Interventions to Reduce Ergonomic Exposures during Drywall Installation

Priyadarshini
Sengupta Dasgupta

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Background – Drywall Installation

Weight of the drywall

- **4ft X 8ft (70 lbs)**
- **4ft X 12ft (105 lbs)**

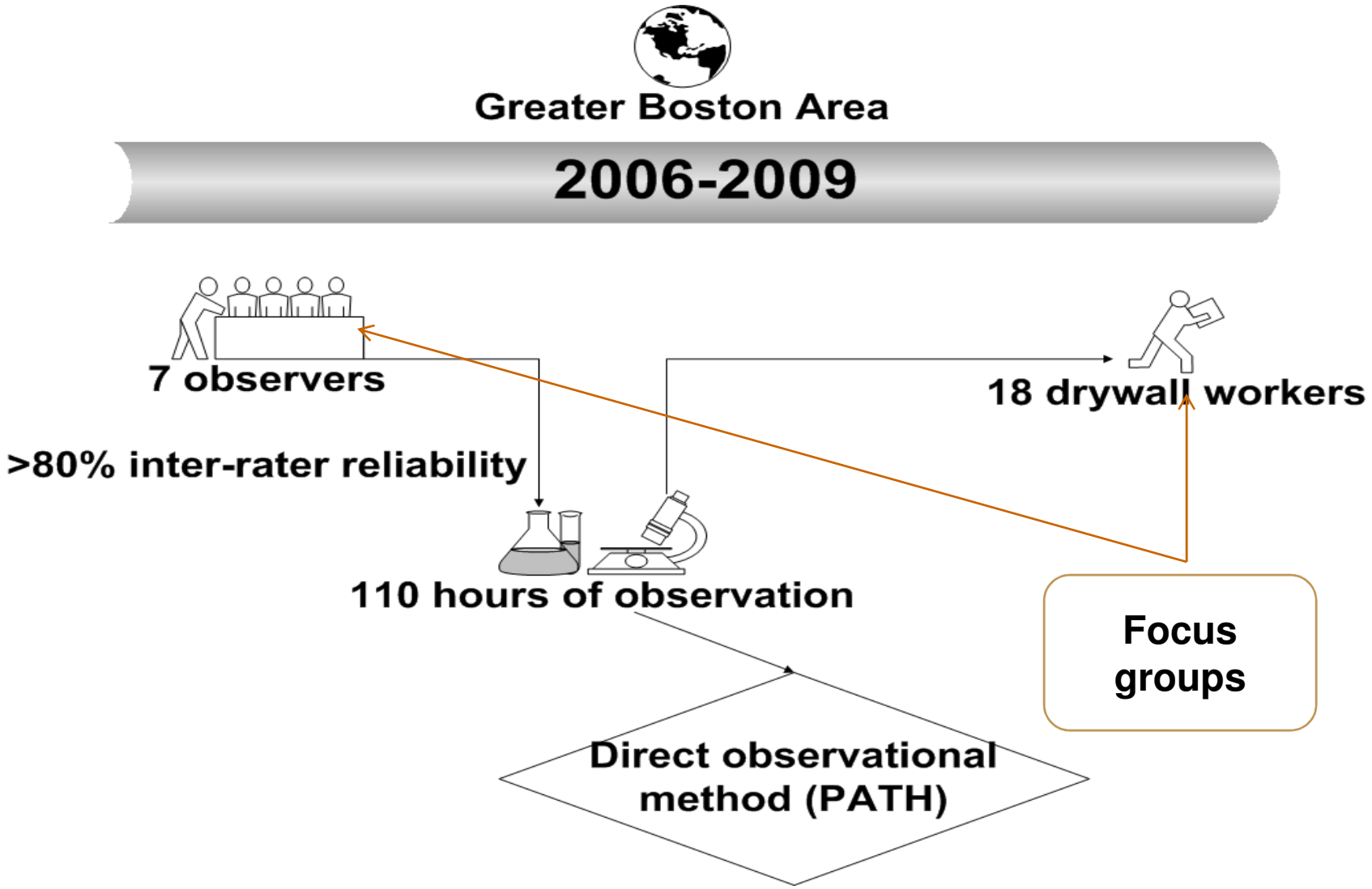
(5/8 inches thickness)

(Yuan, 2007)

Background – Reported Exposures

Study, year	Concerns of drywall installation task	Affected body area
Lipscomb, 2008	• Repeated handling of heavy panels	Lowback
Pan, 2000	• High postural demands while being on ladder • Fall from ladder during panel installation	Lowback, neck, shoulder, wrist
Pan, 1999	• High compression force while lifting panels	Lowback
Yuan, 2007	• High compression force during drywall installation	Lowback
Lipscomb, 2000	• Overexertion of muscles • Fall from ladder during drywall installation	Lowback
Chiou, 2000	• Overexertion of muscles • Awkward bodily motion or position during installation process	Lowback, shoulder

STUDY I-Assessing the Ergonomic Exposures for Drywall Workers

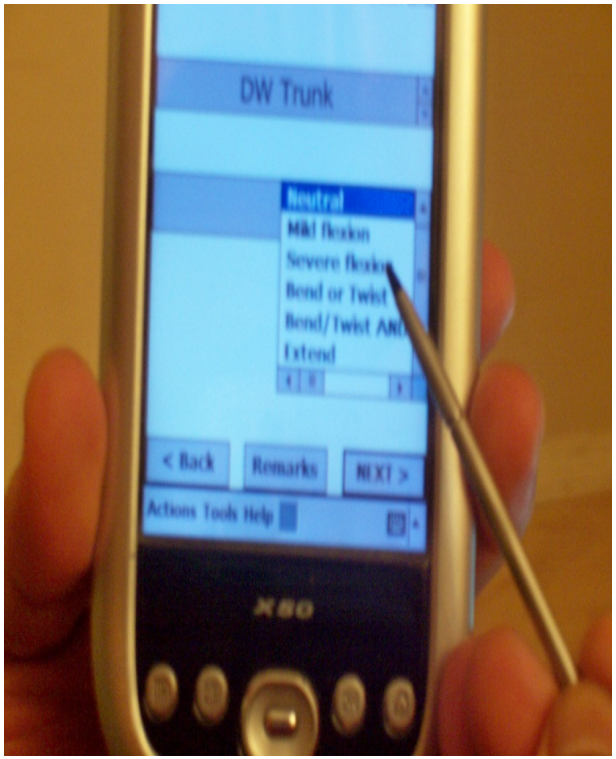


STUDY I: Methodology

PATH (Posture, Activity, Tools and Handling) (Buchholz, 1996)

- Posture categories based on OWAS (1977,1981)
  - Trunk, arms, legs
- Direct observation
- Fixed interval sampling (1 min)
- PDA with data collection template (PenFact)

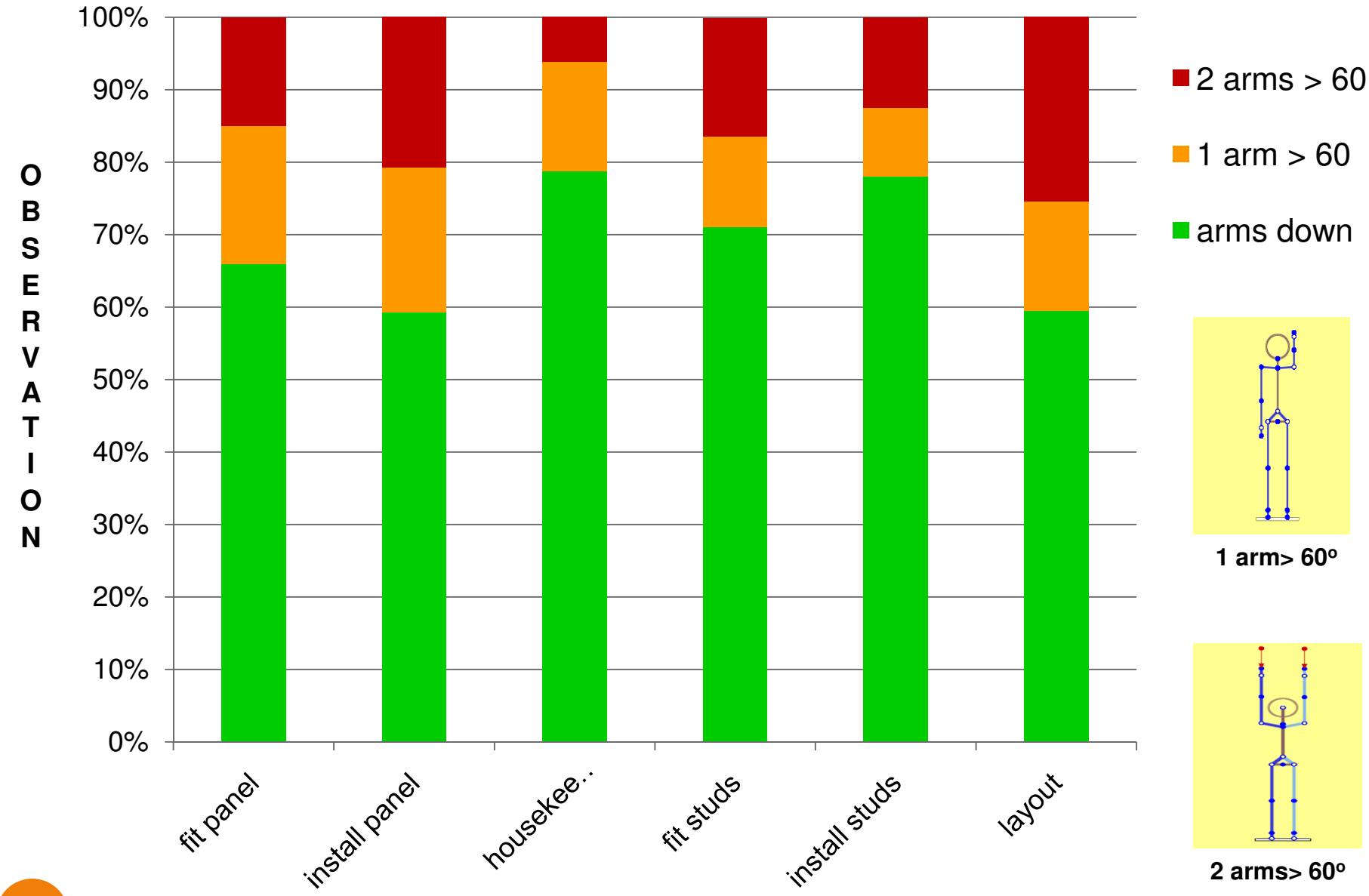
Taxonomy to collect exposure data (Moir, 2003)



Buchholz, Paquet, Punnett, Lee, Moir. PATH: A work sampling-based approach to ergonomic job analysis for construction and other non-repetitive work. Applied Ergonomics. 27(3) pp. 177-187. 1996.

Moir, Paquet, Punnett, Buchholz, Wegman. Making Sense of Highway Construction: A Taxonomic Framework for Ergonomic Exposure Assessment and Intervention Research . Applied Occupational and Environmental Hygiene, 18(4), pp.256 – 267. 2003.

Study Results - Arm postures



1 arm> 60º

2 arms> 60º

Workers' perception

WEIGHT OF PANELS	AWKWARD POSTURE	OTHER RISK FACTORS
•Bulky weight of panels •Pressure on shoulder	•Overhead arm postures •Shoulder and wrist fatigue	•Risk of falling from ladder during ceiling installation

Summary of key findings

- Install drywall panel - load handled (18% of work time)
- Lifting load on ladder with awkward body postures
- Layout - does not include load handling
- Housekeeping - carried out at the end of work day

Study II: WORKERS INNOVATIVE IDEA FOR REDUCING THE ERGONOMIC EXPOSURES IN DRYWALL INSTALLATION

Research questions

- Could workers' innovative idea(s) be implemented as an intervention for drywall installation?
- Would it reduce the exposure(s)?
- Could it lead to the formation of a permanent assistive tool?

Focus groups (2010-2011)

Discomfort/ concern

- Back pain
- Shoulder pain
- Hands over shoulder

Suggestions

- Lighter weight of the panel
- 4 men lifting
- Higher ladder

FEASIBILITY ????

SUSTAINABILITY ????

Methodology

Site

- Commercial residential construction site in Boston

Participants

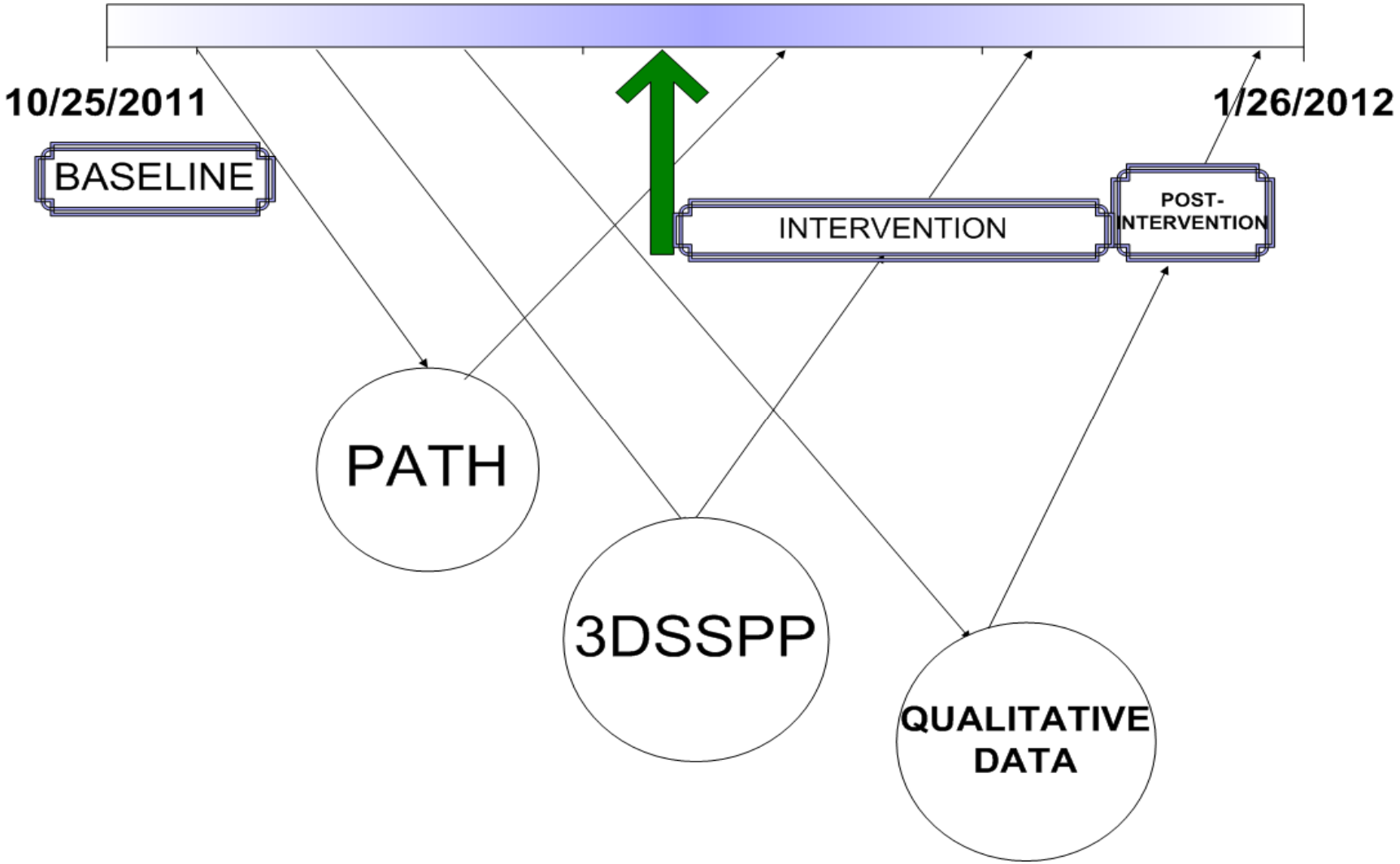
- 5 drywall installers at the site
- All agreed to participate
- All men, between 23-55 years of age
- All right handed and English speaking

Focus Group Meetings

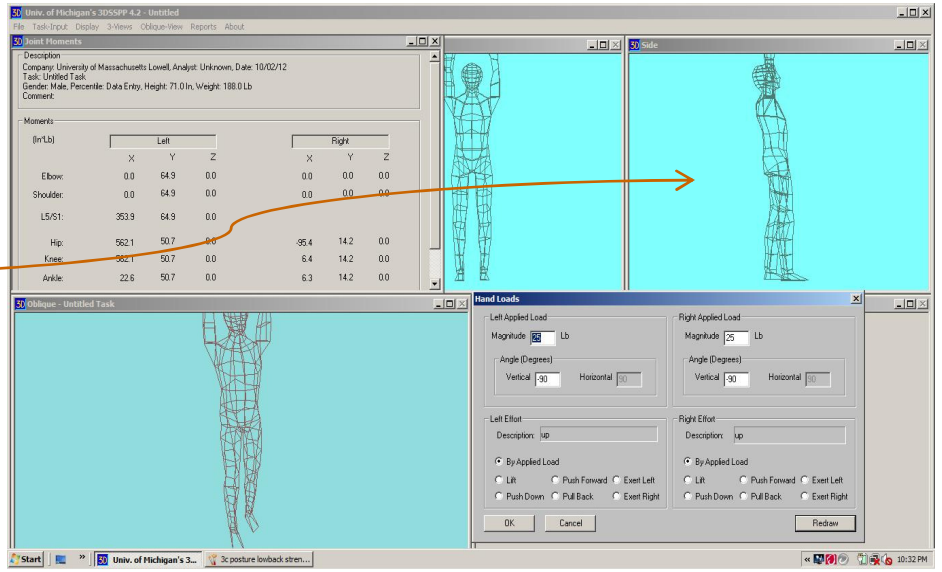
- Meeting 1 – Possible modification of any activity
- Meeting 2 – Potential intervention ideas
- Meeting 3 – How to implement?

Equipment Use (Pre-Intervention)

Methodology: Pre-post intervention exposure assessment



Methodology: 3DSSPP



- Anthropometric measurements
- Still frames from video at 10s interval
- Sequence of static postures
- Hand forces estimated using weight of drywall and static model

- Compressive force at the low back
- Moments produced at the shoulder joints

Results: Qualitative Approach

Meeting 1

- Shoulder pain during ceiling installation on ladder
- Wrist pain while driving screws

Meeting 2

- Stilts (pros and cons)
- Lighter drywall

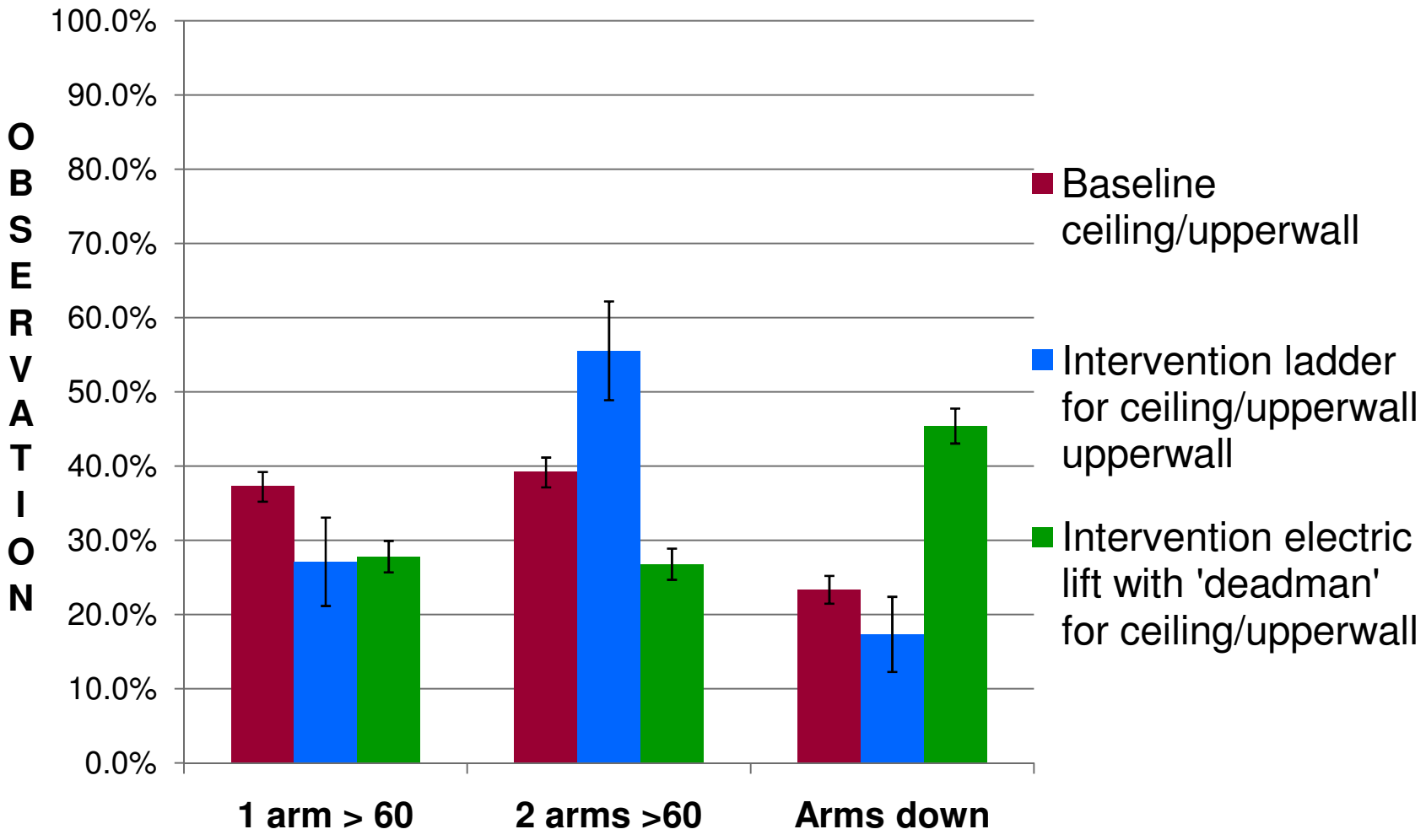
Meeting 3

- Electric lift and "deadman" (a scrap drywall panel piece to hold the ceiling drywall)

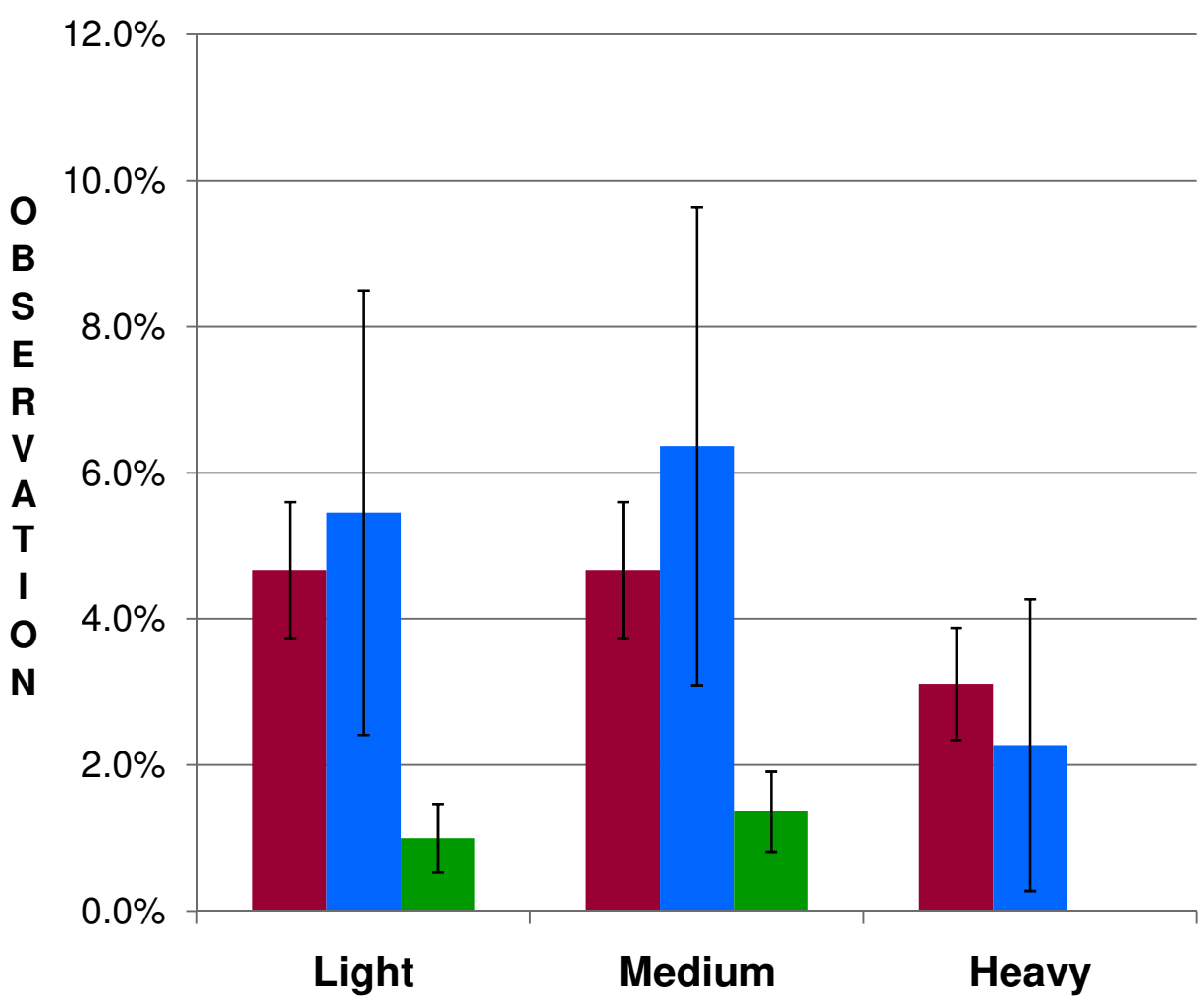
Results: Equipment Use (Intervention phase)

An Innovative Idea for Reducing the Musculoskeletal Disorders in Drywall Installation .Dasgupta P., Punnett L.,, Moir S., Kuhn S.,, Buchholz B., PROCEEDINGS of the HUMAN FACTORS and ERGONOMICS SOCIETY 57th ANNUAL MEETING – 2013, 989 – 993.

Results: PATH Data Analysis - Arm Postures



Results: PATH Data Analysis - Weight Handling



PATH Categories

0-5 lb = very light

5-15 lb = light

15- 50 lb = medium

>50 lb = heavy

Results: 3DSSPP analysis

Variable	Baseline mean	Intervention mean	p*
Low-back Compressive Force	2689.8 N Standard Dev. = 971.52 N	1280.1 N Standard Dev. = 680.24 N	0.001
Right Shoulder Moment	383.4 N-m Standard Dev. = 256.5 N-m	311.8 N-m Standard Dev. = 249.7 N-m	0.43
Left Shoulder Moment	556.4 N-m Standard Dev. = 374.0 N-m	359.1 N-m Standard Dev. = 233.5 N-m	0.04

*Student t-test

Results: Qualitative analysis

Disadvantages of the 'deadman'

- Holder has to stand on the floor
- Upward force applied to ceiling panel
- Not a permanent structure

&

- Can not be placed on its own

Study III: IMPLEMENTATION AND EVALUATION OF A DRYWALL INSTALLATION ASSISTIVE TOOL (structured by the research team)

Objective of the research

- To evaluate this prototype tool to find out its efficacy in reducing existing drywall installation exposures
- Sustainable intervention

Specific Aims

- Quantitative evaluation of efficacy of the tool (PATH, 3DSSPP)
- Qualitative evaluation of efficacy of the tool

  (Focus group, questionnaire)

Methodology: Qualitative efficacy evaluation

Focus group scripts

- Ways to install ceiling drywall panels with the tool
- Feasible idea that can be carried out at the site

Suggestion box and opinions

- Modification of the tool

Questionnaire

- Workers perception on stability, usability, ceiling supportive structure etc. of the tool
- Tool's effect on the working speed

BASELINE/Pre-INTERVENTION PHASE

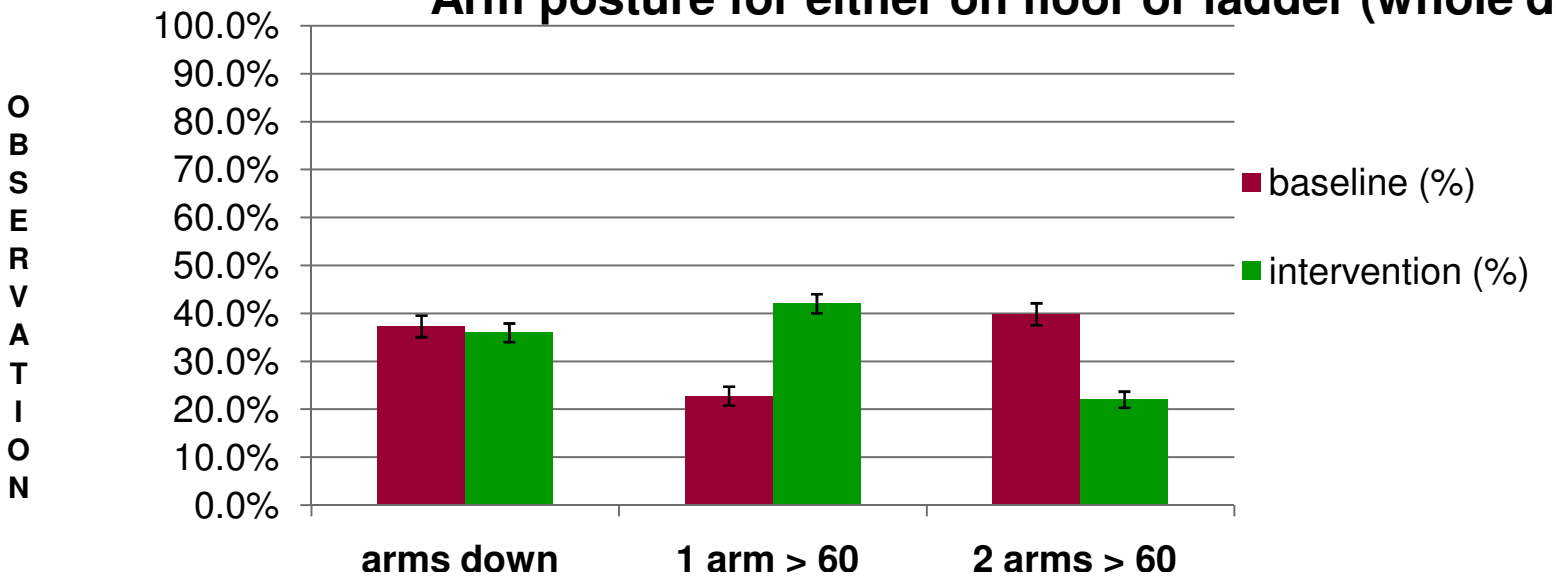
Use of the tool at intervention

- 6 (3*2) installers working as 3 pairs
- Baseline PATH data collection = 20 hours (n=6)
- Intervention PATH data collection = 27 hours (n=6)
- 3DSSPP analysis on 2 pair of installers
- 1 installer added for qualitative evaluation

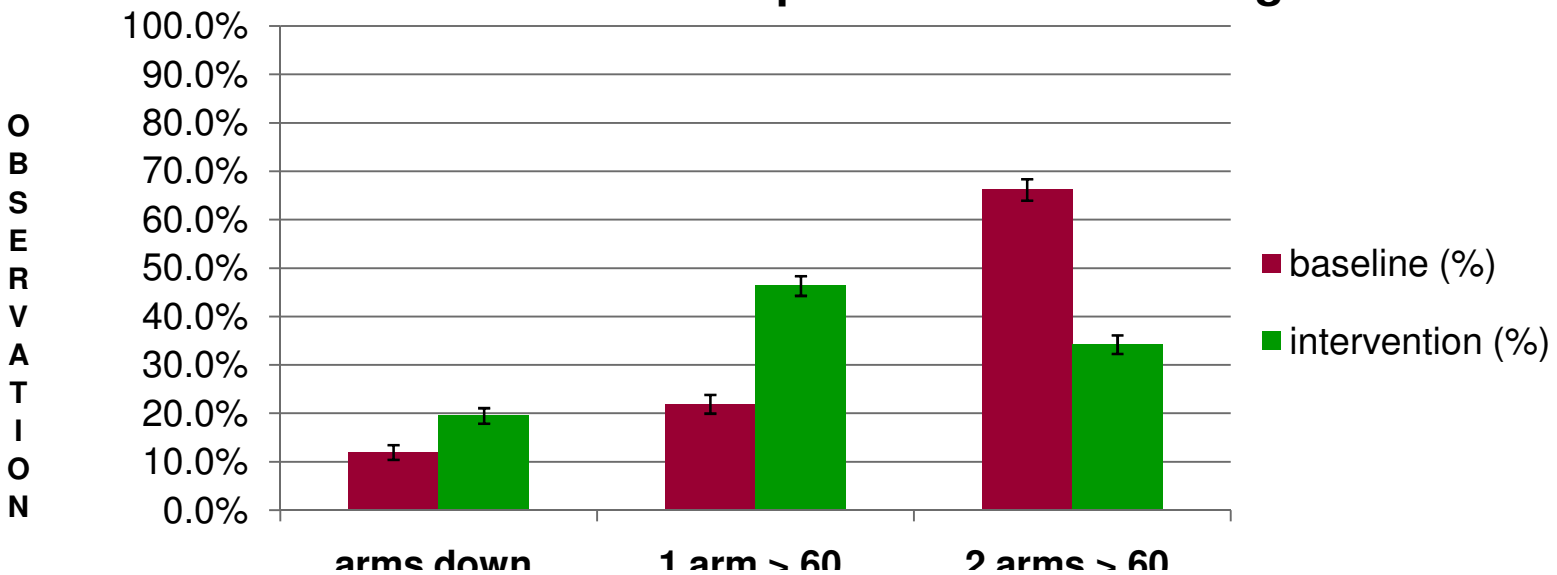
(1 pair was shifted to other job at the intervention phase)

RESULTS: Arm postures while ceiling installation

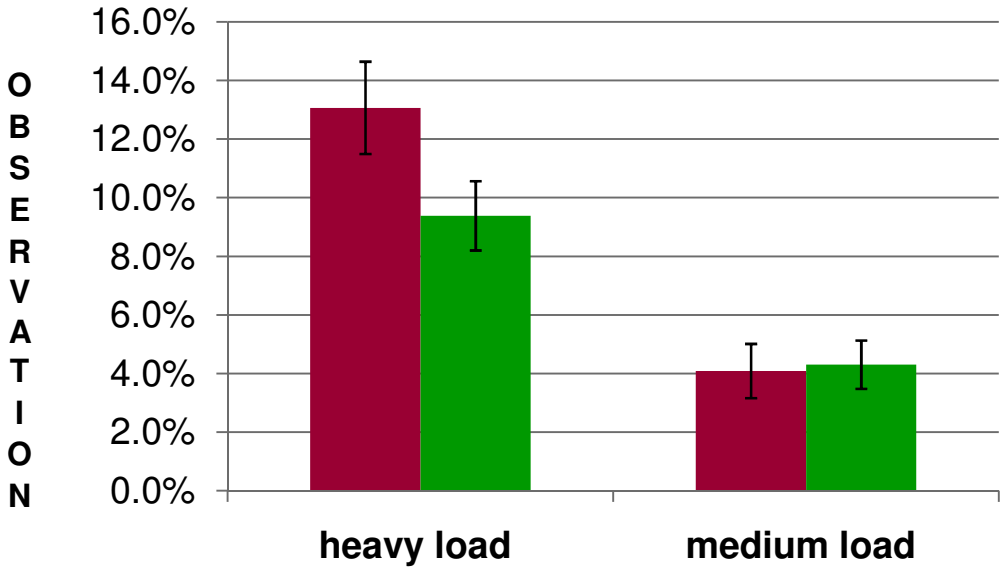
Arm posture for either on floor or ladder (whole day)



Arm posture while working on ladder



RESULTS: Load handling while whole day ceiling installation



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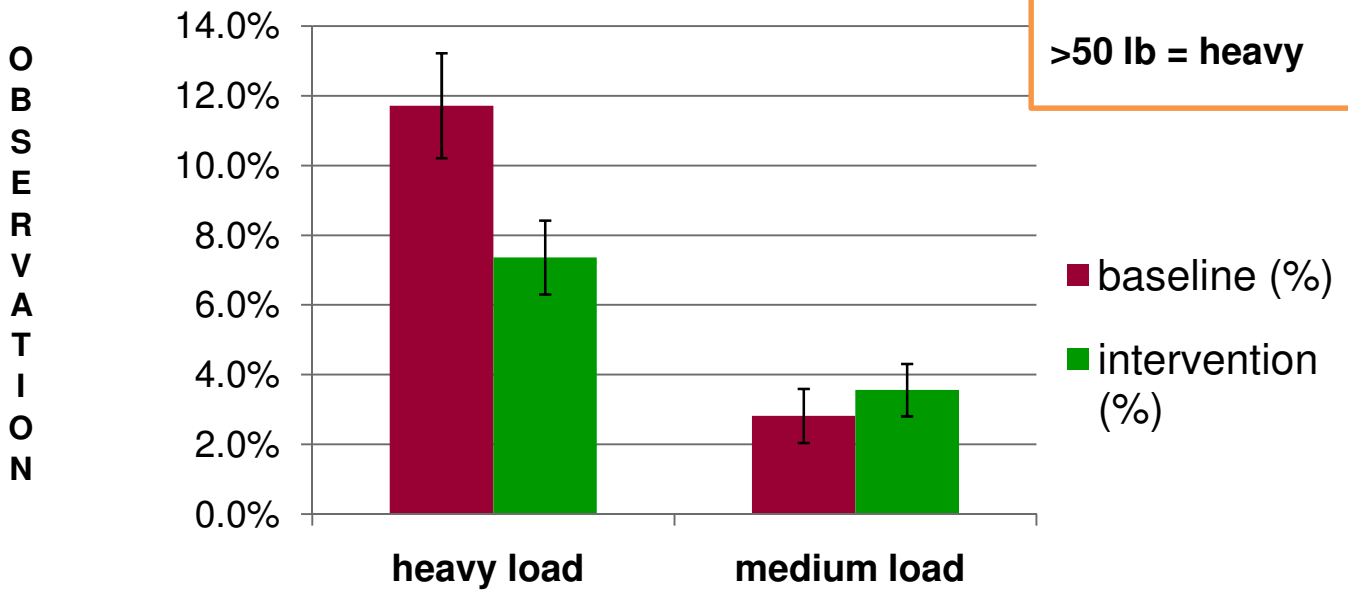
While being on ladder



Results: 3DSSPP analysis- paired t test results

Variable	Baseline mean	Intervention mean	P*
Lowback compressive force	**1544.4 N** Stand. Dev. = 655 N	**1084.4 N** Stand. Dev.= 695.2 N	0.005
Shear force	**171.8 N** Stand. Dev. = 59.4 N	**180.7 N** Stand. Dev. = 91.08 N	0.20
Right shoulder moment	**486.2 N-m** Stand. Dev. = 258.66 N-m	**154.5 N-m** Stand. Dev. = 95.58 N-m	0.0005
Left shoulder moment	**348.5 N-m** Stand. Dev. = 194.6 N-m	**186.8 N-m** Stand. Dev. = 143.1 N-m	0.04

Qualitative analysis: questions on tool set up and usability

Questions	extremely easy (%)	easy (%)	somewhat easy(%)	not at all easy(%)
Tool set up	85.7 (6/7)	0.0 (0/7)	14.3 (1/7)	0.0 (0/7)
Length adjustment	85.7 (6/7)	14.3 (1/7)	0.0 (0/7)	0.0 (0/7)
Moving the tool	71.4 (5/7)	14.3 (1/7)	14.3 (1/7)	0.0 (0/7)
Stability	71.4 (5/7)	28.6 (2/7)	0.0 (0/7)	0.0 (0/7)
Ceiling support	57.1 (4/7)	42.9 (3/7)	0.0 (0/7)	0.0 (0/7)

Qualitative analysis: Focus group

Discomfort feeling	Yes (%)	No (%)
Back	0 (0/7)	100.0 (7/7)
Shoulder	0 (0/7)	100.0 (7/7)
Wrists	14.3 (1/7)	85.7 (6/7)

Features of the tool that reduced bodily discomfort

- An extra third palm
- Less amount of wrist force
- Takes pressure off the shoulder

Could you modify/suggest a feature

- Foldable tool
- Stronger top portion

Key findings

Changes observed at the intervention phase

- Reduction of 2 arms elevation
- Reduction of heavy load handling
- Increase in arms down posture
- Increase in one arm elevation
- 6-7 extra panels/day

Some quotes from the workers

- *"Both of my hands are free so I can screw faster"*
- *"The pole supports the weight of the sheetrock so the pressure on the shoulders get diminished and I can work more"*
- *"I feel I have better energy in the afternoon to work faster"*
- *"I just love this tool, I do not have to stretch my hands and use my head to hold the sheetrock, the tool is just so cool……."*

Limitations

- Convenience sampling
- No control group
- Small sample size
- Only one site
- No commercial site included

Strengths

- Data collected in real field working situation
- Preliminary effectiveness
- Biomechanical variables based on direct field observation

Thank you for your attention !