Effect of lifting two different weights for female workers in a transfer of boxes during a palletizing task

André Plamondon, Christian Larivière, Denys Denis, Hakim Mecheri and the IRSST MMH Research Group
Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), Montréal, Québec, Canada.

1. Introduction
Numerous literature reviews indicate a moderate to strong association between manual material handling (MMH) and back injury. A few biomechanical studies contrasted the work techniques of female and male workers during MMH. Recently, Plamondon et al. (2014) found that one important biomechanical variable that characterized experienced females relative to male experts, during lifting of 15-kg boxes from the floor, was their patterns of interjoint coordination. Female workers showed a sequential motion initiated by the knees, followed by the hip and the back, while expert males showed a more simultaneous motion between segments. This had the consequence of putting the females at greater risk of back injuries due to the excessive back flexion that this type of coordination yields. An important question is why females used a more sequential coordination pattern? Strength could be one possibility considering that the same “absolute load” (15-kg) was studied. Interestingly, several studies reported that with an increase of the load, the interjoint coordination became more sequential, which delays lumbar spine extension (Burgess-Limerick et al., 1995). The objective of this study was to test whether female workers would repeat the same coordination pattern with a load adjusted for their overall back strength (females 10-kg; males: 15-kg), which can be considered as a “relative load” considering that the overall back strength of females is 2/3 of male’s strength (Mital et al., 1997).

2. Methods
Fifteen experienced women handlers (age: 41 yrs; experience: 7.3 yrs), 15 expert handlers (age: 38.1; experience: 15.4 yrs; no previous back pain) and 15 novice workers (age: 25 yrs; experience: 0.5 yr) performed series of box transfers under conditions similar to those of large distribution centres. The tasks consisted of transferring 24 boxes of 15-kg from one pallet to another at a free lifting pace and at a forced pace of 9 lifts/min. Then, after a 30-minute break, the females had to repeat the transfer with boxes of 10-kg. The boxes were stacked straight up in 4 layers of 6 boxes: three boxes in the front and three in the back. The distance between the two palettes was 1.65 m. The handlers were free to choose their lifting techniques. The participants were instrumented in such a way that a dynamic 3-D linked segment model was used to estimate the net moments at L5/S1. Interjoint coordination, as assessed using relative phase angle analyses (Burgess-Limerick et al. 1995), was studied during the lifting phase of each box transfer from the floor level.

3. Results
Lifting a load of 10-kg instead of 15-kg for females had some positive effects. For instance, it was not surprising to find that the peak resultant moment at L5/S1 dropped significantly (more than 15 Nm; P < .05) with the 10-kg load and cumulative moment decreased by 37 Nm·s, a drop of close to 25%. Moreover, the duration of the lift decreased from 5.7 s (15-kg) to 4.7s (10-kg) which is a duration equivalent to the males lifting a 15-kg load. Unfortunately, the females adapted to the 10-kg load by significantly increasing the distance of the box from L5/S1 by close to 2 cm in the lifting phase and by decreasing the knee flexion by about 5°. Nevertheless, decreasing the load did not significantly affect the upper body posture. With the 10-kg load, a significant (P < .05) but small change occurred in the joint coordination patterns (knee-hip, hip-back) of females, where the maximum amplitude of the phase angle decreased. The sequential motion was present to a less extent than with the 15-kg load, but stayed significantly different from the expert males.
Discussion

Results showed that reducing the load from 15-kg to 10-kg in females had a small but significant impact: back loading and task duration were reduced, posture did not change considerably. The more sequential joint coordination pattern previously seen in females, when compared to males, with an absolute load (15-kg), was still present with the use of the same overall relative load (females 10-kg; males: 15-kg). This suggests that this sequential lifting pattern is probably not related to back strength. A sex difference in the hip-extensors/back-extensors strength ratio is an alternative explanation, but this remains to be tested. Considering that this sequential lifting pattern stretches posterior passive tissues, potentially leading to higher risks of injuries, the reason for this sex effect must be identified to propose preventive interventions.

Keywords: Gender, Lifting, Biomechanics

Acknowledgements

This study was funded by the Institut de Recherche Robert-Sauvé en Santé et en Sécurité du Travail du Québec (IRSST).

References

