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Work Schedules and Sleep Patterns of Railroad Signalmen

SUMMARY

The Federal Railroad Administration (FRA) Office of Research and Development sponsored a project to study the work schedules and sleep patterns of U.S. railroad signalmen and examined the relationship between these schedules and level of alertness of the individuals working the schedules. This study methodology was a survey of a random sample of currently working U.S. railroad signalmen who completed a background survey and kept a daily log for 2 weeks. Signalmen are a predominantly healthy middle-aged male population. They work either construction or maintenance jobs. Both groups get the same amount of nighttime sleep but the construction group reports better sleep quality and better daytime alertness. This difference is likely due to the unscheduled work periods and nighttime calls that maintenance jobs entail, as well as the start time variability of maintenance jobs. During the study period nearly two-thirds of the non-construction signalmen had at least one unscheduled work period. Over 50 percent of signalmen get less than 7 hours of sleep on work nights while 39 percent of U.S. adults get this amount. Possible explanatory factors for daytime alertness levels, including an unscheduled work period the prior day, time working without a break, total hours worked and commute time, were explored. Based on the experience of this study, several methodological changes are suggested for future studies of this type.

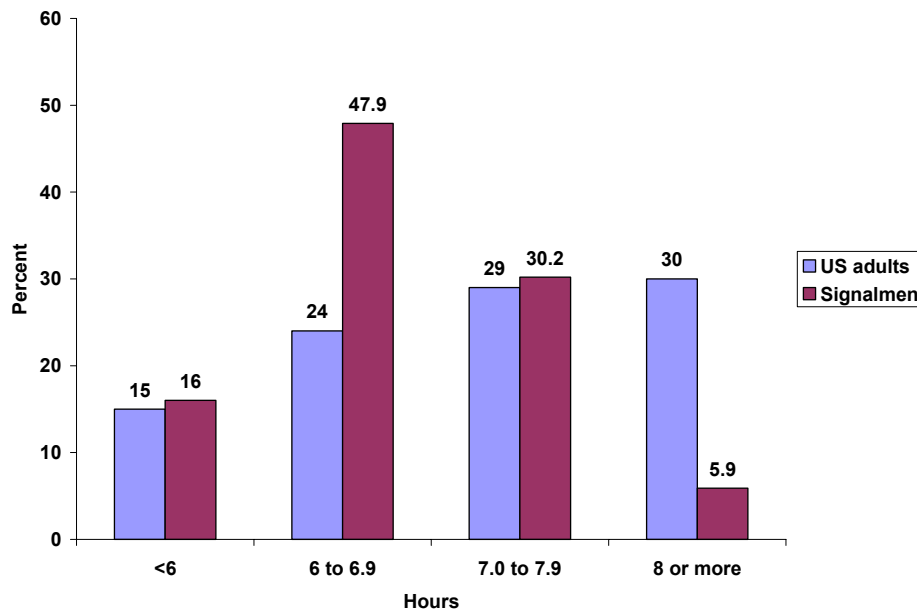


Figure 1. Duration of nighttime sleep on workdays for signalmen vs. U.S. adults



BACKGROUND

Because railroading is a round-the-clock, 7-days-a-week operation, many of the crafts involved in operating and maintaining the nation's railroads are subject to fatigue. With the non-operating craft groups, staff shortages, seasonal work, expanding territories, and response to emergency situations can result in long work hours leading to fatigue. In 2001, the FRA suggested and the North American Rail Alertness Partnership agreed, on the need to study the fatigue issues of the non-operating crafts. The FRA decided to focus initially on signalmen.

Signalmen work two fundamental types of jobs: maintenance and construction. Signal maintainers are responsible for inspecting and certifying the functioning of the signal and communication equipment. The maintainer is also responsible for making minor repairs as s/he inspects. The job of a maintainer has a regular daily schedule but the maintainer is also subject to call for emergencies at night and on weekends.

Major yards have maintainers permanently assigned to maintain the signal system in the yard. These individuals work on a shift work schedule to cover the yard around the clock.

In contrast to the maintainer, a signalman who works on a construction gang will usually work a compressed schedule of, for example, 8 workdays followed by 6 days off, and is rarely called for an emergency. A construction signalman frequently works at a site that necessitates a long drive and sleeping away from home.

OBJECTIVES

The objectives of the research were to:

- Document and characterize the work/rest schedules and sleep patterns of U.S. signalmen, and
- Examine the relationship between these schedules and level of alertness/fatigue for the individuals who work the schedules.

METHODS

This research involved a survey of actively working U.S. railroad signalmen. The study used two survey instruments, a background survey and a daily log. The background survey

was designed to gather demographic information, descriptive data for the signalman's job type and work schedule, and a self-assessment of overall health. The daily log was developed for recording sleep and work periods on both regular workdays and planned days off for a 2-week period.

In October 2003 the survey materials were distributed to a random sample of 819 U.S. signalmen. The overall response rate for the survey was 49.9 percent. Respondents received a gift certificate to a national retail chain as compensation for their participation in the survey. A non-response bias study based on participant age found no difference between respondents and non-respondents.

RESULTS

Signalmen Demographics

The survey respondents held primarily maintenance jobs (65 percent) and construction jobs (29 percent). The remainder worked yard maintenance. Since construction jobs are usually not subject to emergency call and since these jobs frequently require working far from home, all analysis by job type was done for construction jobs vs. all non-construction jobs.

Average signalman experience was 18 yr, but construction signalmen had 7 yr less experience than non-construction signalmen. The majority of signalmen are middle-aged with over 70 percent being 40 yr and older. The average age for construction and non-construction signalmen differed by 4 yr with non-construction signalmen being older.

Over 86 percent of the signalmen report their health as good or excellent. More than 84 percent had not taken a day off due to illness in the last 6 mos. The low number of workdays lost due to illness may be due in part to the fact that signalmen are not compensated for sick days.

Approximately 6 percent of the signalmen reported having a diagnosed sleep disorder and almost one third of those have gone without treatment.

Job Characteristics

The work schedules of construction and non-construction signalmen differ in several respects. While both types of jobs are defined to work 80 h in a 2-week period, nearly all non-construction jobs have a 5-day workweek but



less than a quarter of the construction jobs have this schedule. (See Table 1.) Actual hours worked exceeded 80 h for both groups, with the non-construction signalmen working 87.5 h over the 2-week period and construction signalmen working 83.25 h. Comparison of these results with the 2002 average straight time equivalent (ASTE) hours for signalmen indicated that the survey period was one of lighter than normal workload.

Table 1. Work schedule by job type

Work schedule	Job Type	
	Construction	Non-construction
4-day week	50.5 %	3.2 %
5-day week	22.5 %	95.7 %
8-on 6-off	26.1 %	--
Other	0.9 %	--
Missing data	--	1.1 %

Over a third of non-construction signalmen experienced start time variability at least once during the survey period, most likely as a result of an emergency call or unscheduled work. (Start time variability was defined as a change in start time of more than 1 h from the previous day.) In contrast, 90 percent of the construction signalmen experienced no start time variability (see Table 2).

Nearly two-thirds of the non-construction signalmen had at least one unscheduled work period in the 2-week period of the study. This group averaged 1.9 unscheduled work periods. On any given day, the probability of an unscheduled work period was .12.

The study examined the relationship between characteristics of the signalmen's work schedules and alertness. Unscheduled work periods appear to affect morning alertness ratings but the effect size for this relationship was small. While the correlations between alertness and time without a break, total hours worked and commute time were significant, the strength of the relationships was weak.

Sources of work-related stress were different for the two groups of signalmen. Only in the case of "travel to work" did construction signalmen report a statistically different and higher level of stress than their non-construction counterparts.

Table 2. Start time variability by job type

Number of start time variations	Job Type	
	Construction	Non-construction
0	89.9 %	62.9 %
1	4.6 %	12.9 %
2	1.8 %	15.7 %
3	2.8 %	5.0 %
4+	0.9 %	3.6 %

Sleep Characteristics

Signalmen get less nighttime sleep than U.S. adults on workdays but more on planned days off (see Figure 1). They average 6.75 h on workdays and nearly an hour more on planned days off.

Total daily sleep, which includes naps as well as nighttime sleep, for both construction and non-construction signalmen, is about 1 h longer on planned days off than on workdays. While both groups of signalmen get about the same amount of sleep daily, construction signalmen rated their sleep of higher quality than the non-construction signalmen group on both workdays and planned days off. This is likely due to disrupted sleep resulting from nighttime emergency calls that the non-construction group must handle. Construction signalmen rated their work night sleep at home of higher quality than the sleep they get when away from home, although the duration of their nighttime sleep is shorter at home.

As might be expected, there was a positive correlation between nighttime sleep duration and morning alertness ratings. Nighttime sleep explained 10 percent of the variance in morning alertness rating.

Signalmen with diagnosed but untreated sleep disorders rated their sleep of lower quality and had lower alertness ratings throughout the day than those with treated sleep disorders or no sleep disorders.



CONCLUSIONS

Key findings of the study include the following:

- In spite of the fact that the 2-week survey period was one of lighter than normal workload, one quarter of the construction signalmen worked at least 1 d of overtime and one quarter of the non-construction signalmen worked at least 1.5 d of overtime. Had the study been done at a time of a more typical workload, the amount of overtime would have been greater.
- While the overall signalman workday allows adequate time for nighttime sleep, the nighttime call of non-construction signalmen likely prevents them from getting adequate and restful sleep when they are called.
- Unscheduled work periods were responsible, to a limited degree, for lower alertness the following morning. This suggests that other factors contribute to morning alertness.
- A total of 16 percent of signalmen are getting less than 6 h of nighttime sleep. Research has shown that this level of sleep deprivation leads to performance degradation and that the individual is likely unaware of his/her degraded performance. Railroad industry and labor organization fatigue education programs should emphasize the performance consequences of inadequate sleep.
- Individuals with diagnosed but untreated sleep disorders should be encouraged to accept treatment. Fatigue education programs should point out the possible performance consequences of untreated sleep disorders.

Based on the experiences of this study, several methodological changes should be a part of any future studies of this nature. The recommended changes include the following:

- The background survey should inquire whether or not the respondent has been diagnosed with sleep apnea as well as a sleep disorder so that the results can be compared with U.S. adult norms for sleep

apnea.

- If possible, data collection should occur at a time of year with a typical workload.
- The data collection period should avoid daylight savings time changes and holidays.

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