Differential Effects of 8 and 12 Hour Non-rotating Shifts on Alertness, Sleep and Health of Public Safety Workers

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Abstract. Shiftwork causes disruption in circadian and social rhythms of the shift workers. Extended hours shifts and non-rotating (permanent) shifts are increasingly being adopted in police agencies across United States. The aim of this study was to evaluate alertness, sleep, and wellness of workers in permanent shift systems in a public safety department. A self-reported questionnaire survey was administered to 39 police and security officers working in 8 and 12 h permanent shifts. When compared with the 8 h shift, 12 h shift work was associated with a significantly lower alertness level ($p = 0.076$), lesser sleep duration ($p = 0.023$), more perceived sleep insufficiency ($p = 0.088$), more perceived negative effect of shift type on sleep ($p = 0.037$), and higher frequency of back or lower back pain ($p = 0.005$). The results of this study are potentially useful when designing interventions to improve shift work experience.

Keywords: Shiftwork · Permanent shift · Alertness · Sleep · Wellness

1 Introduction

Shiftwork is designed to make use of all 24 h of a day and it is a common feature of today's work life across a broad range of occupations. Reasons for adopting shiftwork are varied. Manufacturing and engineering industries utilize shiftwork for economic reason. Equipment utilization increases when equipment is used 24 h per day. Other service sectors such as public safety, hospitals and air traffic control have to be available 24 h per day to meet the social need for these services. Whatever the reason for shiftwork may be, it is associated with increased health problems, including sleep disturbances, fatigue, productivity loss, digestive problems, emotional problems, and stress related illnesses [1]. One of the most common problems related to shift work is the decrease in quantity and quality of sleep which impacts alertness, fatigue level and health of the workers [2, 3]. As a consequence, these effects increase the risk of operator error, injuries and accidents [4].

Health studies on shift workers reported a series of physical, psychological and social problems due to the disruption of circadian and social rhythms [1]. Morning, afternoon and night shift work creates different kind of conflicts between the sleep and wakefulness hours and the internal timing mechanism [2]. Twelve or ten hour shift

S. Bagnara et al. (Eds.): IEA 2018, AISC 819, pp. 522–531, 2019.
https://doi.org/10.1007/978-3-319-96089-0_56

systems, as opposed to eight hours shift system, allow workers a compressed work week (CWW) of three to four days of work. The CWW shifts are gaining popularity because it requires fewer workdays and provides a larger block of time off, in a week [5]. It promotes fewer circadian changes, more free time for social life, reduced number of night shifts, and reduced commuting. However, the longer work shifts decrease the time available for sleep and may lead to increase of fatigue, reduced alertness, and increased safety risk during shift work [5].

In rotating shift systems workers take turns working on all shifts following a set schedule. The rotation or change of shifts adds more disruption for workers' routine of sleep and work [2]. Rotating shift system covers a wide variety of work schedules that varies in speed of rotation and direction of rotation. Speed of rotation is determined from the number of consecutive days a worker follows the same shift. The direction of rotation is determined from the chronological order of the change of shift. The combination of these two features of a shift schedule affects shift workers' physiological and psychological wellbeing [1]. To completely avoid the negative effects of rotating shifts, non-rotating or permanent shift systems were implemented [6].

Public safety departments operate 24 h to maintain security and safety services. An early study conducted in 1981 described the experimental implementation of non-rotating shift system in two Detroit Police Precincts for duration of one year [6]. Before and after survey showed favorable ratings for the non-rotating shifts. Several other indicators of health and quality of family life showed improvement. Later, in 1991, another study [7] in Lexington, Kentucky Police Department also noted improved sleep quality, sleep hygiene and reduction in absenteeism when changed from rotating to permanent shift system.

A recent study [8] investigating the effect of CWW on police personnel found negative effect on sleep, fatigue, and alertness, positive or no effect on quality of life, and insignificant effect on work performance, safety, and health [8]. Majority of other CWW studies came from health services or nuclear energy plants [5]. A review article on the effects of 12 h CWW shiftwork, summarized no great problems with sleep, health, safety, productivity or error rate when working 12 h compared to 8 h shifts [5]. All the above articles on CWW, employed rotating shift systems. No studies were found on CWW for non-rotating shift systems.

In recent times CWW as well as permanent shifts are increasingly being adopted in police departments [9]. A random telephone survey of 300 police agencies in United States revealed that between 2005 and 2009, the number of 8 h shift agencies dropped from 115 to 88, and the number of agencies with rotating shifts declined from 132 to 71 [9]. The aim of the present study was to evaluate alertness, sleep, and wellness of workers in permanent shift systems in a public safety department, and compare effects on 8 h and extended shift workers. A secondary objective was to determine the difference in impacts on rotating and non-rotating shift schedules in CWW workers.

2 Materials and Methods

The security staff and police officers from the Public Safety Department of New Jersey Institute of Technology participated in this study. The questionnaire survey and the study design were approved by both the Institutional Review Board (IRB) and the Chief of Public Safety Department. A detailed questionnaire survey was designed based on the standard shiftwork index [10]. The survey included 29 items covering alertness, sleep habits, and wellness factors. The printed copy of survey including a consent form was distributed to the shift workers on different days. Participation was voluntary, and all participants were guaranteed confidentiality and anonymity. All participants were adult, ranging age between 18 and 50, and English speaking.

The public safety department used three different permanent shift types as follows: 8 h (morning, afternoon, evening), 10 h (day, night) and 12 h (day, night). Job profiles of the shift workers participated in the survey are as follows: Sergeant, police officer, security staff and others (as dispatchers, lieutenant, chief of police and public safety officer) with a percentage of 16%, 22%, 43% and 19%, respectively of 78 total number of staff in the department. All participants were employed in shift system, and the broad task characteristics of their jobs were similar. The data collection continued for about two months and achieved a 50% response rate (39 participants out of 78). Participants were predominantly male (74%). They had an average (standard deviation) shift work experience of 5.7 (0.85) years, overtime per week 9.8 (9.91) h. The workload ratings were not significantly different between any of the groups studied.

The statistical significance of shift effects was determined by analyzing the survey data using a single factor ANOVA and Tukey's test with 90% confidence level. The effects on alertness, sleep and wellness were compared between groups of 8 h shift versus 12 h shift, 8 h morning shift versus 8 h afternoon shift, and 8 h morning shift versus 12 h day shift. Effects of 8 h or 12 h night shifts were not compared individually because of low participation. There were only 3 and 4 participants in 8 h and 12 h night shifts, respectively. Also, there were only two participants from 10 h shift, and as a result, data for 10 h shift system were excluded from the analysis.

3 Results and Analysis

3.1 Alertness

Participants rated their overall alertness level in the shift, and alertness levels during the Early-stage, Mid-stage and Late-stage of their shifts, in a scale of 1 to 5, where "1" is very alert and "5" is very sleepy. The mean rating of alertness levels of 12 h shift workers was lower than 8 h shift workers, for the overall shift and in every stage of the shift (Fig. 1). Also the alertness level for both shift types gradually decreased over the shift, which was expected. A significant decrease in mean alertness level was found for 12 h shift workers as compared to the 8 h shift workers for early-stage ($p = 0.033$), mid-stage ($p = 0.052$) and for the overall shift ($p = 0.076$).

To investigate the effect of the time of the day, alertness ratings of 8 h morning shift (from 07.00 a.m. to 03.00 p.m.) were compared with 8 h afternoon shift (from

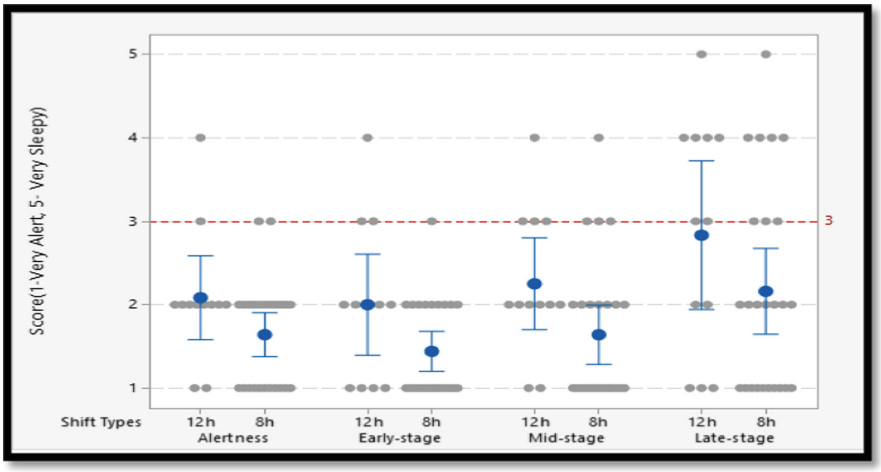

Fig. 1. Individual value plot of alertness ratings in the entire shift and, early, middle and late stage shifts for 8 h and 12 h shift workers with 95% confidence interval for the mean.

03.00 p.m. to 11.00 p.m.). Figure 2 illustrates that 8 h morning shift workers alertness level was almost unchanged over the entire shift, but the 8 h afternoon shift workers alertness level decreased gradually as the shift progressed with a large difference at the late-stage of shift ($p = 0.088$). The results support that working until late evening, 11 p.m., has a negative effect on alertness.

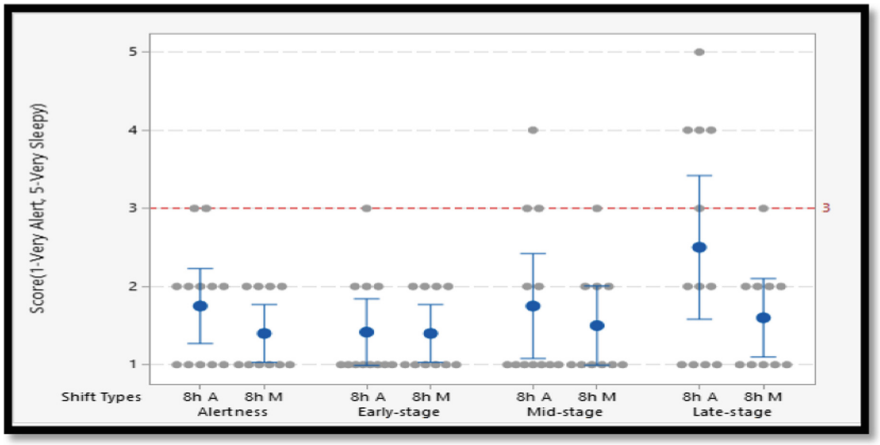

Fig. 2. Individual value plot of alertness ratings in the entire shift and, early, middle and late stage shifts for 8 h morning and 8 h afternoon shift workers with 95% confidence interval for the mean.

Eight hour morning (from 07.00 a.m. to 03.00 p.m.) and 12 h day (from 07.00 a.m. to 07.00 p.m.) shifts data are compared with an objective to find the effect of length of shift on alertness (Fig. 3). Both shifts started at 7 a.m., but the 12 h day shift extends to 7 p.m. Figure 3 shows that the 12 h day shift consistently showed reduced alertness level compared to 8 h morning shifht. A statistically significant difference ($p = 0.037$) was found for early-stage mean alertness level between the 8 h morning and 12 h day shifts. Similar to the results for 12 h versus 8 h shifts, this result of 12 h day to 8 h morning shift also supports that the extended shift has a detrimental effect on alertness.

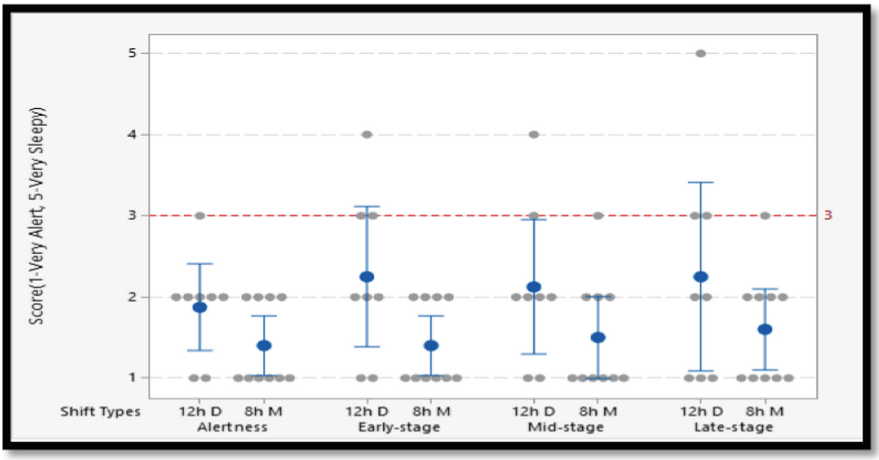

Fig. 3. Individual value plot of alertness ratings in the entire shift and, early, middle and late stage shifts for 8 h morning and 12 h day shift workers with 95% confidence interval for the mean.

3.2 Sleep Duration, Sleep Problem and Sleep Quality

Sleep Duration. The mean value of "amount of sleep needed" reported by the 8 h and 12 h shifts participants are 6.96 and 6.58 h per day, respectively, and the difference in means was not significant. However, the reported mean of the "amount of sleep duration they get" per day, was significantly ($p = 0.023$) less for 12 h shift compared to 8 h shift. The scale used was "1" less than 6 h per day, "2" between 6 and 8 h per day and "3" over 8 h per day. As demonstrated in Fig. 4, there is no individual from 12 h shift system who chose the amount of sleep duration as over 8 h per day. The mean duration of sleep for 8 h morning shift and 8 h afternoon shift, were rated nearly identical, whereas, for 12 h day shift rated lower than 8 h morning shift. These results indicate that sleep duration was affected by longer shift duration and effect of working in the afternoon and evening did not affect the sleep duration, even if they worked until 11 p.m.

Sleep Problems. Sleep problems included 11 questions and participants chose "1" (almost never), "2" (quite seldom), "3" (quite often) and "4" (almost always) to express

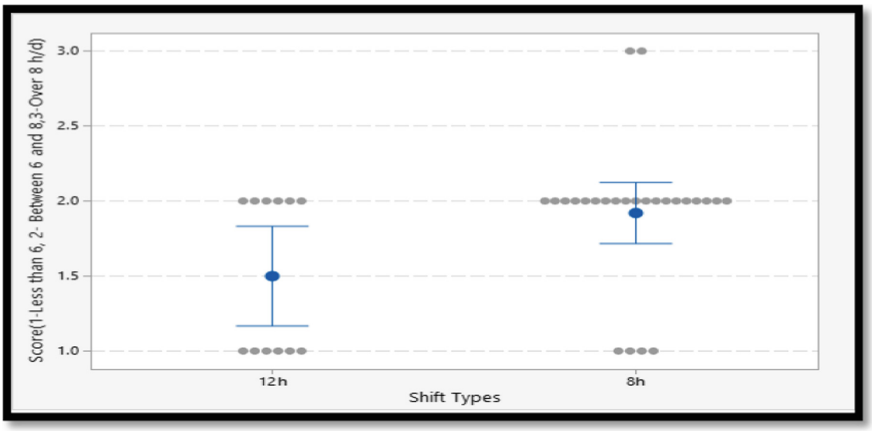

Fig. 4. Individual value plot of ratings of the amount of sleep duration with 95% confidence interval for the mean, for 8 h and 12 h shift workers.

how often they experience these sleep problems. Mean sleep problem indicators were compared for 8 h and 12 h shifts, and there was a statistically significant difference was observed for two sleep problems (see Fig. 5). Twelve hour shift workers scored significantly higher in sleep insufficiency ($p = 0.015$) and in the negative effect of shift type on sleep ($p = 0.082$) compared to normal 8 h shift. These results support the hypothesis that extended shift is associated with increased level of sleep problems.

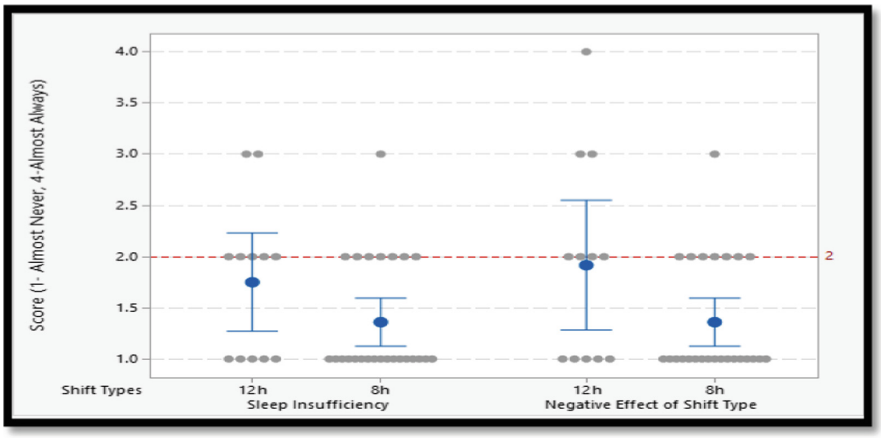

Fig. 5. Individual value plot ratings of sleep habit indicators with 95% confidence interval for the mean, for 8 h and 12 h shift workers.

Sleep problems scored by 8 h morning shift were almost identical to 8 h afternoon shift. Figure 6 shows that the mean score of 8 h afternoon shift of 1.8 is higher than the

8 h morning shift of 1.1. The 8 h afternoon shift felt more difficult (p = 0.017) for initiating sleep compared to the 8 h morning, which is possibly related to the disruption of circadian rhythms.

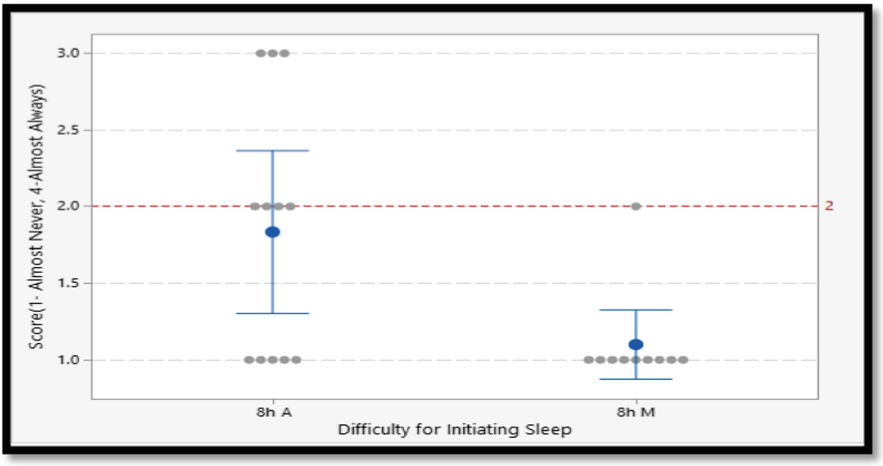

Fig. 6. Individual value plot of ratings of difficulty for initiating sleep for 8 h morning and 8 h afternoon shifts with 95% confidence interval for the mean.

Figure 7 shows that 12 h day shift mean scores for these three questions are much higher than for 8 h morning shift. When comparing 8 h morning shift with 12 h day shift, later had more difficulty in initiating sleep (p = 0.019), more sleep insufficiency (p = 0.015) and scored higher in the negative effect of shift type on sleep (p = 0.082) as compared to 8 h morning shift workers. Results are strongly indicating that 12 h day shift workers have more sleep problems than 8 h morning shift even the start times were the same.

Sleep Quality. The sleep quality was assessed with four questions on a four-point scale: "1" (almost always), "2" (quite often), "3" (quite seldom) and "4" (almost never). Although no statistical difference found, Fig. 8 shows that for every sleep quality indicators; 12 h shift mean scores are higher than the 8 h shift, indicating inferior trend in sleep quality for 12 h shift participants. A similar but less pronounced difference of means was found between 8 h morning and 12 h day shift.

3.3 Physical Health and Satisfaction

Six questions addressed the frequency of pain in various body locations, in a scale "1" (almost never), "2" (sometimes), "3" (usually), and "4" (almost always). Surprisingly, a significantly (p = 0.005) higher mean "back or lower back pain" frequency was reported by the 12 h group (mean 2.66) compared to the 8 h group (mean 1.78). A similar result was noted when comparing 8 h morning with 12 h day shift. 12 h day shift mean score of 2.37 is higher than 8 h morning shift 1.7, and the difference in mean

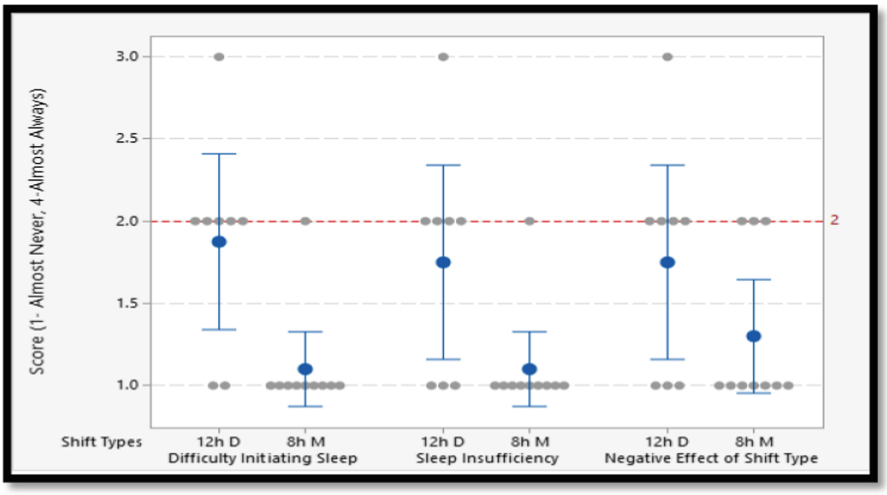

Fig. 7. Individual value plot of ratings of sleep habit indicators of 8 h morning and 12 h day shift workers with 95% confidence interval for the mean.

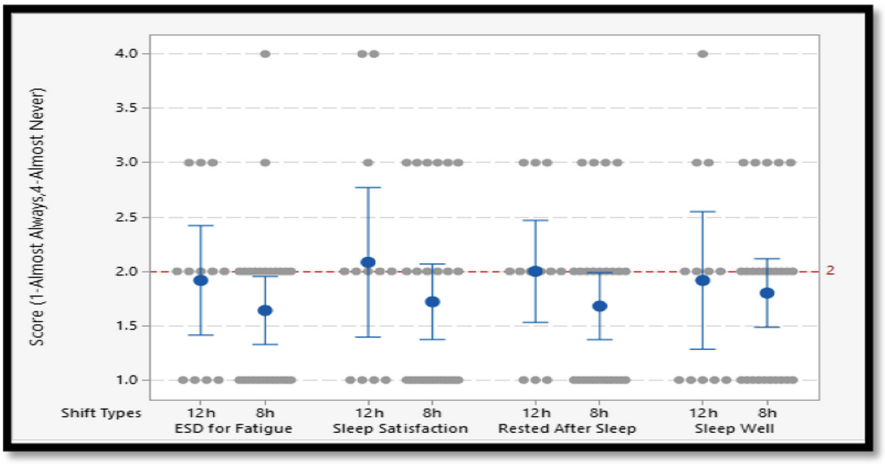

Fig. 8. Individual value plot of ratings of sleep quality indicators with 95% confidence interval for the mean for 8 h and 12 h shift workers.

was statistically significant ($p = 0.019$). These results support the notion that 12 h shift workers suffer from back/lower back pain more than 8 h shift workers.

A statistically significant difference ($p = 0.043$) for the frequency of "Pain in Arm/Wrist" was found between 8 h morning and 8 h afternoon shifts. The mean score for 8 h morning was 1.3 and for 8 h afternoon shift was 1.0. This difference was statistically significant but the difference is small, and the mean values are also small.

The seventh question in this section was "How do you rate your health". There was no significant difference in mean ratings between 8 h and 12 h shifts. Nor there was any difference between 8 h morning and 12 h day or 8 h afternoon shift. The mean ratings tended to be "healthy".

The last question of the survey was the satisfaction with the current shift schedule. It is assessed on a five-point scale ranging from "1" (very satisfied) through "3" (average) to "5" (very unsatisfied). The satisfaction score for 12 h shift type was not any different from that of the 8 h shift type. However, 8 h afternoon workers were more dissatisfied ($p = 0.066$) with their shift schedule compared to 8 h morning shift.

4 Discussion

The overall objective of this study was to evaluate the alertness, sleep and wellness outcomes of 8 h and 12 h non-rotating shift systems. The results of the study strongly supported the notion that 12 h shift workers of non-rotating shifts experience lower level of alertness ($p = 0.076$) as compared to 8 h shift workers. Even though this group receives four off days per week, they get less time to rest/sleep on the workdays, and longer work shift make them less alert and sleepy during the shift [5]. When 12 h day shift was compared with 8 h morning shift workers, alertness scores of former group were lower ($p = 0.037$). Since both the groups worked during day time, diurnal effect was absent, and thus the result indicates the net effect of longer shift duration. When comparing 8 h day with 8 h afternoon shift, the latter group rated significant less alertness at the late state of the shift ($p = 0.088$). The late evening work of the afternoon shift, could be attributable to conflict with circadian rhythm.

The finding on alertness was supported by the lower rating of sleep quantity ($p = 0.023$) and rated sleep problems in terms of perceived sleep insufficiency ($p = 0.015$) and perceived negative effect of sleep for shift type ($p = 0.082$) for 12 h group. Ratings of 12 h day shift workers showed increased difficulty in initiation sleep ($p = 0.019$), increased sleep insufficiency (0.015), and increased negative effect of shift (0.082), when compared to 8 h day shift workers. There was no significant difference among the two groups in terms of measured sleep quality.

A significantly higher ($p = 0.005$) frequency of back pain was reported by the 12 h group, which should be a serious concern for the 12 h permanent shift workers. None of the pervious shift work studies assessed frequency of body pains and this finding should be more carefully reviewed in future studies.

Interestingly, as opposed to the finding of a previous study of police work [8], the rating of satisfaction with current shift schedule was not any different for 8 h and 12 h shift workers. The higher satisfaction ratings after change from 8 h to CWW schedules were noted in several studies [5]. This may be attributable to the short term euphoria recoded in many studies [5]. This study results showed the long term effect of no difference in satisfaction.

It is also apparent that similar effects on alertness and sleep were also highlighted by the previous researchers on rotating 12 h shifts [11–15]. The results of this study are useful when designing interventions to improve shift work experience. One limitation

of this study was lack of participation by the night shift workers, and, as a result, effects of non-rotating night shift for 8 or 12 h shifts could not be investigated.

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