Assessment Methods Used by Certified Ergonomics Professionals

Brian Lowe[1*], Patrick Dempsey[2], Evan Jones[1]
National Institute for Occupational Safety and Health (NIOSH)
[1]1090 Tusculum Ave., Cincinnati, OH 45226, [2]626 Cochrans Mill Road, Pittsburgh, PA 15236
*corresponding author e-mail: blowe@cdc.gov

This paper reports findings from a web-based survey of professional ergonomists with certification through recognized organizations in English-speaking countries (USA, Canada, UK, Australia, and New Zealand). The purpose of the survey is to update knowledge on the types of basic tools and direct and observational assessment methods used by ergonomic practitioners. These results focus on prevalence and frequency of use for 23 ergonomic assessment methods and how ergonomists report using them (pencil and paper, computer software, mobile devices, other). N=405 ergonomists responded to the survey, representing a 34% participation rate. The NIOSH Lifting Equation is the most widely used assessment method, used by 86.9% of responding ergonomists. The findings indicate opportunities for development of mobile interfaces ("apps") by which assessment methods can be deployed electronically. Only 25% of professionals reported using mobile apps, and several frequently used methods are predominantly used in "pencil and paper" format.

INTRODUCTION

This paper reports partial results of a survey of ergonomics professionals as a follow-up to a survey conducted by Dempsey et al (2005). The project extended the original survey conducted by Dempsey et al (2005) in two ways: (1) the sample was broadened to an international community of ergonomists in English-speaking countries, and, (2) the queried tools and methods were updated to reflect newer technologies not in the original survey. As in Dempsey et al (2005), the purpose of the survey was to gather information on the types of basic tools, direct and observational measurement techniques, and software used in the field by ergonomics practitioners to assess risk factors for musculoskeletal disorders and to evaluate workplace interventions. An additional objective was to potentially gain an understanding of the constraints or preferences that influence ergonomists' selection of assessment tools and methods.

Since the 2005 publication of the initial survey findings there has been a proliferation of smart phone/smart device technology with embedded gyroscopic and acceleration sensors and related "apps" for human motion and activity logging. Further, the capture of digital still photos and video is now easily accessible with small touchscreen mobile pads, tablet and smartphones. Little is known about the extent to which ergonomics practitioners are adopting these newer technologies for assessing physical job demands. Thus, the survey will provide a contemporary perspective on the scope of use of assessment tools and methods by these professionals.

METHOD

Survey Design

The survey was designed to be consistent with questionnaire items and response format of the Dempsey et al (2005) survey. Because of the proliferation of smart devices, apps, and portable tablets that were not mainstream technology prior to 2005 the original survey was modified to include questions about these formats, use of "apps" and mobile devices in general, and probed into use of these modernized formats. The investigators held an informal focus group discussion with 9 U.S. Certified Professional Ergonomists to review the newer modified survey questionnaire. The questionnaire was formatted for electronic, web-based administration via Survey Monkey.

Survey Administration

Investigators identified and invited by e-mail 1,221 eligible individuals to participate. Eligibility criterion was having a certified ergonomics professional designation by one of the following recognized organizations: U.S. (BCPE), Canada (CCCPE), United Kingdom (Eur.Erg), Australia (HFES of Australia), and

New Zealand (Board for Certification of NZ Ergonomists). The eligible population was limited to predominantly English speaking countries to avoid need for questionnaire translation. The investigators complied with Canadian anti-spam laws which prevented direct recruiting of Canadian professionals and required an opt-in step intermediated by the CCCPE organization with their members. Eligible participants were e-mailed a unique URL as an assurance that responses were submitted by an eligible respondent. The protocol and information collection were approved by the NIOSH Institutional Review Board and the U.S. Office of Management and Budget.

In the Survey Monkey response file 432 entries were logged for survey participation. Two (2) entrants to the survey link declined participation at the informed consent phase. There were 14 duplicate entries (by-mail address) removed that reflected survey restarts. There were 11 entries in which the participant spent less than 2.5 minutes with the survey URL open and who responded to few, if any, question items. These were treated as declines and were excluded. This resulted in a sample of N = 405 respondents for inclusion in the analysis.

RESULTS

Overall participation rate is estimated as 34% (405/1,192) after subtracting 29 e-mail send failures from the distribution list. Participation rates by countries were: Australia/NZ, 42.7%; USA, 35.9%; UK/Ireland, 22.7%; Canada, 22.0%. Graduate degrees (Masters or Doctoral) were held by 87% of respondents. Years of experience working in the field of ergonomics were reported as: 5% had 0-5 years of experience; 14% had 6-10 years; 28% had 11-20 years; and 50% had 21 or more years. Occupations of respondents were selected as Ergonomist – 45%, Consultant – 15%, Engineer/Human Factors Engineer – 10%, Educator – 8%, Manager – 7%, other – 15%.

Table 1 lists percentages of professionals who reported having used the basic measurement tools queried. Table 2 lists the percentage of professionals who reported having used each of 23 ergonomic assessment methods that were queried. There were 8 assessment methods that were reportedly used by fewer than 25% of respondents that are not further reported for frequency or format of use. The 15 higher prevalence of use assessment methods are shown in Figure 1 by how frequently respondents reported using and in what format they used the assessment method. Response options for the format used were "pencil and paper", "computer software", "mobile device", or "other". Respondents were asked to describe "other" method when that option was selected. Other formats almost always described a specific *software* format (e.g. a spreadsheet program) or a form of mobile app. These responses could have been re-coded into one of those two formats.

Table 3 lists the percentage of certified ergonomics professionals who reported having used instrumentation based methods.

In response to the question "Do you use any Smart Device 'Apps' for ergonomics purposes related to musculoskeletal health, and/or prevention of workplace injury?", 24.7% responded "yes", the remaining 75.3% responded either "no" (63.2%) or did not respond (12.1%). Among those reporting "yes", there were 129 free response entries for the prompt to describe the specific app used. Table 4 shows the classification of smart device Apps used based on investigators' assessment of their functionality.

Table 1. Percent responding "yes" to basic measurement tools used in the field. (N = 405)

%	Basic Tool
96.0%	Tape Measure
90.9%	Digital Video Camera
90.1%	Digital Still Camera
82.2%	Laptop
78.0%	Stopwatch
70.9%	Scale (load cell)
61.2%	Light Meter
61.2%	Goniometer (joint angles)
57.0%	Spring Gauge
54.8%	Sound Level Meter
54.3%	Tablet/Smart Device
36.0%	Thermometer
32.3%	Distance measuring wheel
14.8%	Slip Meter
13.8%	Anemometer (air velocity)

Table 2. Percent responding "yes" to having used individual assessment methods. (N = 405)

%	Assessment Method
86.9%	NIOSH Lifting Equation
80.0%	RULA - Rapid Upper Limb Assessment
77.8%	Psychophysical Material Handling Data (e.g. "Snook tables"[1])
68.9%	REBA - Rapid Entire Body Assessment
66.7%	Biomechanical or digital human modelling
61.5%	Body Discomfort Map (e.g. Corlett and Bishop Map)
59.5%	Strain Index
54.3%	Psychophysical Upper Extremity Data (e.g. "Snook tables"[2])
52.6%	ACGIH Threshold Limit Value (TLV®) for Lifting
49.9%	TLV® for Hand Activity (ACGIH)
39.5%	Washington State (WISHA) Lifting Calculator
31.6%	Rodgers Muscle Fatigue Analysis

31.6%	Energy Prediction Model
31.1%	TLV® for Upper Limb Muscle Fatigue (ACGIH)
27.7%	OWAS - Ovako Working Posture Analysis System
22.5%	*Health Safety Executive (HSE) MAC tool*
21.5%	*JCQ - Job Content Questionnaire*
16.8%	*Ohio Bureau of Workers Compensation - Lifting Guidelines*
16.3%	*Muscle fatigue equations*
13.1%	*OCRA*
12.6%	*Health Safety Executive (HSE) ART tool*
11.4%	*PATH - Posture, Activity, Tools and Handling*
5.9%	*PLIBEL*

[1]Snook and Ciriello (1991)
[2] Ciriello et al. (2001)

Table 3. Percent responding "yes" to having used types of direct measurement technique. (n = 405).

%	Instrumentation
64.9%	Grip Dynamometer
59.3%	Push/Pull Force Sensors
54.8%	Pinch Dynamometer
40.7%	Heart Rate Monitor
30.6%	Instrumented Hand Tools (force measurement)
30.6%	Vibration Measurement
29.1%	Motion capture/measurement (optical)
27.7%	Electromyography
17.5%	Trunk Electrogoniometer (e.g. Lumbar Motion Monitor)
17.5%	Motion capture/measurement (non-optical)
12.1%	Electronic Wrist Goniometer

Table 4. Apps listed in free response query, classified by function.

Classification of Smart Device App	count
Lifting/MMH	36
Ergonomic assessment	21
Whole Body Vibration	11
Biomechanics (U of M 3DSSPP™)	10
Noise/sound level measurement	8
Light measurement	7
Heat stress	5
Posture/motion assessment	4
General measurement/utility	4
Symptom collection	4
Fitness-related (e.g. FitBit/Garmin/Polar)	4
Anatomy reference	2
Functional movement screen	2
Stretching/Rest break	2
Medical management	1
Ladder safety (NIOSH Ladder Safety)	1
Time study	1
generic reference to apps or undefined	6
TOTAL	129

DISCUSSION

The NIOSH Lifting equation (NLE) is the most commonly used ergonomic assessment method of those queried. Of all basic tools, assessment methods, and direct measurement techniques only three basic types of equipment: tape measure, digital video camera, and digital still camera were reported with a higher prevalence of use than the NLE.

The present data suggest opportunities for development of software or mobile app formats for some of the more commonly used assessment methods, such as body discomfort maps, RULA, REBA, and Strain Index. These assessment methods show relatively high percentage of "pencil and paper" format of use – even among professionals who use them more frequently (more than once per week). Body discomfort mapping assessment methods appear to be used relatively frequently, but with relatively low use of electronic/digital technology. This might be because body discomfort mapping methods involve few calculations that would be performed more efficiently in a software/electronic format. Or, this might reflect that body map questionnaires can be deployed to multiple workers more efficiently with paper questionnaires.

Conversely, the NLE has a high prevalence of electronic format of use, via software or mobile apps, which was consistent with the classification of free responses to the survey question about specific apps used (36 of 129 Apps listed were classified as lifting/MMH analyses). Even infrequent users of the NLE (those using less than once per year) appear to apply the NLE in a software or mobile app format. This contrasts with body discomfort mapping assessments in which even among frequent users it is typically via pencil and paper format.

Additional analyses will be conducted on this dataset with a planned publication to contrast the 2005 findings to the present. Dempsey et al (in press) will report comparisons across participating countries for differences in use of these assessment methods.

REFERENCES

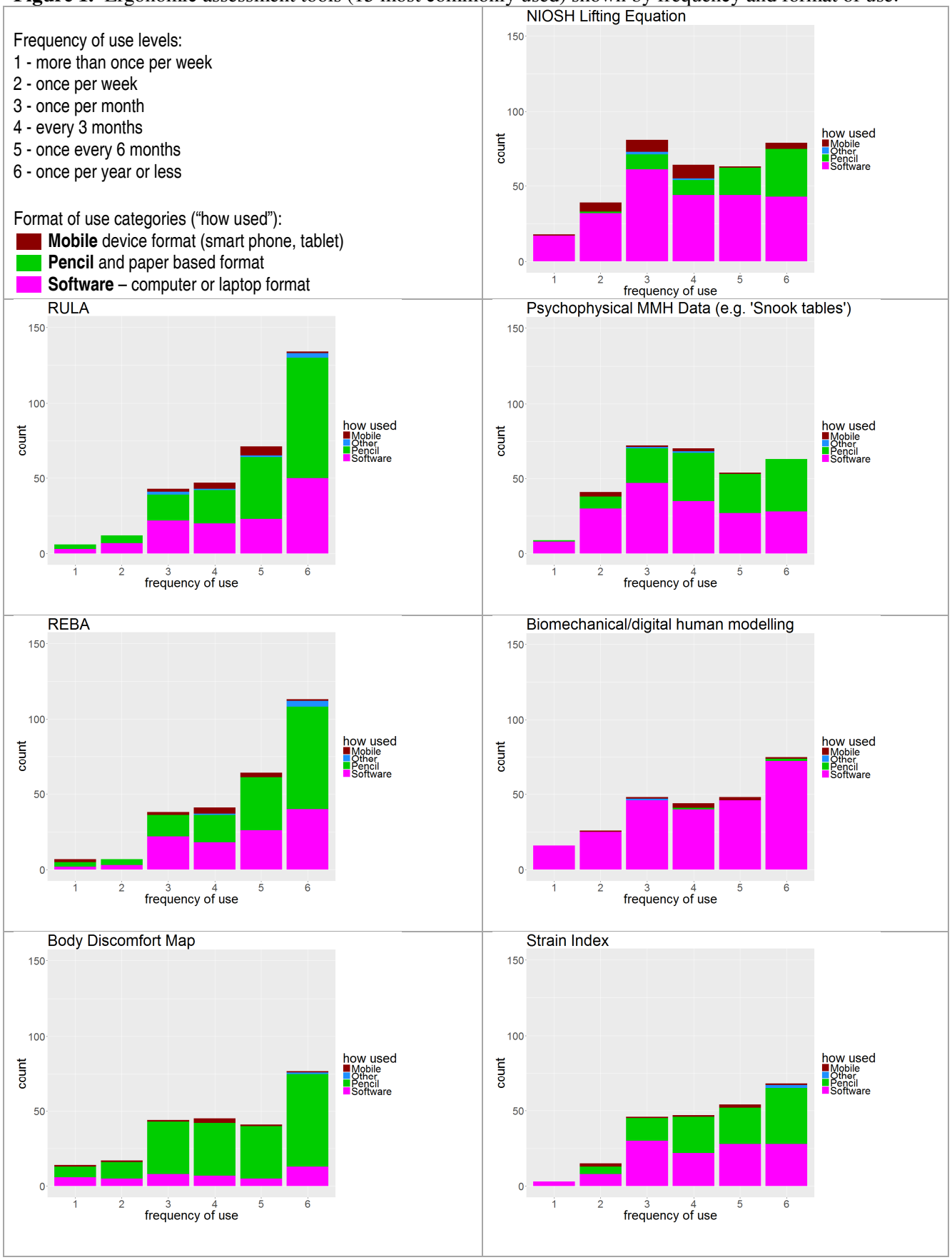
Ciriello, V.M., Snook, S.H., Webster, B.S., and Dempsey, P.G. (2001). A Psychophysical Study of Six Hand Movements. *Ergonomics*, 44, 922-936.

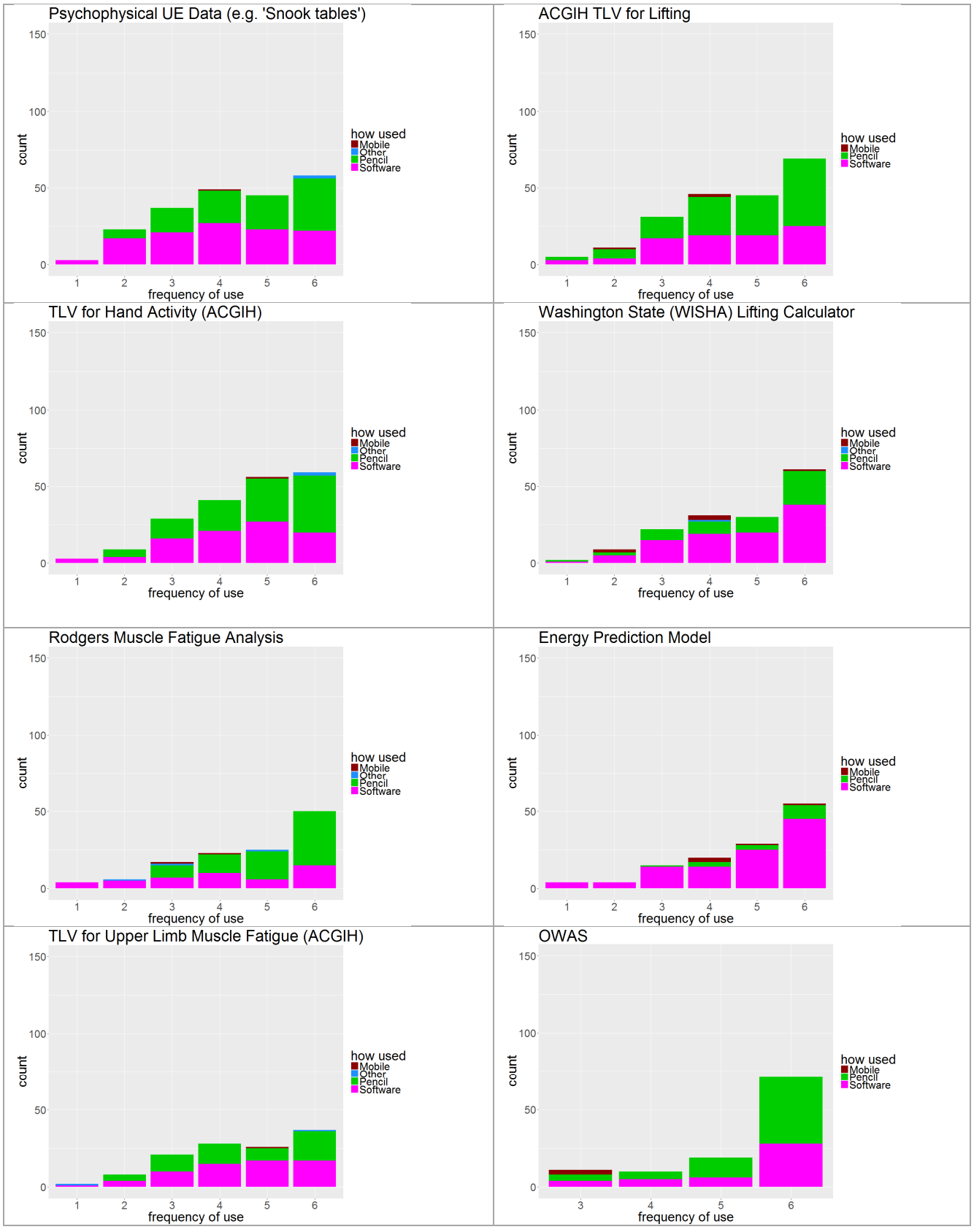
Dempsey, P.G., McGorry, R.W., and Maynard, W.S. (2005). A survey of tools and methods used by certified professional ergonomists. *Applied Ergonomics*, 36, 489-503.

Dempsey, P.G., Lowe, B.D., and Jones, E. (in press). An international survey of tools and methods used by professional ergonomists. 20th Congress of the International Ergonomics Association.

Snook, S.H. and Ciriello, V.M. (1991). The design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics*, 34, 1197-1213.

Figure 1. Ergonomic assessment tools (15 most commonly used) shown by frequency and format of use.




Psychophysical UE Data (e.g. 'Snook tables')
ACGIH TLV for Lifting
TLV for Hand Activity (ACGIH)
Washington State (WISHA) Lifting Calculator
Rodgers Muscle Fatigue Analysis
Energy Prediction Model
TLV for Upper Limb Muscle Fatigue (ACGIH)
OWAS
count
frequency of use
how used
Mobile
Other
Pencil
Software