Shiftwork Scheduling and Individual Factors Associated with the Incidence of Injury/Illness

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Overview

This study examined the association of shiftwork scheduling and individual factors with the incidence of injury/illness at the workplace.

Injury/illness analysis identified that different scheduling and individual factors are related to the risk of injury/illness depending on type of incident:

(1) females and workers with less than 20 years of seniority had an increased risk of injury/illness,

(2) rotational schedules increased the risk of safety-related incidents among females, and

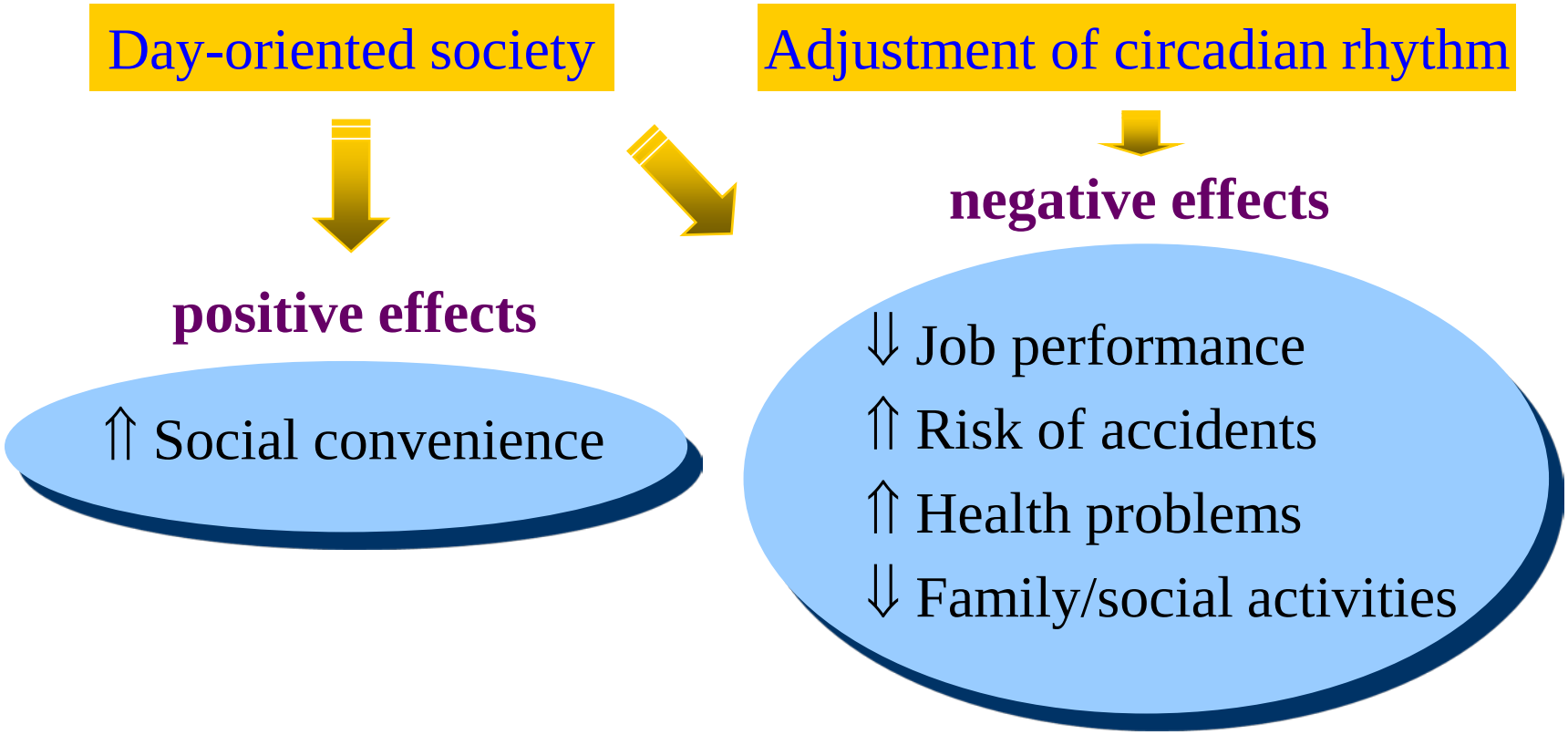
(3) extended (56 hour) work-period schedules increased the risk of ergonomics-related incidents.

These analysis results were used to provide suggestions for a better shift schedule design.

Background

- Definition of Shiftwork: Work schedules other than "normal" daytime (7 AM to 6 PM) (e.g., rotating, evening, and midnight work schedules).
- Shiftwork Statistics: In the US about 20% of workers are on shift schedules (Dekker et al., 1996).
- Reasons for Shiftwork
  - ✓ Public needs (e.g., hospital emergency, grocery stores)
  - ✓ Production needs (e.g., continual material movement)
  - ✓ Economic needs (e.g., faster return of capital investment)
  - ✓ Personal needs (e.g., night school, chronotype)

Effects of Shiftwork



⇒ Explore a better shift system reducing the adverse consequences of shift work.

Design Aspects of Shiftwork

Shift Design Variables	Examples
Type of shift	fixed; rotating
Time of shift	day; evening; midnight
Length of workday	8 hrs; 10 hrs; 12 hrs
# of consecutive workdays	5-days-on, 2-days-off; 7-days-on, 3-days-off
Speed of shift rotation	daily; weekly; monthly; quarterly; annually
Direction of shift rotation	clockwise(forward); counterclockwise(backward)
Shift assignment policy	seniority; personal preference

(Note)
- Fairness: Fairly distributed work load among workers.
- Circadian adaptation: Adjustment of biological clocks to a work schedule.
- Family/social life: Time with family/friends, child/elderly care arrangements, and recreational activities.

Motivation

- No best schedule to any generic shiftwork system
  - ✓ Complex design problems with multiple criteria.
  - ✓ Depending on measures used, a shift schedule has positive, negative, or neural effects.
- Limited generalizability of findings of shift work research
  - ✓ Population: college-aged subjects vs. workers.
  - ✓ Study type: laboratory study, field study, or accident analysis.
  - ✓ Tasks: artificial vs. actual tasks.
  - ✓ Work load: mental vs. physical work.
  - ✓ Outcome measure: short-term vs. long-term effects.

✓ Control of motivation

⇒ A shift scheduling system must be tailored to the workplace intended by assessing the effects of associated factors including shiftwork, individual, and task characteristics to workers' well-being and productivity.

Objectives

- Understand the effects of shiftwork scheduling and individual factors to the risk of injury/illness

  Identify significant factors affecting the incidence of injury/illness by analyzing incident records. **Hypothesized that risk factors contributing to the incidence of injury/illness would be different depending type of injury/illness.**

- Develop suggestions for a better shift schedule

  Provide suggestions to achieve a lower injury/illness rate at the workplace investigated based on results of the injury/illness analysis.

Methods

- Description of Workplace
  - ✓ Fiberglass manufacturing plant.
  - ✓ Round-the-clock operation.
  - ✓ Most tasks including material handling and repetitive motions of the upper extremities.
- Data Collection
  - ✓ Shift schedules.
  - ✓ Shift schedule assignment logs.
  - ✓ Demographic information (age, gender, and seniority) of workers.

- ✓ Reports of OSHA recordable Injuries/illnesses for the period 1994 to 1997.
  - OSHA recordability.
  - Incident severity.
  - Nature of the injury.
  - Body parts injured.
  - Causes (agency/equipment, environmental condition, and unsafe actions).

Variable Definition and Coding

- ✓ Three **individual factors**
  - Age.
  - Gender.
  - Seniority.
- ✓ Five **shift scheduling factors**
  - Type of shift (F: fixed; R: rotational).
  - Length of workday (8: 5 to 9; 10: 10 to 10.5 hours/day).
  - Number of consecutive workdays of the work period (4: 3 to 4; 5: 5; 7: 7 days/period).
  - Variation of weekdays for days-on and days-off (F: fixed; R: rotational).
  - Number of rotating shifts (2: DD, DA, and DN; 3: DNA, where D = day, A = afternoon-evening; N= night).

Injury/Illness Categorization

By referring to both nature of injury/illness and incident type, each of the OSHA recordable cases was classified into:

- ✓ **Ergonomics-related incidents**: cases from repetitive biomechanical stresses as assumed causes (e.g., cumulative trauma disorders, sprains/strains from repetitive motions, over-exertions, and/or awkward postures).
- ✓ **Safety-related incidents**: cases from inattention, decreased safety awareness, and/or errors as assumed causes (e.g., abrasions/scratches, contusions/bruises, and open wounds/cuts/lacerations).

Results

- Injury/Illness Statistics
  - ✓ Ergonomics-related and safety related incidents occurred about the same.
  - ✓ The average severity rate of ergonomics-related case is about 2.5 times that of safety-related case.

	Ergonomics-related Case	**Safety**-related Case
Incidence Rate (per 100 FTWs *)	4.1	4.7
Severity Rate (days per 100 FTWs)	158.6	65.7

* FTWs: Full Time Workers

Factors Associated with the Ergonomics-related Incidence

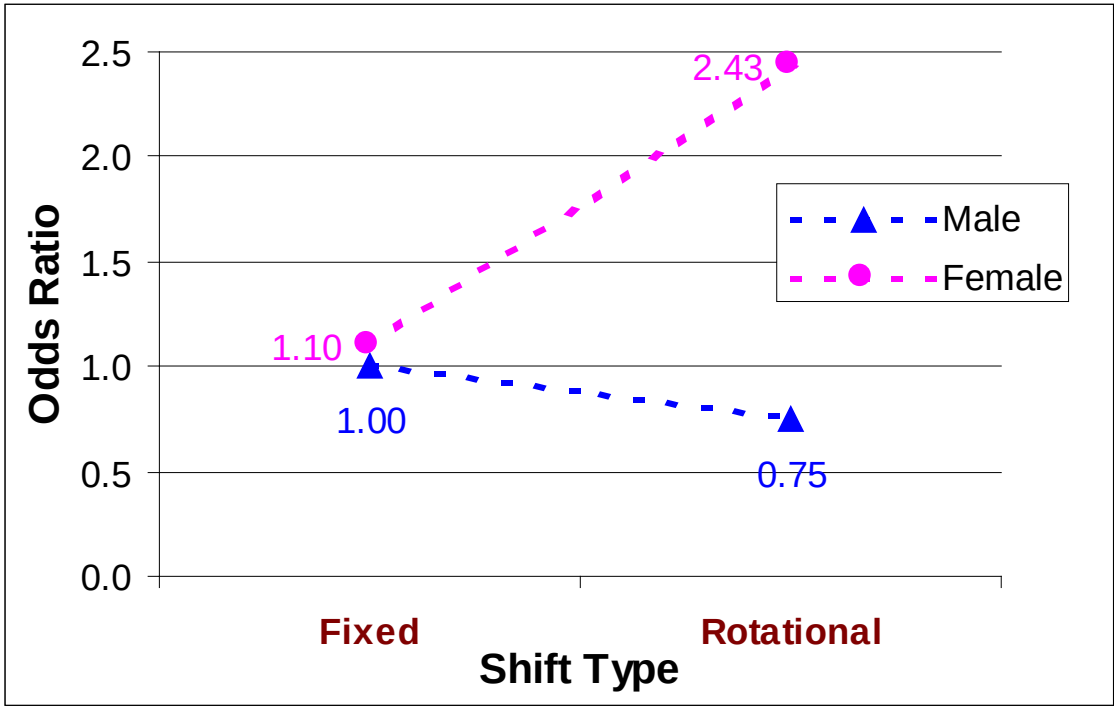
- Logistic regression analysis screened (criterion $p = 0.25$) three shift scheduling variables as weakly associated with the outcome: length of workday, number of consecutive workdays, and variation of days-on and days-off.
- The three variables were combined into a new variable 'length of work hours of the period,' having two levels: 40 and 56 hours.
- Logistic regression model for ergonomics-related incidence indicates that:
  - No interactions are significant.
  - Females and workers less than 20 years of seniority had an increased risk for ergonomics-related incidents.

- Extended work period (56 hrs) schedules increased the risk (odds ratio = 1.58, p = 0.11) of ergonomics-related incidents relative to conventional (40 hrs) schedules.

	Z	Odds Ratio	95% CI
Work Hours			
56 Hours	1.22	1.58	(0.76, 3.29)
Seniority			
11-20 Years	0.78	1.31	(0.67, 2.57)
Above 20 Years	-1.39	0.60	(0.29, 1.23)
Gender			
Female	3.26	2.55	(1.45, 4.47)

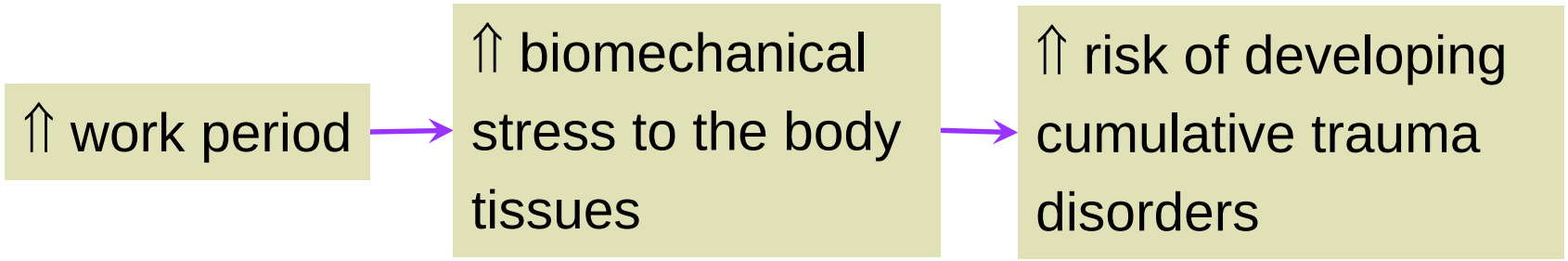
Factors Associated with the Safety-related Incidence

- ✓ Logistic regression model for safety-related incidence indicates that:
  - Significant interaction between shift type and gender.
  - Workers less than 20 years of seniority had an increased risk for safety-related incidents.
  - Rotational schedules increased the risk of safety-related incidents among females (odds ratio = 2.2) compared to fixed daytime schedules.


2.5
2.0
1.5
1.0
0.5
0.0
Odds Ratio
2.43
1.10
1.00
0.75
Male
Female
Fixed
Rotational
Shift Type

Conclusions

- The incidence and severity analyses indicated that the ergonomics-related cases had more severe injuries that the safety-related ones.
- Logistic regression analysis indicated that the extended work period (56 hrs) schedules increased the risk of ergonomics-related incidence, which would result in more severe injuries. This increased risk could be explained by higher biomechanical stress to the body tissues for the longer than 40 hour work period.



- Logistic regression analysis indicated that the rotational schedules increased the risk of safety-related incidence for females, not males, relative to the fixed daytime schedules.
- Females had an increased risk for both incident types, which may have been due to less sleep time than males (Dekker et al., 1996) and lower upper body strength (Chaffin and Andersson, 1991).

Design Suggestion (Example)

- Reduce the length of work period of extended schedules (8-hr or 8.5-hr 7-days-on schedules) with a top priority.
- Institute shiftwork-aid programs to make shiftwork easier and reduce the adverse effects of rotational schedules.

Design Approach (Addendum)

Literature Review

- Design variables of shift schedule system.
- Outcome measures (design criteria).
- Advantages & disadvantages of shift schedule options.
- Shift design recommendations.
- Shiftwork aid programs & management strategies.

Injury/Illness Analysis

- Injuries/illnesses records for the period 1994 to 1997.
- Significant factors associated with the incidence of injury/illness.

Shift Schedule Desirability Survey

- Shift schedules that workers are willing to work.
- Effects of shift scheduling on workers' well-being.
- Relative importance of shift design criteria.

Design Suggestion

- Design suggestions on shiftwork schedule system.
- Examples to implement the design suggestions.