The effect of time of day on injury patterns amongst adolescents in Australia

Rebecca Loudoun*, Cameron Allan¹ Department of Employment Relations, Griffith University

Corresponding author
Rebecca Loudoun
Department of Industrial Relations,
Griffith University, Nathan, Brisbane, Australia, 4111

Phone: + 61 7 3735 7743 Fax: + 61 7 3735 7177

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Labour force participation of adolescents in Australia is growing at an unprecedented rate. This increased participation is coupled with a growing realisation of the vulnerability of adolescents in the labour market in terms of occupational injury. Despite recent evidence that time of day may be an important determinant of adolescent injuries, the impact of non-standard and night work on adolescent injury rates has received scant attention to date. The current study addresses this shortcoming by examining injury patterns of 3,201 working adolescents in Queensland. Results revealed that female adolescents are 2.5 times more likely to sustain an injury on day shift and 4.71 times more likely to sustain an injury on night shift than their adult counterparts when total work hours are taken into consideration. Similar results were found for male adolescents with an injury to work hours ratio of 2.19 on day shift and 3.05 on night shift. These findings point to the value of considering the temporal pattern of adolescent work in future research aimed at minimising injuries at work and improving the work experience of

Key words: Adolescents, shiftwork, work injuries, accident and emergency data

1 Introduction

tomorrow's workforce.

Over the last decade there has been growing concern about the increased participation of adolescents in the labour market as evidence indicates that they are a group at high risk of occupational injury compared to adult workers (Dupre, 2000; Mayhew, 2004). Research investigating this higher injury rate has tended to focus on individual and organisational factors related to the type of work performed by adolescents, their position in the labour market, and aspects of their physical and psychological development. We argue that one aspect of youth

employment that deserves more attention is the impact of working hours on injuries. Support for this argument is drawn from research on the general health effects of shiftwork and from research suggesting that shiftworkers are more likely to be injured during the night shift. Research has not directly examined adolescents and it is not known whether adolescents are more at risk during night work than their adult counterparts. This paper attempts to bring these separate areas of research together by comparing injury patterns of adolescents who work during traditional daylight hours with those who work during the night and with adults on day and night shifts.

1.1 Adolescent employment in Australia

A growing proportion of young people are working in Australia. In the last three decades labour force participation rates for teenagers have increased by nearly 10 percentage points to 61 percent in 2006. The participation rates for males and females have become almost equal (ABS 2006a). Teenage employment is almost entirely in the part-time and casual labour force where the percentage of teenagers with casual job has doubled since 1984 (Campbell and Burgess, 2001; Burgess and Campbell, 1998).

This increased youth labour force participation has been matched by a growing realisation of the vulnerability of teenagers in the labour market. There is mounting evidence that children and young people are an especially high-risk group in terms of occupational injury and disease (ABS, 2006b). For example in Australia, adolescents have higher injury/illness rates than all other workers: 78 injuries per 1000 people (increasing to 91 injuries per 1000 people for teenage males) compared with 64 injuries per 1000 people in the general working population (ABS, 2006b). Further illustrating this vulnerability, a recent large scale study of young people in New South Wales found that over 40 percent of employed 16 year olds had sustained an

injury at work of which 7 percent were serious enough to need hospitalisation, medical treatment or 3 days or more off school or work (NSW Commission of Children and Young People, 2005).

Numerous methods have been used to assess the magnitude, severity and factors affecting the risk of adolescent occupational injuries in Australia, including surveys (NSW Commission for Children and Young People, 2005; Jobwatch, 2002; Mayhew and Quinlan, 2002), interviews (National Occupational Health and Safety Commission, 2000), workers compensation data (Boufous and Williamson, 2003) and hospital inpatient statistics (Boufous and Williamson, 2003). Although the rates and risk estimates from these studies have varied widely, there is a general consistency between the findings that adolescents face adverse working conditions resulting in a higher incidence of injury compared with adults. These findings are consistent with most of the international literature with some evidence indicating that adolescents are at the highest risk of lost time injuries compared to all other workers (Dupre, 2000).

One aspect of youth employment that has received scant attention to date is the impact of working hours and particularly shiftwork on injury rates. Despite the increased significance of non-standard work schedules in Australia, relatively little attention has been paid by both academics and practitioners to understand the effects of such schedules on injuries sustained by adolescents at work. This paucity is significant as recent evidence suggests that time of day may be an important determinant of adolescent injuries (Howitz and McCall, 2005) with those who perform evening and night work being particularly at risk (Dunn et al., 1998).

1.1.1 Working hours of teenagers in Australia

Traditional work schedules involving work during daylight hours are still the dominant work pattern in Australia. Changes in regulations governing working time and trading hours in

Australia, however have led to changes in the structure of the labour market and the industrial landscape more generally over the last few decades which have resulted in a significant and growing proportion of the workforce being employed on non-standard work patterns (ABS, 2006c).

This relaxation of working hours regulation and penalty rates has given rise to many workplaces changing to shift schedules that have long since raised concerns amongst individuals, families and researchers (Healy, 2000). Australia now has the longest working hours in the world with shiftwork being used by a wider cross section of workers (Campbell, 2002). This is particularly the case when considering adolescents because most teenagers in Australia are employed in 'poor quality' service sector employment where temporal patterns of demand mean that evening and night work are common (Wooden and VanDenHeavel, 1999). Teenagers are now more likely to be shiftworkers than any other age group in Australia (ABS, 2006c).

At the same time, however, it is widely accepted that shiftworkers, in general, and nightworkers, in particular, suffer acutely and chronically impaired health and well-being (Akerstedt and Knutsson, 1986; Costa, 1998; Harrington, 1994). There a general consensus in the literature that the negative effects of shiftwork stem from altered sleep-wake schedules and disruption to internal timing mechanisms which are designed to rest at night and to have an active period during the day (Costa, 1998). In essence, shiftworkers are required to work and sleep at times that conflict with normal societal and biological patterns. Disruption to internal timing mechanisms may be particularly problematic for teenagers because of their accelerated growth during puberty. Associated with this growth adolescents have advanced circadian sleep-wake rhythms and a higher need for sleep (Dahl, 1999; Wolfson and Carskadon, 1998).

The impact of working hours in teenage injury rates has been raised in the research literature but not examined in detail. For example in a telephone survey of 14-17 year olds in North Carolina, Dunn et al., (1998) found evidence suggesting that working at night poses a significant risk for injury. Their findings are supported by Horwitz and McCall (2005) using workers compensation claims. However it is unclear whether these findings are generalisable to teenagers in Australia as most of the reported injuries were related to occupational violence amongst females. These findings also need further investigation using alternative sources of data as workers' compensation data do not reflect injuries occurring among adolescents performing illegal work or informal working arrangements such as baby-sitting, lawn mowing, and work for family friends or the family business. Furthermore, evidence suggests that adolescents have less knowledge than full time workers of their legal entitlements to workers compensation and less likely to make a claim when injured (Quinlan and Mayhew, 1999). Comparison is also needed with injuries reported by adult night and evening workers before conclusions can be drawn about the importance of shiftwork as an explanation for the increased risk of teenage occupational injury compared to adult workers.

In an effort to gain a more critical picture of the impact of shiftwork on adolescents, this paper presents results from a study examining the reported incidence and severity of work-related injuries among a large sample of working adults and youths from industries throughout Queensland, Australia. Based on previous research the primary study hypothesis is that working at night increases the risk of suffering occupational injuries when compared with working conventional day shifts for all workers but adolescents are disproportionately at risk. By examining severity of injury we were able to test the possibility that youths have more injuries at night than their adult and day working counterparts, but these injuries are less severe

and thus their injuries are of less concern. This approach provides a fuller picture of adolescent injuries by time of day. The next section provides a brief introduction to the study before examining the findings in detail.

2 Method

2.1 Study population and data sources

The study draws on emergency data from the Queensland Injury Surveillance Unit (QISU) and published and unpublished data from the Australian Bureau of Statistics (ABS). The study population for the study was youths and adults working in Australia. For the purpose of this study, youth was defined as ages up to 19 years (inclusive).

For the QISU data, triage nurses collected information from patients presenting at 17 remote, provisional and metropolitan Queensland hospital Emergency Departments. These departments cover a quarter of the Queensland population with approximately 80 percent ascertainment. Between 1999 and 2006, QISU recorded 29, 479 injuries presenting at hospital emergency departments where the stated activity when injured was working for income; 3,201 of these injuries were from workers aged 19 years and under.

The QISU data was collected by triage nurses for all persons presenting for treatment in the emergency department in selected hospitals. For each patient, the triage nurse collected demographic information on age, gender and industry of injury (classified according to the Australian Classification of Industries). Information was also recorded about the type of activity that patients were engaged in when they sustained an injury, including leisure activities, vital activities (such as eating and drinking), house work, educational activity, sport, childcare and paid work. Our dataset includes only those persons who were injured

undertaking paid work - which includes both employees and the self-employed. The triage nurse also recorded the degree of injury severity into five categories: resuscitation, emergency, urgent, semi-urgent or non-urgent. As detailed below, we use these categories to create an interval scale from one to five of injury severity. Information was recorded by the triage nurse on the time and date the injury occurred. We classified injuries as occurring either during the day shift or the night shift. To be consistent with ABS conventions, the day shift encompassed the period 6 a.m. to 5 p.m. and midnight shift from 5 p.m. through till 6 a.m..

The QISU data were supplemented by unpublished data from the ABS on working time arrangements. Data were collected throughout Australia in November 2003 as a supplement to the ABS monthly Labour Force Survey (LFS). These data were used to control for the possible influence of uneven work patterns across the day, and across different age groups, on the frequency of work-related injuries. Data from 2003 were chosen because this year represents a reasonable mid-way point between 1999 and 2006 when the QISU injury data were collected. The ABS data provided information on: the number of workers who performed shiftwork; the type of shiftwork; and, the number of hours spent at work in the week the data were collected. In total 7,941,600 employees aged 15 years and over in November 2003 completed the survey.

The ABS Labour Force Survey asked respondents to indicate whether they performed any shift work at any time in the 4 weeks prior to the survey and how many hours they worked in their main job. Those who indicated that they worked shifts were asked the type of shift system they normally work. The alternative responses were: (i) rotating shifts that change periodically; (ii) regular morning shift (work between 6.00 am and 12.00 pm); (iii) regular afternoon shift (work between 12.00 pm and 5.00 pm); (iii) regular evening, night or graveyard shift (work between v between 5.00 pm and 6.00 am); or, (iv) other (split shift, on-call, irregular and

other). Some of these shift hours fall outside conventional definitions used in shiftwork research, so workers were divided into day (respondent doesn't work shiftwork or works regular morning, afternoon or other shifts) and night work (regular, evening, night and graveyard shifts). Workers who indicated that they worked rotating shifts that changed periodically were divided randomly between day and night work for the purposes of the analyses. If an employee started a shift in one time period, but finished in another, the shift was recorded according to which time period the respondent worked the majority of their hours. Published data from the ABS were also used for the study to evaluate the representativeness of the injury data and thus the appropriateness of supplementing our sample data with national data. We did this by comparing industry and demographic characteristics of the hospitals districts in our study with characteristics of the nation as a whole. Data for these comparisons was sourced from the 2001 national census (ABS, 2001), which provides data for Australia as a whole and for individual regions defined by electoral districts. We combined the electoral districts in the catchment areas of the hospitals in the study into one region and compared the distribution of persons in this region with Australia by gender, age and industry. These data are shown in Table 1 and discussed in the results section.

2.2 Statistical analyses

To examine relationships between injury frequency, age and work hours data were firstly plotted on a graph (see Figure 1) to give a visual representation of injuries by time of day. Following this, crude occupational injury ratios were calculated. Injury ratios for work-related injuries among youth and adult workers performing night work were compared with those performing conventional day schedules. Two injury ratios were calculated (see Table 2). First,

the total number of employees at work during the day and night (taken from the unpublished ABS data) was expressed as a percentage and divided by the percentage of injuries sustained during these hours. This ratio is labelled 'injuries to employees' in Table 2. Second, the number of hours spent at work during the day and night (taken from the unpublished ABS data) was expressed as a percentage and divided by the percentage of injuries sustained during these hours. This ratio is labelled 'injuries to work hours' in Table 2. The first measure provides a conventional assessment of the likelihood of injury for employees of different ages working during the day or at night. The second ratio measure is superior because many employees do not work full-time, particularly safer you. The work hours to injury ratio measure provides more realistic gauge of the likelihood of injury for men and women at different times of the day. Data were examined separately for males and females where appropriate because previous research has found occupational sex segregation amongst youth, with gender differences in hazard exposure, type of work and employer expectations (Dunn et al., 1998; Loughlin and Frone, 2004).

Multivariate analyses were employed where possible to control for the influence of gender and industry. It was not possible to use these analyses for frequency of injury but it was possible for severity of injury as this variable was scored on a five-point scale devised from the patient's triage category. When a patient presented at the accident and emergency department, the triage nurse classified the injury into one of five categories: resuscitation, emergency, urgent, semi urgent or non urgent. By attaching a score to these categories – (resuscitating equals five, emergency equals four urgent equals three, semi urgent equals two and non urgent equals 1) we constructed an interval index of injury acuity or severity.

3 Results

The distribution of persons in the study region and Australia by gender, age and industry are summarised in Table 1. As can be seen, the characteristics of individuals working in our study region were very similar to the characteristics of the Australian population in terms of the industry composition of employment and gender and age structure. The table illustrates that there are no major differences between our study region and the Australian population that could potentially influence the spread of employment and working hours in our sample data. Thus we argue that it is appropriate to combine the national data with our sample data to create injury ratios.

INSERT TABLE 1 ABOUT HERE

3.1 Injury frequency

An indication of the pattern of injury over the day can be seen in Figure 1, which was derived by looking at each age group and gender separately and plotting the proportion of day and night workers against the proportion of injuries sustained during the day and night by each group. These data were taken from unpublished ABS data. The shaded lines represent the percentage of workers performing work during the day and night by age group (under/over 19) and gender. The non-shaded lines represent the percentage of injuries sustained during day and night groups by age and gender.

For youths and adults, the highest incidence of injury occurred during the day which corresponds with the higher percentage of time spent at work accounted for by day shift.

However, female nightworkers under 19, compared to adults and male workers under 19, tend to have a higher portion of incidences during the night shift. Night work accounts for 42 percent of all injuries to female workers under 19 yet less than 4 percent of women in this age group work these shifts.

INSERT FIGURE 1 ABOUT HERE

Although Figure 1 provides a good visual representation of injuries by age and gender across the day, it doesn't take into account the number of hours spent at work (and thus the number of hours exposed to workplace hazards) and the proportion of day and nightworkers represented by different age groups. This information is illustrated in Table 2.

Column 2 shows the proportion of injuries sustained by different groups on day and night shift; column 3 shows the proportion of day and nightworkers in different age groups. Looking at these two columns together, they indicate that male and female youths have an increased risk of injury on the night shift. Youths account for 4 percent of all male nightworkers yet they are responsible for 10 percent of injuries presented on these shifts. Similarly females account for 5 percent of female nightworkers but 17 percent of injuries to females on these shifts. So, whereas the percentage of injuries sustained on night shift is less for workers aged over 19 years the pattern is reversed for workers under 19.

Column 4 of Table 2 reports percentage of injuries divided by percentage of employees at work at different times of the day. This calculation is expressed as a ratio of injuries to employees with the highest ratio of 3.73 being for teenage females on night shift; more than

four times the rate of their adult counterparts. The ratio is fairly consistent for male and female workers aged over 19 years at about 0.94.

The fifth column of the table report the total hours worked by employees on day and night work. These hours are expressed as a percentage of total hours by gender and age. As can be seen, there is a similar gendered pattern for hours worked to that of percentage of employees. Although female youth represent 17 percent of all injuries to females on night work they are responsible for only 4 percent of the actual hours worked on these shifts. Male youths account for 3 percent of hours worked males on night shift but 10 percent of the injuries. This results in an injury to hours ratio of 4.71 for female youth, which is over 5 times higher than their adult counterparts. The trend for male youths is similar although less extreme with a ratio of 3.05, which is more than 3 times higher than that of their adult counterparts.

INSERT TABLE 2 ABOUT HERE

3.2 Severity of Injury

To examine the relationship between severity of injury, age and work hours, analysis of covariance (ANCOVA) was used. Prior to the analysis, data were examined for missing data and violations of the assumptions of ANCOVA, including homogeneity of slopes. Any cases that presented missing data for the variables of interest were deleted, leaving 26,970 cases for analysis.

In the ANCOVA age and work hours (day, night work) were entered as factors and industry and gender as covariates. The results of these analyses are presented in Table 3. The results

indicated that work hours were related to severity of injury with workers presenting with more severe injuries on the day shift. There was also a significant relationship between industry and severity of injury. Age was not related to severity of injury and there was no significant interaction between age and work hours.

INSERT TABLE 3 ABOUT HERE

4 Discussion

This study provides a detailed picture of injuries sustained at work by adolescents in Queensland by time of day. Overall the results add to existing evidence that adolescent workers are at high risk of work related injury (Castillo, 1999, Boufous and Williamson, 2003, Mayhew, 2005). Our study found that adolescents are more likely to sustain injuries than adults, particularly so when injury susceptibility is calculated based on hours worked rather than employment.

Previous research suggests that part of the explanation as to why adolescents are more susceptible to injury is likely to be their incomplete physical development, which makes them especially susceptible to musculoskeletal disorders associated with weight-bearing activity (Castillo, 1999). Further, immature psychological development in adolescence makes them susceptible to injury due to their poor risk assessment, vulnerability to peer or work pressure and sensation seeking (Castillo, 1999). Additionally, adolescents have less work experience and are commonly not fully trained for the job, especially they are in temporary and part-time employment (Mayhew, 2004).

However, this study extends previous research by showing that work hours should also be considered when looking at determinants of adolescent work injuries. Our findings indicate that youth are between 3 and 5 more likely to sustain an injury during night work than their adult counterparts. It is not possible to draw conclusions from the data as to why adolescents are especially susceptible to injury at night. The shift work literature indicates that shiftwork generally can have negative health effects because altered sleep-wake schedules disrupt normal societal and biological patterns. The disruption of internal timing mechanisms may be particularly problematic for teenagers because of their accelerated growth during puberty, their higher need for sleep and their advanced circadian sleep-wake rhythms (Dahl, 1999; Wolfson and Carskadon, 1998). There is a need for much greater research in this area.

Unfortunately, in our study we were not able to explore the frequency of injury by shift work and industry sector because this would have made the cell sizes in some of the age categories too small to be meaningful. However, we speculate that the high frequency for injuries at night for adolescents may be due, in part, to their heavy concentration in industries, such as food retailing, cafe and restaurant work, where injuries associated with food preparation and cooking are common. Young people tend not to work in industries with very high rates of injury, such as agriculture, manufacturing, and construction (ABS 2006b) but they also are not heavily concentrated in industry sectors whether a very low rates of OHS injury. More research is needed to identify the effects on injuries of the industry composition of youth employment.

Further, we also speculate that young people might be particularly at risk of injury at night because many youth are effectively working a 'double shift' comprised of schooling and other social activities during the day plus paid work at night. Many young people have multiple commitments in terms of schooling and homework, household chores, sports

commitments, creative arts instruction and so on as well as paid work commitments. Undertaking work at night after a long day of busy activities may place young people at attenuated risk of injury. This is likely to be particularly so when we consider the developmental characteristics which make young workers susceptible to risk of injury at night. Much work needs to be undertaken to more fully elucidate the special risk factors of night work for young people.

One of the strengths of this study was the large size of the data set. As our comparison with census data revealed, such large-scale hospital-based datasets can provide a representative sample of the national population and thereby giving researchers greater surety in the conclusions about the OHS risks of different categories of workers. An additional advantage of hospital emergency data is that it records self-employment and minor injuries which are not captured in Workers Compensation data bases (Boufous and Williamson, 2003). Large-scale emergency databases are useful because Workers Compensation databases under-report typical forms of youth employment such as temporary and casual work. Casual or temporary workers commonly tend not to report OHS injuries due to lack of knowledge, minimal bargaining power, inadequate training or fear of employment loss or managerial reprisals.

At the same time, however, we need to exercise some caution in interpreting these results because emergency data is unlikely to capture the full range of work-related injuries to teens (and adults). For example emergency departments are unlikely to capture diseases caused by exposure to hazardous substances, especially those with long latency periods. Emergency department will also not capture occupational diseases of persons who are treated by private medical practitioners and specialists who admit patients directly to hospitals rather than through the emergency department. Nevertheless, ABS statistics coupled with accident and

emergency data does provide a solid platform for this future research using a large scale, representative data set. Ideally future research should use couple emergency data with a comparison group so that multivariate analyses can be performed. It would also be worthwhile to couple the data with workers compensation data and other national injury data to allow a fuller picture of occupational injuries requiring a wider range of medical intervention to emerge.

In Australia at least, the growing recognition of the vulnerability of young people at work has resulted in revised employment laws for young people in all mainland States in Australia in recent years. In some states these new laws restricting hours young people can work and place special obligations on employers to provide adequate supervision and training to young people (Mourell and Allan, 2006). Such restrictions are vitally important because adolescents have a full schedule of learning and social activities during the day before taking on extra hours of work at night (and on weekends). Both governments and employers need to be aware of the special risks of employing young people, so that the future generation of worker can be rightfully protected during their developmental years.

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