

human engineering

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## Obesity and physical loading during manual lifting

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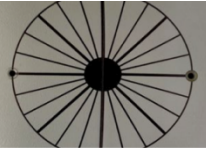
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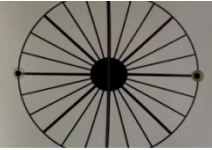
Azurém > Guimarães > Portugal



## Introduction

- **Obesity** is a serious problem in developed countries. In Portugal, **more than 50%** of all population has **an unhealthy weight** (INE, 2010). Obese people represent a **significant fraction of the workforce** (Flegal *et al.*, 2002).
- Obesity is being associated with **social, psychological** and **physical problems**, including work-related musculoskeletal disorders (**WRMSD**), which can negatively affect the **productivity** (Lidstone *et al.*, 2006; Morris, 2007) .
- Employees with overweight are **absent** from work due to illness **more often and for longer periods** than employees with normal weight (Tsai *et al.*, 2008).





## Introduction

- Manual materials handling (**MMH**) tasks, including **lifting loads**, are **very common** in a wide variety of workplaces and represent an **important WRMSD risk factor**, mainly for the back (Yeung *et al.*, 2002). Excessive body **fat mass can negatively affect** the muscles and spine behaviour during MMH...

Some psychophysical data suggested that **obesity does not reduce the maximum acceptable weight** (Singh, Park & Levy, 2009).

Psychophysical data indicate that the **obesity increases postural stress** during static box-holding tasks (Park *et al.*, 2009).

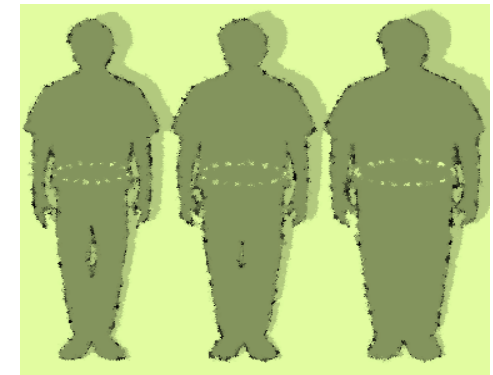
Obese subjects showed a **more flexed trunk posture** during **standing work task** (Gilleard & Smith, 2007).

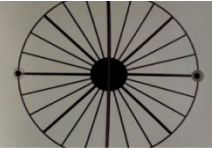
Biomechanical results demonstrated that the **BMI had a strong effect on the peak value of dynamic trunk kinematics variables** (Xu, Mirka & Hsiang, 2008).



## Introduction

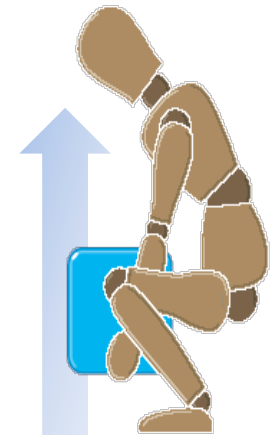
- In the most part of the studies the **BMI** was the **only used technique for obesity assessment**.
- The utility of BMI started **to be questioned**... It does not reflect accurately the physical constitution, because it does **not distinguish fat-free and fat mass rates** (Gallagher *et al.*, 1996). Need to use **more appropriate methods** for obesity assessment (Xu, Mirka & Hsiang, 2008).
- The obesity has been intensively studied in the recent years, but the findings still involve **some controversy**... Ergonomic studies are required to provide a **more complete understanding** for the obesity **effects on work performance** (Williams & Forde, 2009), including manual lifting tasks (Singh, Park & Levy, 2009).

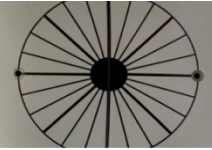




## Purpose of the study

To study the **obesity effect** on **physical loading** during manual lifting.





## Materials and Method

- **10 men** and **4 women**, healthy and **without history of musculoskeletal disorders**; with mean age: 29.2 ( $\pm 10.5$ ) yr.
- Different anthropometric measures were collected: weight, stature, waist circumference. A Body Fat Monitor, based on **bioelectrical impedance**, was used to determinate **the individuals' obesity levels**.

**OMRON BF306**  
**Body Fat Monitor**



**% Body fat mass**  
+  
**Age and Gender**

**Obesity Levels:** (Deurenberg *et al.*, 1998)

**Normal**

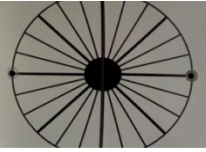
- 5 subjects

**High**

- 4 subjects

**Too High**

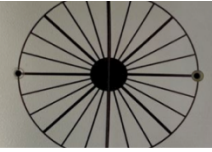
- 5 subjects



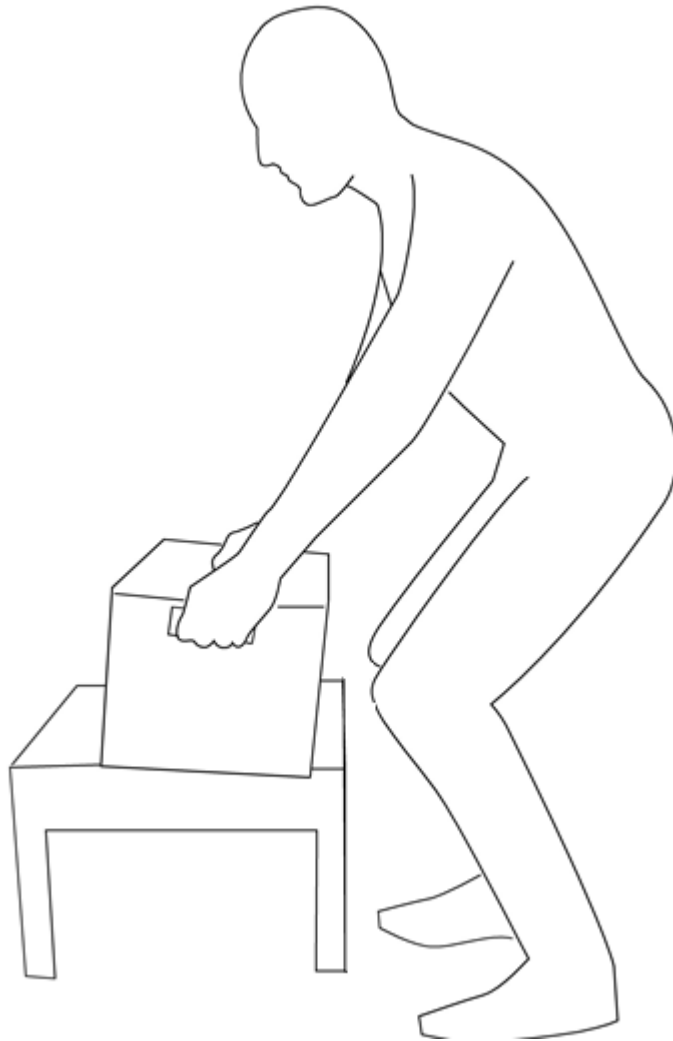
## Materials and Method

- In the sagittal plan, 6 trials of **lifting and replacing a test box** were performed.
- Subjects lift the box between their knees and shoulders height.
- **6 trials = 3 loads** (5, 10 and 15 kg) x **2 styles** (free and constrained)

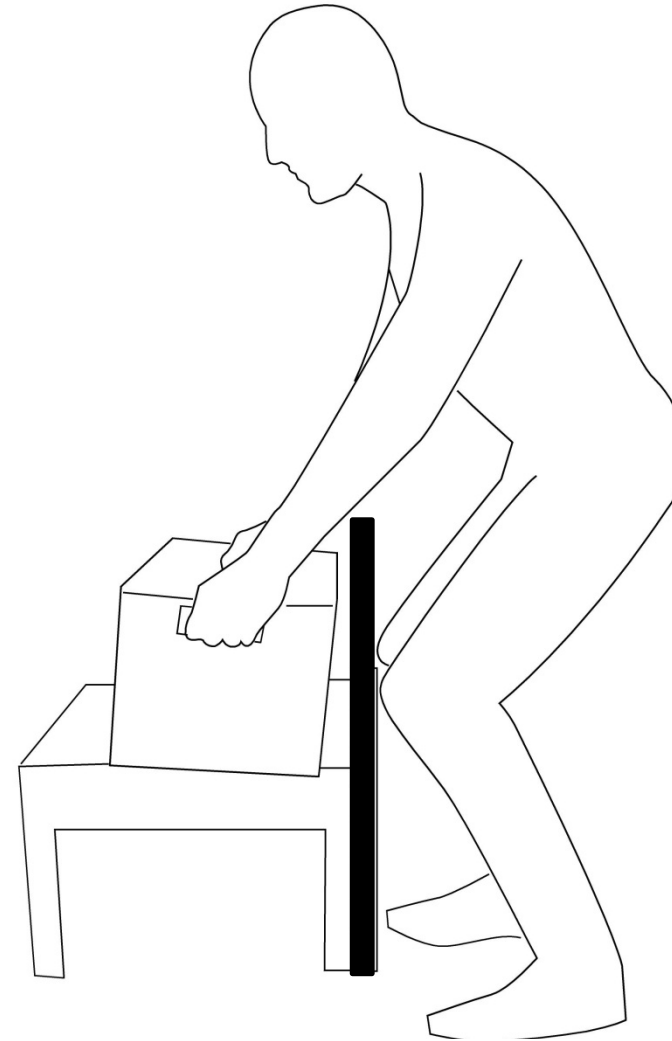
Trials	Load			Style	
	5 kg	10 kg	15 kg	Free	Constr.
1	●			●	
2	●				●
3		●		●	
4		●			●
5			●	●	
6			●		●

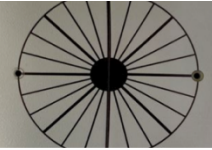


## Freestyle Lifting – Initial position

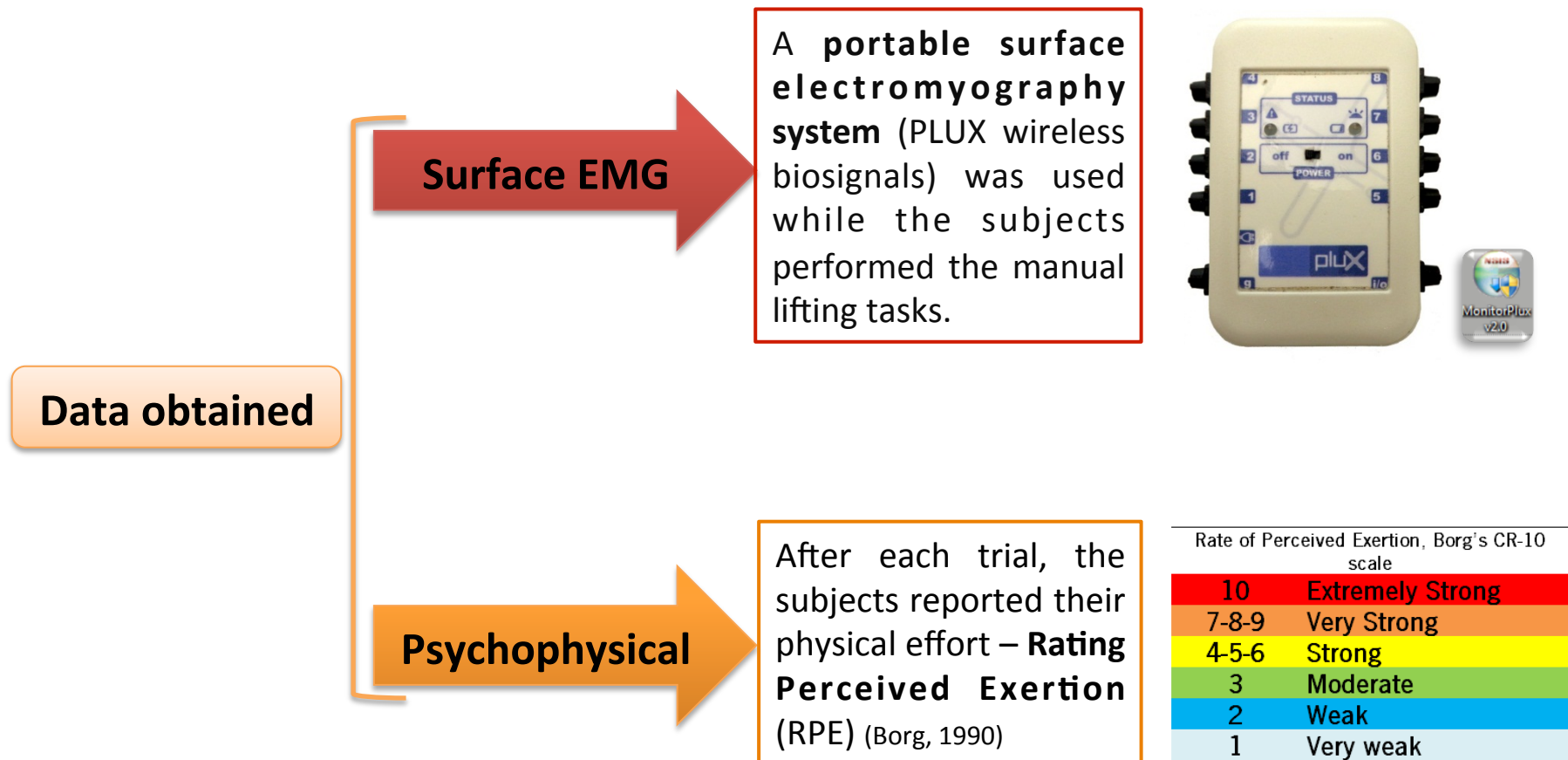


## Constrained Lifting – Initial position





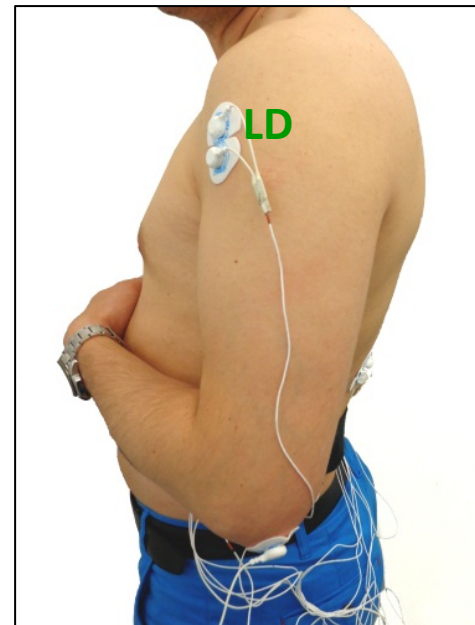
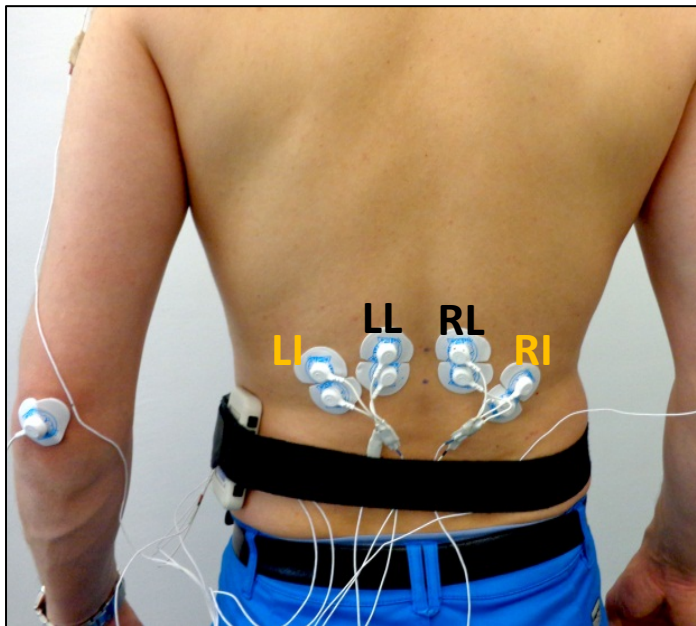
## Materials and Method

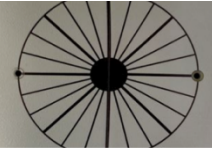




## Materials and Method

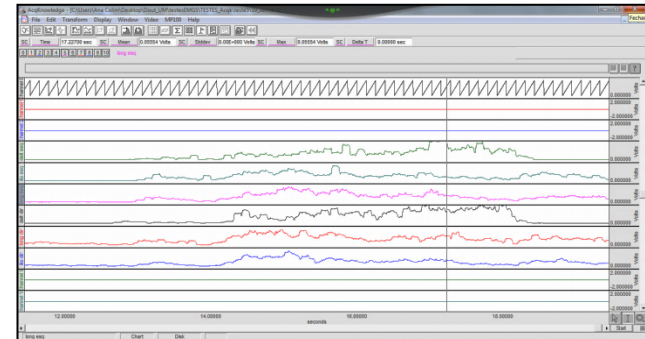
- EMG electrodes were located at 3 **muscles recruited** during this **type of tasks**:
  - Left and Right *Erector spinae (Longuissimus)* at L1 (**LL, RL**);
  - Left and Right *Erector spinae (Iliocostalis)* at L2 (**LI, RI**);
  - Left and Right *Deltoideus Anterior* (**LD, RD**).
- EMG electrodes were affixed to the subject's body according to **Surface Electromyography for the Non-Invasive Assessment of Muscles – SENIAM** standard placement procedures (SENIAM, 2012)





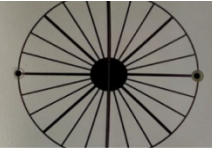
## Materials and Method

- **AcqKnowledge** 3.9.0 software was used to process and to analyze the EMG data.
- The raw EMG signals were amplified, smoothed by Root Mean Square, rectified, high-pass filtered at 20 Hz and low-pass filtered at 500Hz.
- **EMG data were normalized to peak value** during each manual lifting, calculating the percentage of **Maximum Contraction during each task (%MCT)** (De Luca, 1997).



$$\%MCT = (\text{Mean amplitude} / \text{Peak value}) \times 100$$

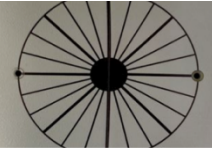
- The MCT percentages were averaged across the subjects belonging to the same obesity level.
- Hypothesis tested: **greater %MCT and RPE** values are observed in individuals with **higher obesity levels**.



## Results and Discussion

- In different muscles, **mean %MCT is higher**, for the group **“Too high”** obese subjects. It is **more evident** in the lifting tasks involving more load handling (10 and 15 kg).
- Higher obesity level** seems to increase the muscle loading during manual lifting tasks.

Surface EMG data – MCT (SD) %						
5 kg Freestyle lifting						
	LI	RI	LL	RL	LD	RD
Normal	58.5 (6.0)	57.0 (5.5)	66.9 (4.3)	66.5 (4.1)	52.9 (7.4)	42.2 (21.9)
High	50.9 (5.7)	49.6 (15.9)	51.4 (21.3)	48.5 (15.6)	45.0 (8.5)	39.5 (8.3)
Too high	55.4 (6.3)	56.4 (5.8)	61.8 (4.5)	58.2 (8.3)	49.7 (6.8)	42.3 (3.4)
5 kg Constrained lifting						
	LI	RI	LL	RL	LD	RD
Normal	59.3 (10.7)	52.0 (4.3)	59.2 (7.4)	61.3 (5.2)	45.7 (13.4)	49.8 (6.9)
High	48.3 (12.0)	50.6 (14.0)	49.0 (12.0)	50.3 (11.5)	42.2 (6.3)	42.0 (6.7)
Too high	48.0 (3.8)	56.5 (7.7)	63.8 (12.1)	58.0 (8.1)	55.3 (13.0)	49.5 (9.8)
10 kg Freestyle lifting						
	LI	RI	LL	RL	LD	RD
Normal	52.7 (4.6)	55.1 (6.8)	59.1 (6.8)	61.5 (11.8)	46.6 (8.8)	48.0 (8.2)
High	53.2 (10.5)	57.2 (7.2)	58.9 (15.0)	52.1 (12.7)	55.9 (1.9)	44.7 (10.7)
Too high	58.6 (6.0)	58.1 (9.3)	65.1 (11.8)	61.9 (6.2)	56.1 (7.5)	56.3 (5.9)
10 kg Constrained lifting						
	LI	RI	LL	RL	LD	RD
Normal	53.3 (8.3)	52.1 (4.6)	52.7 (9.8)	61.1 (4.1)	40.9 (7.2)	47.9 (10.2)
High	55.0 (8.1)	57.3 (7.6)	58.1 (7.1)	62.9 (4.1)	47.7 (4.6)	48.1 (7.0)
Too high	61.9 (5.3)	59.9 (4.7)	59.1 (12.1)	63.1 (6.2)	49.9 (8.3)	50.2 (11.3)
15 kg Freestyle lifting						
	LI	RI	LL	RL	LD	RD
Normal	50.6 (3.6)	47.9 (10.1)	51.0 (6.7)	52.7 (9.5)	39.2 (8.1)	43.7 (6.0)
High	53.9 (9.5)	49.0 (7.0)	55.6 (5.5)	53.1 (8.7)	52.8 (4.1)	51.1 (6.1)
Too high	57.2 (10.3)	57.5 (7.6)	63.9 (17.2)	55.1 (4.6)	52.9 (9.4)	51.9 (8.9)
15 kg Constrained lifting						
	LI	RI	LL	RL	LD	RD
Normal	52.2 (7.9)	49.4 (12.5)	55.3 (10.5)	52.2 (12.9)	40.4 (12.5)	44.3 (14.3)
High	56.6 (8.9)	54.0 (3.6)	57.4 (8.4)	62.1 (4.0)	40.6 (8.4)	42.3 (11.6)
Too high	59.8 (8.4)	54.2 (12.7)	62.9 (14.6)	65.0 (8.5)	47.2 (16.8)	54.4 (13.4)

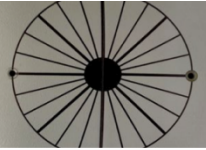


## Results and Discussion

- **Obesity level did not seem to influence the psychophysical data**, in contrast to the findings of Park *et al.* (2009).
- Similarly to Singh *et al.* (2009), this evidence can be related with the fact that **obese** subjects are **continually exposed to higher physical load** than non-obese due to their larger body fat mass. They might be bot so aware of the perceive physical loading.

Psychophysics data – RPE values	
<b>5 kg Freestyle lifting</b>	
RPE	
Normal	2.2 (0.4)
High	2.0 (0.0)
Too high	2.2 (0.4)
<b>5 kg Constrained lifting</b>	
RPE	
Normal	2.4 (0.5)
High	2.3 (0.5)
Too high	2.8 (1.3)
<b>10 kg Freestyle lifting</b>	
RPE	
Normal	4.8 (2.2)
High	4.0 (0.0)
Too high	4.0 (1.2)
<b>10 kg Constrained lifting</b>	
RPE	
Normal	4.8 (2.2)
High	4.8 (0.5)
Too high	4.2 (1.5)
<b>15 kg Freestyle lifting</b>	
RPE	
Normal	6.8 (2.6)
High	6.0 (0.8)
Too high	7.0 (1.4)
<b>15 kg Constrained lifting</b>	
RPE	
Normal	8.0 (2.4)
High	6.5 (0.6)
Too high	7.0 (1.0)

- **Psychophysical data may be less valid for obese workers** as an ergonomic approach...



## Concluding Remarks

- A more completed **statistical analysis is needed** with the aim of testing the possible dependences between the different variables.
- **Other EMG variables will be analyzed**, such as the possibility to quantify differences in **muscles activation time**.
- The study was also limited because only a **few muscles were considered**. However, this selection was influenced by their body position, trying **to avoid regions with more adiposity mass** cumulated.
- Finally, most tasks in workplaces are not scaled in this study and it is possible that differences may exist for tasks with other constrains and loads for all obesity levels.
- Consequently, this area **requires more study**... The future work, it **will consider** other type of data, such as **kinematics data**, to achieve a better understanding of obesity effects on individual lifting performance.
- Globally, these results may highlight the importance to consider the workers' anthropometric variability in workplaces, including those with obesity.



# Thank you

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