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## LUMBAR LOAD IN COMMON WORK TASKS FOR AIRPORT BAGGAGE HANDLERS – A 3D DYNAMIC ANALYSIS

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### SUMMARY

Baggage handlers often have a history of work-related low back pain. The baggage handlers often work in confined spaces, necessitating sitting, kneeling or stooping positions. These positions have been associated with low back pain. The purpose of this study was to quantify the lumbar loading in airport baggage handlers with the help of musculoskeletal modeling.

We selected two common work tasks (standing baggage handling and sitting position inside the luggage compartment). A single subject performed the tasks, while a custom build motion capture system with eight synchronized high-speed cameras recorded 3D kinematics. Two force platforms recorded the ground reaction forces under the feet and one under pelvis during the sitting position. We used The AnyBody Modeling System v. 5.3 to build a model and to compute the compression forces of the lumbar spine (L4/L5-segment).

The standing position produced a peak L4/L5-compression of 3980 N and the sitting position produced 2600 N.

This study described the loading of the lumbar spine during common work tasks for airport baggage handlers. The level of spinal peak compression in the standing task exceeded the recommendation proposed by NIOSH. However, the NIOSH recommendations are based on static measurements and do not allow movement or asymmetrical lifting i.e. one-handed lifts or body rotations.

### INTRODUCTION

Musculoskeletal pain constitutes a major occupational health hazard in highly developed industrialized societies. This is not only a problem for the individual worker; this is also a massive economic issue. In 2011 the cost of back-pain alone amounted to 1.7 billion Euros in Denmark. Around 35% of the Danish population has low back pain, and 13 % of those with long-term illness have back pain.

Approximately 60 % of airport baggage handlers report that they have had low back pain in the last year [1]. The job as an airport baggage handler consists of frequent lifting. The baggage handler lifts suitcases with a mean of 15 kg,

resulting in a mean daily accumulated load of around 5 tons [2]. Further, baggage handlers often work in confined spaces in the luggage compartments of aircrafts, necessitating sitting, kneeling or stooping positions. Non-neutral working positions and lifting are important factors in developing low back pain [3]. Further, working in confined space has been shown to increase the load on the lumbar spine [4]. Increased compression forces in the lumbar spine have also been suggested as a risk factor for developing low back pain [5]. The purpose of this study was to quantify the lumbar loading in airport baggage handlers with the help of musculoskeletal modeling.

### METHODS

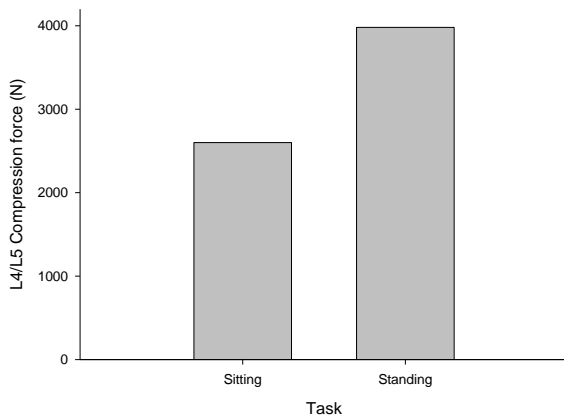
We selected two common work tasks for the airport baggage handler: 1) Sitting position in the luggage compartment and 2) the task of loading baggage from the baggage cart to the conveyor in a standing position. These constituted a main part of work tasks for a baggage handler on the apron.

3D kinematics was obtained by a custom made motion capture system of eight synchronized high-speed HD cameras. A single subject (male, 30 years, 1.69 m., 65 kg.) wearing a full body marker setup of 38 markers was recorded while performing the two tasks with a 15 kg suitcase. Two force platforms (AMTI, Watertown, MA, USA) recorded the ground reaction forces under the feet and one under pelvis during the sitting position.

Inverse dynamics-based musculoskeletal models of the tasks were built in the AnyBody Modeling system v. 5.3 (AnyBody Technology, Aalborg, Denmark) based on the *GaitFullBody* model in the AnyBody Managed Model Repository (AMMR) v. 1.5.

The peak compression forces in the L4/L5-segment were extracted from the model.

## RESULTS AND DISCUSSION

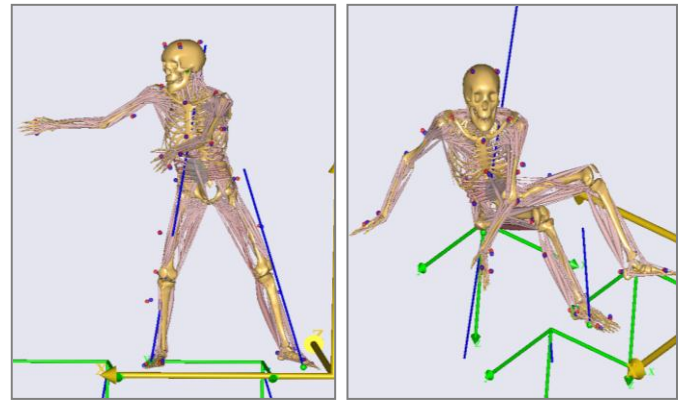


**Figure 1.** The peak compression force on the L4/L5-segment. Standing position: 3891 N (61.2 N/kg\*BW), Sitting: 2600 N (40 N/kg\*BW).

This study estimated the loading on the lumbar spine in two different common work tasks for airport baggage handlers. The standing position (3981 N) produced larger peak L4/L5-compression force than the sitting position (2600 N) (Figure 1).

In the standing position (Figure 2) the peak compression forces exceeded the NIOSH recommendations of 3400 N [6]. The NIOSH equations, however, do not take restricted workspace, working position as seated or kneeling or one-handed lifting into account. Further, these recommendations are based on static 2D calculations where rotations and accelerations are neglected. The present analysis was a 3D dynamical analysis and may therefore have estimated the loading of the body more accurately. Thus, this 3D dynamic analysis can contribute to the extension of knowledge into ergonomic musculoskeletal loading which typically has relied on more simple 2D static analyses.

The sitting position (Figure 2) is only one of many possible postures in the luggage compartment. Kneeling, stooped and squatting are also commonly used positions [7]. Thus, these results only represent a small part of the daily loadings baggage handlers are exposed to inside the aircraft luggage compartment. However, the standing position is a very common position when handling luggage. It is observed that the standing position is used when moving luggage from the belly-cart to the conveyor by the aircraft and vice versa. This position is also used inside the baggage terminal where luggage is transferred into and out of belly-carts. Working in standing position could constitute up to 50 % of a regular work day for an airport baggage handler. Further, the task of handling objects in a standing position can probably be transferred to many other professions, so the results from this study may also be valid in other aspects.



**Figure 2:** The model performing the standing and sitting tasks.

## CONCLUSIONS

In conclusion, the peak compression in the L4/L5-segment was 3981 N (61.2 N/kg\*BW) for handling baggage in a standing position, while the peak compression was 2600 N (40 N/kg\*BW) in the sitting position. However, the selection of work tasks was not exhaustive, so further investigation must be carried out to fully describe the loading of airport baggage handlers.

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