COMPREHENSIVE STUDY OF THE SLEEP OF SHIFT WORKERS

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Although a significant portion of the American work force is involved in shift work, there has been little in the way of a systematic approach to the study of real-world shift workers in this country (Tasto & Colligan, 1977). In general, the data available to date are from studies in which a single method of data collection is employed, and many methodological approaches have not as yet been used (Tepas, 1976). The Work-Sleep Study, initially conducted in St. Louis and now in Chicago, is approaching shift workers using three methodological tactics: A brief survey; intensive laboratory study; and, extended interviews. This study is a comprehensive examination of shift workers in the sense that it includes three methodological tactics. It is also a comprehensive study in another sense. The study is designed to collect redundant information in an attempt to insure a reliable understanding of the data.

The methods used in the Work-Sleep Study have been described previously in detail (Gordon, Tepas, Stock, & Walsh,1979; Walsh, Gordon, Maltese, McGill, & Tepas, 1979). In essence, the study sequentially samples active shift workers with the three methodological tactics or approaches. Access to these shift workers is gained through their labor unions with participation always being confidential and voluntary. The brief survey, titled the Work-Sleep Survey, gathers information on type of work, hours of work, hours of sleep, health, drug use and related matters. Work-Sleep Survey respondents provide a pool of potential participants in subsequent parts of the study as well as demographic estimates of the population sampled.

This paper focuses on selected dimensions of the Work-Sleep Survey from our final St. Louis sample. The importance of a comprehensive approach will be demonstrated through comparison of survey data to similar data collected from the same workers in the laboratory and field interview parts of the study. More detailed reports of data from samples of the laboratory and field interview parts of the study will be found in subsequent papers in this volume (Walsh, Tepas, & Moss; Gordon, McGill, & Maltese). These three papers together provide an initial view of the findings of this comprehensive study.

Work-Sleep Survey Sample

A total of 1442 surveys were collected from the members of 35 St. Louis area locals and lodges belonging to 17 international unions. Of these surveys, 76% were collected by the study staff at union meetings. The remaining surveys were gathered by union officers or through a variety of mailing methods. The mean age of the workers sampled was 39.4 years. Within the sample, 78.3% were males, 73.6% were married, and 75.2% were at least high school graduates. Those working at least seven consecutive hours between 0600 and 1600 hrs were classified "Day" workers and made up 62% of the sample. Those working at least seven consecutive hours between 1500 and 0100 hrs were classified "Afternoon/Evening" workers and made up 10.9% of the sample. Those working at least seven consecutive hours between 2200 and 0700 hrs were classified "Night" workers and made up 9.5% of the sample. Workers on two or more shifts were classified as "Rotators" and made up 17.6% of the sample.

As a rule, the workers surveyed had significant experience with their specific shift schedule. Figure 1 shows the percentage of workers responding to each of five categories when asked how long they had worked these hours. In this sample 79.6% of the workers had been on their shift schedule for one year or more at the time the survey was completed. Rate of shift change for Rotators is shown in Figure 2. Fifty percent of the Rotators changed shifts once per week, whereas only 2.9% changed shifts at a more frequent rate.

In the results presented in the following sections, statistically significant differences are indicated only when they achieved the .05 level or higher. Chi Square and t-tests were used for the categorical and continuous variables, respectively.

Sleep Length

Workers were asked when during the work week they usually go to sleep and get up. Rotators were asked to provide this information for each shift they worked. Mean sleep length in hours is graphed in Figure 3 with the data from the steady permanent shift workers indicated by bracket A and the data from the Rotators indicated by bracket C. The other brackets in this figure contain similar data from two current independent studies. Bracket B contains data from steady permanent shift workers in a NIOSH sponsored study (Tasto, Colligan, Skjei, & Polly, 1978). The data from 1941 food processors and nurses have been combined for this figure. The data used corrects an error in the original report (Colligan, 1979). Bracket D contains data from a national sample comprised of 15% of the total membership of a small union of government workers (Armstrong & Tepas, 1979).

For all four samples shown in Figure 3, Afternoon/Evening shift work is accompanied by the statistically significant longest sleep length whereas Night work is accompanied by the statistically shortest sleep length. It should be noted that the differences in sleep length associated with the three permanent shifts are mirrored in the data from the Rotating shift workers. For the St. Louis data, the sleep length of the Rotating workers on a Day work shift is significantly shorter than that of a permanent Day worker, and the sleep length of the Rotating worker on Night work shift is significantly shorter than that of a permanent Night worker. Afternoon/Evening shift differences of this sort are not statistically significant.

Perhaps the only other comparable data from American shift workers is that reported by Mott, Mann, McLoughlin, and Warwick (1965) almost 15 years ago. Although not statistically significant in all cases, nearly identical trends are evident in this older data. Sleep chart data from European workers reported by Östberg (1973) give much the same picture.

Difficulty Sleeping

A question on the survey asks: Do you often have difficulty in falling asleep or staying asleep? Data from respondents was sorted on the basis of the yes-no response to this question. Figure 4 presents the mean sleep lengths obtained. The bars bracketed as ALL are the data from permanent shift workers and Rotators before the sort on this question. For Rotators the average sleep length for the three shifts is graphed. Bracket DS contains the

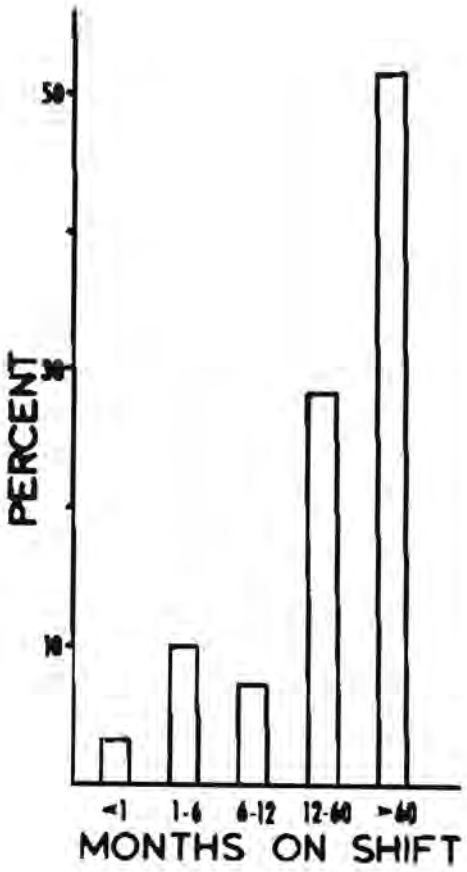

Figure 1. Worker experience on shift schedules for total sample of 1442 respondents.

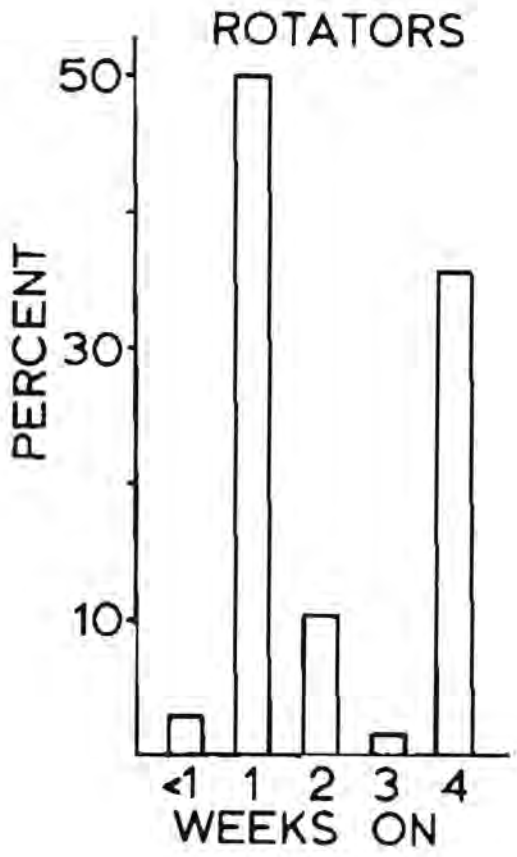

Figure 2. Rate of shift change for workers on Rotating shift schedules.

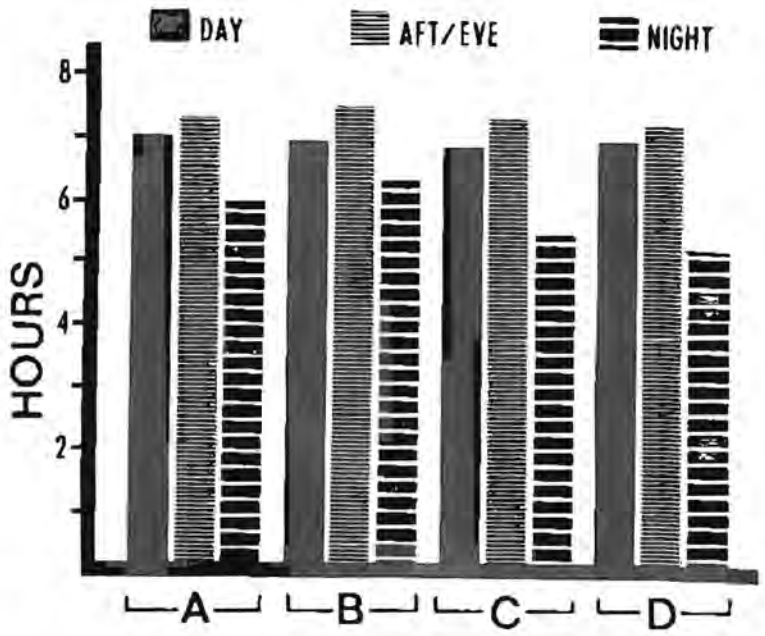

Figure 3. Mean sleep length in hours for Steady and Permanent, and Rotating shift workers. (A = St. Louis sample of Permanent shift workers; B = NIOSH sample of Permanent shift workers; C = St. Louis sample of Rotating shift workers; D = National sample of Rotating shift workers).

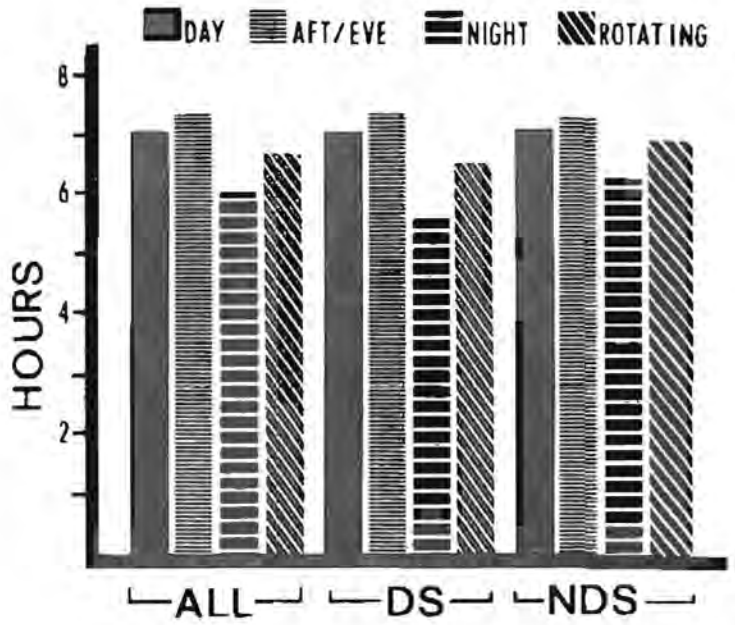

Figure 4. Mean sleep length in hours. (All = All workers responding in St. Louis sample; DS = St. Louis workers who report difficulty in falling or staying asleep; NDS = St.Louis workers who did not report difficulty in falling or staying asleep).

data from those answering "yes" to this question and NDS (No Difficulty Sleeping) brackets the data from those answering "no". There are no significant differences in sleep length between DS and NDS workers on permanent day or Afternoon/Evening shifts. For permanent Night shift, DS workers report significantly shorter sleep times than NDS workers. Also, DS Rotators have reported shorter sleep times than NDS Rotators. Overall, for Rotators the average sleep length is significantly shorter than that of either Day or Afternoon/Evening shift workers, but longer than the reported sleep length of Night workers. These differences are also evident in both the DS and NDS sorts. Thus, the average sleep of Rotators falls short of the reported sleep of either Day or Afternoon/Evening workers, and subjective reports of difficulty sleeping or staying asleep appear to interact with sleep length among both Night and Rotating workers.

Napping and Difficulty Sleeping

A question on the survey asks: Do you often take naps during the work week? Data from respondents was sorted on the basis of the yes-no response to this question. Figure 5 shows the percent responding "yes" to this napping question for each of the four shift groups as well as the percent responding "yes" to the difficulty sleeping (DS) question. For both the napping and DS variables, the Night and Rotating workers respond "yes" at a significantly higher rate than Day workers. In both cases, there are no significant differences in percentage responding "yes" between Day and Afternoon/Evening workers or between Night and Rotating workers.

In Figure 6, the percent responding "yes" to the napping question stated above is graphed for both NDS and DS groups. As we have already pointed out, overall the percent responding "yes" to the napping question is greater for both Night and Rotating workers. Among Night shift workers, DS workers report frequent napping more often than NDS workers. Similarly among Rotating workers, DS workers report frequent napping more often than NDS workers. With regard to nap length, there are no statistical differences between DS and NDS for any of the shift groups. With regard to sleep length, Night shift DS workers sleep less than NDS workers. This significant difference also holds for Rotators, but does not hold for Day and Afternoon/Evening workers. Thus, DS Night workers and Rotators appear to be short sleepers who take frequent average-length naps.

Work/Sleep Phase Type

In addition to being asked when during the work week they usually go to sleep and get up, workers were also asked when they went to work and when they ended work. Again, Rotators were asked to provide this information for each shift they worked. Those reporting sleep periods just prior to work were classified as having a Sleep/Work Phase Type, and those reporting sleep periods just after work were classified as having a Work/Sleep Phase Type. When this classification was not clear, workers were assigned to a number of other categories, but this was not a problem for most workers.

Figure 7 provides a schematic representation for the results of this analysis. In general, Day workers have Sleep/Work Phase Types with 99.4% of the Permanent (P) Day and 100% of the Rotating (R) respondents following this

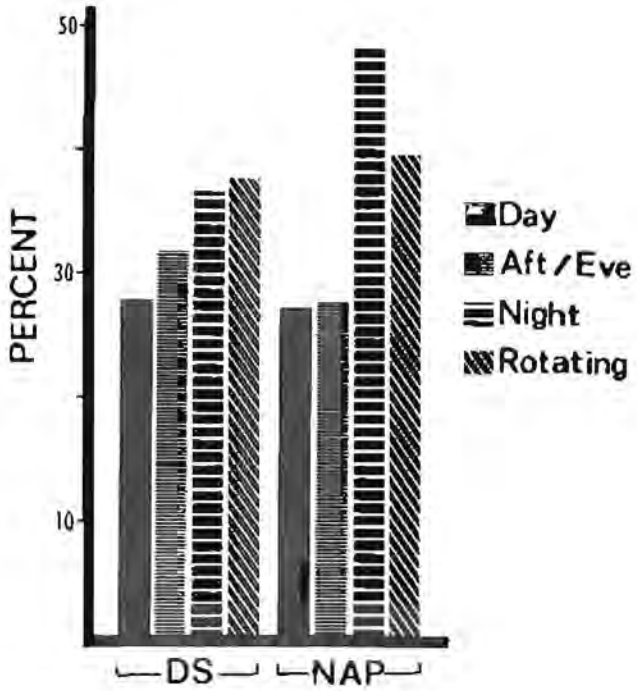

Figure 5. Percent workers responding yes. (DS = Have difficulty falling or staying asleep; NAP = Often take naps during the work week).

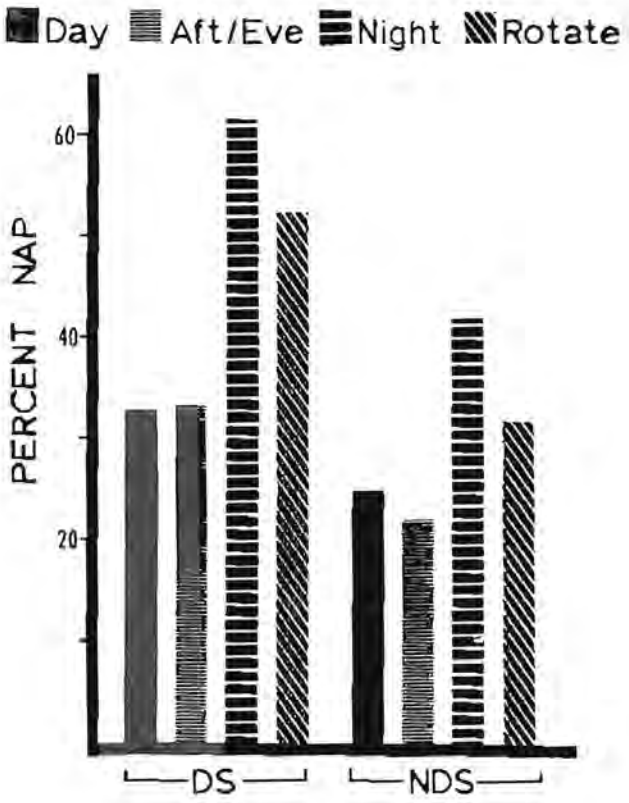

Figure 6. Percentages of workers who responded "yes" to the napping question. (DS = those who have difficulty falling or staying asleep; NDS = those who do not).

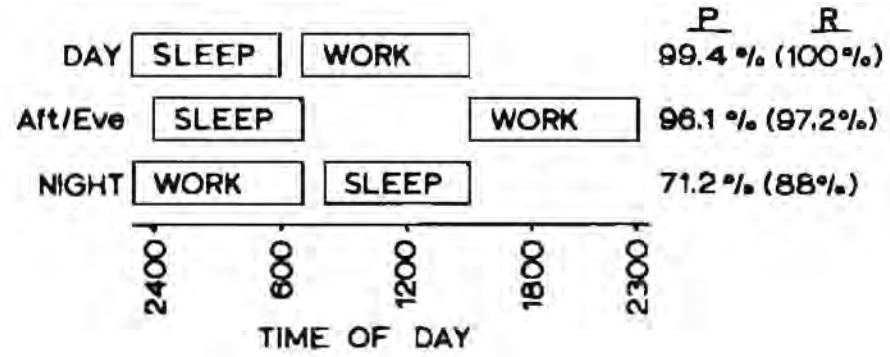

Figure 7. Schematic representation of typical Work/Sleep Phase Types. Percentages are shown for the percent of Permanent (P) and Rotating (R) shift workers conforming to this model.

model. Afternoon/Evening workers and Night workers, on the other hand in general sleep after work rather than before. For Afternoon/Evening work, 96.1% of the Permanent workers and 97.2% of the Rotating workers have Work/Sleep Phase Types. Night work for 71.2% of the Permanent workers and 88% of the Rotators yields times classified as Work/Sleep Phase Type. As one might expect from the napping data, classification of workers into phase types was most difficult for the Night workers. Thus, just as the sleep lengths of the three Permanent shifts are mirrored in the data from the Rotating shift workers, the Sleep Phase Type analysis also yields parallel results for Permanent and Rotating workers.

Correlation Between Sleep Length Estimates

As noted in our introduction, the sequential nature of our design requires that all participants in the intensive laboratory study first complete the Work-Sleep Survey. In addition, many participants in the laboratory study also participate in the extended field interviews. Using the 30 workers from the polysomnographic analysis (Walsh et al.) as our base and interview data when available (Gordon et al.), a correlation matrix was computed using the six sleep length estimates collected in the various parts of the overall study. The results of this analysis are presented in Table 1.

Table 1

Intercorrelations of Various Measures Used to Estimate Sleep Length

Survey	(S)					
Inventory	(I)	.28				
LAB TIB	(TIB)	.81	.40			
EEG TST	(TST)	.83	.31	.91		
LAB PSR	(PSR)	.73	.28	.86	.84	
Field Inter.	(F)	.80	-.20	.83	.83	.77
		S	I	TIB	TST	PSR

S=Work-Sleep Survey;
I=Sleep Inventory;
TIB=Time in bed;
TST=Total sleep time;
PSR=Personal sleep report;
F=Interview sleep estimate.

The six sleep length estimates included in Table 1 are as follows. Survey (S) sleep length estimates are the Work-Sleep Survey data gathered by asking the workers when they usually go to bed and get up during the work week. Inventory (I) sleep length estimates were obtained, on the average for this sample, 117 days after the administration of the Work-Sleep Survey in the course of the laboratory Orientation Session. In this case, workers were asked, on a questionnaire titled the Sleep Inventory: Excluding naps, how long are you asleep every 24 hours? Lab TIB (TIB) is the mean time in bed observed during the last three sleep sessions in the laboratory. EEG TST (TST) is the mean standard polysomnographic measure of total sleep time for the last three sleep sessions in the laboratory (Rechtschaffen & Kales, 1968).

Lab PSR (PSR) sleep length estimates are mean subjective estimates made by workers during the last three sleep sessions in the laboratory while electrodes for the polysomnographic recordings were removed after sleep. In this case, workers were asked, on a questionnaire titled the Personal Sleep Recorder: How long did you just sleep? The laboratory sleep length estimates were obtained, on the average for this sample, 182 days after adminstration of the Work-Sleep Survey. Field interview (F) sleep estimates were gleaned by staff from the extended interview data with the staff blind as to other length estimates (Gordon et al., this volume).

For the correlation coefficients shown in Table 1, an r value of .40 or greater is significant at the .05 level or better. In general, it seems reasonable to conclude that with the exception of Sleep Inventory data, sleep length estimates in the various parts of the study are highly correlated. We suspect that the insignificant Sleep Inventory correlations would be significant with larger samples. Two studies using larger samples from the Work-Sleep Study have reported statistically significant but modest correlations between the Work-Sleep Survey estimates of sleep length and those obtained with the Sleep Inventory (Maltese, 1979; Stock, 1979). Thus, it seems reasonable to suggest that Work-Sleep Survey sleep length estimates provide a reasonable index of other sleep length estimates collected in the laboratory or via interview methods. It should also be noted that these various estimates were distributed over a six month period on the average. This can be interpreted as suggesting that the workers studied have relatively stable and consistent sleep length characteristics.

Discussion

The Work-Sleep Study is aimed primarily at the study of real-world experienced shift workers while they continue to work on their usual job and shift. This is being achieved, but a clear explanation of the findings to date is difficult. By design, our laboratory study to date has been aimed at only Day, Night, and Rotating shift workers. Yet, it may be that the Work-Sleep Survey data collected by hap from Afternoon/Evening shift workers produces the most significant clues of all at this point in our study.

Afternoon/Evening shift workers sleep, in general, longer than workers on any of the other shift groups observed in our study. Since most Day workers sleep before work and most Afternoon/Evening workers sleep after work, this means that in practice the temporal placement of sleep for Day and Afternoon/Evening workers overlaps to a considerable degree. This prohibits a strict circadian/physiological explanation for the increased sleep of Afternoon/Evening workers. One might propose that the sleep length of Afternoon/Evening workers is extended due to increased fatigue produced by not sleeping just prior to work. This suggestion is clearly not totally satisfactory since Night workers also sleep after work rather than just before their work, and their sleep is shorter not longer than that of Day workers.

What remains as feasible major sources of variance are two rather complex groups of social factors. First, following the suggestion of Webb and Agnew (1975) it is reasonable to suggest that the hourly Day workers in our study are free to choose when they wish to go to sleep but must get up to go to work at a specific time in order to keep their jobs. Thus, one can argue that our

Day workers do not get as much sleep as they require due to the demands of their shift schedule. Second, it is also reasonable to suggest that the Afternoon/Evening workers can in practice extend their sleep to a reasonable degree without having this significantly interfere with their social obligations and opportunities immediately after awakening. Thus, one can argue that the Afternoon/Evening workers are the only ones to get as much sleep as they require.

The average sleep for all workers in the St. Louis Work-Sleep Survey sample is 6.96 hours. Obviously, this number has no absolute value since our sampling methods made overt efforts to include a large number of shift workers in the group. The proportioning of various shift groups in the total sample would, of course, influence the relative value of the total sample mean sleep length. However, it is certainly proper to note that the average sleep length observed is a long way from the traditional eight hours frequently touted in popular culture! Mott et al. (1965) provides us with the only comparable sleep length data from American shift workers which was collected some years in the past. Their sleep lengths are longer than our comparable ones and the comparable ones from the contemporary NIOSH study (Tasto et al., 1978). Perhaps these findings are in keeping with Webb's suggestion that sleep lengths have shortened in recent years (Webb, 1969). It is also interesting to contrast and compare our sleep data with that reported by Webb and Agnew (1978) for rotating laboratory shift conditions in which social pressures are minimal.

With regard to both sleep length and Sleep Phase Type, it is very clear from our data that Rotating workers in general change their behaviors as they change shifts so that they pretty much mirror the behaviors of Permanent workers on the same shifts. Thus, it would be quite difficult to argue that the Rotating workers we sampled have developed any unique way of adjusting to the rigors of their shift schedule. In fact, given the percentages of Rotators reporting difficulty sleeping or napping, together with their average sleep times, one is hard pressed to at all suggest on the basis of survey data that our Rotators tolerate well their changing shift schedules.

Night workers tend to nap longer than Day or Afternoon/Evening workers. Assuming that napping is a method used by workers to compensate for reduced sleep periods, we have calculated a variety of adjusted total sleep time estimates based on nap length and sleep extension estimates reported on our Work-Sleep Survey. To date, we have not been able to derive any way of adjusting times so that the total sleep time estimates for each of the three shifts is about the same. For example, when we adjust reported sleep by adding the appropriate mean nap or sleep extension times proportional to their incidence, the adjusted total sleep time estimates per 24 hours for Day, Afternoon/Evening, Night, and Rotating workers are 7.53, 7.86, 7.66, and 7.14 hours, respectively. This analysis does little to change our basic findings in terms of the sleep habits of shift workers.

Stock (1979) completed a detailed analysis of the sleep-related habits and subjective sleep perceptions as reported on the Sleep Inventory for a matched sample of workers in the DS and NDS Work-Sleep Survey response groups defined earlier. This analysis included the data from 134 workers in our sample. Among other things, the DS workers reported longer sleep latencies, more monthly incidents of trouble falling asleep, more problems with awakenings, and rated themselves as lighter sleepers more easily awakened by noise. They

reported being more tense at bedtime and being more tired upon awakening on workdays. They did not differ from the NDS group in estimates of sleep duration, dreaming or napping habits. This analysis makes it quite clear that our DS shift workers do experience a variety of sleep complaints.

The decreased sleep length estimates obtained for Night shift work is particularly meaningful in light of the significant positive correlations with our polysomnographic measures. Maltese (1979) completed analysis of long and short sleepers in groups of workers from our shift worker sample. This analysis defined long and short sleepers using a statistical criteria, based on the total Work-Sleep Survey sample. Long and short sleepers were defined as the top and bottom quartiles of reported sleep length. For Work-Sleep Survey based criteria, short sleepers were those who slept less than 6.5 hours per night. Among other things, short sleepers were more manic, desired and felt they needed less sleep, and reported they were less sleepy after awakening. With a mean sleep length of 6.05 hrs for Permanent and 5.53 hrs for Rotating Night work, one might view Night work as a "producer" of short sleepers or appropriate for short sleepers. In general, the characteristics of a short sleeper are positive ones and therefore one might view Night work as a quite acceptable work alternative. On the other hand, if mortality rate (Kripke, Simons, Garfinkel, & Hammond, 1979) should be higher in short sleepers, Night work might prove to be an insidious silent killer.

As experiment-in-progress, the Work-Sleep Study should provide more light on the problems of shift work as data collection and analysis continue. However, it should be recognized that shift work issues are complex ones, subject to a host of variables. We are only beginning to explore these variables in this country. Although the Work-Sleep Study is a comprehensive approach, comprehensive findings should not be expected. It will be years before we arrive at that point.

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PROCEEDINGS

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
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THE TWENTY-FOUR HOUR WORKDAY: PROCEEDINGS OF A SYMPOSIUM ON VARIATIONS IN WORK-SLEEP SCHEDULES

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