Occupational Injury/Illness Risk Factor Data in the Manual Materials Handling Industry

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Overview

- Background
- Risk factor overview
- Univariate, multivariate, and overall blocked multivariate results

- Work supported by
  - The National Science Foundation grant award EEC-9510092 and the (former) NSF Industry/University Cooperative Research Center in Ergonomics at Texas A&M University
  - The National Science Foundation grant award EEC-0140203

Background

- 442 subjects
- 3 companies
- 9 locations
- 15 job descriptions
- Gathered personal, non-occupational, occupational, and psychosocial risk factor data

Background

- 126 variables
  - 48 personal and non-occupational
  - 37 occupational
  - 41 psychosocial (NIOSH general job stress survey and modified work APGAR)

Previous Research

Personal and Non-Occupational Risk Factors	Previous Research
Low aerobic power	Craig *et al.*, 1998; Waters *et al.*, 1993; Knapik *et al.*, 1993; Garg *et al.*, 1978.
Musculoskeletal fitness (strength, endurance, flexibility)	Moore, 1998; Reimer *et al.*, 1994; Mital *et al.*, 1993; Nieman, 1986; Cady *et al.*, 1985; Keyserling *et al.*, 1980; Cady *et al.*, 1979; Chaffin *et al.*, 1978; Chaffin, 1974.
Anthropometrics	Smedley *et al.*, 1995
Body fat and body mass index (BMI)	Craig *et al.*, 1998; Tsai *et al.*, 1992; Jones *et al.*, 1992; Cady *et al.*, 1979.
Age	Houtman, *et al.*, 1994; Tsai *et al.*, 1992
Gender	Berkowitz *et al.*, 1999; Ayoub *et al.*, 1989
Smoking	McSweeney *et al.*, 1999; Hoffman *et al.*, 1999; Leboeuf-Yde, 1999; Sacks *et al.*, 1994; Tsai *et al.*, 1992; Cady *et al.*, 1979.
Levels of exercise	Hoffman *et al.*, 1999; Cady *et al.*, 1979
Lifestyle, habits, behaviors	Cherpitel, 1999; Eriksen *et al.*, 1999; Scott *et al.*, 1999; Forrester *et al.*, 1996; Cherpitel, 1993; Pollack *et al.*, 1998; Olenckno, 1987; Wechler *et al.*, 1969.
Education	Peterson, 1995; Leigh *et al.*, 1989
Non-occupational activities	Thorbjornsson *et al.*, 1998; Leino, 1993

Previous Research

Occupational Risk Factors	Previous Research
High physical workload	Berkowitz *et al.*, 1999; Krause *et al.*, 1998; Konz, 1996; Marras *et al.*, 1995; Houtman *et al.*, 1994; Tsai *et al.*, 1992; Leigh and Sheetz, 1989; Borg, 1982
Body motions and posture	Marras *et al.*, 1995; Waters *et al.*, 1993; Smith *et al.*, 1992; Marras and Sommerich, 1991; Chaffin and Andersson, 1991; Burdorf *et al.*, 1991; Jager and Luttmann, 1989; Snook *et al.*, 1980; Magora, 1970.
Length of employment	BLS, 1999; Bernard *et al.*, 1994; Bigos *et al.*, 1986.
Lifting frequency	Åstrand and Rodahl, 1986; Gilad and Kirschenbaum, 1986; NIOSH 1981; Garg and Saxena, 1979.
Weight of lift	Kim and Chung, 1995; Chaffin and Andersson, 1991; Jager and Luttmann, 1989; Herrin *et al.*, 1986; Anderson *et al.*, 1985; Chaffin and Park 1973; Garg *et al.*, 1982; NIOSH 1981; Nachemson and Elfstrom, 1970; Chaffin, 1969.
Body discomfort	NIOSH, 1997; Drury and Deeb, 1986; Bhatnager *et al.*, 1985; Kuorinka, 1983.

Previous Research

Psychosocial Risk Factors	Previous Research
Job dissatisfaction	Krause *et al.*, 1998; Holmström *et al.*, 1992; Bigos *et al*, 1991; Svensson and Andersson, 1989; Tola *et al.*, 1988; Magora, 1973.
General tension	Vasseljen *et al.*, 1995
Psychological job demands	Krause *et al.*, 1998
Social support	Krause *et al.*, 1998; Elo *et al.*, 1996; Leino and Hänninen, 1995; Ohlsson *et al*, 1995; Hales *et al.*, 1994; Bongers *et al.*, 1993; Bigos *et al.*, 1986.
Occupational stress	Huang *et al.*, 1998
Increased job pressure	Bernard *et al.*, 1994
Rushed work pace	Ekberg *et al.*, 1994
Monotonous work	Houtman *et al.*, 1994; Ekberg *et al.*, 1994; Hopkins, 1990; Svensson and Andersson, 1989.
Job control	Elo *et al.*, 1996; Hales *et al.*, 1994; Houtman *et al.*, 1994; Bongers *et al.*, 1993; Theorell *et al.*, 1991.
Job clarity	Ekberg *et al.*, 1994
Job security	Hales *et al.*, 1994;
Job challenge	Finkelman, 1994
Working conditions and atmospheric issue	Tola *et al.*, 1988, Kvarnström, 1983

Risk Factor Overview

- Personal and non-occupational
- Occupational
- Psychosocial

- This presentation – the blocked multivariate analysis

Personal and Non-occupational

- Gender
- Age
- Anthropometrics (5)
- Body fat
- BMI
- Body frame size
- Aerobic power
- Dynamic lifting strength (3)
- PU/SU/HG/FL
- Smoking
- Outside exercise (3)
- Perceived fitness (2)
- Overall health
- Food consumption (2)
- Hobbies (top 10)
- Another job (y/n, # of hours)?

Personal and Non-occupational

- Usual mode of transportation
- Miles driven/year
- Education level
- Alcohol use
- Drinking and driving
- Percent of time wearing seatbelt
- Speed limit range
- Times witness/involved in violent fight
- Wear helmet

Occupational

- Frequency of lift
- Average weight of lift
- Weight lifted/day
- Work intensity
- Maximal weight of lift
- # Trunk flexions/hour (≥ 45°)
- # Trunk twists/hour (≥ 45°)
- # Trunk motions/hour (≥ 45°)
- Time spent in static trunk flexion (≥ 45°)
- # Knee flexions/hour (≥ 45°)

Occupational

- # Shoulder flexions/hour (≥ 45°)
- # Shoulder flexions/hour (≥ 90°)
- Time spent in static shoulder flexion (≥ 45°)
- # Shoulder abductions (≥ 45°)
- Working HR
- Working O_2 consumption
- % Of max aerobic capacity
- Above/below 33%
- BPDS
- Borg scale
- Length of time employed

Psychosocial

- NIOSH general stress survey
- Modified work APGAR

Objective

- To provide descriptive statistics of a large sample of industrial manual materials handlers
- Focus on large number of different risk factor groups

Objective

- Univariate/multivariate association of each group of risk factors with injury
- Overall blocked multivariate model including all risk factor groups (association with occupational injury)

Objective

- Develop job/task specific risk factor priority list
  - Optimize utilization of resources and personnel in the pursuit to reduce injuries and increase productivity in the workplace
- Critical evaluation of existing research
- Previous research replication
- Potential improvements MMH analysis tools

Objective

- Provide better understanding of causation of work related injury
- Identify what risk factors have the strongest relationship with work related injury
  - This data can be used to establish fiscally conscious injury reduction programs

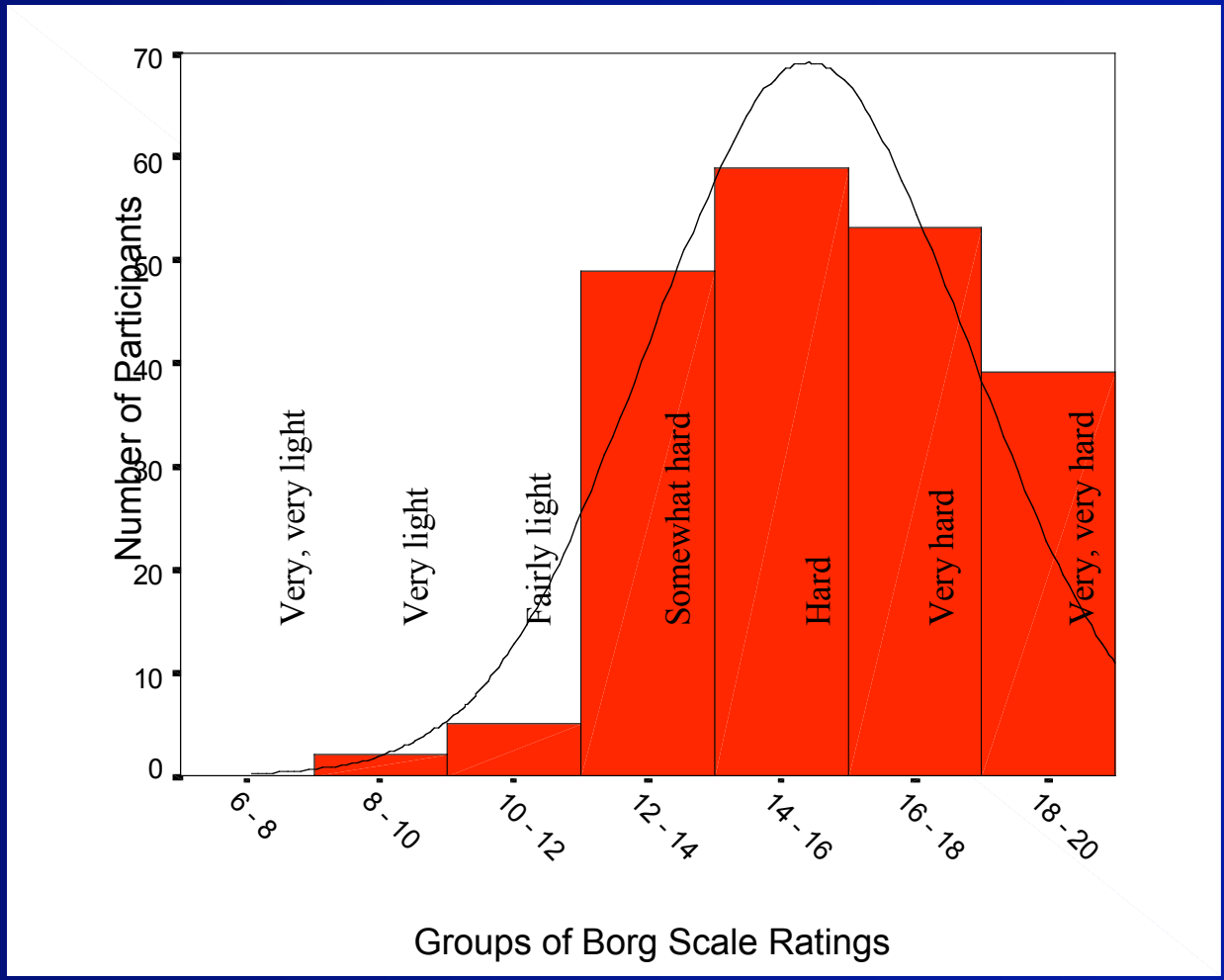
Methods

- Randomized Latin Square
- Descriptive
- Logistic regression
  - A flexible model which works well (good fit, reasonable interpretation) in many biological, social, and engineering datasets
  - Forward inclusion followed by backward elimination

Summary of Task Intensity

- Lift/hour avg. = 835/hour
- Pounds/day avg. = 45,536 lb
- Pounds/hour avg. = 11,125 lb
- Avg. weight of lift = 15.8 lb
- Avg. max weight of lift = 92 lb
- Percentage of maximal oxygen consumption = 47.74% → 85.8% of the population working over 33%

Summary of Task Intensity



Results

- This presentation will focus on the overall blocked, multivariate analysis
- NOT to infer that the univariate and multivariate ‘single risk factor’ analysis does not provide potentially useful information

Results

- In the final logistic model, after univariate and multivariate analyses of 126 potential risk factors, six emerge as possessing the strongest association with occupational injury in the current research

Overall Multivariate Analysis - Results

- Aerobic power (p = 0.0127, RR = 4.20)
- BMI (reversed relationship) (p = 0.0224, desirable BMI compared to Grade one RR = 5.32, desirable BMI compared to Grade two RR = 8.09)
- Frequency of lift (p = 0.0035, RR = 4.57)
- Average weight of lift (p = 0.0041, RR = 1.82)
- Service to public (p = 0.0121, RR = 2.97)
- Worker satisfied with their jobs (p = 0.0361, RR = 10.78)

Discussion

- Low estimated aerobic power (ml/min/kg)
  - The present study supports the findings of Craig *et al*. (1998), Jones *et al*. (1992), and Cady *et al*. (1985) in which greater aerobic fitness was found to be strongly associated with decreased occupational injury

Discussion

- Body mass index
  - However, the relationship is opposite to what previous research has found (Tsai *et al*., 1992, Cady *et al*., 1979)
  - This may be due to the fact BMI does not necessarily differentiate between high levels of lean muscle mass and high levels of body fat
  - Participants in the current research perform physically demanding jobs that require significant lifting, lowering, pushing, pulling, and/or carrying
  - One indicator of this is the high overall average of the dynamic lifting strength values

Discussion

- Lifting frequency
  - The significant association between lifting frequency and occupational injury supports previous research
  - Using psychophysical methods, it has been established that maximum acceptable workloads are significantly affected by frequency (Garg *et al*., 1979)
  - Waters *et al*. (1993) states that local muscle fatigue may develop from such high frequency lifting
  - Frequent lifting has been related to occupational injury, specifically low back pain, in industry (Gilad and Kirschenbaum, 1986, NIOSH, 1981)

Discussion

- Average weight of lift
  - Previous research has suggested object weight as a risk factor for low back pain (Kim and Chung, 1995, Chaffin and Anderson, 1991)
  - When lifting frequencies are high, any increase in the average weight of the objects being handled will greatly increase the physical workload, and occupational injuries have been associated with high physical workloads (Berkowitz *et al*., 1999, Marras *et al*., 1995, Tsai *et al*., 1992, Krause *et al*., 1998, Houtman *et al*. 1994, Leigh and Sheetz, 1989, NIOSH, 1981)

Discussion

- Participant's feelings if his/her job was not a "service to the public" is related to the outcome of occupational injury
  - Possessing a job in which there is an intrinsic reward, such as serving the public good, may assist in building an employee's social and/or esteem needs (Maslow, 1954) and may work as a positive motivating factor

Discussion

- Participants responding they were “not at all” satisfied with their job demonstrated a increased relative risk for injury as compared with the respondents stating they were “very” satisfied with their job
  - No other levels of job satisfaction in the multivariate model were associated with injury
  - The current research supports findings by Bigos *et al*. (1991), Tola *et al*. (1988), and Magora (1973)
  - Several negative job attributes such as poor social support, low levels of appreciation, increased pressure, monotonous work, lack of job control, and a job that is perceived as unenjoyable, unfulfilling, and providing few assets can lead to job dissatisfaction
  - It is not too unreasonable to associate decreased morale, increased absenteeism, decreased productivity, and decreased quality with increased worker stress

Conclusion

- An attempted to continue the effort in unraveling the multi-factorial etiology of occupational injury/illness
- Complex relationship of occupational injury with personal, non-occupational, occupational, and psychosocial risk factors through an individual's attributes, capabilities, buffers, and filters which may work to increase injury resistance by means of physical fitness, physical ability, lifestyle, knowledge, social support, coping skills, feelings of self worth, and attitude
- This study demonstrates occupational injuries are most likely not caused by one risk factor, or even one group of risk factors and suggests that many of these injuries are preventable but only through a multi-disciplined approach

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