New Guidelines for Designing Safe Pushing and Pulling Tasks

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Industrial Push / Pull Tasks
Topics to be Covered in this Webinar

• Why new guidelines were developed
• Work design factors included in guidelines
• How to use a free online push-pull assessment tool
• New findings on taking push-pull measurements

Recent Push / Pull Task Statistics

• Manual materials handling tasks appear to be shifting away from lifting and towards pushing & pulling
• Up to 20% of low-back disorders are linked to push / pull tasks
• Back injury costs from pushing & pulling have been increasing, while costs for non-push / pull tasks have been decreasing
Why Develop New Push / Pull Guidelines?

1. Popular recommendations derived using a psychophysical approach
   - Low association between determined perceived "acceptable" work levels and spine loads

2. Few guidelines are based on biomechanical load tolerances

3. Significant advances in our ability to estimate spine loads

Biomechanical Advances in Assessing Spine Loading
Advances in Understanding and Measuring Spine Loads

- Loads can now be accurately estimated across the entire lumbar spine
- Can determine when an activity is believed to exceed spine tolerance (cause vertebral endplate micro-fractures)

Advances in Understanding and Measuring Spine Loads

- Pushing and pulling greatly impacts loads at the upper lumbar levels
Advances in Understanding and Measuring Spine Loads

• Shear forces (A/P) on lumbar discs are as or more important than compression when assessing risk due to pushing and pulling.

Push-Pull Research Recently Published

Biomechanically determined hand force limits protecting the low back during occupational pushing and pulling tasks


• Partial funding provided by the Ohio BWC
Pushing & Pulling Activities Included in Guidelines

Pushing / Pulling Activities Guideline Development Basis

- Push / pull activities in guidelines are based on data obtained from:
  - 14 different companies
  - 24 separate facilities
- Guidelines designed to be protective for both males and females, across a wide range of employee ages
Push / Pull Activities
Direction: Straight-Line Motions

One-Handed Pull
Example: Fiber drum manufacturing

Two-Handed Pull
Example: Plastics Processing
Push / Pull Activities
Direction: Straight-Line Motions

Two-Handed Push
Example: Hotel housekeeping

Push / Pull Activities
Direction: Turning Motions

One-Handed Pulling Turn
Two-Handed Push / Pull Turn
Using the Push-Pull Guidelines for Design or Evaluation

Using the Online Push-Pull Guidelines

- Available online
- Need a force gauge and tape measure
- Guidelines designed to be protective for both males and females, across a wide range of employee ages
Using the Online Guidelines
Home Page


Using the Online Guidelines
Input 1 → Action Performed
Using the Online Guidelines
Input 1 → Action Performed

1.
Pull with 1 hand
Pull with 2 hands
Push with 2 hands

Using the Online Guidelines
Input 2 → Type of Exertion

2.
Using the Online Guidelines
Input 2 → Type of Exertion

Using the Online Guidelines
Input 3 → Hand Height
Using the Online Guidelines
Input 3 → Hand Height

Range: 32” - 48”

Using the Online Guidelines
Input 4 → Force
Using the Online Guidelines
Input 4 → Force (Straight)

Using the Online Guidelines
Input 4 → Force (Turning)

• Assume user’s hands are placed about shoulder-width apart

• These guidelines:
  • Accommodate hand distances of 12” - 36”
  • Are not applicable for significantly wider or narrower hand distances
Guideline Outputs

According to the guideline, your task is safe for at least 80% of the population.

According to the guideline, your task is safe for 50-80% of the population. It is suggested that you make changes in the task to make it safer for more people.

Case Study
Case Study
Straight-Line Pushes / Pulls

- Task data:
  - Two-handed push
  - Hands: 35” above floor
  - Forces:
    - 55 lbf. (loading 80 plates / 1,200 lbs.)
    - 49 lbf. (loading 54 plates / 864 lbs.)
    - 43 lbf. (loading 40 plates / 600 lbs.)

- How many plates can be pushed safely?

<table>
<thead>
<tr>
<th>Handle Height</th>
<th>Percent of Population Protected (lbs)</th>
<th>Two-Handed Pushing (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32”</td>
<td>More than 50%</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Less than 50%</td>
<td>67</td>
</tr>
<tr>
<td>35”</td>
<td>More than 80%</td>
<td>61</td>
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<tr>
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<td>55.8%</td>
<td>60</td>
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<tr>
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<td>Less than 50%</td>
<td>64</td>
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<td>60.8%</td>
<td>71</td>
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<tr>
<td></td>
<td>Less than 50%</td>
<td>74</td>
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<tr>
<td>48”</td>
<td>More than 80%</td>
<td>77</td>
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<tr>
<td></td>
<td>62.8%</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Less than 50%</td>
<td>80</td>
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* Subset of available handle height data
Case Study
Straight-Line Pushes / Pulls

• Task data: Improvement Option #1
  Load Fewer Plates
  • Two-handed push
  • Hands: 35” above floor
  • Forces:
    • 55 lbf. (loading 80 plates / 1,200 lbs.)
    • 49 lbf. (loading 54 plates / 864 lbs.)
    • 43 lbf. (loading 40 plates / 600 lbs.)
• How many plates can be pushed safely?

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<td>77 lbf.</td>
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<td>55”</td>
<td>Less than 50%</td>
<td>80 lbf.</td>
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Case Study
Straight-Line Pushes / Pulls

• Task data: Improvement Option #2
  Raise "Handle" Height
  • Two-handed push
  • Hands: 45” above floor
  • Forces:
    • 55 lbf. (loading 80 plates / 1,200 lbs.)
    • 49 lbf. (loading 54 plates / 864 lbs.)
    • 43 lbf. (loading 40 plates / 600 lbs.)
• How many plates can be pushed safely?

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Why isn’t task frequency included in the guidelines?

Guidelines are based on if the specific push-pull action exceeds what the spine can tolerate without damage, not cumulatively.
Addressing Recent Questions

Q. What do you do when forces aren’t applied to handles horizontally?

A. Guideline results have been adjusted to account for this, and horizontal forces are easier to measure.

Addressing Recent Questions

Q. How are turning forces measured?

A. Force measurement may require help (one to measure; one to guide)

Guidelines based on common distances between hands (~shoulder width apart); guidelines adjusted to account for torque

Best to take multiple readings
The Latest…

Accurately Measuring Push / Pull Forces

• Recent findings:
  • Measurements from a single-axis force gauge closely mirror those obtained from a three-dimensional hand transducer
  • Force measurements recorded at a “fast” pace (traveling one meter in three seconds) most closely resemble the speed individuals choose to push / pull in industry
Take-Home Messages

• Guidelines:
  • Are based on biomechanical spine tolerances and intended to protect both the low back and the shoulder
  • Apply to a wide range of push-pull tasks
  • Can be used for both initial design or current evaluations
  • Allow one to consider several options for task improvement
  • Are integrated into a free online tool

Questions?

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