Experimental Study on Short-Time Physical Load and Demand While Pushing Loads With a Hand Truck

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Notification
Due to the pandemic situation in Germany, the implementation of the planned study was stopped. Therefore, this poster only presents the methodological structure.

Problem Statement
Pushing and pulling single-axle transport devices, in particular hand trucks, remain a typical and common form of physical work in practice. Furthermore, high physical workload causes and modifies musculoskeletal disorders [1] and, as a result, may lead to incapacity for work, occupational diseases and/or early retirement. Studies that examine the effects of pushing single-axle transport devices on the physical demand and that sufficiently fulfil quality criteria are rare [2]. Therefore, appropriate practical screening procedures that record and assess physical workloads such as the Key Indicator Method “Pushing/Pulling” [3] are largely based on expert knowledge. However, valid risk assessment tools require scientific findings with sufficient quality criteria.

Research Objective/Questions
To examine short-time effects of physical load and demand in healthy male participants who are pushing loads with a hand truck under everyday conditions in a controlled experimental setting.

1. To what extent do the workload conditions lead to an increase in physical load and demand?
2. Which interaction of the different workload conditions leads to amplified effects?

Hypothesis
We assume that increased loads, high-angle upward inclination of the path as well as greater unevenness and softness of the ground increase the physical load and demand when pushing a hand truck.

Study design
- controlled laboratory experimental study with repeated measurements
- participants push a modified hand truck (Fig. 1) on a test track (start → pushing → stop):
  - different combinations of workload conditions
  - two measurements per combination
  - measurements of physical load and demand

Participants
- 32 healthy men aged 18 - 40 years
- body height 170 - 190 cm and average fitness level

Setting
- constructed 5-meter-long test track (Fig. 2)
- wheelchair for hand truck
- ground surfaces and inclination adjustable
- modified hand truck (Fig. 3)
- to load with different weight plates
- workload conditions (independent variables), systematically varied (not all combinations feasible)
- 4 typical ground surface conditions (Fig. 4)
- 4 different upward inclinations (Fig. 2)
- 8 weight loads (Fig. 3)

Methodology

Measurements | Dependent variables | Location | Realization: devices and scales
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Physical load | ground reaction force | test track | 7 force plates embedded in the path (for each foot contact)
 | hand force | hand truck | handles replaced by hand force measurement systems
 | posture and movement | whole body and hand truck | motion capture system using 10 infrared-light cameras
 | surface electromyography (sEMG, 28 channels) | sensor/markers
Physical demand | muscle activity | main muscles | surface electromyography (sEMG, 28 channels)
 | heart rate | chest | heart rate monitor
 | perceived exertion rating | Borg scale

References