UMEÅ UNIVERSITY

Umeå University Medical Dissertations, New Series No 2363

Risk Assessment of Hand-Intensive Work Using Ratings and Technical Measures

Sex and Gender Considerations

Gunilla Dahlgren

Akademisk avhandling

som med vederbörligt tillstånd av Rektor vid Umeå universitet
för avläggande av filosofie/medicine doktorsexamen
framläggs till offentligt försvar i Lokal: Sal BIO.E.203, Aula Biologica.
Fredagen den 5 september 2025, kl. 09.00.
Avhandlingen kommer att försvaras på svenska.

För att delta digitalt via Zoom:
https://umu.zoom.us/j/64967143127

Fakultetsopponent: Wim Grooten, Docent
Institutionen för neurovetenskap och samhälle. Karolinska Institutet

Department of Epidemiology and Global Health
Department of Community Medicine and Rehabilitation

Organization
Umeå University
Department of Epidemiology and Global Health
Department of Community Medicine and Rehabilitation

Document type
Doctoral thesis

Date of publication
15 August 2025

Author
Gunilla Dahlgren

Title
Risk Assessment of Hand-Intensive Work Using Ratings and Technical Measures: Sex and Gender Considerations

Abstract

Background In ergonomic risk assessment of hand-intensive work, observational methods are typically used to rate risk exposure. However, it remains unclear whether women and men performing identical work tasks are rated differently for the established risk exposures: hand activity/repetitivity and hand force. To better understand these ratings, wrist joint angular velocity and forearm muscle activity could be examined in parallel.

Aim The aim was threefold: (1) to investigate whether hand activity (Hand Activity Level, HAL) and hand force (Borg CR-10) are rated differently between women and men performing identical work tasks; (2) to compare technically measured wrist angular velocity and forearm muscle activity between female and male workers; and (3) to examine the correlations between these ratings and their corresponding technical data.

Methods In total, 59 workers (29 women, 30 men), also constituting 28 female–male pairs, participated. The worker pairs performed 18 different hand-intensive tasks in their real-world workplaces. Workers' wrist joint angular velocity (°/s) was recorded using inertial measurement units. Forearm flexor and extensor muscle activity was measured via surface electromyography as percentage of maximal voluntary electrical activation. The workers self-rated their hand activity level (HAL) and hand force (Borg CR-10). They were video recorded during task performance. Additionally, two mixed-gender pairs of experienced ergonomists (n = 4) and 54 individual ergonomists (27 women, 27 men) video-rated the workers' tasks using the HAL and Borg CR-10 scales. In Paper I, differences in ratings of female and male workers were compared using both self-ratings and ergonomist mixed-gender pairs ratings. Paper II examined the correlations between HAL and wrist angular velocity, as well as between Borg CR-10 and forearm muscle activity. Paper III compared wrist angular velocity and muscle activity between women and men. In Paper IV, individual ratings by ergonomists of different sex were analyzed in 27 pairs of female–male workers to determine whether female and male ergonomists rated female and male workers differently.

Results No significant sex differences were observed in workers' wrist velocity (Paper III). There were also no significant sex differences in rated HAL, both as workers self-rated and ergonomist-rated (Papers I and IV). Significant correlations were observed between wrist velocity and HAL, both as rated by the workers themselves and by the ergonomists. However, measured forearm muscle activity was significantly higher in women compared to men (Paper III). Moreover, ergonomists rated hand force significantly higher in women workers (Papers I and IV). Measured forearm muscle activity and ergonomist-rated hand force were significantly correlated in 4 out of 6 variables, and for recovery only for forearm flexor muscle (Paper II). Self-rated hand force did not differ significantly between women and men (Paper I), and did not correlate significantly with measured muscle activity (Paper II).

Conclusions In identical tasks, wrist velocity and HAL ratings do not differ on average between women and men. For hand force ratings, only ergonomist-rated hand force should be used, as it detects sex differences and reflects women's higher muscle activity. Self-rated hand force using the Borg CR-10 should be avoided due to the risk of underestimating women's hand force and does not reflect measured muscle activity. Technical measures should be preferred in real-life work risk assessment when possible. Moreover, women should be prioritized in the assessment of hand force or muscle activity. These strategies may contribute to a more inclusive risk assessment, reduce the risk of musculoskeletal disorders, and support a sustainable working life.

Keywords: Risk assessment, hand activity, force, IMU, EMG, sex, gender

Language
English

ISBN
978-91-8070-730-5 (print)
978-91-8070-731-2 (pdf)

ISSN
0346-6612

Number of pages
52 + 4 papers