task at knee-level ($p = 0.210$) showed no significant differences. For PTD, significant differences were found in trunk bending ($p < 0.05$), bolting task at elbow-level ($p < 0.05$), and bolting task at knee-level ($p < 0.05$), whereas wide stance ($p = 0.703$) and bolting task at shoulder-level ($p = 0.394$) were not significant. Regarding GD, there are significant differences during trunk bending ($p < 0.05$), bolting task at elbow-level ($p < 0.05$), and bolting task at knee-level ($p < 0.001$), while wide stance ($p = 0.726$) and bolting task at shoulder-level ($p = 0.609$) showed no meaningful differences. These findings suggest that the impact of exoskeleton use is contextual and dependent on the type of work activity performed.

Keywords: Lower-limb exoskeleton, performance, perceived task difficulty (PTD), general discomfort (GD), static activity