Worker Health and Safety Apps for Smartphones

Gino Fazio

NIOSH Office of Communication, Research to Practice
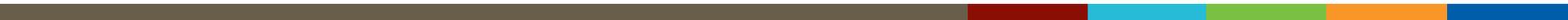
California Industrial Hygiene Council

December 4-6, 2017

NIOSH r2p Team

- Institute-wide focus
- Innovative solutions to bridge r2p gaps
- Entrepreneurial thinking
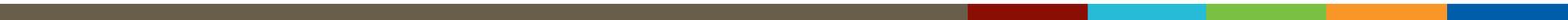- Standard and novel approaches

Why apps?

- 77% of Americans now own a smartphone
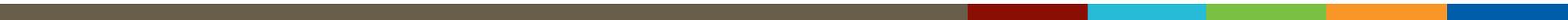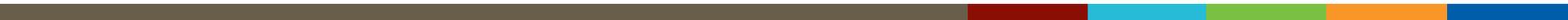- 92% of 18- to 29-year-olds own a smartphone

5,000,000

30

10

Our determination process

- Top webpages
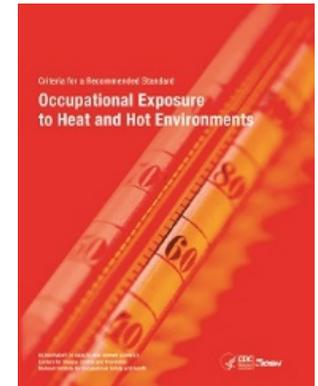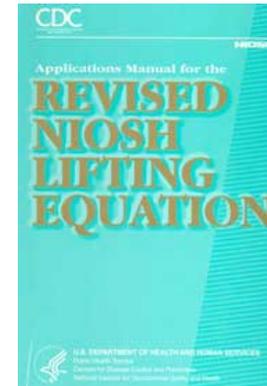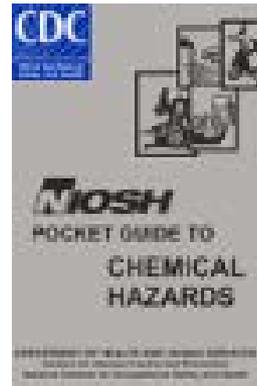- Top publications
- Top blogs

Top NIOSH Webpages

- NIOSH Pocket Guide
- Heat Stress
- Respirators

Top NIOSH Publication Downloads

- NIOSH Pocket Guide
- Applications Manual for the Revised NIOSH Lifting Equation
- Criteria for a Recommended Standard – Occupational Exposure to Heat and Hot Environments

Most Popular NIOSH Blog Posts

- Noise

So How Accurate Are These Smartphone Sound Measurement Apps?

Posted on April 9, 2014 by Chucri A. Kardous, MS, PE and Peter B. Shaw, Ph.D.

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Figure 1. The SoundMeter app on the iPhone 5 (L) and iPhone 4S (R) compared to ½" Larson-Davis 2559 random incidence type 1 microphone (C).

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Video: CAPT Kardous testing mobile sound-meter apps in the lab

We selected and acquired a representative sample of the popular smartphones and tablets on the

Most Popular NIOSH Blog Posts

- Heat stress

Extreme Heat: Are you prepared for summer work?

Posted on May 23, 2016 by Brenda Jacklitsch, MS; and Joanna Watson, MSc, DPhil

The approach of summer is a reminder to us all of the need to recognize, and act to prevent, the harmful effects of excessive heat. The White House has designated May 23–27, 2016, as Extreme Heat Week, during which Federal agencies will work with community planners and public health officials to enhance community preparedness for extreme heat events. Workers are particularly vulnerable to the health impacts of heat exposure. Workers may experience longer or more intense heat exposures and are more likely to engage in strenuous physical activity in the heat than the general public. Also, in many cases workers rely on their employers to provide opportunities for limiting their time in the heat, ensuring adequate rest breaks, and promoting hydration.

The recently published NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments contains a lot of information related to how heat stress affects the body, individual and environmental risk factors, heat-related illnesses, and recommendations to protect workers. We have selected and summarized some of these recommendations below.

Most Popular NIOSH Blog Posts

- ▪ Respirators

N95 Day 2017: When to think Beyond the N95 FFR

Posted on September 5, 2017 by Margaret Sietsema, PhD, and Jaclyn Krah Cichowicz, MA

Buckle your seat belts! Put on your high-speed safety gear! We're about to blast off on a journey to explore the N95 respirator … and beyond. It's N95 Day, and that means we are focusing on respiratory protection, and invite you to do the same. We'll make it easy. NIOSH and our N95 Day partners (see the N95 Day webpage for a complete list of partners) will be orbiting the internet to spread resources for proper respiratory protection practices. As always, you can find this information by searching #N95Day on Twitter, Facebook, Instagram, and Pinterest.

During this observance, NIOSH advocates for the proper selection and use of respiratory protection. The N95 filtering facepiece respirator (FFR) is the most commonly-used type of respirator, especially in healthcare environments. This piece of personal protective equipment is a vital and essential instrument in the safety toolbox for many professionals. We cannot stress our love for N95 respirators enough. (Heck, we made an entire observance to honor them.) However, there are certain situations in which respiratory protection program managers and users should pause to consider if another type of respirator would be a better fit (pun intended). This blog identifies times when an N95 respirator should NOT be selected as the most appropriate respiratory protection device.

Top Topics and Publications

- NIOSH Pocket Guide
- Revised NIOSH Lifting Equation
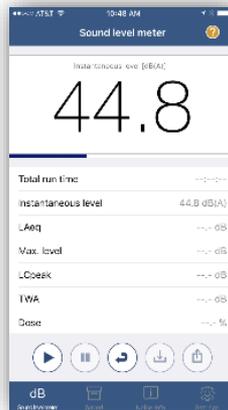- Noise
- Respirators
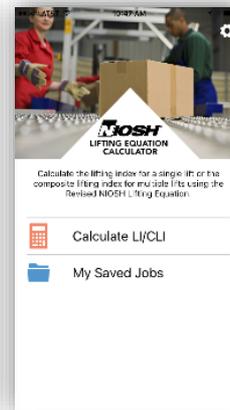- Heat Stress
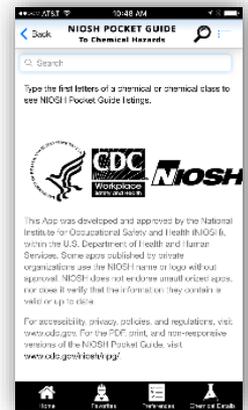
NIOSH Apps

Heat Stress

Heat Safety Tool

Noise

SLM

RNLE

NLE Calc

Pocket Guide
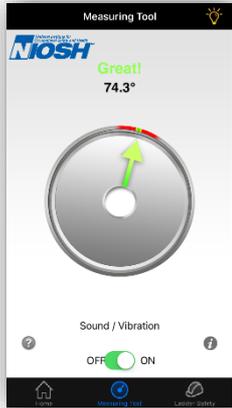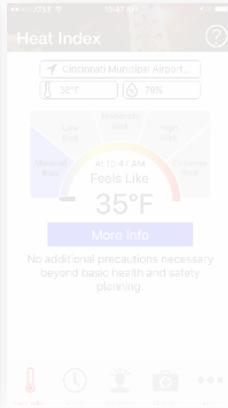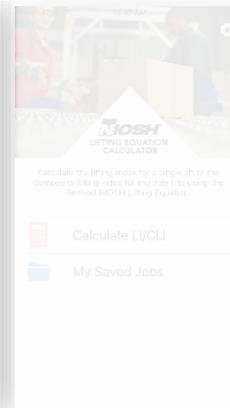
mNPG

*Respirator Selector in Development

NIOSH Apps

Ladder Safety

Heat Stress

Heat Safety Tool

Homecare Safety

Noise

SLM
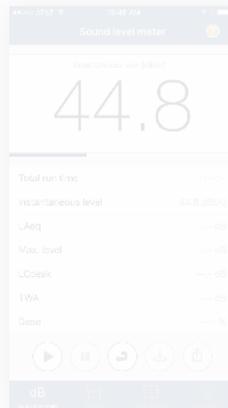
RNLE

NLE Calc

ErgoMine
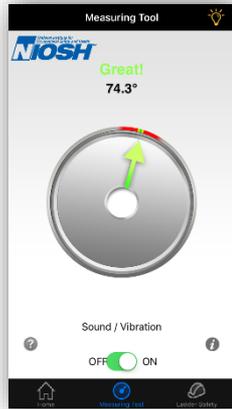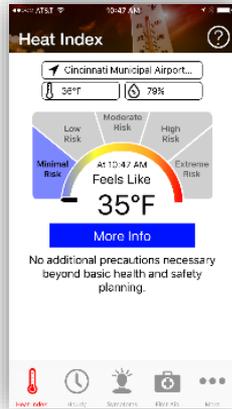
Pocket Guide

mNPG

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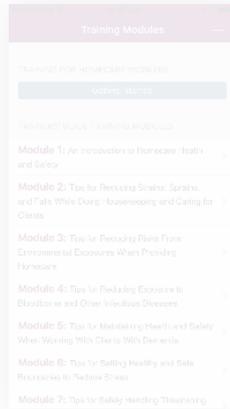
NIOSH Apps

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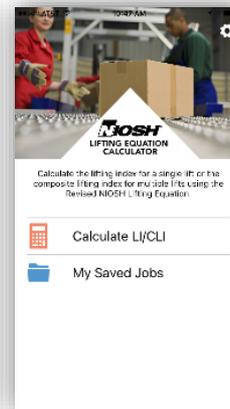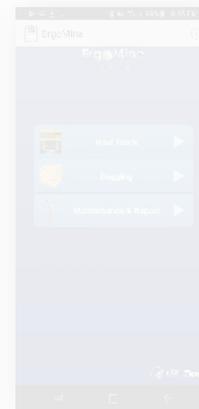ErgoMine

mNPG

Ladder-related Injuries

- 500,000 people per year are treated

Ladder-related Injuries

Estimated annual cost of ladder injuries in the U.S. is...

$24 Billion

Ladder-related Injuries

- In 2011, work-related ladder fall injuries in the United States resulted:
  - 113 fatalities
  - 15,460 nonfatal injuries
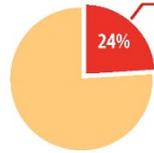 - 34,000 nonfatal injuries treated in emergency departments

Ladder-related Injuries

- Who's at risk?
  - Male
  - Hispanic
  - Older
  - Self-employed
  - Work in smaller establishments
  - Work doing construction, maintenance, and repair

Ladder-related Injuries

Falls are the leading cause of death in construction

Fatal falls from ladders account for 24% of all deaths from falls in construction.*

24%

Small business owners be aware:
55% of fatal falls in construction are in companies with 1-10 employees.*

NIOSH Ladder Safety for iPhone and Android
Download the Ladder Safety app. Available in English and Spanish.

Download on the App Store

GET IT ON Google play

You can help prevent fall-related deaths and injuries.
Join the Campaign! www.stopconstructionfalls.com

NIOSH

CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

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Source: *http://www.cpwr.com/sites/default/files/publications/CB%20page%2044.pdf.
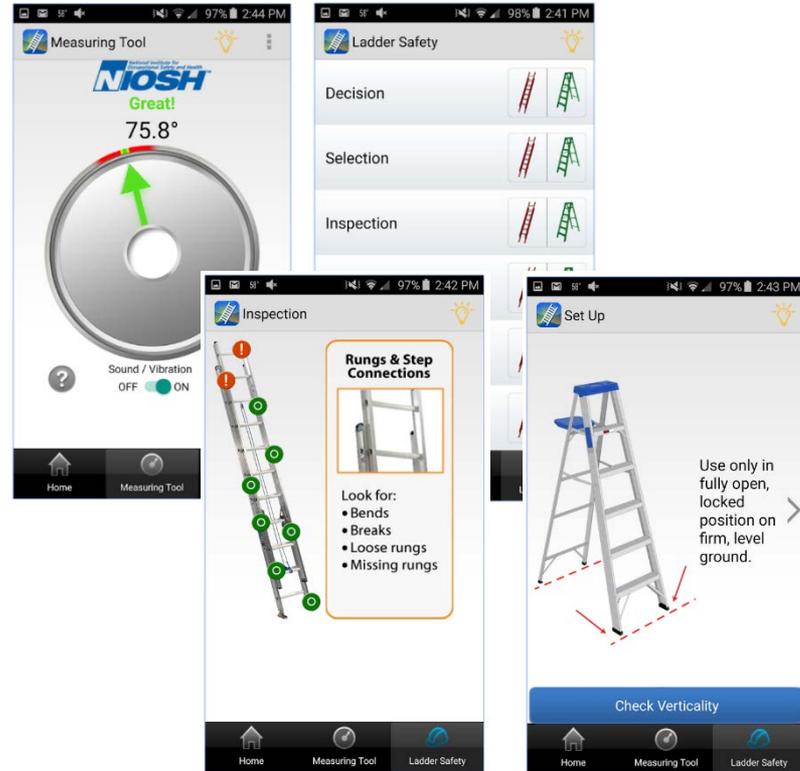
Ladder-related Injuries

- Workplace and at home
- There are five major causes:
  - Incorrect setup angle
  - Wrong ladder
  - Insufficient inspection
  - Improper ladder use
  - Lack of access to ladder safety tools and information

Ladder Safety

- App features:
  - Angle Measuring Tool
  - Selection Tool
  - Inspection Tool
  - Proper Use Tool
  - Accessories Tool

Ladder Safety: How it was made

- External contract
- Reviewed by NIOSH SMEs
- Published to CDC app stores

Hazardous Noise

- Estimated 22 million workers are exposed yearly
- Carries a high economic price

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Video: CAPT Kardous testing mobile sound-meter apps in the lab

Hazardous Noise

- Hearing loss is the **third-most common** chronic physical condition
- **11%** has hearing difficulty
- **24%** of the hearing difficulty caused by occupational exposures
- **8%** has tinnitus
- **4%** has both hearing difficulty and tinnitus
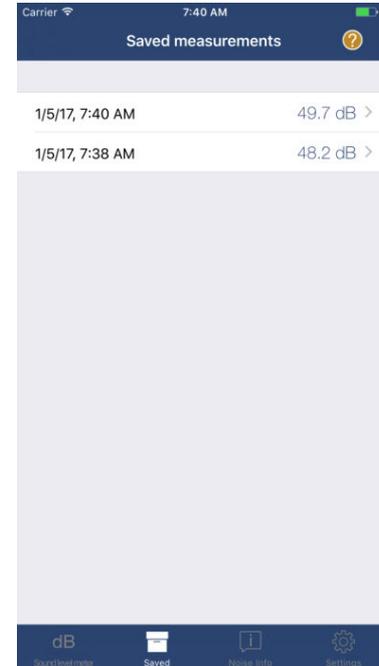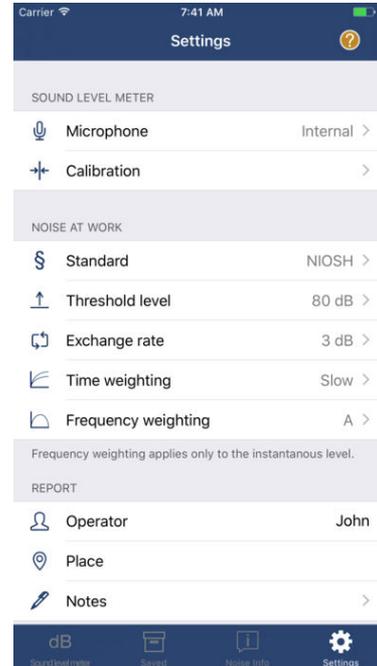
Sound Level Meter

- App Features:
  - Sound level readout (built-in or external mic)
  - Reports instantaneous sound level in A, C, or Z-weighted dBs
  - User-selectable weighting
  - Dose
  - Projected dose

Sound Level Meter

- App Features:
  - Prevention information
  - Save and share data
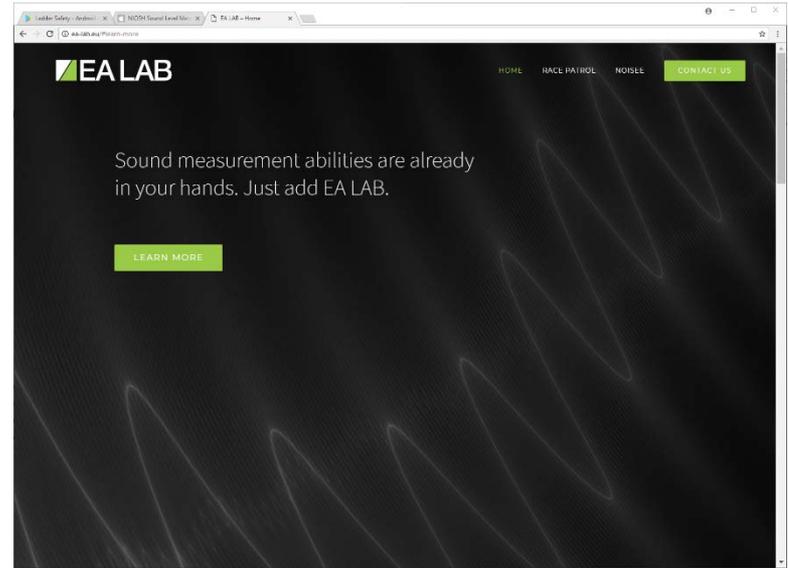 - Utilize GPS positioning

Sound Level Meter

- Raise workers' awareness about noise
- Help them make informed decisions
- Serve as a research tool

Sound Level Meter: How it was made

- Collaborated with EA LAB
- iOS only

Heat Stress

- Workers who are exposed to extreme heat or work in hot environments may be at risk of heat stress.

- Exposure to extreme heat can result in occupational illnesses and injuries.

Heat Stress

- Symptoms of Heat stress
  - Heat stroke, heat exhaustion, heat cramps, or heat rashes.
  - Heat can also increase the risk of injuries in workers as it may result in sweaty palms, fogged-up safety glasses, dizziness, and burns.

Heat Stress

- Who's at risk?
  - Firefighters
  - bakery workers
  - Farmers
  - construction workers
  - Miners
  - boiler room workers
  - factory workers, and others

Heat Stress

- Who's at risk?
  - > 65 years of age
  - Overweight
  - Heart disease
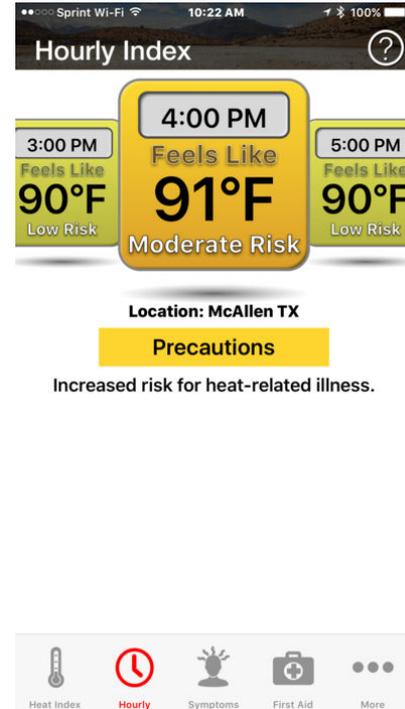 - High blood pressure
  - Take medications

OSHA-NIOSH Heat Safety Tool

- Features:
  - Visual indicator of the current geographic heat index
  - Custom location, temperature, and humidity

OSHA-NIOSH Heat Safety Tool

- Features:
  - Hourly forecast

OSHA-NIOSH Heat Safety Tool

- Features:
  - Signs and symptoms and first aid

OSHA-NIOSH Heat Safety Tool: How it was made
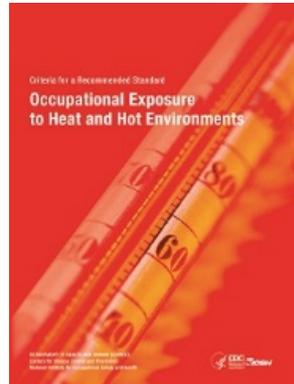
Work-related Musculoskeletal Injuries

- Exposure to repetitive motion, force, vibration, and awkward positions put workers at risk

Work-related Musculoskeletal Injuries

- Globally, MSDs account for ~21% of the years people live with disabilities

- Low back pain and neck pain among top five leading causes

- In U.S. and Canada, more are unable to work because of MSDs than of any other group of diseases

- For 20 years, the Revised NIOSH Lifting Equation has been the international standard

NLE
CDC

Work-related Musculoskeletal Injuries
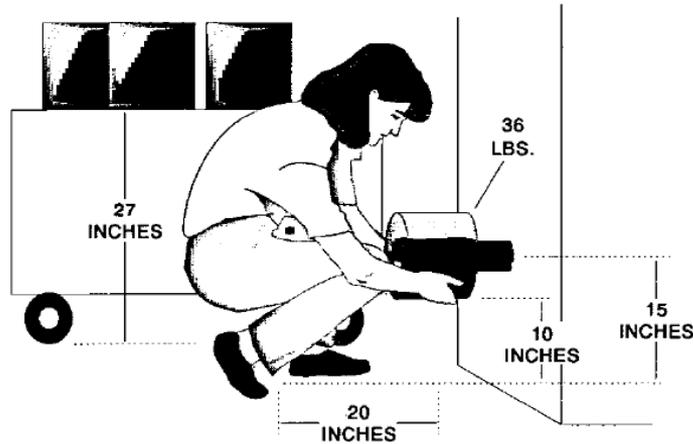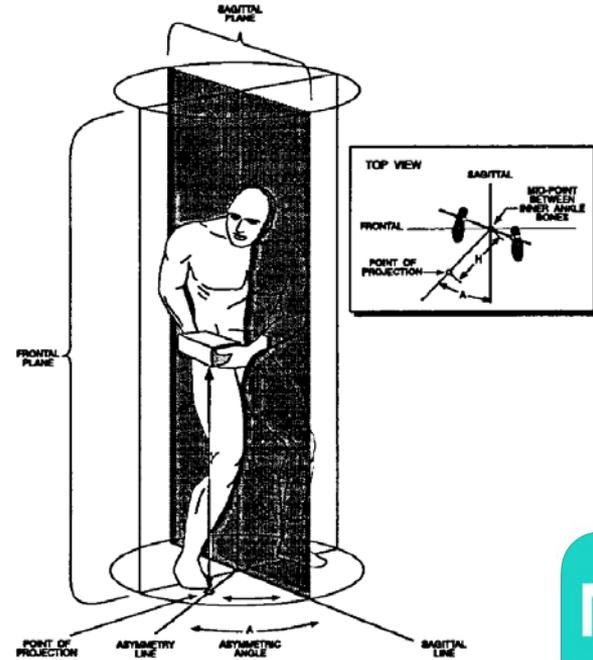
- Revised NIOSH lifting equation is complex

Figure 8 Loading Supply Rolls, Example 2

Work-related Musculoskeletal Injuries

- Revised NIOSH lifting equation is complex

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}$$

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

		METRIC	U.S. CUSTOMARY
Load Constant	LC	23 kg	51 lb
Horizontal Multiplier	HM	(25/H)	(10/H)
Vertical Multiplier	VM	$1-(.003\,|V\text{-}75|)$	$1-(.0075\,|V\text{-}30|)$
Distance Multiplier	DM	.82 + (4.5/D)	.82 + (1.8/D)
Asymmetric Multiplier	AM	1-(.0032A)	1-(.0032A)
Frequency Multiplier	FM	From Table 5	From Table 5
Coupling Multiplier	CM	From Table 7	From Table 7

NLE
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Table 1
Horizontal Multiplier

H in	HM	H cm	HM
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

Table 2
Vertical Multiplier

V in	VM	V cm	VM
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

Table 3
Distance Multiplier

D in	DM	D cm	DM
≤10	1.00	≤25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

Table 4
Asymmetric Multiplier

A deg	AM
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration					
	≤1 Hour		>1 but ≤2 Hours		>2 but ≤8 Hours	
	V < 30 †	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

Table 7
Coupling Multiplier

Coupling Type	Coupling Multiplier	
	V< 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

Work-related Musculoskeletal Injuries

Figure 26: Example 9, JOB ANALYSIS WORKSHEET

Work-related Musculoskeletal Injuries

Figure 26: Example 9, JOB ANALYSIS WORKSHEET

Work-related Musculoskeletal Injuries

$$CLI = STLI_1 + \sum \Delta LI$$

Where:

$$\sum \Delta LI = \left(FILI_2 \times \left(\frac{1}{FM_{1,2}} - \frac{1}{FM_1} \right) \right)$$

$$+ \left(FILI_3 \times \left(\frac{1}{FM_{1,2,3}} - \frac{1}{FM_{1,2}} \right) \right)$$

$$+ \left(FILI_4 \times \left(\frac{1}{FM_{1,2,3,4}} - \frac{1}{FM_{1,2,3}} \right) \right)$$

$$\vdots$$

$$+ \left(FILI_n \times \left(\frac{1}{FM_{1,2,3,4,\ldots,n}} - \frac{1}{FM_{1,2,3,\ldots,(n-1)}} \right) \right)$$

NLE

CDC

NLE Calc

- Features
  - Uses NRLE
  - Calculates CLI and LI

NLE Calc

- Features
  - Promotes musculoskeletal health
  - Raises workers' awareness about their job tasks
  - Helps workers make informed decisions about the potential hazards to their musculoskeletal health
  - Serves as job design guidelines for manual lifting tasks
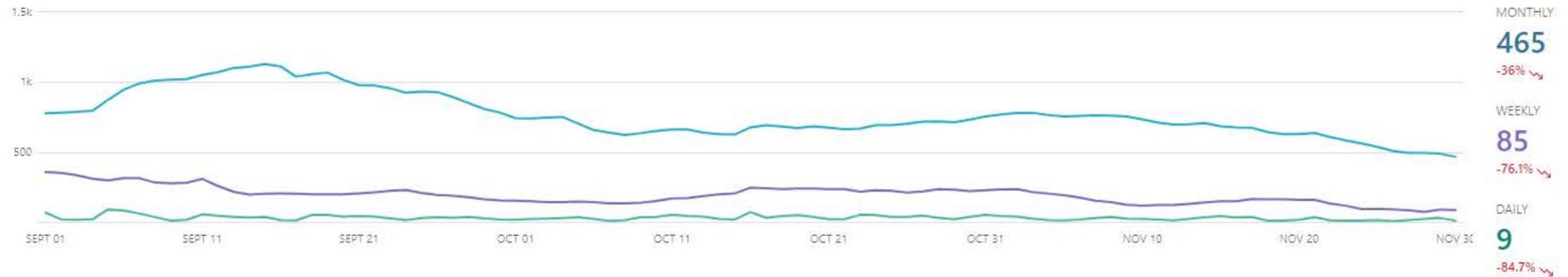 - Research tool to collect manual lifting data

App Analytics

	Ladder Safety (May 2013)	Sound Level Meter (January 2017)	Heat Safety Tool (May 2017)	NLE Calc (August 2017)
Total Downloads	201,450	100,000	130,209	6,880
iOS	75%	100%	84%	83%
Android	25%		16%	17%

App Analytics

App Analytics
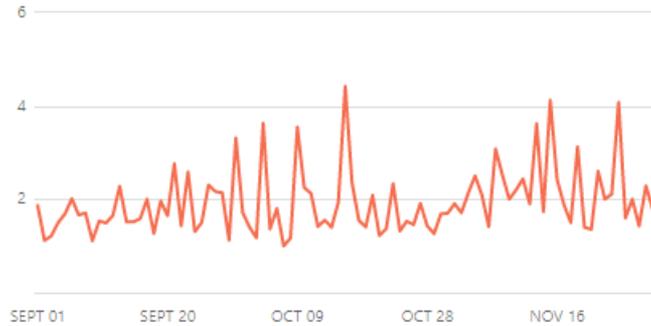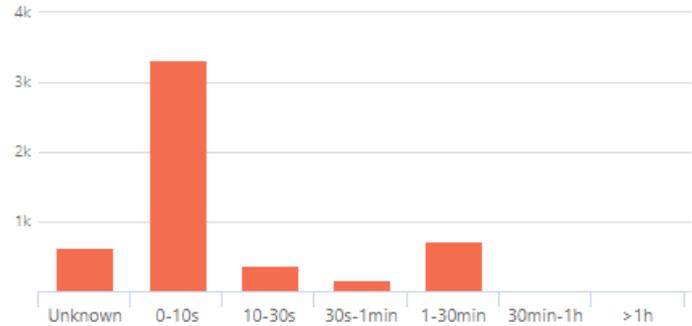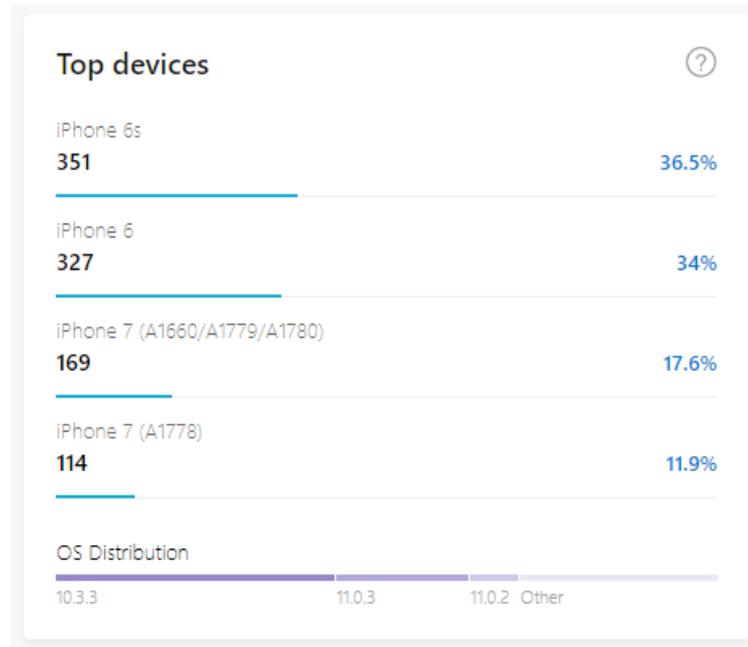
App Analytics

App Analytics

Countries			
United States	1.2k	112.5%	↗
Canada	124	416.7%	↗
none	97	76.4%	↗
Spain	40	N/A	
Australia	26	160%	↗
China	26	116.7%	↗
Other	217	N/A	

Languages			
English	1.5k	133.8%	↗
Spanish	85	962.5%	↗
Chinese	25	127.3%	↗
Portuguese	14	55.6%	↗
Dutch	13	8.3%	↗
French	10	66.7%	↗
Unknown	32	N/A	

App Analytics

Events	Count ▼	Trend	Users	User change	Per user
Calculate button clicked	735	-163 18.2%	178	-94 34.6%	4.13
StartPage - Calculate LI/CLI button clicked	728	-303 29.4%	375	-225 37.5%	1.94
StartPage - My Saved Jasks button click	146	-12 7.6%	103	+1 1%	1.42
SettingsPage - Button clicked	118	-57 32.6%	104	-35 25.2%	1.13
Calculate CLI button clicked	18	-7 28%	4	-3 42.9%	4.5

App Analytics

CRASH-FREE USERS PER DAY

99.8%

100%

75%

50%

25%

OCT 31   NOV 10   NOV 20
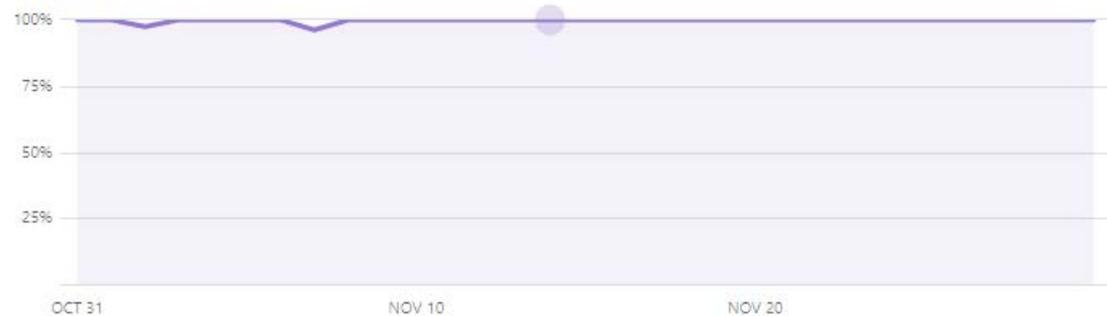
Contact

- **Gino Fazio**
- **NIOSH**
- **Communication/research to practice**
- **ggfazio@cdc.gov**

For more information, contact CDC
1-800-CDC-INFO (232-4636)
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