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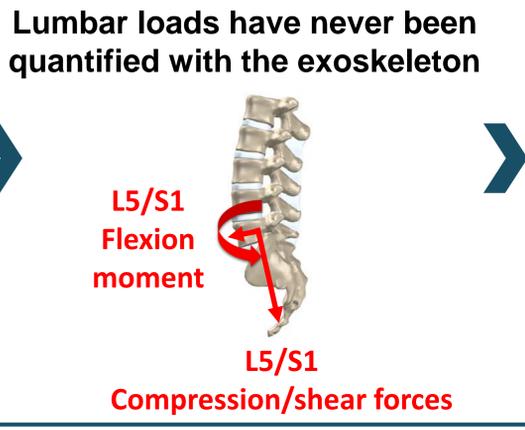
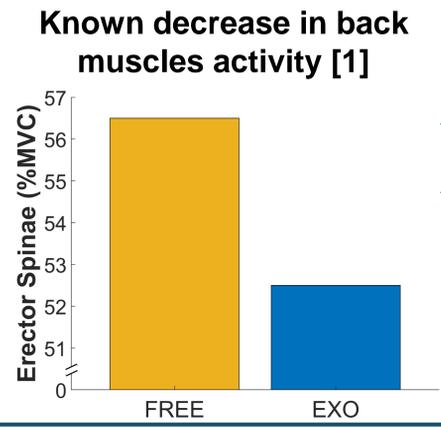
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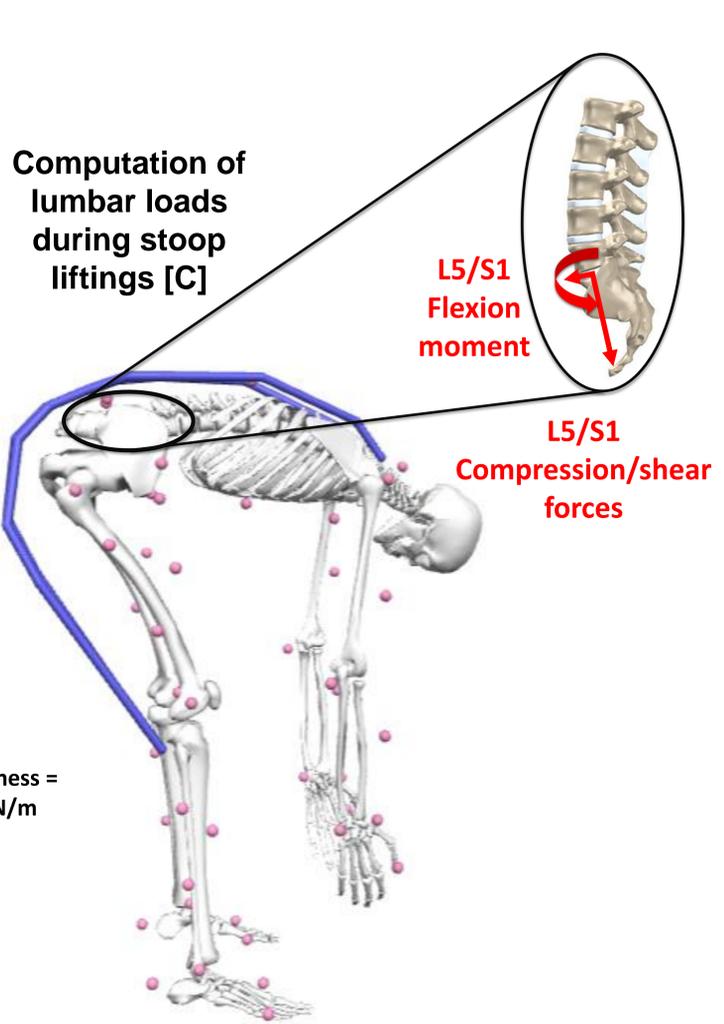
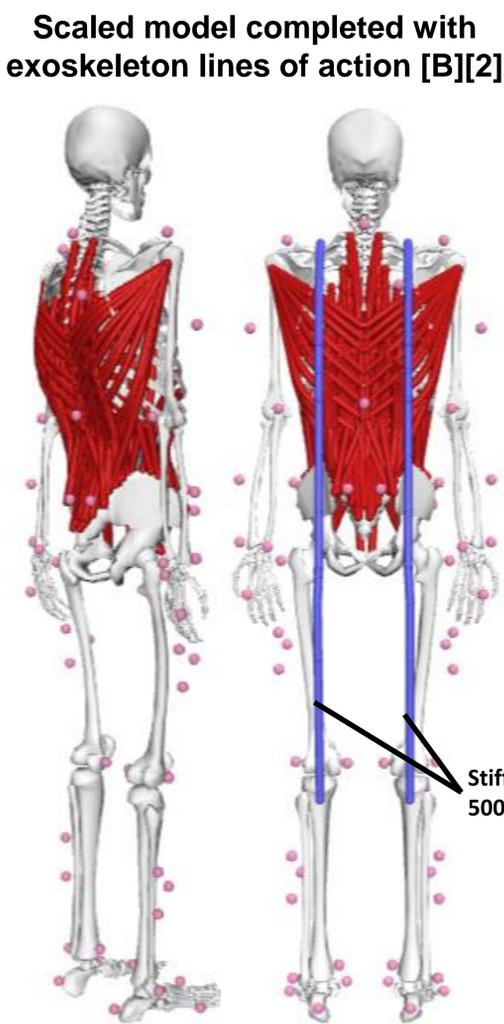
Effects of a soft back exoskeleton on lumbar loads during a manual handling task: a pilot simulation study.

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Does the exoskeleton reduce lumbar loads during manual handling tasks ?

- Material and methods:**
- 8 asymptomatic participants
 - 10 consecutive liftings (8 kg box) using **stoop technique** with (**EXO**) and without (**FREE**) the **CORFOR®** back exoskeleton.
 - Recordings of full body **kinematics [A]** + ground reaction **forces and moments**.
 - **Opensim 4.3**
 - Model adaptation and scaling [B]
 - Inverse Kinematics
 - Inverse Dynamics
 - Static optimisation
 - Joint reaction analysis [C]
 - **Estimation of lumbar (L5/S1) compression force, shear force, and flexion moment.**
 - **Student t-tests** to assess the effect of the exoskeleton by comparing **EXO** and **FREE**.



Results: Statistical analyses showed that **L5/S1 peak compression forces (Fig. 1) were significantly 5.7% lower** ($p = 0.02$, $d = 1$) in **EXO** than in **FREE**. **Peak shear forces (Fig. 2) were significantly 22.2% lower** ($p = 0.002$, $d = 1.7$) in **EXO** than in **FREE**. **Peak flexion moments (Fig. 3) were significantly 16.7% lower** ($p \leq 0.001$, $d = 2.8$) in **EXO** than in **FREE**.

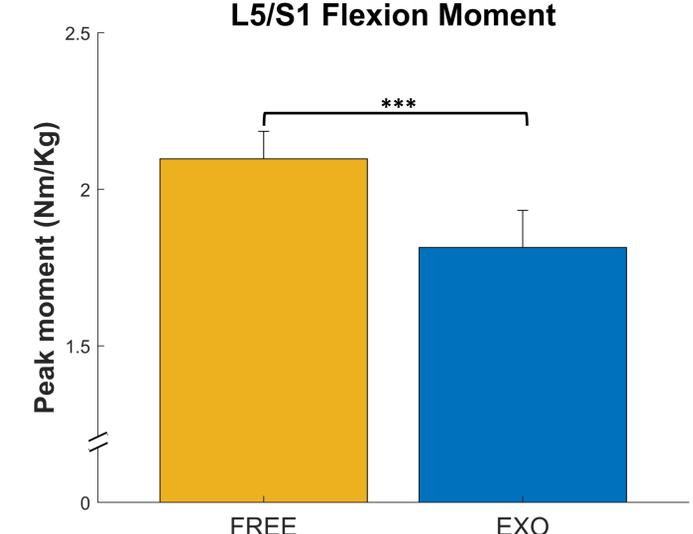
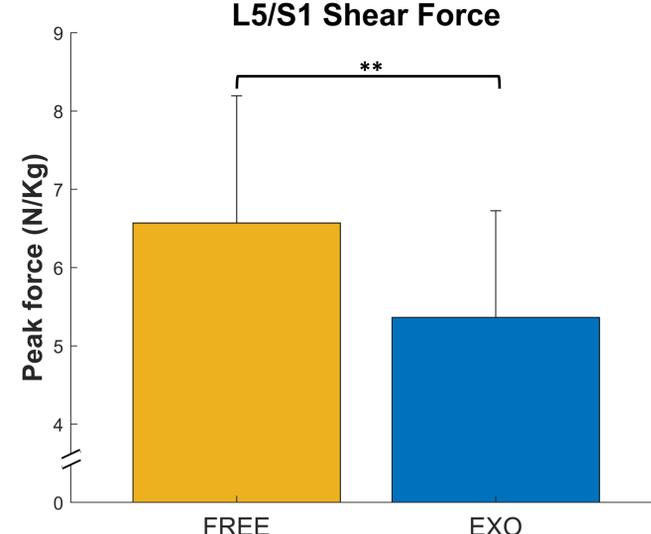
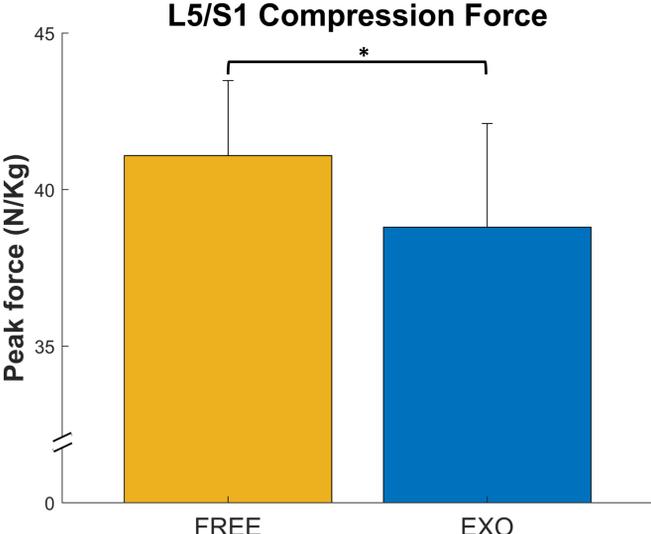


Fig. 1 : Peak L5/S1 compression forces during FREE and EXO Fig. 2 : Peak L5/S1 shear forces during FREE and EXO Fig. 3 : Peak L5/S1 flexion moment during FREE and EXO

Discussion: This study suggests that **wearing the CORFOR® exoskeleton decreases lumbar loads and may thus contribute to the prevention of low back disorders**. These results are consistent with the decreased back muscles activity observed while using this exoskeleton [1]. Future experiments should focus on the effect of such an exoskeleton during other handling tasks (e.g. squat, asymmetric lifting). Simulating the impact of different stiffnesses and paths of the exoskeleton springs on lumbar loads may also help to optimise the exoskeleton design.

[1] Schwartz, Theurel and Desbrosses, IJERPH, 2021
 [2] Beaucage-Gauvreau et al., Comput Methods Biomech Biomed Engin, 2019
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