Does age affect the relationship between control at work and sleep disturbance for shift workers?

Abstract

Among miners, shift work, ageing and lack of control at work may be factors leading to increased sleep problems. Such risk factors may also operate in interaction, resulting in an even increased harm for sleep disruption. The present study aims at evaluating these relationships drawing on a sample of Australian mine and energy workers and their partners. The workers were mainly men. All performed shift work that included either nights (95%) or multiple shifts (92%), usually both (87%), while 36% were aged 50 years or above. The results show that low latitude over work activities is associated with higher sleep disturbances across the sample, though the effects are clearer amongst younger workers. By contrast, for younger workers, control over shift scheduling is not associated with sleep disturbances but for workers aged 50 or more, low control results in more sleep disturbance. Misalignment between shift workers and partner work schedules, and partner dissatisfaction with shift worker's employment and shift worker's work-life balance, are also associated with more sleep disturbances amongst shift workers.

Introduction:

There is a growing body of empirical evidence linking low work-based support and control over shift schedules to poor tolerance of shift work with negative health effects including anxiety, depression, burnout, somatic complaints, raised cholesterol levels and substance abuse (Frone, 2003). In general, research suggests that the more control shift workers have to vary their work intensity, duration and timing, the more they can minimize work life conflict, particularly time-based conflict. This form of conflict occurs when time devoted to paid work inhibits or precludes full participation in non-work roles (Carlson et al., 2000), which is a common complaint of shift workers (Pisarski & Loudoun, 2007).

Another broad body of research suggests that aging shift workers have marked increases in individual differences in physical, social and personal needs. Indeed looking at individual factors that decrease shift work tolerance, aging is the most commonly cited factor (Harma & Kandolin, 2001). In spite of these general age-related variations, however, it is not known whether aging shift workers have a higher need for control over shifts than younger workers. General recommendations for shift scheduling certainly argue for individual flexibility in working hours for older workers but whether this need is greater for these workers than their younger counterparts has not been tested empirically. This study brings together these two separate, but interrelated areas of research, with a view to examining the impact of aging and control at work on sleep quality. Understanding ways to make shift work more tolerable for older workers is increasingly critical as most populations in the industrial world are aging creating a growing imperative to recruit and retain older workers (Bohle et al., 2008).

The study utilises data from an Australian national matched-pairs study of mine workers and their partners to assess the influence of age, control over the duration and intensity of shift hours,

perceptions of partners about the shift worker's job and contribution to the household and sleep disturbances. Mining in Australia is male-dominated and features shifts that are frequently 12 hours in length (Australian Bureau of Statistics, 2010). The industry has been responsible for much of the growth in shift work in Australia, with workers often living remotely from their families due to the lack of infrastructure near the mines (Murray and Peetz, 2010). The study contributes to broader scholarship addressing work-life boundaries (Skinner & Pocock 2008) for older workers as well as scarce knowledge about the impact of organizational level variables on workers' well being more generally.

Shift work, sleep and aging workers

Without considering interactions between aging and fatigue, performance and risk of accidents, shift work alone is well documented as leading to impairment in all these areas owing to sleep deprivation and changes in circadian rhythms. It is well known that shift work, and particularly night work, results in decreased quality and quantity of sleep (Akerstedt, 1998) and evidence indicates a clear relationship between sleep loss and attention deficits by way of increased response failure or lapses, impaired information processing and slower reaction times (Dinges, 1995). It is also widely accepted that aging shift workers need individual flexibility in working hours owing to a marked increase in individual variations in interrelated physiological, psychological, and social disruptions, which result in a reduced ability to tolerate shift work (Bohle et al., 2008; Loudoun & Pisarski, 2005). For example empirical evidence points to relationships between age and alterations of the circadian timing system such as misalignment of phase relationship, amplitude decrease, difficulty of entrainment, increased 'morningness' and a phase advance of the general activity rhythm (Dijk et al., 2000; Van Someren, 2000).

Although general recommendations for the design of optimal shift work systems for elderly workers emphasise the need to take into account factors such as increased flexibility and time for recovery (Harma & Ilmarinen, 1999), very few studies have tested this empirically. There is considerable discussion about which features of shift systems are likely to be least disruptive for older shift workers but the bulk of research to date has revolved around the speed and timing of shift system changes. For example Harma and colleagues (2001; 2006) found quickly forward rotating shift systems are better suited to older workers than slower backward rotating shift systems as they result in fewer consecutive night shifts. As a result of this narrow discussion there is little evidence about how organizational factors, other than the work schedules themselves, might be managed to reduce disruption for older shift workers.

Looking beyond shift work research to work psychology in general, Karasek's demand-control-support model (Karasek & Theorell, 1990) and the more recent job demands-resources model (Demerouti et al., 2001), consider flexibility to exercise some control over various aspects of work as critical for improving stress, health and well-being (Allan et al., 2007). The explanatory power of control in determining prevalence and impact of illness is well established in the literature (Taylor et al., 2010). Task discretion has been linked to physiological indicators such as blood pressure, and concomitant disorders, such as cardiac disease (Theorell & Cooper, 1998). Not surprisingly insufficient autonomy and inadequate control over work schedules and workload are also leading causes of turnover and job dissatisfaction in some disciplines (Loudoun & Pisarski, 2005).

Research focussing specifically on shift workers, confirms that flexibility and giving shift workers the opportunity to exercise some control over working time and practices can help minimize the negative impact of work schedule (Smith et al., 1998). For example Pisarski et al (2008) found that nurses who reported more control over workload and task autonomy also reported lower levels of work life conflict and, in turn, better psychological well being. Based on

these findings, Pisarski and colleagues extended their model of shift work tolerance (Pisarski et al., 2001) to suggest that intervention at both the organizational and individual levels is required to reduce negative health effects. Specifically, they highlight the importance of interventions to enhance social support from various sources to maximize control over work schedules.

The well-established link between shift work and ill health is sufficient reason to make control at work an important area of investigation. More information is needed, however, about the importance of control over aspects of shift work for different groups of workers and workers in different industries. To date research on control at work, shift work and health has focused mainly on narrow groups of industries such as health care and services and groups of workers such as women with children, single parent families and those providing eldercare (Chang et al., 2010). This is not surprising given that there is considerable evidence indicating that interference is most acute for these workers (Skinner & Pocock, 2008). However, it is important to know the factors influencing interference for workers of different ages and at different life-stages as studies focusing primarily on younger workers may not be directly generalised to older workers. Substantial differences are likely to exist between the two populations in life circumstances, home responsibilities, job tasks, and work-related experience (Pires et al. 2009).

There is also very little research targeting male shift workers specifically, much less those in higher-risk exposure industries such as mining. This shortcoming is significant as Australia, like most western countries, has traditionally had an emergency and essential-services bias to its typical shift worker profile but with dramatic changes in the work profile of the Australian miner over the last three decades, mining has, more than any other, embraced shift work with 52 per cent of all mine employees now working shifts. Furthermore while evidence suggests that consultative and participative frameworks have increased in most workplaces, task discretion is decreasing (Gallie et al., 2004), this industry is now characterized by a high degree of organizational constraint on worker latitude of behaviour.

Further emphasizing the importance of research on control at work in mining, evidence shows that sleep curtailment and reduced sleep quality represent risk factors for sleepiness and errors, and traffic accidents are one of the leading causes of deaths and injuries amongst miners in Australia. Although researchers cannot precisely calculate to what extent sleepiness contributed to the elevated work-related mortality rate in mining a cross-national study found it to be between seven and ten times that of the general population of workers (Feyer et al., 2001). Sleep deprivation has been independently linked to safety and performance in a work setting (e.g. Vetter et al., 2012).

In an effort to gain a more critical picture of the impact of control over shift duration and intensity on workers in mining, this study compares younger and older shift workers on their perceived control over day-to-day aspects of shift work and sleep disturbances. In a final departure from much of the existing literature on aging and shift work this study uses matched-pair samples and examines relationships between control over shifts and partners' perceptions of the shift workers employment and contribution to the household. This approach was adopted for the study because it provides a unique perspective on workers' ability to reconcile their work and nonwork life and on the importance of support on shift work tolerance and it overcomes the positive illusions characteristic of individual reporting (Murray & Holmes, 1997).

Partner Studies

There is no doubt that support from partners is critical for adjustment to shift work and indirect evidence suggesting that marital quality is associated with disrupted sleep (Hale, 2005). Simon (1990) found a range of problems associated with poor integration of partner waking and sleeping cycles in a nonshift working population, including challenges with parental roles, sexual activity and eating routines. More recently Presser (2000) found that amongst relatively newly married

men with children, working fixed night shift made divorce six times more likely than for those working days only. Given these results it is not surprising that many argue that partner perceptions and experiences of shift work are so critical for promoting adaption to shift work that the influence of shift work should be viewed within the context of the household as a whole (Fourie & Vsser, 2001, Pisarski et al., 2001; 2008).

In the context of mining in Australia, disproportionate numbers of miners work at sites distant from the family home, and maintaining 'homes' both near the mine, and in their communities of origin. There can be no question that maintaining a household and family life requires support at home under these shift arrangements. In a study of oil and gas workers in the UK and the Netherlands showed family relationships were a strong predictor of both job dissatisfaction and mental ill-health (Cooper and Sutherland 1987). "Intermittent husband syndrome", with a focus on the European oil and gas industry has received considerable scholarly focus (e.g. Morrice, Taylor et al. 1985, Taylor, Morrice et al. 1985), with the studies finding a mixture of positive and negative impacts of absence.

Despite general agreement that a change in shift schedules requires a change in the way a shift worker's entire household organises itself, (Rosa et al., 1996) very few studies have directly examined the impact of shift work on the partners of shift workers (Loudoun, 2007; Newey & Hood, 2004). This paucity is significant as partners consistently report that diminished family and social lives are among the most negative aspects of shift work. Furthermore, research has linked the quality of family life rated by the non-shift working partner to the shift workers' physical, psychological and behavioural adjustment to shift work (Loudoun, 2007; Loudoun & Bohle, 1997; Lushington et al., 1997). Although this research hasn't examined sleep disturbance directly it seems likely that the research will extend to this health-related variable.

In summary, research has indicated that low control at work for shift workers is characterized by risks to health and well-being. Research also shows that older workers have more difficulty tolerating shift work than younger workers and partner support is critical for promoting adaption to shift work. Important progress has also been made in understanding the importance of policies designed to assist shift workers in general to meet competing demands between their work and other spheres of life and on a range of individual coping strategies that may alleviate interference for shift workers. Whether these facilitate work-life boundaries for older workers and male shift workers in higher-risk exposure industries such as mining is not known. Indeed, there exists little knowledge of either the extent of work-life interference experienced by male workers, or the dimensions of work itself that impact on this.

The research described here seeks to add to this existing research by comparing younger and older shift workers on their perceived control over the duration and intensity of their shift hours, perceptions of partners about the shift worker's job and contribution to the household and sleep disturbance. The main hypothesis investigated in the paper is that older workers require more control over their shift scheduling and latitude over their work to minimize sleep disturbances, compared with their younger counterparts. An additional sub hypothesis is that the more dissatisfied partners are with their shiftworking spouse's job and contribution to the household the more likely the shiftworker will report sleep disturbances.

Materials and Methods

Participants were drawn from a sample of 2640 male (96.3%) and female (3.1%) respondents participating in wave one of a study of mine and energy workers from five states in Australia. Some 1829 of these had partners who also completed a survey. Surveys were originally sent by mail after obtaining home addresses for members of the dominant union of coal miners in

Australia, the Construction, Forestry, Mining and Energy Union's (CFMEU) Mining and Energy Division. Where member telephone numbers were available, members were contacted prior to despatch of the survey packets to obtain verbal consent and check address details. Surveys were mailed to 9304 members in 5 states in Australia with 2640 responding, a gross response rate of 28.4 %. This figure is likely to under-represent the response rate as contact lists in some districts contained out-of-date information. Data were collected on demographic and shift characteristics, including control of day-to-day aspects of shift work (Allan et al., 2007) and sleep disturbance. The experimental protocol of the study conforms with the Helsinki Declaration of Human Studies and the ethical standards of the journal (Portaluppi et al., 2010).

Analysis has been undertaken using ordinary least squares regression. The sample has been restricted to shift workers, that is respondents who were either nightworkers or people who were employed on at least two different shifts, and for whom a matching partner questionnaire was available. Listwise deletion of observations with missing data for any variables reduced the number of observations in the main regressions to 556 (when certain partner variables were included) or 1319 (when those variables were excluded). Descriptives of the key variables used in regressions are in Table 1. Post hoc analysis showing no significant difference in education or other key variables between the subset and the cohort as a whole and, as will be seen later, the smaller final sample gave similar results to the larger one that excluded certain partner variables. Participants reported mean working hours of 46.1, mean age of 46.8 and an average shift length of 11.3 hours. All performed shift work that included either nights (95%) or multiple shifts (92%), usually both (87%), while 18% were Fly-in Fly-out/Drive-in Drive-out [FIFO/DIDO] workers (meaning they flew or drove to the workplace and slept onsite). Of the final sample, 36% were aged 50 years or above. Almost all (98%) had completed high school with some additional training. The cohort was well established within the industry, with the modal time spent in mining being 20 years or more.

Key measures

Sleep disturbance: Four questions and associated sub-questions extracted from the Standard Shiftwork Index (SSI) (Barton et al., 1995) were used to provide an overall sleep disturbance score. Whereas typically sleep disturbance scores are obtained by summing scores, in this case an *average* of responses were used, to account for missing data from respondents who did not experience particular variants of shift (e.g. night-only workers). This was because the blend of rotating shift workers and fixed shift workers (atypical of SSI respondents) meant that some questions were not relevant for all participants. The overall sleep disturbance scale used in this analysis represented the degree of disturbance *only* in the realms salient to the worker's shift profile.

Insert Table 1 about here

Worker control variables

Respondents were asked about nine aspects of control over their work, including questions extracted from Allan et al. (2007) and from the SSI and a single item from the Household, Income and Labour Dynamics in Australia survey (HILDA, 2011). Responses were subjected to a principal component analysis. Responses to the 9 item relating to control and say over work and work characteristics were subjected to a principal component analysis. The principal components (PCA) method was used to extract the components, and was followed by a varimax rotation with Kaiser normalization. Only the first two components displayed eigenvalues greater than 1, with

the two-factor nature of the results confirmed by a scree test. The two factors retained for rotation accounted for a total of 57.6% of total variance. Question items and their loadings are presented in Table 1, with all but one item showing a loading in excess of 0.6. Costello and Osborne (2005) suggest that five or more items loading in excess of 0.50 indicate a solid factor, although components possessing four or more variables with loadings in excess of 0.60 are widely considered also acceptable, particularly in larger data sets such as the ACES cohort offers (Guadagnoli & Velicer, 1988). The two extracted control factors were labelled 'Shift control' and 'Latitude'.

Insert Table 2 about here

Two interaction variables were created to test the interaction of age and control. The interaction variable is created by multiplying a dummy variable for age (0 = under 50 and 1 = 50 years and above) by the relevant control variable (shift control or latitude). As a result, the values of this interaction variable are: for all people under 50, zero; and for all people aged 50 or over, their score on the relevant control variable. As a result, in the final equation including the interaction term, the coefficient on the main control variable shows its effect for the under 50s, while the coefficient on the interaction term shows control's additional effect on the 50+ year olds, over and above its impact for the under 50s.

Partner satisfaction variables

Partners were asked 12 questions relating to the shift workers' jobs, including general attitude toward their spouse's shift work (e.g. satisfaction with working hours, "advantages of your partner's working hours outweigh the disadvantages"), and questions relating to mood and work-life balance (e.g. "my partner's working hours interfere with my ability to maintain connections and friendships in the community" and "my partner is often so emotionally drained when they get home from work that it prevents them from contributing to the family"). Again, the principal components method was used, with the scree test confirming a clear two-factor solution, explaining 49% of total variance. The two extracted factors related to partner dissatisfaction with their shiftworking spouses work-life balance (6 items $\alpha=0.807$) (*Ptnr dissatisfaction with shiftworker WLB*) and partner global dissatisfaction with spouse's work and working hours more generally (5 items, $\alpha=0.648$) (*Ptnr dissatisfaction with shiftworker's work*). Partners were also asked about the degree of synchronicity between their shift schedules and their mine and energy working spouses using a single item.

Other variables

Circadian type was measured through four items from the Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976), while five dimensions of personality were measured by the Mini-IPIP scales (Donnellan, Oswald, Baird, & Lucas, 2006), broken into subscales extraversion, agreeableness, conscientiousness, neuroticism and intellectualism. Dichotomous variables of shift work (11 hours or greater versus shorter shifts) and age (split at age 50) were created, and total working hours per week were included in the regressions. Additionally respondents were asked about their shift characteristics including whether they were employed on Fly-in Fly-out/Drive-in Drive-out [FIFO/DIDO] arrangements (meaning they flew or drove to the workplace and slept onsite - called *sleep location*), rotating or fixed roster (called *roster variability*), length of time on roster, and hours per week worked.

All non-dichotomous explanatory variables were standardized (this was not done with dichotomous variables, to allow analysis of interactions), and cases with missing data were eliminated on a listwise basis.

Results

Correlations between major variables are shown in Table 3. Regression analysis below found that the majority of variables that had significant correlation coefficients remained significant in regressions, so our discussion mostly focuses on those regressions.

Insert Table 3 about here

Results of the sequential regression analyses, used to examine impact on shift worker sleep disturbance, are shown as the equations in Table 4. The equations are arranged in three pairs. Within each pair, there is an (odd-numbered) equation that includes all variables (with a smaller N), and a corresponding (even numbered) equation that excludes three partner-related variables (with consequently a larger N). As can be seen, those variables that are significant in one equation generally remain significant in the other equation; hence, the discussion below focuses on the equations with the larger number of variables. Each pair tests one or both of the two identified factors of control: equations 1 and 2 test shift control, equations 3 and 4 test latitude, and equations 5 and 6 test both. In each case, interaction variables are shown alongside the simple control variables.

It is worth noting here that, while simple correlations showed negative, significant, relationships between both simple control variables and the key dependent variable (sleep disturbance), the pattern became more complicated once the interaction terms were introduced.

Shift control equations. Equation (1) shows the final form of a model predicting sleep deprivation with variables that included shift control. Several intermediate steps occurred. In the first step, shift worker gender, age, morningness and personality was added, with this model proving significant ($F_{(8,562)}=13.99$, $p<.001$, $r^2=.17$), with increases in neuroticism, and age associated with increased sleep disturbance. In the second step partner variables were added, including misalignment between the shift worker/partner's working hours and the two factors associated with partner dissatisfaction with shift worker's work. These variables significantly increased model fit, $F_{(3,554)}=23.04$, $p<.001$, $\Delta r^2=.09$, with all three variables positively associated with sleep disturbance. The resulting model r^2 was significantly greater than zero, $F_{(11,562)}=17.67$, $p<.001$, $r^2=.27$. Partner dissatisfaction may also indicate within-household disputes which, other things being equal, may exacerbate sleep disturbance. Partner dissatisfaction variables were examined separately to see what happened when the were taken out, in case reverse causality were confounding results. However, doing so made limited difference to the final stage outcomes. Given the theoretical potential for intra-household disputation to affect sleep disturbance, and prior evidence that this is indeed the case in the wider health arena (Loudoun, 2007), these variables were left in the equations.

At the third stage, the shift workers' work variables were added, but did not significantly improve the model fit, $F_{(5,551)}=1.64$, $p=.147$, $\Delta r^2=.01$, though length of time on roster was positively and significantly related to sleep disturbance. The resulting model r^2 was still significantly greater than zero, $F_{(16,562)}=12.73$, $p<.001$, $r^2=.27$. Next, shift control was added, but it was not quite significant and did not improve model fit. Finally, the interaction variable between age and shift control was added, significantly increasing the model fit, $F_{(1,545)}=6.676$, $p<.001$, $sr^2=.01$, with the

interaction term negatively and significantly predicting sleep disturbance. Age in turn became non-significant (that is, workers aged over 50 had greater sleep disturbance because of lack of shift control, with which there was a significant positive correlation). The resulting model r^2 was significantly greater than zero, $F_{(18, 562)} = 11.983$, $p < .001$, $r^2 = .284$. Adjusted r^2 for the model was .260.

Thus for respondents aged under 50, the impact of shift control was non-significant, but for respondents aged 50 and over, there is a significant positive impact of shift control upon sleep disturbance over and above that arising for the under 50s. For 'younger' workers, shift control had no independent impact on sleep disturbance once other variables in the equation were held constant, but for older workers higher shift control led to significantly lower sleep disturbance.

This pattern is confirmed in equation (5), which shows the final form of the equation, which included both shift control and latitude as well as interaction terms for both, reinforcing the negative impact of shift control on sleep disturbance for older workers.

To re-examine the effect, the dataset was split into two subsets: respondents aged under 50 years, and those aged 50 or more. This has the disadvantage of reducing the N and so increasing standard error of estimates, but offers the possibility of confirmation. Final regression equations (not shown) were run with the same explanatory variables as equation (1) in both subsets. In the younger subset, shift control was not significant; in the subset comprising workers aged 50 and over, shift control was a significant, negative influence on sleep disturbance.

Insert Table 4 about here

Latitude equations.

The variables were entered in the same order in equation (2) as with the previous model in equation (1). Again, age was significant when added in the first step but this time it remained significant through all steps of equation (2). Shift asynchronicity and the partner dissatisfaction variables were again significant. Shift location was only weakly significant (at the 10% level) when added and remained so throughout: FIFO/DIDO workers were, if anything, subject to less sleep disturbance than locally-based workers, again perhaps reflecting selection effects as well as the reduced opportunity for 'family' to disrupt sleep when sleeping at the worksite. Further research is needed on this topic as there are also likely to be selection effects relating to FIFO/DIDO workers in particular.

At the fourth step, latitude was added, and this significantly improved model fit, $F_{(1,544)}=8.80$, $p=.003$, $\Delta r^2 = .012$. Latitude was a negative and significant influence on sleep disturbance. The resulting model R^2 was significantly greater than zero ($F_{(17,560)}=12.674$, $p<.001$, $r^2 = .284$). Addition of the interaction term at the fifth stage, however, did not improve model fit, and the interaction term was non-significant with a positive sign. Adjusted r^2 was .261.

Thus the effect of latitude was significant for all but there was no significant difference between the impact on younger workers and the impact on older workers. Again, the pattern was confirmed in equation (5), which showed a significant main variable and no significance on the interaction term.

Again the dataset was split into two subsets: respondents aged under 50 years, and those aged 50 or more, and re-ran the equation (2) regressions in each. This time the outcome was ambiguous. In the younger subset, latitude was a significant and negative influence on sleep disturbance; in the subset comprising workers aged 50 and over, latitude had a negative sign but was non-significant. While overall it is possible to conclude statistically that, for all ages, latitude reduced

sleep disturbance, as it did for under 50-year olds, it isn't as clear that it reduces sleep disturbance for the 50 and above age group. What is clear is that, for younger workers, latitude is more important than shift control in reducing sleep disturbance, for older groups shift control is more important than latitude in reducing sleep disturbance.

Discussion

This study is among the most in-depth investigations of sleep disturbances amongst older shift workers in mining. The hypothesis, based on previous research, was that older workers would require more control over their shift scheduling and latitude over their work tasks to minimize sleep disturbances, compared with their younger counterparts. Deliberate attempts were made to include partners' views in this investigation with the hypothesis that the more synchronicity between shift worker and partner schedules and the more favorable partner views of the shift workers' work-life balance and employment in general, the fewer sleep problems reported by the shift worker. Results were partially supportive of the hypothesized relationships. There were significant differences in regard to the need for control over shift scheduling by older and younger workers. Partner perceptions of the shift workers' work-life balance and employment in general and alignment between partner and shift workers' schedules also predicted sleep problems amongst shift workers.

The results show that while control over shift scheduling is not associated with sleep disturbances for younger workers, for older workers aged 50 or more, low shift control results in more disturbances. However, contrary to our expectations, there is no convincing evidence that older workers have greater need than younger workers for latitude over work tasks, if the objective is to minimize sleep disturbance. This variable was negatively associated with sleep disturbances for all workers irrespective of age. Older workers do report more sleep problems than their younger counterparts but this is no more influenced by latitude over work tasks than is the case for younger workers. In combination these findings suggest that for younger workers, decision latitude over work tasks is more important for minimizing sleep disturbances than control over shift scheduling; whereas for older workers, control over both aspects of shift work may be important but shift scheduling is clearly the more critical of the two.

The findings contrast with previous research emphasizing the importance of control over work for all workers irrespective of age (Pisarski et al., 2001; 2008). Further research is needed to determine why the pattern regarding the impact of the control of shift variables 'flips' in middle age. One possible explanation is that previous studies have tended to use a single measure of control, which fails to differentiate between control over the timing of shifts and the latitude regarding the conduct of work once on shift, thus folding two effects into one. The work/job-level variables examined here provide a more nuanced analysis of control with distinctions made between scheduling and latitude in work tasks. The impact of these facets of employment on work-life has been hitherto neglected in research addressing older workers and in research on the impact of mining operations on workers and their families (Shandro et al., 2011).

One might speculate that having control over the structural components of shift roster is less important to younger workers in mining than older workers because for younger workers conflict with shifts is more determined by social constraints such as family and sporting commitments than physiological factors. As mining can take workers away from their home, especially but not only for those employed in FIFO/DIDO arrangements, the timing of the actual shifts may not be as relevant once workers are on site. For older workers, however, research suggests that these workers are less likely to tolerate shift work than younger workers, owing to rigid shift systems that fail to accommodate the individual flexibility required to meet their marked individual differences in interrelated physiological, psychological, and social disruptions (Bohle et al.,

2008). For these workers the timing of actual shifts is still very relevant once they are on site; it does not seem to help, as it might for younger workers, to be working in mining operations or towns where working shift work is more common and social rhythms less wedded to standard 9-5 employment (Monk & Buysse, 2014).

The finding that latitude over tasks on shift appears important of all workers irrespective of age, but is most unambiguous for workers aged under 50, supports this view. The issues embodied in this latitude index are less physiologically based and potentially more relevant to workers of all ages. The personal need that drives the desire to vary a start or finish time might differ across the age spectrum (for example attending a child's school concert as opposed to a doctor's appointment), but the end request is the same.

The makeup of the sample used in this study may also be relevant when considering differences between the findings here and previous research. This study examined responses only from current union members employed in the mining and energy industry. Very few studies have examined the impact of organizational level variables on workers in mining (Shandro et al., 2011). Furthermore, evidence suggests that twenty per cent of all workers choose to leave shift work within a short time period due to serious maladaptation and intolerance (Costa, 2006). Labour turnover in mining is amongst the highest of any Australian industry (ABS, 2013), thus, the respondents in this study can be seen as a survival sample population exhibiting selection bias and the 'healthy worker effect'.

Findings in relation to partners largely support previous research. Although very few studies in shift work have considered the views of partners in research on the impact of shift work on sleep, stress and shift work research have considered links between social support at work and both physical and psychological health (Cooper et al., 2001; Pisarski et al., 2008). In this study support from partners was not measured directly, instead the focus was on satisfaction with their spouse's work-life balance, mainly via their contribution to the household, and with their spouse's employment in general. Although these variables do not examine partner support narrowly defined, they are interrelated. These variables were strong predictors of sleep quality, supporting previous indirect evidence suggesting that marital quality is associated with disrupted sleep (Hale, 2005). Synchronicity between shift worker and partner schedules was also examined. This result, in a shift-working sample, extends Simon's (1990) research, in a non-shift working population, that showed a range of problems associated with poor integration of partner waking and sleeping cycles. The findings here suggest that these problems extend to sleep disruption amongst shift workers.

The finding that work process variables influence sleep disruption, as does partner satisfaction with shift workers' ability to contribute to their household, should concern researchers, organizations and those involved in policy development. Most industrialized countries are increasingly utilizing shift work as a way to meet changing economic and social demands (Costa & Di Milia, 2008). Concomitantly, the general aging of the population in most of these countries means that the number of older shift workers is growing, leading to concerns of an increase of occupational health problems. As a result, finding optimal ways of organizing work for these employees is a critical issue. Shift work may be coming back into fashion at exactly a time when demographic changes make it most difficult to accommodate.

Further emphasizing the importance of optimizing shift systems in mining, the capacity of mining organizations to improve development of the social fabric and health of mining families and the local community is increasingly considered a critical determinant of the long term success of the operation (Laurence, 2011). It is also becoming increasingly important for corporate social responsibility and sustainable development (Cheshire, 2010).

One of the strengths of this study was the large size of the matched-pair dataset. At the same time, however, some caution in interpreting these results is needed. For one thing, the ambiguity of some findings, regarding the effects of latitude for older workers, suggest a need for replication studies. For another, the cross-sectional nature of the study means it cannot prove the causal direction of the identified relationship, or indeed, whether these relationships are caused by a third variable. For example it is possible, indeed likely, that a reciprocal relationship exists between shift workers' problems and partner disruption (Shandro et al., 2011). Longitudinal studies measuring variables at multiple levels of analysis and prior to outcomes (sleep disturbances) are needed to minimize common method variance concerns and to establish causality. The present results were also obtained from a relatively narrow population of shift workers and we should be cautious about the extent to which the findings can be generalized to populations other than shift workers employed in mines with strong union dominance, although similar results have been obtained from nurses (Pisarski et al., 2008).

In conclusion the study contributes to the relatively neglected research area of sleep in aging male shift workers by revealing insights into organizational level aspects of work that impact on sleep. The findings indicate that control over wider aspects of work, not just the length and time of day of working hours, have positive effects on minimizing sleep disturbances experienced by all workers and that control over the scheduling of shifts has strong positive effects for older shift workers. Overall, our findings indicate that while regulation and policy to restrict work hours are important in mitigating risks associated with shift work, work/job-level characteristics are also critical in facilitating the integration of work and non-work spheres for workers, particularly those aged over 50 years.

Declaration of Interest statement

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