Fatigue and Mental Health in Ambulance Paramedic Shiftworkers

Submitted by
James Andrew Courtney
Bachelor of Applied Science (Psychology) Honours
Graduate Diploma in Behavioural Science
Diploma of Applied Science in Medical Radiography

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Clinical Psychology

School of Psychological Science
Faculty of Science Technology and Engineering
La Trobe University
Bundoora, Victoria 3086
Australia

October 2010
Table of Contents

Appendices ........................................................................................................ vi
List of figures .......................................................................................................... vii
List of Tables .......................................................................................................... vii
Abstract ............................................................................................................... x
Statement of Authorship ......................................................................................... xii
Acknowledgments .................................................................................................. xiii
Manuscripts Arising from this Research ............................................................... xv

Chapter 1: Introduction ......................................................................................... 1
Format of Chapter 1 ............................................................................................... 2
Shiftwork in the population ................................................................................... 3
Healthcare services and shiftwork ......................................................................... 3
Ambulance paramedics as shiftworkers ............................................................... 4
Circadian disruption from shiftwork ..................................................................... 4
Outcomes of circadian disruption ......................................................................... 6
Sleep loss and fatigue ............................................................................................. 7
Investigations of ambulance personnel ................................................................ 8
Deficiencies in current knowledge ......................................................................... 9
Shiftwork and mental health .................................................................................. 10
Depression and anxiety ......................................................................................... 10
  Studies of ambulance personnel ....................................................................... 12
Workplace stress .................................................................................................... 12
  Past empirical outcomes ................................................................................... 13
  Nationwide studies ............................................................................................ 14
Potential mechanisms from stress to ill health .................................................. 16
Glucocorticoid release .......................................................................................... 16
Co morbidities and interrelationships .................................................................. 17
Longer-term physical health disorders associated with shiftwork ..................... 18
Adverse cardiac outcomes .................................................................................... 18
  Potential pathways ............................................................................................ 19
  Limitations and conclusions ............................................................................. 19
Gastrointestinal disease ......................................................................................... 20
  Contemporary opinion ...................................................................................... 21
Final synthesis of evidence ................................................................................. 22
Individual differences and shiftwork tolerance ................................................ 22
The impact of work hours ..................................................................................... 23
### Chapter 3: Caring for the Country: Fatigue, Sleep and Mental Health in Australian Rural Paramedic Shiftworkers

- Abstract .................................................................................................................. 1
- Method ...................................................................................................................... 2
- Participants .............................................................................................................. 9
- Materials .................................................................................................................. 10
- Procedure ............................................................................................................... 13
- Results ..................................................................................................................... 14
- Discussion ............................................................................................................... 17
- References .............................................................................................................. 25

### Chapter 4: A Path Model of Health Outcomes in Ambulance Paramedic Shiftworkers: Testing the role of Individual Circadian Differences and Mental Health

- Abstract .................................................................................................................. 1
- Morningness – eveningness chronotype .................................................................. 5
- Rhythm stability and amplitude ............................................................................ 6
- The influence of age and gender ........................................................................... 7
- Models of shiftwork .............................................................................................. 8
- Method ..................................................................................................................... 10
- Participants .............................................................................................................. 10
- Materials ................................................................................................................ 11
- Predictors ............................................................................................................... 11
- Mediators .............................................................................................................. 12
- Outcomes ............................................................................................................. 13
- Analyses ................................................................................................................. 14
- Procedure ............................................................................................................... 15
- Results ..................................................................................................................... 16
- Discussion ............................................................................................................... 17
- References .............................................................................................................. 24

### Addendum to Manuscripts: Data Screening Procedures

- Identification of outliers ......................................................................................... 1
- Missing data ........................................................................................................... 1
- Examination of normality ..................................................................................... 4

### Chapter 5: General Discussion

- Summary of research rationale ............................................................................. 2
- Expanded detail of study samples ......................................................................... 3
- Urban-rural job role differences ............................................................................ 4
Appendices

Appendix A

Standard Shiftwork Index (SSI) ................................................................. 2

Appendix B

Project Information Statement ............................................................... 19

Appendix C

Letter to Team Manager ...................................................................... 23

Appendix D

Ethics Approvals

1. RMIT University .............................................................................. 25
2. La Trobe University ......................................................................... 26
3. Rural Ambulance Victoria Medical Standards Committee ............ 27

Appendix E

Typeset version of Study 1 ................................................................. 28
List of figures

Chapter 4

*Figure 1.* Basic structure of the proposed path model, ordered temporally from left to right. Dotted lines indicate predicted mediating pathways .......... 35

*Figure 2.* Path model showing individual path coefficients and $R^2$ values for each variable ................................................................. 36
List of Tables

Chapter 2

Table 1. Mean Scores for Chronic Fatigue in the Paramedic Sample and Data Obtained From Other Shiftwork Studies ........................................ 30

Table 2. Mean Scores for Depression, Anxiety and Stress in the Paramedic Sample, and Normative Data from Non-clinical Studies ..................... 31

Table 3. Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity among Paramedics in the Present Study ...... 32

Table 4. Mean Global Score obtained on the PSQI in the Present Study, and Published Studies of Non-clinical Norms ................................. 33

Table 5. Inter-correlations Between Scores Obtained on the IPAQ, DASS, and PSQI in the Paramedic Sample ................................................. 34

Chapter 3

Table 1. Mean Global Score obtained on the PSQI for Rural and Metropolitan Paramedics, and Selected Reference Samples .................................. 31

Table 2. Mean Scores for Chronic Fatigue in the Two Paramedic Samples and Data Obtained From Non-paramedic Shiftwork Studies ............ 32

Table 3. Mean Scores for Depression, Anxiety and Stress in the Rural and Metropolitan Paramedic Samples, and Normative Data from Non-clinical Studies .......................................................... 33

Table 4. Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity among Rural Paramedics ............. 34

Table 5. Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity Among Metropolitan Paramedics ........... 35

Table 6. Correlations Between Scores Obtained on the PSQI, DASS21 and IPAQ in the Rural Paramedic Sample ............................................. 36
Chapter 4

Table 1. Age, Gender, and Marital Status of Respondents .......................... 31

Table 2. Type of Shift Structure Worked, Years on Present Roster, and Total Years of Shiftwork Service ................................................................. 32

Table 3. Mean Scores, Variability and Range for major Study Variables .......... 33

Table 4. Correlations Amongst Major Study Variables ................................. 34

Chapter 5

Table 1. Age, Gender, and Marital Status of Respondents .......................... 27

Table 2. Type of Shift Structure Worked, Years on Present Roster, and Total Years of Shiftwork Service ................................................................. 28
Abstract

This thesis investigated fatigue and mental health in paramedic shiftworkers. Previous studies have observed elevated fatigue and poor health in this sector from occupational demands and shiftwork rostering. Study-1 investigated 342 paramedics from the Metropolitan Ambulance Service in Melbourne, while Study-2 investigated 150 paramedics from Rural Ambulance Victoria and examined potential rural-urban differences. The Standard Shiftwork Index was administered to prospective participants in both cohorts who worked a rotating shiftwork roster. Single sample \( t \)-tests found significantly elevated indices of mental health, higher fatigue, significantly poorer sleep quality, and less physical activity than reference samples. Depression and sleep quality explained the greatest amount of variance in fatigue scores for both groups. No differences were detected in levels of depression or fatigue on the basis of gender. Findings suggested that both rural and urban ambulance paramedics could be at particular risk of elevated fatigue and depression (regardless of age or gender) and poor quality sleep. Organisational intervention was suggested for both studies. Study 3 proposed a theoretically derived path model of shiftwork aimed at elucidating those factors most likely to predict individual circadian differences in the combined samples. Circadian type and chronotype were tested as moderator variables, and mental health variables as mediators of sleep quality, fatigue, and longer-term physical health outcomes. A good to excellent fit of the model to the data was found, with substantial variances explained. While individual differences contributed some predictive value, the path coefficients were relatively small. Morning-types were largely absent from the sample, and evening typology was correlated with adverse
health outcomes. Flexible-rigid typology was considered to confer some benefit in shiftworkers. The path model demonstrates the direct and indirect effects of mental health indices on other variables. The model also offers potential points of clinical intervention to address adverse health outcomes for these shiftworkers.
Statement of Authorship

Except where reference is made in the text of the thesis, **this thesis contains no material published elsewhere** or extracted in whole or in part from a thesis submitted for the award of any other degree or diploma.

Chapter 1 of this thesis has been published under joint authorship. I am the primary author of this publication and made the most substantial contribution to the work contained therein. The second author is Associate Professor Andrew Francis who acted as the external supervisor for this thesis. The third author is Professor Susan Paxton who was my internal La Trobe University supervisor. No other person’s work has been used without due acknowledgement in the main text of the thesis.

This thesis has not been submitted for the award of any degree or diploma in any tertiary institution.

The research undertaken in connection with this thesis was approved by the La Trobe University Human Ethics Committee (approval number FHEC07/R71); the RMIT University Human Research Ethics Committee (approval number SETNBAPP 11 – 06 COURTNEY); and the Rural Ambulance Victoria Medical Standards Committee.

James Courtney    October 2010
Acknowledgments

I would like to thank several people for indulging me with their time, patience, support and understanding over the several years involved in completing my doctoral research thesis, as well as the preceding time spent in undergraduate studies.

To Associate Professor Andrew Francis, thank you for your consistent efforts that have endured from honours through to doctoral level, and from RMIT to La Trobe University. Your always helpful and timely responses to my needs and requests have contributed immensely to achieving this endpoint, and to the publication of the research. I have enjoyed working under your guidance, the time spent in our many meetings together, and have learned much. I look forward to the potential of ongoing collaboration.

To Professor Susan Paxton, thank you for assisting and guiding this research effort as my primary supervisor at La Trobe University. In particular, your support in the collaboration with Dr. Francis as an external supervisor has created a very healthy research framework, and has allowed me to pursue this project in a focussed and efficient manner.

The support received from two organisations also proved invaluable in obtaining data for the studies contained herein. Steve McGhie (Ambulance Employees Australia, Victoria Branch) facilitated the distribution of the survey packages for Study 1 and offered general encouragement for the project. Associate Professor Tony Walker (Rural Ambulance Victoria; now Ambulance Victoria) facilitated the approval process required to collect data from rural paramedics (Study 2), and also arranged assistance for the internal distribution of surveys to rural ambulance branches.
I have also received support from the national and international academic community throughout this project. Although this support has often comprised one-off communications, I would like to thank those people who have contributed by responding to email requests for expert information, and for providing assistance with statistical procedures, especially in relation to the path modelling analyses in Study 3.

My day-to-day and year-to-year prime support for this work has come from my family. To my (gorgeous) wife Edda, thank you for your emotional, practical, and financial support, without which I could not have attained this achievement. To my (also gorgeous) daughter Cristina, and my son James (Critter), thank you for understanding that I need silence to work, lots of time, and have probably missed being with you on the many occasions when Microsoft Word has won out. To all three of you, I formally apologise here for being grumpy!

To my much younger (and again gorgeous) friends that I have gained through returning to university, thank you for helping me through the many frustrations of research by including me in your debriefs, ‘group-therapy’ sessions, discussions and dinners that have endured throughout. Your support has helped me to reach my goal.

Finally, I would like to thank those paramedics who chose to participate by completing the rather long survey document, and for disclosing their personal information. I aim to ensure that your efforts will make a significant contribution to the shiftwork literature by publishing several papers in peer reviewed scientific journals. In this way, the findings may assist others who could be experiencing poor health outcomes from the shiftwork.
Manuscripts Arising from this Research


Chapter 1: Introduction

The major aim of the research presented in this thesis is to examine adverse health outcomes associated with participation in occupational shiftwork rostering. The thesis is presented in the 'alternative' format and comprises a general introduction, three empirical research studies written for publication, and a final discussion. At the time of submission, the first paper (Chapter 2) had been published (Courtney, Francis, & Paxton, 2010), the second was under peer review, and third being was in the final stages of preparation for review. One limitation inherent to this format is some level of repetition, especially in the introductory section of each chapter or paper. Chapter 1 contains the substantive literature review providing the background for the later and more focussed introductions to the empirical papers, which are individually edited to suit the specific nature of the associated work.

While later chapters focus specifically on emergency ambulance paramedics, the literature review presented in this first chapter is not restricted to a single occupational group. Rather, a critical review encompassing topics relevant to the contemporary investigation of shiftwork is provided. Published work relating specifically to ambulance paramedics is incorporated where available and as appropriate. The following Chapters 2 and 3 represent two independent empirical studies investigating predictors of fatigue and mental health outcomes in metropolitan and rural paramedic cohorts respectively. Finally, and incorporating a new set of variables into the analysis, Chapter 4 examines the influence of individual factors on the response to shiftwork. A theoretically driven model of adaptation to
shiftwork is conceptualised and then tested in the combined rural-urban sample.

**Format of Chapter 1**

The critical review presented in this introductory chapter commences by reporting statistics and trends for shiftwork in the population, and highlights the essential role that shiftwork rostering now plays in the delivery of 24-hour emergency healthcare services. A discussion of circadian theory ensues, which examines the generally conflicting association between shiftwork and the functioning of endogenous biological rhythms that influence several domains of human functioning. The impact of non-standard working hours on sleep behaviour is then reviewed, along with the well-established association between disrupted sleep and fatigue. On the basis of past evidence, potential mental health issues for shiftworkers follows, with a focus on elevated indices of depression, anxiety and stress that have been observed in some shiftwork populations. The longer-term effects that shiftwork may pose on physical health is then addressed with particular attention given to adverse cardiac and gastrointestinal outcomes. Given that individual differences are known to exist in response to shiftwork, the influences of age, gender and several parameters related to personality (namely chronotype and circadian type) are examined for their potential influence on shiftwork tolerance. The role of physical exercise is also discussed in relation to individual differences, and as a potential intervention strategy. The subsequent section reviews organisational and personal interventions that may assist individuals to cope with irregular hours of work and also potentially improve health outcomes. The foregoing health variables are then considered together through the major theoretical
models of adaptation to shiftwork, which have attempted to predict health outcomes via specific pathways and inter-relationships. Finally, the several methodological concerns regarding shiftwork investigation are discussed, suggestions made for future research, and conclusions drawn. An outline of the empirical work that ensues in the body of the thesis is then provided.

Shiftwork in the population

The notion that personnel who participate in shiftwork rosters may suffer from a range of adverse health outcomes is well documented, with an abundance of research detailing the negative impact that non-standard working hours have on several domains of social, biological and psychological functioning. The term shiftwork is generally used to describe occupational functions that rotate and occur anywhere within a 24-hour cycle (Costa, 2003). Population analyses report that 14-percent of the Australian workforce participated in shiftwork in 2003, with nearly half of this group involved in some form of rotating roster system (Australian Bureau of Statistics [ABS], 2003). This figure had increased to 17-percent of the workforce by November 2006, or around 1.4 million employees (ABS, 2006a). By industry, employees of the government department of Healthcare and Social Assistance (formerly Health and Community Services) were amongst those most highly represented as shiftworkers.

Healthcare services and shiftwork

Healthcare and Social Assistance employs healthcare professionals such as doctors, nurses, and ambulance paramedics who are responsible for providing 24-hour, non-stop medical and emergency services to the community (ABS, 2003; ABS, 2006b). Although actual shift structures may vary, the provision of 24-hour services by healthcare workers means that
rotating shift rosters and night duty are common (Pease & Raether, 2003). Shiftwork is widely acknowledged to adversely impact multiple domains of biopsychosocial functioning and, furthermore, working night duty as a routine component of a shift roster is recognised to be a serious risk to the health and well being of personnel (Akerstedt, 1998; Sallinen & Kecklund, 2010).

*Ambulance paramedics as shiftworkers*

The empirical investigations presented in this thesis focus on ambulance paramedic shiftworkers who provide 24-hour pre-hospital emergency treatment and medical transport, typically through rotating rosters and nightshifts. Rather than providing a detailed description of work roles and demographics in this introductory chapter, this material has been included in the general discussion at the end of the thesis. Given the critical role of paramedics in delivering essential emergency health services to the community, it was considered imperative to understand the physical and mental health status of this group of workers, which may have some bearing on their service-delivery as well as their own occupational safety. Given that the literature examining outcomes specific to this occupational group is limited in scope, the broader pool of shiftwork literature will also be drawn on to discuss issues relevant to shiftworkers generally throughout the present review.

*Circadian disruption from shiftwork*

Participation in 24-hour shiftwork rosters typically entails workers remaining awake throughout their preferred time of sleep at some point in the shift cycle. As humans show a marked biological preference to sleep during the night, forced wakefulness during the night hours imposes a level
of disruption on the endogenous circadian system (Costa, 2003; Olson & Ambrogetti, 1998). The circadian system acts as a near 24-hour biological clock to regulate daily functions that form the psycho-physiological basis for the regular sleep-wake cycle and, when typically aligned with salient geophysical cycles, results in sleep at night and active wakefulness during the day (Harrington, 2001; Horowitz & Tanigawa, 2002). In a process termed entrainment, environmental cues termed zeitgebers act upon the circadian clock to align behavioural and physiological functions in accordance with the typical diurnal pattern of sleep and waking in humans. Although the most powerful zeitgeber is light, a wide range of other social and environmental cues that occur as a part of everyday life may also act to modulate the timing of bodily functions. The regularity of meal times, the routine pattern of traffic noise and, in particular, work schedules and sleep patterns provide inputs to phase-regulate the rhythms generated by the circadian system (Harrington, 2001; Horowitz & Tanigawa, 2002; Monk, 1994).

Stably entrained by zeitgebers in the preferred human diurnal sleep-wake pattern, the circadian system regulates our body states such that alertness, cognitive performance and metabolism dip in the mid afternoon, reach a peak in the late afternoon, and drop to a low point in the early morning hours (Akerstedt, 2003; Reynolds, Buysse, & Kupfer, 1995). Applying this diurnal phasing of the arousal rhythm to personnel working a night roster, the period of maximum alertness causes premature waking from daytime sleep, and its low point promotes sleep during the latter part of the night shift. Although some adjustment (reentrainment) of endogenous rhythms to a night work schedule is possible in workers, this
process typically lags well behind the time-shift imposed by workplace rostering, occurring progressively at a rate of about one hour per day (Akerstedt, 2003). As the maintenance of a robust circadian sleep-wake cycle is vital to human functioning and regulates mood and cognitive processes, disruption to the underlying endogenous rhythms from shiftwork can impact negatively on overall level of functioning and quality of life (Reynolds et al. 1995).

Outcomes of circadian disruption

This chronobiologic theory provides a framework that is generally drawn upon to explain the most common outcomes of shiftwork: severe sleepiness and fatigue, and a reduction in the health and well being of workers (Akerstedt, 1990; Costa, 2003). Sleepiness results from a loss in both the quantity and quality of sleep, with the latter demonstrated through a reduction in rapid eye movement and stage-two sleep in shiftworkers (Harrington, 2001). Even accounting for individual variation in the response to shiftwork, it is generally agreed that sleep loss is the major negative outcome, especially on nightshift rosters (Fletcher & Dawson, 2001; Harrington, 2001; Rajaratnam & Arendt, 2001). A comprehensive review of shift work and sleep by Akerstedt (2003) examined morning, afternoon and evening shiftwork rosters in relation to sleep disruption and circadian rhythmicity. Akerstedt concluded that night and early morning workers suffered the most from irregular work hours, with the effects lingering into days off at a level of disturbance consistent with clinical insomnia. Consistent with preceding discussion, it was proposed that the circadian regulation of specific psycho-physiological outputs truncate daytime sleep by promoting wakefulness, and contribute to sleepiness on night shifts;
especially during the early hours. Sleepiness for individuals on early morning shifts was thought to result from forced wakening around the circadian nadir, the curtailed opportunity for sleep, and the extended time spent awake.

Sleep loss and fatigue

It is generally agreed that a directional association exists between sleep loss and fatigue, whereby the former predicts the latter (Akerstedt, Fredlund, Gillberg, & Jansson, 2002; Akerstedt, et al. 2004). While sleep loss is relatively easy to conceptualise (see previous section), the concept of fatigue lacks a clear definition, is frequently interchanged with the term sleepiness, and is measured using a wide array of instruments (see Akerstedt, et al. 2004). For the purposes of this thesis, fatigue will be operationalised as a general tiredness and lack of energy irrespective of whether an individual has had enough sleep or has been working hard, which persists even on rest days and holidays (consistent with Barton, et al. 1995).

While it is well established that shiftworkers generally experience significant sleep loss and fatigue (Akerstedt, 1998; Akerstedt, Kecklund, & Gillberg, 2007; Sallinen & Kecklund, 2010), specific investigations in the healthcare sector are largely represented by samples drawn from the nursing profession (e.g. Barton et al. 1995; Eriksen, 2006; Iskra-Golec, Folkard, Marek, & Noworol, 1996; Ruggiero, 2003) and to a lesser degree medical doctors; and then, particularly, post-graduate residents (e.g. Baldwin & Daugherty, 2004; Papp et al. 2004; Veasey, Rosen, Barzansky, Rosen, & Owens, 2002). In contrast, there is a paucity of research examining shiftwork related outcomes in ambulance paramedics,
notwithstanding concerns about occupational health problems in these workers (e.g. Bennett, Williams, Page, Hood, & Woollard, 2004). Despite being underrepresented, the research evidence that does exist suggests that paramedic shiftworkers may experience more occupational health problems than other healthcare workers and the general community. A recent systematic review of 49 ambulance studies identified high rates of fatigue, poor sleep and other health problems in personnel (Sterud, Ekeberg, & Hem, 2006), and additional concerns have also been raised about increased rates of mental health disorders in paramedics (Bennett et al. 2004).

**Investigations of ambulance personnel**

A small number of studies have specifically investigated fatigue in ambulance workers. Van der Ploeg & Kleber (2003) conducted a longitudinal investigation of work related stressors in 123 ambulance workers in the Netherlands and observed levels of fatigue considered to place more than 10-percent of the sample at risk of subsequent sick leave or work disability. Furthermore, a clinical level of post-traumatic stress was also found in 10-percent of respondents. One investigation specific to rural paramedic shiftworkers (Hussey, Baker, and Holmes, 2001) assessed fatigue levels in the Operations and Communications Centres (OpCens) staff using a fatigue index program (Fatigue Audit InterDyne; Centre for Sleep Research) that predicts levels of work-related fatigue based on the time of day worked, length of shift, and expected recovery. This investigation was commissioned by Rural Ambulance Victoria following a State Coroner’s report that implicated working arrangements in the delayed dispatch of emergency services to a time-critical event.
As trained paramedics, OpCens staff were tasked with the coordination and dispatch of emergency ambulance services to the community via an identical rotating roster structure to their ‘on-road’ colleagues; a role considered ‘high-risk’ due to the inherent decision-making responsibilities and high mental workload. Elevated fatigue scores were determined in this cohort and associated with 14-hour nightshifts, especially when worked consecutively. It was noted that 14-hour nightshifts were uncommon in other industries for this reason. The allocation of formal breaks on nightshift was recommended, as well as more control over the timing and amount of overtime worked. Training and education of staff in the management of shiftwork and fatigue was also suggested.

Deficiencies in current knowledge

While these studies raise occupational health concerns, specifically with regard to elevated fatigue, a systematic review of health status in ambulance services (Sterud, et al. 2006) failed to establish reliable prevalence rates for fatigue (or other indices of health) in ambulance workers. Particular methodological criticisms were raised including small sample sizes, low response rates, poorly defined and non-representative samples, a lack of definition of the nature of the work, and potential regional differences (e.g. urban vs. rural). In addition, comparison with population norms was found to be lacking, and wide differences existed in assessment methods and instruments. The authors concluded that these significant methodological shortcomings limited the value of many studies. A more recent editorial (Harma & Kecklund, 2010) extended these concerns by recommending that improvements were required in shiftwork methodology generally, but focussed on a lack of shiftwork exposure.
assessment (i.e. roster type and hours worked) as particularly problematic. These criticisms raised the need for further investigation based on sound methodological principles in order to establish clearly the prevalence and predictors of fatigue in this occupational sector. Additional attention was also drawn to the importance of organisational management of shiftwork and fatigue.

Shiftwork and mental health

**Depression and anxiety**

There is strong and consistent empirical support for a positive relationship between the sleep loss and fatigue experienced by shiftworkers (e.g. Veasey, et al. 2002) and increased symptomatology related to depression and anxiety. Prior to examining this evidence, it is important to identify that indices of mental health can be conceptualised from a categorical perspective (e.g. as a clinical disorder) or on a dimensional scale.

While the latter will be adopted throughout the present work, the array of assessment instruments adopted in the general literature creates some difficulty in directly comparing studies. For the purposes of this thesis, depression will be operationalised as a state categorised by a loss of self-esteem and incentive, and associated with a very low perceived probability of attaining personal life goals of significance to the individual.

Characteristics typical of anxiety will be include worry about performance and possible loss of control, awareness of dryness in the mouth, breathing difficulties, pounding of the heart, sweatiness, apprehensiveness, and shakiness (Lovibond & Lovibond, 2004).
A link between depression and nightshift rosters has emerged in particular, as evidenced by several studies in the healthcare sector based on nurse samples. For example, Ruggiero (2003) investigated 142 female critical care shiftwork nurses and found that 23-percent of respondents met criteria for clinical depression (a categorical assessment). The nightshift group reported significantly more depression and poorer sleep quality than dayshift nurses, and fatigue was significantly and positively correlated with depression, anxiety, and sleep quality. By regression analysis, depression explained the highest component of variance in fatigue. This study established useful data in a non-clinical group of healthcare shiftworkers, which is often lacking in the empirical literature.

Another study in the healthcare sector by Healy, Minors, and Waterhouse (1993) demonstrated rapid onset of depressive symptomatology in a sample of 43 second-year student nurses following exposure to their first shiftwork roster. Questionnaires measuring neuro-cognitive functions were administered both before and after a three-month night shift rotation. The post-rotation data found psycho-behavioural changes typical of depression, and night work was linked to altered perceptions about whether life was going according to plan, the perceived level of support or criticism from others, and general pessimism. While adverse mental health outcomes have been acknowledged in other shiftwork cohorts (and are also examined in this thesis), the authors claimed that no other study had demonstrated such a rapid temporal relationship between exposure to shiftwork and adverse mental health outcomes. It is worth noting that the participants were young healthy
individuals with a mean age of 19 years and so below the typical age of shiftworkers in other studies.

Studies of ambulance personnel

Although shiftwork paramedics are of prime interest to the present work, only limited investigation of mental health exists in these workers. One of the most comprehensive studies located was a mental health survey examining the prevalence of post-traumatic stress disorder (PTSD), depression and anxiety in 617 ambulance personnel working across both rural and urban settings for the one service in the United Kingdom (Bennett et al. 2004). Claimed to be the first study to report large-scale population prevalence data in this occupational sector, nearly 10-percent of respondents reported clinical levels of depression, and 22-percent clinical levels of anxiety. Approximately two-thirds of these workers also reported experiencing intrusive work-related thoughts. When considered along with previous smaller studies, the authors suggested that these analyses were likely to represent stable occupational prevalence rates.

Workplace stress

While the preceding studies have focussed on elevated depression and anxiety related problems in workers, ambulance work is also considered to present significant occupational stressors for personnel and is generally considered to be a stressful occupation (Sterud, Hem, Ekeberg, & Lau, 2008). As such, there are relatively more studies of occupationally related stress in ambulance personnel. This premise is important as work related stress is associated with unhealthy living habits, physical inactivity, poor diet, chronic activation of the physiological stress system, insufficient recovery and sleep, activation of the autonomic system, impaired
inflammatory and immune responses, and early atherosclerosis (Harma, Kompier, & Vahtera, 2006). Workplace stress has also been specifically associated with development of mental health disorders (Stansfeld & Candy, 2006) and increased risk of coronary heart disease (Kivimaki, et al. 2006). Despite such compelling reports, the conceptualisation of stress varies widely (Harma et al. 2006), and the assessment of stress as an index of mental health along with potential associations with depression and anxiety, is underrepresented. Furthermore, some investigators have adopted assessment tools and methodologies that limit the utility of findings or potential for comparison with other data. Some outcomes derived from very small samples and temporal changes in physiological markers are noteworthy in this respect. For the purposes of this thesis, stress will be conceptualised on a dimensional scale and assessed by an inability to relax, irritability, an intolerance of interruption or delay, a state of over-arousal, tenseness, being nervy, jumpy, fidgety, and easily startled (Lovibond & Lovibond, 2004).

_Past empirical outcomes_

One Swedish study (Aasa, Kalezic, Lyskov, Angquist, & Barnekow-Bergkvist, 2006) investigated physiological and subjective stress markers via cortisol levels, heart rate variability, autonomic reactivity and other psychobehavioural variables in 24 male and two female ambulance workers. No significant differences were observed between these measures during work duties and the subsequent two days of leisure time afterwards. However, during the monitoring period, these workers mostly remained at the ambulance station waiting for calls, and managed more than five-hours of continuous sleep at night. Furthermore, the psychobehavioural measures
administered were generally inconsistent with those used for shiftwork investigation (limiting the potential for comparison to other data) and no psychometrics were reported. An even smaller study of cortisol levels and heart rate variability was conducted in nine Japanese ‘ambulance men’ to also compare stress levels between a single on-duty 24-hour shift and the following off-duty day (Mitani, Fujita, & Shirakawa, 2006). No significant differences were observed in sleep duration between work and home, and no call outs occurred during the duty time. The authors drew potentially unwarranted conclusions regarding significant differences on study measures related to perceived stress at work, and the implications for increased cardiac risk in ambulance personnel. A raft of methodological limitations applies to both studies, and the findings can only be considered as indicative of the need for more robust future research.

**Nationwide studies**

In contrast to these smaller studies, two nationwide surveys of ambulance personnel have examined categories of occupation-specific stressors. Van der Ploeg and Kleber (2003) assessed occupational stressors in a longitudinal investigation of 123 ambulance workers in the Netherlands. The role of acute (e.g. critical incidents) and more chronic stressors was examined for potential predictive associations with longer-term adverse health outcomes. While personnel were found to cope reasonably well with acute incidents, the consistent levels of chronic stressors were more predictive of health symptoms. These chronic stressors were related to the social climate at work, for example lack of support from colleagues and poor communication, and were the most significant predictors of PTSD, burnout symptoms and fatigue. While the authors considered these organisational
parameters to underpin levels of support following acute and critical incidents, it could be argued that poor social infrastructure in the workplace may also predict health outcomes in other occupations. However this study did establish categories of occupational stressors and also highlighted the role of the organisational climate.

In another nationwide survey (Sterud et al. 2008), data from 1286 Norwegian ambulance personnel from 19 service regions were examined to test the notion that ambulance work is inherently stressful. While stressors related to clinical work were rated as the most severe (‘dealing with seriously injured friends and people you know’; ‘dealing with seriously injured children’), social aspects of the work environment (e.g. lack of support from co-workers or management), and physical demands (e.g. heavy lifting) were rated as relatively high on both frequency and level of severity. However these workers did not report a generally high frequency and severity level of stressors overall, most of which were rated as moderate. This study was claimed to be the largest investigation of ambulance personnel yet conducted, and again identified categories of organisational and occupational stressors. However the question of whether ambulance work is inherently stressful was not definitively addressed.

There are consistent findings and limitations in the studies by Van der Ploeg and Kleber (2003) and Sterud et al. (2008). Both identified and reported categories of organisational stressors and highlighted the important role of personal support in the workplace. Contrary to general assumptions, neither established that exposure to stressful incidents in the clinical work-role was a major predictor of adverse health outcomes, or indeed that ambulance work was inherently stressful per se. Unfortunately,
the assessment of dimensions of psychological stress and potential associations with related indices of mental health (namely depression and anxiety) were not considered, and would have potentially facilitated comparisons with other data sets and more clinically relevant health nosology.

Potential mechanisms from stress to ill health

The preceding discussion of workplace stressors, irrespective of their precise origins, is consistent with the widely acknowledged contention that chronic stress can negatively impact health (e.g. Van der Ploeg & Kleber, 2003). Hence, the system responsible for regulating the pathophysiological response to stress in humans (and indeed, most organisms) warrants discussion to examine the potential pathways in this association. The neurophysiological basis of the human stress system is the hypothalamic-pituitary-adrenal (HPA) axis, which if successful, restores homeostasis in response to a perceived stressor by regulating biological activities related to the central nervous system, metabolic processes, the immune response and others (Chrousos, 2009). However, when the response of the HPA is not properly tailored to the stressful stimulus, adverse outcomes can result. For example, hyper-activation has been associated with the development of PTSD, and chronic activation with prolonged elevation of serum cortisol levels (Nader, Chrousos, & Kino, 2010).

Glucocorticoid release

Through a rather complex physiological operation, the HPA mediates the adaptive response to stressors by facilitating the secretion of glucocorticoids from the adrenal cortex. These steroid hormones influence the activity of nearly all organs and tissues and are necessary for the
maintenance of many biological functions (Chrousos & Kino, 2007). Under conditions of transient stress, the release of glucocorticoids enhances specific elements of the immune system in an adaptive manner to deal with ‘the threat’. Glucocorticoids also phase shift the circadian rhythm of target tissues and organs (e.g. the liver, kidney and heart) to further adjust the body’s response to stressors.

Under conditions of chronic stress, the persistent stimulation of the HPA axis can alter metabolic functioning and result in suppressed immune response, central obesity, insulin resistance, hyper-lipidemia, muscle loss, thinning of the skin and increased cardio-metabolic risk (Nader et al. 2010). It is thought that work-related factors (e.g. extended hours of work and/or shiftwork) can pose chronic stressors that sustain the activation of the stress system, suppress recovery to a homeostatic state, and contribute to a range of adverse physical health outcomes (Geurts & Sonnentag, 2006; Harma et al. 2006).

Co morbidities and interrelationships

A simple cause-effect relationship cannot be inferred from the foregoing, as work related stress also likely increases the probability of a co-manifestation of several unhealthy risk factors in individuals (e.g. smoking, less physical exercise, and excessive alcohol consumption) that may also predispose them to chronic disease (Harma et al. 2006). Stress states and persistent activation of the HPA axis are also known to impair sleep, and impaired sleep, to exacerbate the effects of stress (Akerstedt, 2006). In the absence of targeted interventions, the end result here is a vicious cycle that underpins mechanisms for both psychophysiological and behavioural patterns that contribute to the development of disease
processes in the medium to long term (Harma et al. 2006). These outcomes are reviewed in the following section.

**Longer-term physical health disorders associated with shiftwork**

In addition to sleep problems, elevated fatigue and mental health issues, there have also been consistent concerns regarding longer-term adverse physical health outcomes in shiftworkers. While associations with breast cancer, compromised pregnancies, and the aggravation of existing conditions have been reported (Boivin, Tremblay, & James, 2007; Knutsson, 2003) there has been a somewhat stronger focus on cardiac disease and gastrointestinal disorders in shiftworkers. On this basis, the present review will be limited in scope to these latter domains of health.

*Adverse cardiac outcomes*

There has been particular interest in adverse cardiac health outcomes in shiftworkers. Over a decade ago, reviewers classified shiftwork as one of the major work environmental factors related to cardiovascular disease (Akerstedt & Knutsson, 1997) but failed to identify specific causal mechanisms. The range of potential contributing factors was thought to include heavier work tasks, poor eating habits, metabolic changes from sleep loss, socio-economic status, and shift type. Ongoing investigation was strongly suggested in order to clarify specific pathways. A subsequent population based study investigated job strain as a potential mediator of cardiac disease in shiftworkers (Knutsson, Hallquist, Reuterwall, Theorell, & Akerstedt, 1999) by comparing 2006 individuals with first time myocardial infarction against 2642 asymptomatic controls. While shiftworkers were found to have an increased risk of 30-percent for both genders that held across all shift systems including night work, again, no causal pathways
were identified. Given that cardiovascular disease is also associated with lower socioeconomic status, the higher prevalence of unskilled workers in shiftwork was posited as one potential explanation. In support of this notion, the relative risk of disease reduced when the results were controlled for educational level. However, specific mechanisms remained unclear.

*Potential pathways*

While ongoing empirical investigation has sought to tease out the precise mechanisms that might best explain any association between shiftwork and cardiovascular disease, specific pathways remain elusive. A contemporary review of the literature by Puttonen, Harma, and Hublin (2010) supported this position by concluding only that sufficient evidence exists to substantiate a causal link. Rather than precise mechanisms, it was suggested that interrelated pathways relating to psychosocial, behavioural, and physiological parameters are likely to be responsible for adverse cardiac outcomes in shiftworkers. Psychosocial factors encompassed difficulties in controlling working hours, a reduced work–life balance, and poor recovery from work. Behavioural factors relating to weight gain and smoking were also considered relevant. The physiological and biological mechanisms were thought to be associated with activation of the autonomic nervous system, inflammation processes, changed lipid and glucose metabolism, and related changes in the risk for atherosclerosis, metabolic syndrome, and type II diabetes.

*Limitations and conclusions*

In considering the foregoing, it is clear that any association between shiftwork and cardiovascular disease is likely to be multidimensional in nature. As such, it is equally likely that a range of multidimensional
confounding factors will limit findings to the consideration of broad parameters rather than narrow causal explanations, as identified by Puttonen et al. (2010). This conceptualisation is supported by epidemiologic data derived from 14 studies examining the causal relationship between shiftwork and ischemic heart disease (Frost, Kolstad, & Bonde, 2009). In contrast to previous reports, only limited evidence for any relationship was established. Furthermore, the positive associations reported in several studies were considered to be potentially explained by chance, bias or confounding influences. In particular, methodological issues relating to small samples, unknown exposure to shiftwork hours, mixed shift rosters, selection bias and a lack of consistent patterns limited the ability to draw conclusions. It therefore appears reasonable to assume that investigation is still required to establish whether shiftworkers are indeed at risk of adverse cardiac outcomes. Any such efforts should be informed by the methodological concerns raised by previous investigators.

**Gastrointestinal disease**

The other area of consistent physical health concern in shiftwork populations is related to gastrointestinal symptomology (e.g. pain, constipation, and diarrhoea) and ulcerative disease (Knutsson, 2003). In particular, an association between shiftwork and peptic ulcers (describing gastric and duodenal ulcers) has been recognised since the 1950s, to the point that peptic ulceration was deemed to be an occupational disease of shiftworkers (Knutsson & Boggild, 2010). Several large studies were spawned from these concerns (especially in Japan), including a particularly large investigation of 11,657 employees by Segawa et al. (1987). Based on mass screening using a barium meal x-ray procedure, this study determined
an increase in relative risk of 2.18-percent for the development of gastric and duodenal ulcers in shiftworkers compared to day workers. No information was provided regarding shift rosters or exposure to hours of shiftwork or night work, so the parameters defining shiftwork in this study are unknown.

Contemporary opinion

A recent systematic review examining published literature on the association between shiftwork and gastrointestinal disorders serves as a contemporary update on this matter (Knutsson & Boggild, 2010). Of the 26 studies that met inclusion criteria for this review, four of six studies reported increased gastrointestinal symptomology in shiftworkers, five of six reported an increase in peptic ulceration, and two of three found an association between shiftwork and functional gastrointestinal disease (symptoms without structural changes). The reviewers concluded that in their judgement, shiftworkers appear to have an increased risk of gastrointestinal symptoms and peptic ulceration. However, several of the methodological caveats already raised in the previous discussion regarding cardiac outcomes also apply here. Potential confounds were not controlled in the majority of the studies (e.g. smoking, drinking, socioeconomic status, and age) and few were of longitudinal design. The use of medications related to ulcerative disease (e.g. aspirin) was also not controlled for in most of the published studies. Finally, insufficient detail regarding the precise nature of working hours was again raised as problematic, limiting any assessment of which shifts may have been related to specific disease processes.
Final synthesis of evidence

To sum up the present review of shiftwork and adverse physical health outcomes, it appears that despite decades of research evidence, conclusions regarding causal associations between shiftwork, gastrointestinal disorders and cardiovascular disease remain limited. An editorial by Harma and Kecklund (2010) suggested, on the basis of contemporary wisdom, that shiftwork probably increases the risk of these diseases in shiftworkers. These authors again raised the need to improve the quality of published studies by controlling for potential confounds; in particular shiftwork exposure assessment. A more thorough review of these methodological concerns is offered towards the end of the present review.

Individual differences and shiftwork tolerance

While the adverse health effects reviewed so far have been reported across a range of shiftwork populations and occupations, individual differences are also evident between samples and studies and generally conceptualised as shiftwork tolerance. For example, some workers report serious adverse health effects after a brief period of shiftwork whilst others tolerate many years without health compromise (Tamagawa, Lobb, & Booth, 2007). Several parameters are thought to influence adjustment or tolerance to shiftwork schedules including the workers commitment to shiftwork (e.g. Harma, 1993), personality variables such as introversion/extroversion and neuroticism (e.g. Soehner, Kennedy, & Monk, 2007), and locus of control (e.g. Nachreiner, 1998). Variables associated with circadian functioning are arguably the most prominent given that shiftworkers incur regular disruption to the normal phase relationships between endogenous circadian rhythms (such as the body temperature and
Introduction

sleep-wake cycles) and imposed work-rest schedules (Barger, Wright, Hughes, & Czeisler, 2004). For example, the requirement to work at night when one would usually be asleep contrasts with the circadian down-regulation of body temperature and alertness rhythms that would typically occur at that time. While acknowledging that a range of individual differences may influence shiftwork tolerance, the present work will focus on circadian personality variables given that past investigation and reviews have identified these parameters as most influential (e.g. see Harma, 1993; Tamagawa, et al. 2007).

The impact of work hours

The work-rest cycle is a strong social synchroniser of human circadian rhythms, which along with other stimuli such as light, noise, and social activity acts to align the circadian clock with the exogenous 24-hour day (Cain, Rimmer, Duffy, & Czeisler, 2007; Tankova, Adan, & Buela-Casal, 1994). For those working ‘regular’ hours, this produces a rhythm where peak activity occurs somewhere between 08:00 and 22:00 (Harma, 1993). For shiftworkers, a misalignment of phase occurs that is associated with health-related problems including sleep disruption, decreased alertness, elevated levels of fatigue, and poorer cognitive performance (Barger, et al. 2004; Costa, 2003); by implication putting these workers at higher risk for poorer occupational performance and workplace mishap. Individual differences in circadian adaptation to these imposed changes are reviewed in the following sections.

Morningness – eveningness chronotype

The ability to adapt to disturbances imposed on the preferred sleep-wake cycle (e.g. by night work) is thought to be at least partially dependent
on individual differences reflected by chronotype (Natale & Alzani, 2001).
The morningness-eveningness dimension is generally applied to describe inter-individual variability in chronotype and describes the phase or timing of a given circadian rhythm (e.g. body temperature) within the 24 hour day, and in turn individual preference for the timing of activities (see Kerkhof, 1985 and Tankova, et al. 1994 for a detailed review). The Composite Morningness Questionnaire (Smith, Reilly, & Midkiff, 1989) is one of the more popular scales used to assess a preference for morning or evening activities and is based on three reliable factors related to morning activities, morning affect, and eveningness. Although dimensional, extreme chronotypes can been categorised as either morning-types (or ‘larks’) or evening-types (or ‘owls’). Larks are more active in the first part of the day, retire to bed early in the evening and wake spontaneously and early in the morning feeling refreshed. In contrast, owls are more active in the second part of the day, stay up later in the evening and rise later in the morning feeling tired (Cavallera & Giudici, 2008; Natale & Alzani, 2001).

Neurophysiological basis

From a neuro-anatomical perspective, individual morningness-eveningness is a function of the activity and timing of the human circadian pacemaker, which comprises approximately 20,000 neurons in the suprachiasmatic nucleus (SCN) of the hypothalamus. In mammals this region generates endogenous circadian rhythms, synchronised to the environment largely by photic input via the retinohypothalamic tract (RHT), and outputs to various brain structures controlling physiological, behavioural and psychological functions in a complex feedback system (Cavallera & Giudici, 2008; Edery, 2000). Differences in the phasing of
endogenous periodicity relative to the environment (as reflected by chronotype) can be observed through a range of objective physiological outputs. For example, Kerkhof and Van Dongen (1996) measured body temperature in seven morning and seven evening-types in a controlled routine procedure that removed confounding influences on the circadian oscillator. Daily records of body temperature showed pronounced 24-hour periodicity, but significantly different phase between groups. Although both types reached their acrophase (peak value) for body temperature in the second half of the day, morning-types peaked from one-to-three hours earlier than evening-types.

*Empirical evidence*

Initial evidence linking shiftwork tolerance to chronotype strongly suggested that evening-types might be more suitable for shiftwork (e.g. Folkard, 1987a), while morning-types are likely to cease shiftwork at a disproportionate rate due to poor tolerance of the circadian disturbances imposed (Kerkhof, 1985; Monk, 1990). Some empirical work has supported this notion. A study of 18 male air traffic control shiftworkers (Natale, Martoni, & Cicogna, 2003), found that when compared to morning-types, the nine evening-types slept less, were able to sleep immediately following a shift, and used naps as a strategy for recovering lost sleep; altogether suggesting greater adaptability to the disrupted sleep-wake cycle. It should be noted that these findings were limited by a very small and gender biased sample. Another somewhat larger study of 613 Japanese power plant shiftworkers (Smith et al. 2005) also suggested more adaptability to shiftwork in evening-types by observing positive associations between eveningness, better quality sleep during the day, and less fatigue on
nightshifts. The delayed circadian phase associated with evening-typology was posited as the main explanation.

Some indicators also suggest that, through natural disposition, evening-types are more likely to self-select for shiftworking, while morning-types prefer to abstain from irregular hours of work. A landmark study of morningness (Adan, 1992) investigated 908 participants aged from 17 to 50 years according to five different work schedules. Using a dimensional approach, night workers tended towards eveningness and morning workers towards morningness. From a categorical approach, none of the night workers reported being a morning-type. An epidemiological analysis of 2526 New Zealand adults aged from 30 to 49 years (Paine, Gander, & Travier, 2006) also found work schedules to be predicative of chronotype as night workers were more likely to be definite evening-types. One alternative explanation for these findings is that individuals might adapt to their prevailing work conditions by becoming more morning or evening type through long-term phase adjustments. This notion does not appear to have been examined in the shiftwork literature as yet, but could form the basis of future longitudinal investigation.

Practical application and limitations

On the basis of the foregoing, it seems reasonable to predict that eveningness might confer some level of tolerance to shiftwork. However, associations have also been established between evening typology and adverse outcomes in shiftwork populations. Contrary to their hypotheses, Barton et al. (1995) found more physical and psychological ill-health, higher chronic fatigue, more sleep problems, and more social and domestic disruption in evening-types (compared to morning-types) in a sample of
1532 shiftwork nurses and 332 industrial shiftworkers. In discussing these unexpected findings, the authors suggested that chronotype might not be as useful a predictor of shiftwork tolerance as was previously considered. Likewise, Paine et al. (2006) found that while evening-types were more likely to be involved in afternoon or night work, these individuals were also 2.5 times more likely to report poor health and excessive daytime sleepiness when compared to morning-types. Other authors have cautioned that any predictive value of chronotype is likely to be limited by the generally small effect sizes reported by most studies (e.g. Kaliterna, Vidacek, Prizmic, & Radošević-Vidacek, 1995).

Rhythm stability and amplitude

In addition to measures of phase, Folkard, Monk & Lobban (1979) posited that the stability and amplitude of circadian rhythms might also help to explain why some individuals adjust more readily to the disruptions caused by shiftwork. These parameters are commonly assessed as two independent factors using the Circadian Type Inventory (Folkard, 1987b). The first factor (flexible-rigid) assesses rhythm stability in the context of sleeping habits. Rigid-types find it more difficult to sleep at unusual hours, and prefer to eat and sleep at regular times while flexible-types are more able to stay awake and function at odd times of the day or night. The second dimension (languid-vigorous) assesses rhythm amplitude or strength. Languid types report difficulty overcoming drowsiness, feel lethargic after reduced sleep, and prefer to work at normal times of the day. Again, vigorous-types exhibit contrasting qualities (Di Milia et al. 2005; Folkard et al. 1979). Vigorous and flexible-types appear to adjust more readily to changes imposed on the circadian system on a number of
psychological (subjective alertness, need for sleep) and physiological measures (oral temperature, renal excretion) suggesting better adaptation to shiftwork (Folkard, et al. 1979; Harma, 1993).

The predictive value of circadian type

In contrast to unclear role of chronotype, empirical evidence gathered in shiftwork populations has generally supported an association between circadian type and shiftwork tolerance. Rigidity of sleeping habits has been consistently associated with poorer sleep, reduced alertness, poor general health, and psychosomatic and gastrointestinal complaints (Kaliterna et al. 1995; Tucker & Knowles, 2008). Furthermore, flexibility has been negatively correlated with chronic fatigue (Iskra-Golec et al. 1995) and sleep disturbance (Ognianova, Dalbokova, & Stanchev, 1998), and also found to be predictive of those who both tolerate and choose to work night shifts (Humm, 1996; Tamagawa, Lobb, & Booth, 2007). Languidity has been associated with higher fatigue levels, poorer mental health, gastrointestinal symptoms, poorer well-being, lower alertness, and poorer health outcomes generally (Iskra-Golec et al. 1995; Ognianova et al. 1998; Tucker & Knowles, 2008). The weight of evidence therefore supports the contention that, by and large, vigorous and flexible types show better tolerance of the circadian disruption created by shiftwork compared to languid and rigid types.

In order to further investigate this premise, a recent study by Di Milia et al. (2005) assessed alertness and need for sleep in a shiftwork and non-shiftwork sample using the CTI (Folkard, 1987b). Languid-types were more influenced by sleep inertia after waking in the morning as demonstrated by low levels of alertness in the morning hours and early afternoon (suggesting
a stronger circadian influence during these periods). By contrast, vigorous-types maintained higher alertness across the day and needed significantly less sleep. Flexible-types were significantly more alert between 16:00 and 22:00 hours, again suggesting less circadian influence. As such, vigorous and flexible typology was posited to cope best with the circadian disruption created by shiftwork. Similar conclusions were drawn from an investigation of thermo-electric operators working a rotating day and night shift roster (Ognianova, et al. 1998). Languidness was associated with more sleep disturbance and fatigue, and reduced alertness during the nightshift. Negative correlations were found for chronic fatigue and sleep disturbance in flexible types. Circadian typology was again suggested as a predictor of individual response to shiftwork.

Summary of individual circadian differences in shiftwork tolerance

In sum, the individual difference variables of chronotype and circadian type have been drawn on to predict psychological and physical adaptation (tolerance) to shiftwork cycles. Interpreting the evidence, it appears that while evening-types may be more represented in shiftwork populations (possibly through their own volition) as observed by Adan (1992) and Paine et al. (2006), chronotype may not confer any level of shiftwork tolerance for these individuals as initially predicted. Furthermore, it remains unclear whether morningness or eveningness is associated with any level of shiftwork tolerance, as measured through variables related to adverse health outcomes. As such, ongoing research is clearly required to untangle the contrasting nature of existing findings and to determine the relevance of chronotype to work schedules (Cavallera & Giudici, 2008). The role of circadian type on the other hand appears to find more consistent
support in terms of predicting shiftwork tolerance. The dimensions of flexibility and rigorousness have been consistently associated with generally better health and sleep behaviours in shiftwork investigations. It therefore seems reasonable to conclude that circadian type may be a better *a priori* indicator of suitability for shiftwork, although ongoing research based on longitudinal methodology is again clearly required to identify the utility of such a measure in real-world populations.

**Increasing age and health outcomes in shiftworkers**

Conflicting opinions are evident as to whether increasing age either ameliorates (e.g. Akerstedt, et al. 2002) or compounds (e.g. Costa, 1996; Marquie & Foret, 1999; Monk, 1994) adverse health outcomes in shiftworkers. Developmental changes in sleep-stage physiology and disruption to the sleep cycle have been cited as potential health risks for workers that lead to a progressive intolerance to shiftwork through lowered psycho-physical fitness (Costa, 2003). The age at which shiftwork is considered to present a particular risk varies, with some suggesting that additional problems commence from 40 years (especially for night workers; Costa, 1996; Costa, 2005; Ognianova, et al. 1998) and others suggesting age 50 years onwards (Monk, 1994).

*Circadian changes with age*

Increasing intolerance to shiftwork as one grows older is thought to result from age-related changes in the circadian regulation of several bodily functions. These changes in circadian regulation include a shift in phase, an alteration in rhythm structure, and decreased amplitude in particular (Harma, 1993). As a result, the sleep-wake pattern becomes fragmented and there is an increase in the number and duration of arousals from sleep
along with an increase in daytime naps. It is thought that these changes are consequent to an internal desynchronisation or weakening of the endogenous biological clock with age which, in turn, creates a stronger dependence on socio-environmental synchronisers that tend towards morning patterns (Tankova, Ada, & Buela-Casal, 1994). This leads to an increase towards morningness that Baehr, Revelle, & Eastman (2000) observed even in an age-restricted cohort of 18 to 43 year old participants, such that older age was significantly associated with more morningness and a phase-advanced temperature rhythm.

Empirical findings

While these arguments for poorer shiftwork adaptation with ageing are grounded in robust circadian theory, empirical support for the associated predictions is very much lacking. When age-related differences in shiftworkers have been detected, the effects are generally modest and limited in scope to isolated variables such as increased sleepiness on day and night shifts (e.g. Smith et al. 2005). One explanation is that the circadian changes with age might result in less need for sleep, which infers that younger shiftworkers might suffer more from the sleep disruption associated with shift rostering (Costa, 2003; Harma, 1996). Accordingly, older workers would show some level of tolerance to shiftwork through a reduced need for sleep, suffer less sleepiness after nightshift, and cope better with acute sleep loss. In support of this notion, Spelten, Totterdell, Barton, & Folkard (1995) found that older age was associated with shortened sleep duration, but not with increased sleep difficulties or on-shift alertness in sample of 572 shiftwork nurses aged 20 to 60 years. The development of effective coping strategies by the older and more
experienced workers was also offered as an explanation for these findings. A shift towards morningness with increasing age was also suggested to be beneficial for older workers on early morning rotations.

Adding further weight, a study investigating fatigue, work, and sleep in 5270 Swedish workers (Akerstedt et al. 2004) observed lower fatigue in older workers, contrary to expectations, and suggested a process of self-selection in the workforce as the main explanation rather than developmental change in biological parameters. Other studies have also failed to observe age-related gender differences for the prediction of fatigue, or poorer mental health outcomes (e.g. Ruggiero, 2003). Costa (2003) raised the additional possibility that some younger workers might find it difficult to compromise their social commitments for work, leading to poor sleep hygiene practices. In sum, despite robust circadian arguments, empirical investigations have thus far failed to report a consistent association between age and shiftwork-related health outcomes. As such, further evidence is required to establish whether age is a predictor of health outcomes per se in shiftworkers, or whether other (possibly behavioural) parameters might be more influential.

Gender and response to shiftwork

Gender differences have also been drawn on to explain individual responses to shiftwork, with consistent arguments suggesting poorer tolerance in females. These differences are derived from social rather than biological pathways (Barton et al. 1995; Nachreiner, 1998) and point to additional domestic and childcare responsibilities females are presumed to incur in most cultures (Harma, 1993). Female shiftworkers with small children are thought to especially suffer from the potential requirement to
balance irregular work schedules with additional domestic duties, resulting in elevated fatigue and increased sleep problems (especially during the daytime; Costa, 1996; Costa, 2003). In support of this position, a study examining the association between domestic commitment and sleep duration in female shiftworkers (Spelten et al. 1995) identified the number of dependents in the household as a significant predictor of sleep loss for the night shift cohort. Finally, Harma (1993) also asserted that females might be inclined to report health symptoms more frequently than men, although there appears to be little empirical work to substantiate this notion.

_Lack of empirical support_

Despite predictions for poor shiftwork tolerance in females, many empirical studies have failed to observe any consistent or substantial association between shiftwork related problems and gender. Ruggiero (2003) examined the impact of social factors though parenting, domestic, and marital responsibilities on health-related measures in 142 female shiftwork nurses, but reported inconclusive findings. The potential association between gender and fatigue were examined by Ashberg, Kecklund, Akerstedt, & Gamberale (2000) in a sample of 48 male and 44 female shiftworkers. Three fatigue inventories were administered to explore different dimensions of self-reported fatigue over an entire forward rotating shift cycle. While females reported a higher degree of fatigue than males on the Swedish Occupational Fatigue Inventory, with the strongest effect found for night work, findings were not consistent on measures that tapped different dimensions of fatigue. As such, any association between gender and fatigue remained unclear in this study. Likewise, a study of mental
health problems in 617 UK ambulance workers Bennett et al. (2004) failed to establish any significant gender differences on indices of depression and anxiety. The analyses also revealed a lower prevalence of PTSD in females than found in the general community, suggestive of some level of hardiness in female ambulance workers.

Only limited investigation of gender-related biological differences in shiftwork tolerance have been conducted; mostly based on chronotype and circadian type. Women have been reported by some to exhibit more morningness than men (Baehr, et al. 2000), whilst others argue that no difference can be detected other than a one-hour advance in acrophase of the core body temperature rhythm in females (Tankova et al. 1994). An investigation of 580 university students reported inconclusive results for circadian type by gender (Di Milia, Smith, & Folkard, 2004). Likewise, gender was not an important determinant of morningness-eveningness in a sample comprising 2526 members of the New Zealand general community (Paine et al. 2006). As such, there appears to be no evidence for a biological difference between genders to sustain an argument for differential response to irregular working hours.

The healthy worker effect

One of the more likely explanations for the lack of detectable gender (and possibly other) differences in shiftworkers is that shiftworkers of both genders potentially self-select to work irregular hours based on their resources and ability to cope (Boivin, Tremblay, & James, 2007; Spelten et al. 1995). Consistent with this premise, Knutsson and Akerstedt (1992) found that shiftwork applicants showed less rigid sleep patterns than applicants seeking regular work and concluded that the former group may
self-select on the basis of an inherent ability to withstand odd working hours. Other factors related to type of occupation (e.g. blue collar vs. professional status) and differences in marital and domestic expectations (e.g. the primary caregiver for children) might also contribute to inconsistent findings and limit the broader predictive value of gender. Nachreiner (1998) noted the role of cultural differences by pointing out that shiftwork was better tolerated in old coal and steel communities, as it was common and received more social support. While there is certainly a need for ongoing investigation to determine any predictive role for gender in determining shiftwork related outcomes, research to date has failed to inform a definitive position on this matter. A focus on the process of self-selection and differences in domestic responsibilities (akin to Spelten et al. 1995) is therefore suggested. Another broader perspective suggests that the notion of shiftwork tolerance and any associated global criterion may prove unrealistic given the complexity of research findings, mixed samples and diverse range of roster structures (Tamagawa, et al. 2007).

**Physical activity in shiftworkers**

In contrast to individual parameters that may influence shiftwork tolerance, several investigators have posited that physical exercise may mediate individual responses to shiftwork (e.g. Atkinson & Davenne, 2006), and represent a potential intervention. Regular physical activity plays a protective role for a wide range of health domains in the general community (World Health Organisation, 2006), so it seems reasonable to predict that exercise could potentially assist in managing the health-related consequences of shiftwork. It is increasingly more common to assess physical activity levels by ascertaining all exercise undertaken over a
specified timeframe related to sport, recreation or fitness. In conjunction with information regarding the intensity (walking, moderate, vigorous), frequency and duration of exercise, categorical classifications can be made to an exercise level of low, moderate or high, or a dimensional scale adopted (ABS, 2006c). Additional detail regarding the measures adopted for the investigations in this thesis are described in subsequent chapters, but follow the conceptualisation described here.

**Exercise and fatigue**

One older study investigated the outcomes of an exercise intervention in 75 female shiftwork nurses aged 20 to 49 years (Harma, Ilmarinen, Knauth, Rutenfranz, & Hanninen, 1988a; 1988b). A moderate level of jogging, walking, swimming and gymnastics was prescribed from two-to-six times per week over a four-month period. Based on a matched-pairs design, a range of self-report and physical parameters were measured both before and after the training period. Compared to the control group, the training program resulted in decreased fatigue during nightshifts, reduced general fatigue and sleepiness over the shift cycle (from 21 to 4-percent), increased alertness on evening shifts, and a reduction in musculoskeletal problems. A regime of regular moderate level physical exercise was recommended for shiftworkers, although planning for regular engagement in such activities around an already disrupted lifestyle, altered sleep-wake cycle and rotating rosters were considered to be potential barriers to adherence.

**Exercise and mental health**

A substantial amount of evidence also supports the beneficial role of exercise on mood states and especially depression (Byrne & Byrne, 1993).
Another intervention study demonstrated the positive effect of an aerobic fitness-training program on depression for individuals who felt that they experienced ‘difficulties’ during the dark winter months in Helsinki (Leppamaki, Partonen, & Lonnqvist, 2002). Physical training programs were conducted two-to-three times per week over a one-hour period with 160 participants aged from 22 to 63 years. After eight weeks, scores on the Hamilton Depression Rating Scale were significantly reduced, and a marked reduction found in levels of morning fatigue and increased need for sleep. The authors concluded that physical exercise was effective for alleviating depressive symptoms and other health-related quality of life outcomes.

*Exercise as an intervention*

Although the empirical work reviewed here lends support for the efficacy of physical exercise as an intervention for low mood and fatigue, its potential for improving these parameters in shiftworkers remains poorly investigated. However clinicians and organisations have also been reluctant to consider exercise as a treatment approach for the general population (Daley, 2002). This is surprising given that regular daily activity is a major factor in preventing chronic diseases and can provide a wide range of physical, social and mental health benefits (World Health Organisation, 2006). From the limited work that does exist in shiftwork populations, exercise has been noted as one of the few leisure activities that may promote tolerance and improve long-term favourable outcomes including reduced levels of fatigue (Atkinson & Davenne, 2006; Harma, 1996). Indeed there is also evidence that bouts of exercise can phase-shift the circadian clock in animals as well as humans (Yamanaka et al. 2006), raising the possibility that timed exercise might be used as a means for
improving circadian adaptation to changing shiftwork cycles. Reviewers have called for research to establish specific exercise guidelines, especially in regards to timing around the sleep-wake cycle and disrupted lifestyle, however no study has measured actual exercise behaviours in a large shiftwork population and its relationship with other behavioural indices such as sleep quality and fatigue. This information would be useful to inform the development of practical intervention strategies in particular.

Organisational shift scheduling

Whilst the preceding discussion has focussed on variables associated with the individual worker, organisations can also influence health-related shiftwork outcomes through shift scheduling or roster design. The potential permutations and combinations of different shift structures are clearly numerous, which creates some level of difficulty in producing definitive answers. Despite such challenges, a recent systematic review of 26 organisational intervention studies (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008a) identified that the speed and direction of shift rotation, and level of personal choice in the work roster offered the most beneficial outcomes for workers. Changing from slow to fast shift rotations produced positive effects on sleep and fatigue, possibly because of better alignment with the natural circadian cycle. A smaller effect was also noted for improvements in work-life balance. Forward rotating rosters (morning, afternoon, night) were particularly beneficial for sleep and subsequent health outcomes; again because of alignment with the circadian cycle as it delays phase to re-entrain to an altering schedule. Finally, health, work-life balance, and organisational effectiveness were improved when workers could self-schedule their rosters.
Problems associated with night work

A common component of shiftwork is the requirement to participate in night work, which is consistently associated with adverse health outcomes in workers. Although the associated problems have already been presented in the circadian section of this review, they are relevant again to the present focus on organisational rostering. In brief, night work has been associated with sleep disturbances, premature awakenings from day sleep, sleepiness and fatigue, longer-term physical health symptoms, and poor mental health status (Pallesen et al. 2010). Given that some organisations are likely to depend on night work (e.g. emergency services), the main options for work arrangements are fixed versus rotating shifts.

Despite limited support for fixed shifts (see Bambra et al. 2008a), two recent studies have suggested that neither structure offers any advantage over the other. First, Folkard (2008) investigated the notion that fixed night shift rosters may reduce some of the associated adverse health outcomes through more complete circadian adaption. On the basis of previous studies, it was found that less than three-percent of workers showed complete circadian adaption to night work, and less that 25-percent adapted at any substantial level, suggesting no benefit for fixed versus permanent shift rostering. A second study also based on pre-existing work (Sallinen & Kecklund, 2010) concurred that there was no evidence to differentiate these shift structures on measures of tolerance or health outcomes and suggested that the choice should rest with the individual worker.
The compressed working week

It is also common for organisations to structure shiftwork rosters in accordance with a compressed working schedule. This working arrangement describes a system whereby the hours worked per shift are increased (commonly to 12-hours), whilst the number of days worked per week is decreased (Bambra et al. 2008b; Wallace & Greenwood, 1995). For example, a near-fulltime working week could be achieved by working three consecutive twelve-hour shifts, although multiple combinations are clearly possible.

It appears that the notion of a compressed working week gained popularity in the early 1990s. Wallace and Greenwood (1995) published an editorial that discussed the potential pros and cons of this shift system in response to growing concerns about the potential impact of extended shifts on worker health. While 12-hour extended shifts were highlighted as offering several benefits associated with time away from work, it was suggested that the consecutive number of shifts be limited to four, as the 12-hour period between shifts allows little time for travel, eating, sleep and family time. Furthermore, certain job roles were identified as potentially unsuitable for extended shifts, especially under conditions of high mental or physical demand, and where noise, heat, cold or other environmental parameters may prove problematic under extended exposure. The final recommendations were to limit compressed working week systems and 12-hour shifts to carefully considered situations where benefits in terms of reduced fatigue and improved quality of life could be reasonably predicted.

Concerns regarding the potential health impact of extended shifts have also generated several empirical investigations, although contrary to
dire predictions, most have observed negligible effects. In an empirical study of 92 police shiftworkers, Smith, Hammond, Macdonald, & Folkard (1998) sought to examine the effects of changing from 8-hour to 12-hour shift lengths. Following a 6-month trial period, few substantial differences were identified between the control (8-hour shifts) and two experimental (12-hour shifts) groups, suggesting neither detrimental nor beneficial effects. However, significant differences were observed on measures of sleep quality and alertness between the two experimental groups, which differed on the ability for workers to negotiate their rosters. Flexibility and choice of working time were determined as the only significant factors to predict the impact of rosters on individuals in this study. Note that these findings are consistent with those reported by other investigators (Axelsson, Akerstedt, Kecklund, & Lowden, 2004; Bambra et al. 2008a). Another study of 24 fire fighters investigated differences between a slow backward rotating shift system based on 8-hour shifts, and a compressed and fast forward rotating structure comprising two 10-hour dayshifts followed by two 14-hour night shifts. No significant adverse effects were detected on measures of fatigue, mood or sleepiness on this latter roster. Consistent with the findings reported by Smith et al. (1998), the compressed working week was deemed to offer an acceptable option with negligible impact on worker health.

A more contemporary systematic review of the compressed working week (Bambra, et al. 2008b) examined outcomes for shiftworkers based on the findings of 40 studies. The overall results suggested that while the compressed working week did not improve the self-reported health of shiftworkers, there appeared to be no consistent detrimental effects. In
particular, expectations of increased fatigue were not met as the majority of studies showed no effect on this measure, and three reported a slight reduction in fatigue levels. The majority of studies reported an improvement in work-life balance following the introduction of a compressed working week, especially on measures of time available for recreation, time spent with family, and reduced work-home conflicts. Whilst these results should be viewed with some caution due to methodological inconsistencies (and a lack of attention to the specific effects of night work), the overall findings suggested that a compressed working week might offer either negligible or slightly positive effects on worker health and well-being.

Conclusions and recommendations

From the foregoing, it is clear that organisation-determined parameters have considerable potential to mediate sources of occupational distress. The evidence-based conclusions documented by Bambra et al. (2008a) appear to offer the most practical recommendations for organisations by suggesting beneficial guidelines for the speed and direction of shift rotation, and the ability for workers to self-select or negotiate their own shift rosters. At the same time, none of the studies reviewed here suggested a shiftwork structure that is free from adverse outcomes for workers.

Models of shiftwork

Based on the strength of the evidence suggesting a causal association between shiftwork and adverse health outcomes, several conceptualisations of the shiftwork-illness pathway have been offered through theoretical models (Smith et al. 1999). Earlier attempts offered a simple linear representation from shiftwork, to circadian disruption, to poor
health outcomes (Taylor, Briner, & Folkard, 1997). As an example, Rutenfranz, Knauth, and Angersbach (1981) proposed that shiftwork acts as an objective stressor that results in changes or disruptions to circadian rhythms (especially the sleep-wake cycle) that lead to subjective strain, as evidenced by the development of health problems. Intervening variables such as personality, family situation and physiological adaptability were posited to mediate outcomes in the stress-strain pathway at an individual level. An extension to this model (Olsson, Kandolin, & Kauppinen-Toropainen, 1990) incorporated the concept of appraisal and coping in a stressor-strain framework whereby shiftwork forms only one of several job related stressors hypothesised to influence health. In addition to occupational factors such as shiftwork and time pressure, non-occupational stressors such as family/social disruption contribute to the development of illness and are affected by appraisal and coping. Inappropriate or unsuccessful attempts at coping are hypothesised to result in mental and physical illness.

Another model (Haider, Kundi, & Koller, 1981), informed by the Rutenfranz’s et al. (1981) stress-strain approach, conceptualised shiftwork as a destabilising influence on the equilibrium maintained amongst the domains of sleep, attitudes towards shiftwork, and social elements. Adverse health outcomes were thought to result directly from disruptions to any one of these domains, or from poor coping responses. For example, Haider et al. identified an association between difficulties in fulfilling expected family/social roles because of shiftwork, and psychosomatic symptoms.

Ongoing work grew increasingly more complex, but maintained a focus on
the role of sleep disruption, circadian functioning, social domains and attempts at coping (e.g. Monk, 1988).

While several theoretical conceptualisations are evident amongst the various past models, one commonality is evident: shiftwork leads to disrupted sleep and long-term health problems, and moderating or mediating variables influence response at an individual level. Despite much theory, these earlier models drew criticism for the lack of empirical work underpinning their origins. Smith et al. (1999) claimed that most were generated from the general beliefs of the shiftwork community, and served only as heuristic frameworks to guide ongoing research.

Later conceptualisations

It is generally accepted that empirical testing of these theories commenced with a model of shiftwork proposed by Barton et al. (1995) and statistical path analysis based on a large shiftwork sample. Barton’s model posited that specific features of the shift system disrupt biological rhythms, sleep and family life, and that situational and individual differences act to moderate adverse effects. Acute disturbances result in longer-term effects on mental and physical health in a defined temporal order. This effort produced the Standard Shiftwork Index (SSI), which comprises a battery of instruments aimed at assessing these domains in shiftwork populations. The SSI and abridged versions has been adopted internationally for the assessment of shiftwork related outcomes since its publication (Tucker & Knowles, 2008).

Ongoing adaptations of the model by Barton et al. (1995) produced the process model of shiftwork (Smith et al. 1999). This restructure was considered a mid-range model as it tested a narrower and more focused
theory than the original model (as suggested by Taylor et al. 1997). Based on the same sample as Barton et al. this later conceptualisation tested an expanded stressor-strain framework by examining factors in the environment and person that could influence disturbances in sleeping and social/family life for shiftworkers. According to the model, the stress resulting from these disturbances generates coping attempts, which if ineffective, lead to short and long-term adverse health outcomes. The authors claimed that the process model could potentially be generalised to other samples on the basis of acceptable fit statistics. This model not only indicated that sleep disturbance should form a primary focus for shiftwork interventions (a finding common to most), but also raised the roles of non-work disturbances and ineffective coping attempts in the development of ill health.

The need for ongoing work

While this review of theory and evidence suggests that a range of parameters may contribute to the shiftwork-illness association, a universally agreed model is yet to be determined. Unfortunately, the conceptualisation of models of shiftwork appears to have largely ceased in the late 1990s (with notable exceptions such as Smith et al. 2005) despite a growing number of shiftworkers being represented in the international workforce (ABS, 2006a). Recent reviews of this situation concur with the need for ongoing attention, with a focus on specific health outcomes in known shiftwork conditions and subsequent interventions sensitive to the needs of a particular occupation (Harma & Kecklund, 2010).
Methodological concerns

The preceding sections of this review have highlighted methodological concerns that apply to much of the published shiftwork literature. Despite criticisms being raised for more than a decade (e.g. Taylor, et al. 1997), ongoing investigations have frequently failed to acknowledge calls to address important elements of research design that subsequently impose significant limitations on reported findings. This viewpoint receives strong support in a recent editorial (Harma & Kecklund, 2010) titled ‘Shiftwork and health: How to proceed?’ The authors raised several key areas that have limited the quality of published studies to date. Exposure assessment was of particular concern, which describes the measurement of the number of shiftwork hours worked by individuals, and is often ignored. While researchers set out to establish large sample sizes and gather representative data for a given population to underpin statistical analyses, if samples are expanded without concurrently improving exposure assessment, the estimation of shiftwork-exposed individuals only grows weaker. As such, it was considered vital to record the precise characteristics of the type of shift worked (fixed vs. rotating), level of exposure to night shift, speed and direction of shift rotation, and the timing of each shift.

A systematic review of health outcomes in ambulance workers (Sterud et al. 2006) highlights the manner in which methodological drawbacks can limit findings. While evidence was found across 49 studies to suggest high rates of fatigue, psychopathology, poor sleep and other health problems in ambulance workers, no clear conclusion could be established because of the many small, loosely defined and non-representative samples. Furthermore, some studies included mixed occupations with
clearly different work roles (e.g. fire-fighters and paramedics), failed to define the nature of ambulance work (e.g. medical transport vs. attending critical incidents), or did not consider the impact of regional differences (e.g. urban vs. rural). Particularly strong criticisms were raised regarding the lack of comparison of symptomology and prevalence of health disorders against relevant population norms. Finally, the healthy-worker effect (as discussed throughout the present work) has generally been ignored (see also Pallesen et al. 2010).

The need for intervention studies

Critical reviews of the shiftwork literature (e.g. Harma & Kecklund, 2010) have also identified a need for intervention studies. In examining associations between sleep-wake cycles in workers and different shift schedules, Sallinen & Kecklund (2010) considered the lack of intervention studies in this area as a crucial limitation. No randomised controlled intervention studies were located for any of the included shift system categories, and many exiting methodologies were considered to lack integrity. Earlier reviewers (Taylor et al. 1997) had also called for a focus on specific health outcomes in specific shift systems and occupational sectors, however subsequent work has not always adhered to these recommendations, contributing perhaps to the more recent methodological concerns already discussed. In sum, consistent concerns related to a range of methodological shortcomings appear to have limited our contemporary understanding of the causal mechanisms underlying the shiftwork–illness relationship. Adoption of more robust research procedures may improve matters in future studies.
Conclusions and Rationale for Current study

To conclude, this first chapter has presented a comprehensive and critical review of published literature that has underpinned shiftwork investigation for at least the past two decades. Furthermore, contemporary matters likely to guide ongoing research have been included, along with suggestions for methodological improvements. The diverse topics covered here encompass parameters of physiological, biological, psychological, behavioural, situational, and organisational functioning. As such, one can reasonably conclude that understanding and predicting responses to shiftwork will require a multidimensional approach. However, calls for investigations focussed on individual occupational groups, under known conditions of shiftwork exposure, and aimed at well-defined health outcomes (Harma & Kecklund, 2010; Taylor et al. 1997) is likely to be a more productive way forward compared to the replication of established knowledge and quantification of known problems ongoing.

Thesis outline

The central focus of this thesis is chronic fatigue and mental health in paramedic shiftworkers. While continuing concerns have been documented in the literature for this occupational group, the health status of paramedics remains poorly represented in shiftwork investigation, and past studies are often limited by methodological confounds as already highlighted. Given the vital role of these workers in delivering 24-hour emergency healthcare services to the community, the present research sought to progress several specific areas of concern through empirical enquiry, to establish methodologically sound and occupationally relevant data, and to also identify potential areas for future research efforts.
As discussed in detail in the foregoing, the notion that shiftworkers suffer from sleep loss and elevated fatigue is widely acknowledged in the shiftwork literature (see Akerstedt, et al. 2007; Akerstedt, 1998; Sallinen & Kecklund, 2010). Furthermore, there is substantial evidence to conclude a causal relationship between these variables to the extent that (incorrect) reference is sometimes made to sleep loss and fatigue as a single outcome in the literature (e.g. Baldwin & Daugherty, 2004). The extent of this issue as a potential occupational outcome was highlighted in at least one study of ambulance workers that observed fatigue at a level considered to pose a significant risk of work disability and sick leave in personnel (Van Der Ploeg & Kleber, 2003). While the association between shiftwork and fatigue has been well documented, other parameters potentially associated with fatigue (e.g. mental health) remain poorly understood or relatively unexplored scientifically.

These apparent deficits in the existing literature contributed to the impetus for the present investigation and also underpinned the rationale for the research. On the basis of theoretical predictions and past empirical findings, Study 1 and Study 2 (presented here as Chapters 2 and 3) investigated sleep quality, chronic fatigue, indices of mental health, and physical exercise in metropolitan and rural ambulance paramedic shiftworkers respectively. Age and gender were also examined for their potential role in predicting individual response to shiftwork rostering. As already noted, Study 1 has been published (Courtney, Francis, & Paxton, 2010) and has since attracted media attention for the potential benefits that the findings might hold for paramedic shiftworkers. Study 2, which was
novel with respect to rural paramedics, is also intended for publication and will be submitted for peer review in due course.

Study three (presented as Chapter 4) sought to advance past attempts at modelling health outcomes in shiftworkers. Based on theoretical predictions and previous conceptualisations, a path model was hypothesised that included novel pathways and interrelationships. Of particular note, indices of mental health were included as mediating variables and individual circadian differences as moderating variables. Given that similar work has been lacking over the last decade, this work represents a contemporary advance in the area and identifies potential points of intervention and prevention found to be relevant to the health status of workers. This third manuscript was also written for peer review and publication.

A short Addendum is provided after Chapter 4 that describes the data cleaning procedures adopted for the three empirical investigations. Due to publication requirements, this detail was condensed into a single short paragraph in each of the manuscripts (Chapters’ 2 to 4) but is included in the form of an addendum in the thesis for the sake of completeness.

Chapter 5 comprises a general discussion and synthesis of findings from the three preceding empirical investigations. Given that these studies were written for publication, there was a necessary conciseness and brevity in relation to the material included in each. The opportunity is taken to expand discussion on specific topics, and to present analyses and/or data that were previously excluded or considered less relevant in the context of the focussed empirical manuscripts. This chapter also offers the first opportunity to discuss and compare differences between the metropolitan and rural samples. The theoretical and practical implications of the work
overall is considered and discussed. Methodological limitations that apply to
the investigation of shiftwork generally are then reviewed and compared to
the methodology underpinning the present work. Next, limitations of the
research in general are discussed followed by the potential direction of
future research in this area. Finally, conclusions that can be drawn from this
body of research are presented.
References


Folkard, S. (1987b). Circadian Type Inventory. Sheffield, United Kingdom: University of Sheffield, Department of Psychology.


with a working system of 24-h shifts. *International Archives of Occupational and Environmental Health, 79*, 27-32.


Chapter 2: Caring for the Carers: Fatigue, Sleep and Mental Health in Australian Paramedic Shiftworkers.

James Courtney
School of Psychological Science, La Trobe University, Australia

Associate Professor Andrew Francis
Division of Psychology, RMIT University, Australia

Professor Susan Paxton
School of Psychological Science, La Trobe University, Australia

The Australian and New Zealand Journal of Organisational Psychology
Submitted: 14 September 2009; Final revision: 2 October 2010; Accepted 10 August 2010
Abstract
This study investigated fatigue, sleep quality, mental health and physical activity in paramedic shiftworkers. Although limited, previous studies have established high fatigue levels and poor health in this sector from shiftwork rostering and occupational demands. A modified version of the Standard Shiftwork Index was completed by 342 paramedics (243 male and 98 females). Single sample $t$-tests found significantly higher levels of fatigue, depression, anxiety, and stress, and significantly poorer sleep quality than reference samples. Paramedics also reported less physical activity than community samples. Depression and sleep quality explained the greatest amount of variance in fatigue scores, followed by level of exercise. No differences were detected in levels of depression or fatigue on the basis of gender. The findings suggest that ambulance paramedic shiftworkers are at particular risk for increased levels of fatigue and depression (regardless of age or gender) and poor quality sleep. Organisational intervention was suggested.
Caring for the Carers: Fatigue, Sleep and Mental Health in Australian Paramedic Shiftworkers

Recent population analyses show a growing trend towards shiftwork in the community, with around 17 percent of the Australian workforce (1.4 million employees) working ‘non-standard’ hours (Australian Bureau of Statistics [ABS], 2006a). By industry, healthcare providers such as doctors, nurses, and ambulance paramedics were amongst those most highly represented (ABS, 2003; ABS, 2006b). As shiftwork is widely acknowledged to adversely impact multiple domains of biopsychosocial functioning, it is important to determine the consequences for these workers given their vital role in the community. The present work focuses on ambulance paramedic shiftworkers who provide 24-hour pre-hospital emergency treatment and medical transport, typically through rotating rosters and nightshifts (Pease & Raether, 2003).

It is well established that shiftworkers experience significant sleep loss and fatigue, particularly those working at night (Akerstedt, 1998; Sallinen & Kecklund, 2010). Whilst studies have assessed doctors and nurses in this respect, the investigation of ambulance paramedics is limited despite concerns about occupational health problems in these workers (Bennett, Williams, Page, Hood, & Woollard, 2004). In a study of 123 Dutch ambulance workers (Van der Ploeg & Kleber, 2003) the authors considered 10 percent of respondents to be at risk of sick leave or work disability through elevated fatigue levels. Another study of paramedics rostered to a dispatch centre (Hussey, Baker, & Holmes, 2001) also reported elevated fatigue in workers, especially for staff working consecutive 14-hour nightshifts. However a broader review (Sterud, Ekeburg, & Hem, 2006)
failed to establish reliable prevalence rates for fatigue in ambulance workers, pointing to methodological limitations such as small and non-representative samples, and a lack of comparison with population norms in existing studies. Along with existing evidence, this suggests the need for further investigation to establish clearly the prevalence and predictors of fatigue in this occupational sector.

Concerns have also been raised about mental health disorders in ambulance workers. In a mental health survey of 560 UK ambulance workers (Bennett et al. 2004), nearly 10 percent of respondents reported clinical levels of depression, and 22 percent clinical levels of anxiety. The authors considered these figures to represent general prevalence rates, but noted a lack of comparison with normative data. Although ambulance work is considered stressful, the assessment of stress in personnel is limited and often based on temporal changes in physiological markers and small samples (e.g. Aasa, Kalezic, Lyskov, Angquist, & Barnekow-Bergkvist, 2006). A nationwide study of Norwegian ambulance personnel (Sterud, Hem, Ekeberg, & Lau, 2008) identified significant organisational and occupational stressors for workers, but did not assess psychological stress. Based on the existing evidence, Sterud et al. (2006) concluded that up to 20 percent of ambulance personnel might suffer from mental health problems. As emergency care relies on critical decision-making and the peak cognitive functioning of staff, further investigation is required to establish levels of psychopathology, and to determine risk levels based on statistical comparisons with normative data.

Age, gender and physical exercise have been identified as potential predictors of shiftwork related heath outcomes. The role of gender is poorly
understood given that most studies report inconclusive findings (e.g. Ashberg, Kecklund, Akerstedt, & Gamberale, 2000). Bennett et al. (2004) failed to establish any relationship between gender and depression or anxiety in 560 UK based emergency ambulance workers, but cautioned that females were under-represented in the sample. Experienced shiftwork investigators have proposed that females may suffer from higher sleep problems and chronic fatigue through the difficulties encountered in combining irregular working hours with additional domestic and family obligations (Costa, 2003; Harrington, 2001), although robust empirical support for this relationship is still lacking. It is possible that female (and male) shiftworkers self-select to work irregular hours based on their resources and ability to cope (Boivin, Tremblay, & James, 2007), and that factors related to occupational status and culture might contribute to inconsistent findings and limit the broader predictive value of gender. This highlights the need for ongoing investigation and sound methodology to establish the potential role of gender in determining shiftwork related outcomes.

Contrasting opinions also exist as to whether increasing age either ameliorates or compounds adverse health outcomes in shiftworkers. Changes in sleep-stage physiology and disruption to the sleep-wake cycle have been cited as potential health risks for shiftworkers aged 40 years and older (Costa, 1996; Monk, 1994; Ognianova, Dalbokova, & Stanchev, 1998). The alternative position is that humans require less sleep with advancing age, which infers that age might act as a protective factor for older shiftworkers (Harma, 1996). These arguments are based on robust circadian theory, but empirical investigations have nevertheless failed to
establish age as a clear predictor of shiftwork-related health outcomes (e.g. Ruggiero, 2003). One possibility is that a process of ‘self-selection’ occurs for shiftworkers generally, resulting in a cohort with adaptive sleep behaviours (Boivin, et al. 2007; Knutsson & Akerstedt, 1992). Given the lack of empirical evidence for either circadian argument, further evidence is required to establish whether age is a predictor of health outcomes \textit{per se} in shiftworkers, or whether other (possibly behavioural) parameters might be more influential.

Several investigators have posited that physical exercise may mediate individual responses to shiftwork (e.g. Atkinson & Davenne, 2006), however only one shiftwork study was located that reported decreased fatigue and sleepiness in nurses following an exercise intervention (Harma, Ilmarinen, Knauth, Rutenfranz, & Hanninen, 1988a; 1988b). Physical exercise is known to alleviate depressive symptoms for individuals with seasonal affective disorder, and reduce morning fatigue and the need for sleep (Leppamaki, Partonen, & Lonnqvist, 2002). Regular physical activity also plays a protective role for a wide range of health domains in the general community (World Health Organisation, 2006) and a substantial amount of evidence supports the beneficial effect of exercise on mood states; particularly depression (Byrne & Byrne, 1993). On this basis, it seems reasonable to predict that exercise could assist in managing the health-related consequences of shiftwork. Given the lack of prior research for this variable, there is a need to first establish levels of exercise behaviour in shiftwork populations, examine relationships with other behavioural indices, and then potentially develop specific exercise recommendations for these workers.
Whilst discussion so far has focussed on variables associated with the individual worker, organisational shift scheduling can also influence outcomes. A systematic review of 26 organisational intervention studies (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008) identified that fast rotations (e.g. three or four consecutive shifts) and forward rotating rosters (morning, afternoon, night) produced positive effects on sleep and fatigue. Work-life balance, and organisational effectiveness were also improved when workers could influence their own work hours. Other investigators have associated extended shifts (more than eight hours) with elevated fatigue, and increased risk of accidents and health problems in the work place (Paley, Price, Tepas, 1998; Pallesen, et al. 2010). Nightwork is considered to be particularly problematic in terms of adjustment and tolerance, and is associated with episodes of involuntary sleep and increased sleepiness at work that extends to days off (Akerstedt, 1998; Sallinen & Kecklund, 2010). Clearly organisation-determined parameters have considerable potential to mediate sources of occupational distress.

While these investigations provide useful knowledge, many studies are methodologically limited by a lack of attention to the specific characteristics of the shift roster. This confounds the assessment of shiftwork exposure in a given sample and remains one of the most limiting factors in shiftwork research (Harma & Kecklund, 2010). These concerns, along with several other methodological issues, were highlighted in a review of health outcomes in ambulance workers (Sterud et al. 2006). Although evidence was found across 49 studies to suggest high rates of fatigue, psychopathology, poor sleep and other health problems in ambulance workers, no clear conclusion could be established because of the many
small, loosely defined and non-representative samples. Sterud et al. (2006) advocated strongly for the reporting and comparison of larger sample ambulance data against population norms.

The present investigation examines shiftwork related health variables in paramedics working for the Metropolitan Ambulance Service (MAS) in Melbourne, Victoria. These workers participate in shiftwork as part of a normal career structure and typically work a ‘10/14’ roster: two ten-hour dayshifts, followed by two fourteen-hour nightshifts and four days off (commencing after the second nightshift). This structure has existed for at least 30 years in MAS and grew from the need to provide 24-hour emergency services to the community. Based on the literature reviewed here, the nature of the shiftwork roster and requirement to work nightshift likely pose significant health risks for these paramedics.

The following hypotheses were formulated:

1. Paramedic shiftworkers will report elevated levels of fatigue, depression, anxiety, and stress, and poorer sleep quality compared to other reference samples.

2. Fatigue in paramedic shiftworkers will be positively correlated with depression, anxiety, stress, and age, but negatively correlated with level of exercise and sleep quality; and that at least some of these variables will explain a significant amount of variance in chronic fatigue scores.

3. No significant gender difference will be detected for mean scores of depression and fatigue.

This study also aimed to establish normative data on the major study variables for publication and comparison with selected reference groups.
Method

Participants

Emergency ambulance paramedics were recruited from the MAS in Melbourne, Victoria. Participation was voluntary and limited to active personnel who routinely worked a 24-hour roster cycle with a nightshift component. It was expected that most paramedics meeting this criteria would be working the 10/14 roster previously described. A sample of 128 participants was required to satisfy planned analyses based on a moderate effect size ($r = .30$), a significance level of .05, and a power of .80 (Cohen, 1992).

Completed surveys were returned by 342 respondents, or around 35 percent of the 990 paramedics estimated to meet inclusion criteria (MAS, 2006/2007; S. McGhie, personal communication, September 12, 2006). The response by gender of 243 males (71 percent) to 98 females (29 percent) was consistent with the 2.5 to 1 male to female ratio for operational personnel (MAS, 2006/2007), therefore producing a gender representative sample. Eighty percent of respondents worked the 10/14 roster and the remainder worked a roster with a nightshift rotation.

Materials

Shiftwork. A modified form of the Standard Shiftwork Index (SSI; Barton, et al. 1995) was administered, which comprises a battery of instruments to assess shiftwork-related outcomes in workers. Measures of psychological distress and sleep were substituted with instruments considered more satisfactory, and a measure of physical exercise inserted (see following sections). A Chronic Fatigue Scale (CFS) was specifically constructed for the SSI, which conceptualises fatigue as a general tiredness
and lack of energy irrespective of whether an individual has not had enough sleep or has been working hard, and which persists even on rest days and holidays. A score ranging from 10 to 50 is produced with a higher score indicating more fatigue. Barton et al. (1995) found the validity and internal reliability of the CFS ($\alpha$ from .91 to .93) to be satisfactory in a sample of shiftwork nurses and industrial workers.

CFS data was selected from three previous shiftwork studies for statistical comparison, as normative data has not been established in community samples. Barton et al. (1995) published chronic fatigue scores for 1532 shiftwork nurses (mean age 33.2 years; 91.8 percent female) and 332 industrial workers (mean age 39.2; 6.9 percent female). Ruggiero (2003) reported data based on 142 female shiftwork nurses aged from 28 to 63 years ($M = 44.9$, $SD = 8.3$). Iskra-Golec, Folkard, Marek, and Noworol (1996) also reported fatigue data on female shiftwork nurses, but in a more restricted age range of 20 to 32 years ($M = 25.96$, $SD = 3.75$).

**Depression.** The Depression Anxiety Stress Scales 21 (DASS21) were used to measure the emotional states of depression, anxiety and stress (Lovibond & Lovibond, 1995). Seven items on each of the three scales were summed to obtain an overall score for each state. The psychometric properties of the DASS21 were found to be satisfactory by Henry and Crawford (2005) in a non-clinical population ($N = 1,794$). Alpha values for reliability were: Depression 0.81; Anxiety 0.73; and Stress 0.81 (Lovibond & Lovibond, 2004).

Normative data for the DASS is limited, but three studies were located for statistical comparison. A study that closely matched census data for the Australian population (Taylor, Lovibond, Nicholas, Cayley, & Wilson, 2005)
published DASS scores for 219 males and 272 females (age $M = 42.3$, $SD = 17.7$). Henry and Crawford (2005) also published DASS scores for 979 female and 815 male members of the general UK population (age $M = 41.0$, $SD = 15.9$). Normative data from the DASS manual (Lovibond & Lovibond, 2004), derived from six samples comprising 1044 males and 1870 females aged 17 to 69 years, was also selected for comparison to the current sample.

**Quality of sleep.** Quality of sleep was assessed using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI generates component scores for seven domains of sleep quality that are summed to obtain a maximum achievable score of 21, indicating the highest level of sleep disturbance. The PSQI was normed on 52 healthy, 34 depressed and 62 sleep disordered participants and demonstrated sufficient internal reliability ($\alpha = .83$) and validity (Buysse et al. 1989).

Although normative data for statistical comparison was again limited, the authors of the PSQI (Buysse et al. 1989) published scores for a control group of 52 healthy sleepers comprising 40 males and 12 females aged 24 to 83 ($M = 59.9$). Piperno and Francis (2008) also collected local community data from 84 males and 138 females aged 18 to 66 ($M = 32.5$, $SD = 13.5$). Ruggiero’s study of shiftwork nurses has already been described and also produced PSQI scores in a sample of shiftwork nurses.

**Physical activity.** Estimates of physical activity were obtained using the International Physical Activity Questionnaire – Short Form (IPAQ; The International Consensus Group for Physical Activity Measurement). IPAQ data was reported as the ratio of the work metabolic rate for each type of
activity to the resting metabolic rate (termed METs) derived as follows: Walking = 3.3 METs, Moderate Physical Activity = 4.0 METs, and Vigorous Physical Activity = 8.0 METs. MET-minutes/week were calculated by multiplying the duration (in minutes) and frequency (in days) of each activity type by its corresponding MET value. Results were summed to obtain a total score based on median values. Craig et al. (2003) found the validity the IPAQ to be acceptable in a 12-country study, and reported test-retest reliability correlations of around 0.8.

Only two studies were identified as suitable for statistical comparison. Craig et al. (2003) published data for the IPAQ - Short Form for a community sample comprising 1974 males and females across 12 countries. Participants ranged in age from 18 to 65, with a predominantly middle-aged mean in each sample. Scores from a local community sample (described above; Piperno & Francis, 2008) were also considered useful.

Procedure

Ambulance Employees Australia (AEA) managed the distribution of 930 surveys to 93 MAS Branches across Melbourne between July and November 2006. Awareness of the study was enhanced through announcements and reminders, and the survey was also made available on the AEA intranet. Participation was voluntary and the survey took around 25 minutes to complete. This study was not limited to AEA members; however AEA membership was reported to be at 90 percent for paramedics at the time of data collection (S. McGhie, personal communication, September 12, 2006). No further arrangements were entered into with AEA. Statistical analyses were performed using SPSS version 15.0.
Results

Distributions of all variables were judged adequate in terms of normality, linearity and homoscedacity. Data were also examined for outliers, missing values and data entry errors. Corrections were made to the IPAQ in accordance with specific data cleaning instructions that resulted in the removal of 15 cases due to missing respondent data.

Mean scores for chronic fatigue are shown in Table 1. An independent samples $t$-test found no significant gender difference; $t$ (335) = -.23, $p$ = .82. A single sample $t$-test found significantly higher chronic fatigue scores in the paramedic sample compared to a group mean calculated from the three other shiftwork studies also shown in Table 1; $t$ (337) = 6.56, $p$ < .001, $d$ = .36. The internal consistency of the 10 item scale was estimated as .94 using Cronbach’s alpha.

**TABLE 1**

Mean scores obtained on the DASS21 scales are shown in Table 2. An independent samples $t$-test found no significant gender difference on scores of depression; $t$ (338) = 1.60, $p$ = .11. Table 3 shows the percentage distribution of scores by clinical severity for the paramedic sample in accordance with data published in the DASS Manual (Lovibond & Lovibond, 1995). The paramedic sample reported rates above the normal range for depression (36.1%, $n$ = 123), anxiety (24.6%, $n$ = 84) and stress (39.3 %, $n$ = 134). Single sample $t$-tests found the paramedic sample reported poorer mental health relative to group means derived from the three non-clinical community samples (Table 2) on all three scales; depression, $t$ (340) = 6.70, $p$ < .001, $d$ = .41, anxiety, $t$ (340) = 3.07, $p$ = .002, $d$ = .16, and stress, $t$ (340) = 9.30, $p$ < .001, $d$ = .55. Internal consistencies
based on Cronbach’s alpha were .90 for the depression scale, .73 for the anxiety scale, and .88 for the stress scale.

**TABLES 2 & 3**

Paramedics reported a total median score of 2088 MET-minutes/week on the IPAQ – Short Form. This represented 14 percent less physical activity than participants in a 12-country study (Craig et al. 2003; 2514 median MET-minutes/week) and 11 percent less than a local community sample (Piperno & Francis, 2008; 2346 median MET-minutes/week). Internal consistency using Cronbach’s alpha was estimated as .78 based on subscale scores.

Mean PSQI global scores are shown in Table 4 along with data from the three reference groups. Seventy two percent of the paramedic sample reported a global score greater than five; the cutoff score used to identify bad sleepers. A single sample t-test found significantly higher scores in paramedics (indicating poorer sleep) compared to a group mean derived from two community samples; $t (331) = 18.82, p = < .001, d = 1.17$. Paramedics also reported significantly poorer sleep than a sample of female shiftwork nurses again based on a single sample t-test; $t (331) = 2.40, p = .017, d = .13$. Internal consistency using Cronbach’s alpha was estimated as .84 based on individual items (per Buysse et al. 1989).

**TABLE 4**

The data were further analysed for correlations amongst variables, and to address study hypotheses (Table 5). Chronic fatigue was found to have a significant association of moderate to large size with all variables except age.

**TABLE 5**
Multiple linear regression determined the extent to which the six major study variables predicted chronic fatigue. No a priori hypotheses were considered to determine the order of predictor variables, so a direct method was adopted. The six study variables produced an adjusted $R^2$ of .42 for the prediction of chronic fatigue; $F(6, 315) = 39.66, p < .001$. Depression was the most important variable ($\beta = .34, p < .001$), followed by global sleep quality ($\beta = .32, p < .001$) and total METs ($\beta = -.14, p = .001$). The remaining variables did not contribute significantly; anxiety, $\beta = .004, p = .94$, stress, $\beta = .10, p = .08$; age, $\beta = -.07, p = .12$. Squared semi-partial correlations were also determined for each of the significant predictor variables: depression $sr^2 = .06$, global sleep quality $sr^2 = .08$, and total METs $sr^2 = .02$.

Discussion

This study investigated psychobehavioural correlates of fatigue in ambulance paramedic shiftworkers. Compared to reference samples, paramedics reported higher levels of fatigue, depression, anxiety, and stress, and poorer sleep quality, thus supporting the first hypothesis. The second hypothesis was partially supported as fatigue was positively correlated with depression, anxiety, and stress, and negatively correlated with level of exercise and sleep quality. However the relationship between fatigue and age was weak and nonsignificant. Depression and sleep quality explained the greatest variance in fatigue scores, followed by physical activity. The third hypothesis was supported as no gender difference was detected on mean scores of depression or fatigue.

Elevated fatigue levels in ambulance workers reported in previous studies (e.g. Van der Ploeg & Kleber, 2003) are corroborated in this
The majority of the sample worked at least 48-hours per week (two ten-hour dayshifts and two fourteen-hour nightshifts), with additional hours also accrued through early arrivals to assist with shift changes, and late call-outs that result in overtime. Extended shift lengths are known to be inherently fatiguing, and workers in the current sample were required to sustain long hours of alertness across a rotating 24-hour roster whilst delivering emergency care. This contrasts with empirically-based recommendations to limit extended shifts to ‘appropriate’ types of work, and in a system designed to minimise fatigue (Smith, Macdonald, Folkard, & Tucker, 1998). The association between extended shifts and increased workplace accidents (Paley et al. 1998) is also noteworthy in an occupational group who make critical clinical decisions and utilise ‘lights and sirens’ emergency driving skills.

Although paramedic fatigue scores were significantly higher than the three available comparison studies, each of these samples was limited by gender and/or age bias, and mixed roster structures that prohibit an accurate assessment of shiftwork exposure. This highlights the need to investigate variables in relation to a given shift system as recommended by Harma and Kecklund (2010). The methodology adopted for the present study addressed these latter concerns as the majority of the sample worked an identical shift system and all worked nightshift. As such, we suggest that the CFS scores reported by paramedics are representative of occupational fatigue levels as an outcome of a specific shiftwork system. This data may be useful for statistical comparison in future studies.

From an organisational perspective, the shift structure worked by the paramedic group is ‘fast and forward rotating’ which are two important
elements of beneficial shift scheduling predicted by circadian theory (see Bambra et al. 2008). Despite this, the delivery of 24-hour services split over two extended shifts (rather than three shorter shifts) is likely to contribute significantly to accrued worker fatigue and imposes a high and potentially unsustainable demand on cognitive functioning in a challenging work environment, particularly during the fourteen-hour nightshifts (Sallinen & Kecklund, 2010).

Mental health measures in this Victorian paramedic group demonstrated elevated scores on each of the DASS scales compared to reference data. This was expected given that previous studies in ambulance personnel have estimated a 20 percent prevalence for psychopathology (Sterud et al. 2006). Of specific concern, over 10 percent of paramedics reported Severe or Extremely-Severe levels of depression. Bennett et al. (2004) reported a similar prevalence rate for depression in ambulance workers, although these findings were based on the category of ‘probable clinical depression’ (indicating the presence of a mood disorder).

Existing prevalence rates for psychopathology in the ambulance sector are limited by variations in psychometric assessment tools and non-specific psychopathologies. This study established elevated levels of depression, anxiety and stress using a measure that has been validated in both clinical and non-clinical populations. The influence of variations in demographic variables is also small on the DASS21 (Henry & Crawford, 2005). Given the homogenous nature of the paramedic sample in terms of shiftwork exposure, the findings provide initial normative data for ambulance workers that may be more representative than existing datasets. Despite methodological differences, our findings are consistent
with previous concerns (e.g. Bennett et al, 2004) and suggest that Victorian metropolitan paramedic shiftworkers are at increased risk of developing mood disorders compared to the general population. Paramedics reported lower levels of physical activity compared to community samples. It is possible that shiftwork rostering for these paramedics imposes a lifestyle that limits the opportunity for regular exercise and prohibits a commitment to team-oriented sporting activities. No existing studies of physical activity in ambulance workers were located, so the present data is novel in this respect. Given that empirical measurement of exercise in shiftworkers is lacking generally, these findings should be treated as initial. Nevertheless, given the well-demonstrated positive associations between exercise and health generally (World Health Organisation, 2006), these findings provide impetus for further investigation and potential organisational intervention. Associations between exercise and other study variables will be discussed in subsequent sections.

Although poor quality sleep is a well-established outcome of shiftwork, only 30 percent of paramedics were categorised as ‘good sleepers’ which infers that the majority of the group suffered severe difficulties in at least two domains of sleep, or moderate difficulties in more than three (Buysse et al. 1989). No previous investigations of sleep in ambulance workers were located, so these findings contribute initial normative data. Despite paramedics reporting poorer sleep than the shiftwork reference sample (Ruggiero, 2003), the latter group comprised female nurses rostered to permanent rather than rotating shifts which limits a direct comparison between studies. Paramedics also reported significantly poorer sleep than a local community-based sample. This is a useful finding.
given the lack of control group for the current study (Sterud et al. 2006) and, we would suggest, may provide some indication of the level of shiftwork-related sleep disruption in the paramedic sample.

Several elements of the paramedic roster are associated with sleep disturbance and potentially contribute to the present findings of poorer health in the sample. Early morning shifts, quick returns and nightshifts are all problematic in this respect (Sallinen & Kecklund, 2010). The 7am dayshift limits the opportunity for sleep, as workers need to wake early enough to prepare for the day and then commute to branch. The pairing of two 14-hour nightshifts requires a quick ‘turnaround’ that results in a strong exposure to night work, and the intervening period for rest is likely to be reduced by travel time, difficulty sleeping during the day, and social factors. Given that sleep is thought to be a marker of further health problems in ambulance shiftworkers (Sterud et al. 2006) the poor sleep reported by most paramedics is an important finding in this study.

A major interest of the study was to examine the data for associations amongst variables and identify predictors of fatigue. While previous analyses are limited in ambulance workers, investigations in other shiftwork groups (Ruggiero, 2003) report associations between fatigue, and depression, anxiety, and sleep quality of similar magnitude to those reported here. The significant association between exercise and chronic fatigue is novel from an occupational perspective, but is consistent with decreased fatigue following an exercise intervention in nurses (Harma et al. 1988a; 1988b). Exercise has also been associated with a reduction in fatigue in general populations (Leppamaki et al. 2002) and there was no reason to suspect that paramedic shiftworkers would differ in this respect.
The results of the regression analyses demonstrate the significance of depression, sleep and exercise amongst the study variables as predictors of fatigue. Ruggiero (2003) also identified depression and sleep to be the strongest predictors of fatigue in shiftwork nurses using comparable assessment instruments. Other investigation of these variables is limited to demographic reports and bivariate associations, and the role of physical activity for shiftworkers is underrepresented, as already discussed. As such, the current study extends the work of Ruggiero (2003) albeit in a different occupational group, and highlights the role of depression, sleep disruption and exercise in this Victorian metropolitan paramedic sample.

While contrasting arguments have been offered regarding the relevance of age to shiftwork adaption, no significant association was found between age and fatigue in the current sample, congruent with past empirical studies (e.g. Ruggiero, 2003). The demographics of the current sample (age and shiftwork years) were broad enough to permit detection of any potential relationship, but even a fine-grained analysis based on upper quartile data produced non-significant results. Our findings are not inconsistent with the explanation of self-selection, whereby individuals who cope (more or less) with shiftwork remain and those that suffer do not (Boivin, et al. 2007; Knutsson & Akerstedt, 1992), but clearly do not directly inform this hypothesis.

Despite regular literature narrative suggesting poorer health outcomes in female shiftworkers, gender failed to predict differences in depression or fatigue in the current sample. Previous studies of shiftworkers have also failed to observe differences on the basis of gender (Ashberg et al. 2000) and a review of 49 ambulance studies (Sterud et al. 2006)
concluded that the influence of age and gender remain poorly understood. Contrasting arguments are drawn from presumed additional responsibilities for females in domestic, social, parenting and marital domains that lead to increased fatigue levels (Harrington, 2001). The impact of these responsibilities may be influenced by culture and demographics (e.g. marital status) and would require specific investigation. A process of self-selection (Boivin, et al. 2007) in both male and female workers is again likely to produce fewer detectable gender differences and might be the most plausible explanation here. The paramedic sample was representative in terms of gender, so the current findings contribute initial empirical validation that gender may not be a reliable predictor of chronic fatigue or other outcomes in shiftworkers as previously assumed.

The most significant findings in this study were elevated levels of chronic fatigue and depression, and poor quality sleep in paramedic shiftworkers. Initial evidence also suggests that paramedics might engage in a lower level of physical activity than reference groups. Organisational parameters are known to influence health outcomes in ambulance workers, which in turn creates a responsibility for organisational management (Bennett et al. 2004; Van der Ploeg & Kleber, 2003). Workplace monitoring programs would be useful to confirm the prevalence and trends for these important domains of functioning. Subsequent responses could include custom-designed workshops and individual counselling as well as workplace psychoeducation. This would require individuals to comply with monitoring and take responsibility for personal change, which may prove problematic in some instances. Specific advice regarding sleep hygiene and exercise would seem appropriate for the paramedic group.
Further organisational dimensions include the shift system worked by this group. Although fast and forward rotating rosters are more beneficial for workers (Bambra et al. 2008) it is well established that extended shifts and nightshifts result in significant fatigue (e.g. Pallesen, et al. 2010) as detected in the current sample. Previous authors have suggested an organisational focus on fatigue management, including the allocation of breaks on nightshift, regulation of overtime, and staff training programs (Hussey et al. 2001). Some flexibility offered in self-scheduling has also proven beneficial for health, work-life balance, and organisational effectiveness through reduced absenteeism (Bambra et al, 2008), although the associated difficulties for a large organisation are acknowledged.

The present study addressed several of the methodological concerns raised in a systematic review of ambulance worker health (Sterud et al. 2006). Scores were compared to normative data wherever possible, and examining a specific roster system enhanced known exposure to shiftwork. The assessment instruments were considered to be psychometrically robust, although scores were not always comparable to previous studies. The cross-sectional methodology limits any evaluation of causality, so longitudinal investigations would be useful in further exploring associations amongst the key variables. The generalisation of findings is also limited given that the study investigated a group of workers from a single ambulance service. Shiftwork studies are limited by the self-selecting nature of workers, however the possibility of this effect has been highlighted in the relevant sections.

To conclude, this study examined variables related to health and well-being in Victorian metropolitan paramedics working a homogenous
rotating shift structure that incorporated a nightshift component. Our findings suggest that these paramedics are at particular risk for increased levels of occupational fatigue and depression (regardless of age or gender) and poor quality sleep. The sample also reported less physical activity than reference groups, which may be associated with negative health outcomes. Organisational attention may assist with several domains of functioning in these workers, and contemporary psychological treatment modalities have much to offer in this respect. However integrated interventions for the negative sequela of shiftwork remain relatively unexplored and would be a useful focus for future studies.
References


Table 1

*Mean Scores for Chronic Fatigue in the Paramedic Sample and Data Obtained From Other Shiftwork Studies*

<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Sample Size</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramedic sample</td>
<td>Male</td>
<td>239</td>
<td>28.79</td>
<td>8.80</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>98</td>
<td>29.03</td>
<td>9.03</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>338</td>
<td>28.86</td>
<td>8.84</td>
</tr>
<tr>
<td>Rugierro (2003)*</td>
<td>Female</td>
<td>142</td>
<td>26.68</td>
<td>9.24</td>
</tr>
<tr>
<td>Barton et al. (1995)</td>
<td>Male</td>
<td>422</td>
<td>24.77</td>
<td>7.41</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1429</td>
<td>25.12</td>
<td>7.63</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>1864</td>
<td>25.04</td>
<td>7.58</td>
</tr>
<tr>
<td>Iskra-Golec et al. (1996)*ab</td>
<td>Female</td>
<td>96</td>
<td>26.97</td>
<td>-</td>
</tr>
</tbody>
</table>

*a* Female shiftwork nurses. *b* 12-hour shift rotation sample, no standard deviation provided. *c* Missing respondent data.
Table 2

*Mean Scores for Depression, Anxiety and Stress in the Paramedic Sample,*

*and Normative Data from Non-clinical Studies*

<table>
<thead>
<tr>
<th>Study</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Paramedic sample&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.77</td>
<td>8.54</td>
<td>4.83</td>
</tr>
<tr>
<td>Lovibond &amp; Lovibond (1995)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.34</td>
<td>6.97</td>
<td>4.70</td>
</tr>
<tr>
<td>Henry &amp; Crawford (2005)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.66</td>
<td>7.74</td>
<td>3.76</td>
</tr>
<tr>
<td>Taylor, et al. (2005)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.06</td>
<td>7.57</td>
<td>3.41</td>
</tr>
</tbody>
</table>

<sup>a</sup>*N* = 341. Missing respondent data. <sup>b</sup>*N* = 2914. <sup>c</sup>*N* = 1,794. <sup>d</sup>*N* = 491.
Table 3

*Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity among Paramedics in the Present Study*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extremely severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>63.9% (n = 217)</td>
<td>13.8% (n = 47)</td>
<td>12.0% (n = 41)</td>
<td>4.7% (n = 16)</td>
<td>5.6% (n = 19)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>75.4% (n = 257)</td>
<td>8.2% (n = 28)</td>
<td>12.0% (n = 41)</td>
<td>1.8% (n = 6)</td>
<td>2.6% (n = 9)</td>
</tr>
<tr>
<td>Stress</td>
<td>60.7% (n = 207)</td>
<td>14.7% (n = 50)</td>
<td>12.9% (n = 44)</td>
<td>7.6% (n = 26)</td>
<td>4.1% (n = 14)</td>
</tr>
</tbody>
</table>

*Note.* Missing respondent data on some variables.
Table 4

*Mean Global Score obtained on the PSQI in the Present Study, and Published Studies of Non-clinical Norms*

<table>
<thead>
<tr>
<th>Study</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramedic sample&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.48</td>
<td>3.21</td>
</tr>
<tr>
<td>Buysse et al. (1988)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.67</td>
<td>1.70</td>
</tr>
<tr>
<td>Piperno &amp; Francis (2008)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.66</td>
<td>2.97</td>
</tr>
<tr>
<td>Ruggiero (2003)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>7.06</td>
<td>3.42</td>
</tr>
</tbody>
</table>

*Note:* Global PSQI >5 = poor sleep quality.

<sup>a</sup>*N = 332. Missing respondent data. <sup>b</sup>Control group, N = 52. <sup>c</sup>Community sample, N = 247. <sup>d</sup>Female shiftwork nurses, N = 142.*
### Table 5

*Inter-correlations Between Scores Obtained on the IPAQ, DASS, and PSQI in the Paramedic Sample*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
<th>PSQI</th>
<th>IPAQ</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Fatigue</td>
<td>.56**</td>
<td>.37**</td>
<td>.43**</td>
<td>.51**</td>
<td>-.27**</td>
<td>.03</td>
</tr>
<tr>
<td>Depression</td>
<td>.55**</td>
<td>.62**</td>
<td>.42**</td>
<td>-.19**</td>
<td>.17**</td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>.63**</td>
<td>.36**</td>
<td>-.13*</td>
<td></td>
<td></td>
<td>.10</td>
</tr>
<tr>
<td>Stress</td>
<td>.39**</td>
<td>-.13*</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSQI</td>
<td></td>
<td>-.13*</td>
<td>.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPAQ</td>
<td></td>
<td></td>
<td>-.03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: *p < .05, two-tailed. **p < .01, two-tailed.*
Chapter 3: Caring for the Country: Fatigue, Sleep and Mental Health in Australian Rural Paramedic Shiftworkers.

James Courtney
School of Psychological Science, La Trobe University, Australia

Associate Professor Andrew Francis
Division of Psychology, RMIT University, Australia

Professor Susan Paxton
School of Psychological Science, La Trobe University, Australia
Abstract

This study investigated sleep quality, fatigue, mental health and physical activity in rural paramedic shiftworkers. Although limited, previous studies have associated high fatigue levels and poorer health in this sector with shiftwork rostering and occupational demands. A modified version of the Standard Shiftwork Index was completed by 150 paramedics (117 male and 31 females; age $M = 42.4, SD = 10.29$) from rural Victoria. Single sample $t$-tests found significantly higher levels of fatigue, depression, anxiety, and stress, and significantly poorer sleep quality than reference samples. Paramedics also reported less physical activity than community samples. Using regression analysis, sleep quality explained the greatest amount of variance in fatigue scores, followed by depression and age. No gender differences in levels of depression or fatigue were found. Consistent with an earlier study of metropolitan paramedics based on the same methodology, findings suggest rural ambulance paramedic shiftworkers are at particular risk for increased levels of fatigue and depression (regardless of age or gender) and poor quality sleep. Organisational intervention was suggested.
Caring for the Country: Fatigue, Sleep and Mental Health in Australian Rural Paramedic Shiftworkers

Growing research evidence suggests that paramedic shiftworkers may experience more occupational health problems than other healthcare workers and the general community. A recent review of 49 ambulance studies identified high rates of fatigue, poor sleep and other health problems in personnel (Sterud, Ekeberg, & Hem, 2006), and concerns have also been raised about increased rates of mental health issues in paramedics (Bennett, Williams, Page, Hood, & Woollard, 2004). The present study examined several indices of health in ambulance paramedics, specifically, those working in a rural context. This study follows from our recent findings of higher levels of fatigue and mental health issues in metropolitan paramedics (Courtney, Francis, & Paxton, 2010), and from suggestions in the literature of apparent differences in the general health status of rural versus metropolitan communities (e.g. Kelly et al. 2010). Given the critical role of paramedics in delivering essential emergency health services to rural communities, it was considered imperative to understand the physical and mental health status of these workers, which may have some bearing on their service-delivery as well as their own occupational safety.

With respect to physical health, sleep loss and elevated fatigue are of prime concern in healthcare shiftworkers (e.g. Olson & Ambrogetti, 1998). Although targeted studies of ambulance personnel are limited, Courtney et al. (2010) reported severe sleep difficulties and elevated fatigue in 342 metropolitan paramedics rostered to a 24-hour shift system. Another study of 123 Dutch ambulance workers (Van der Ploeg & Kleber, 2003)
established levels of fatigue considered to place 10-percent of respondents at risk of sick leave or disability. Only one study of rural-based paramedics was located (Hussey, Baker, & Holmes, 2001), reporting elevated fatigue in personnel while rostered to shiftwork in the call-taking and dispatch centre; although differences between this role and their usual on-road duties limits direct comparison with other studies. Further investigation would be useful to extend this initial evidence, to determine occupational prevalence rates and, in particular, to identify predictors of fatigue for this occupational group.

Concerns have also been raised about the mental health of ambulance paramedics. In a mental health survey of 560 UK ambulance workers (Bennett et al. 2004), nearly 10-percent of respondents reported clinical levels of depression, and 22-percent registered clinical levels of anxiety. These were considered to reflect occupational prevalence rates, although a lack of comparison with normative data was noted. Increased stress has also been associated with ambulance work (e.g. Van der Ploeg & Kleber, 2003), although the assessment and conceptualisation of stress varies across studies. A nationwide study of Norwegian ambulance personnel (Sterud, Hem, Ekeberg, & Lau, 2008) identified significant organisational and occupational stressors for workers, but did not assess psychological stress. Whilst acknowledging the limitations of previous studies, a review of existing evidence (Sterud et al. 2006) suggested that up to 20-percent of ambulance personnel may suffer from poor mental health.

Whilst no previous studies specifically address the question of whether rural paramedics are at increased risk of mental health disorders, it
seems reasonable to suggest that their level of risk would be at least commensurate with the general rural community. Epidemiological data certainly suggests that rates of mental health problems are roughly equivalent between rural and metropolitan communities (Caldwell, Jorm, & Dear, 2004; Judd et al. 2002), although the methodologies responsible for producing these estimates have been heavily criticised (Allen, 2010; Fraser et al. 2002). Indeed the only noted difference between rural and metropolitan communities with some demonstrable relevance to potential mental health issues is a higher rural rate of suicidality, primarily amongst younger adult males (Caldwell et al. 2004). Even in this group, suicide risk was associated with specific risk factors not typical of ambulance paramedics: limited education, a lack of social support and social isolation (Caldwell et al. 2004). Deficiencies in the existing data suggest a need to assess the mental health status of paramedics generally and, specifically, to determine if rural ambulance workers are at increased risk of mental health disorder.

It has been suggested that individual variables such as gender and age may influence health outcomes in shiftworkers, although their actual contribution is debated. For example, it has been speculated that female shiftworkers may be more susceptible to fatigue due to additional domestic and family obligations (Costa, 2003; Harrington, 2005). By contrast, empirical studies of ambulance shiftworkers have failed thus far to establish gender differences on outcome measures (Bennett et al. 2004; Courtney, et al. 2010). Conflicting opinions also exist as to whether increasing age either ameliorates (e.g. Akerstedt, Fredlund, Gillberg, & Jansson, 2002) or compounds adverse health outcomes in shiftworkers (e.g. Costa, 1996;
Marquie & Foret, 1999; Monk, 1994). Again, empirical investigations have often failed to observe consistent associations between age and measures of health in shiftworkers (e.g. Courtney et al. 2010; Ruggiero, 2003). It is likely that shiftworkers self-select to work irregular hours based on their resources and ability to cope (see Boivin, Tremblay, & James, 2007; Knutsson & Akerstedt, 1992; Marquie & Foret, 1999), thus reducing the influence of individual variables (see Costa & Di Milia, 2008 for a keynote review on this topic). Given the disparity between empirical outcomes and theoretical predictions, further measurement would be useful to establish potential associations of age and gender with the health status of shiftworkers.

Several investigators have also posited that physical exercise may influence individual responses to shiftwork (e.g. Atkinson & Davenne, 2006). Regular physical activity confers a protective role for a wide range of health domains (World Health Organisation, 2006), with specific benefits demonstrated for mood states and especially depression (Byrne & Byrne, 1993). Exercise is known to alleviate depressive symptoms for individuals with seasonal affective disorder, and reduce morning fatigue and the need for sleep (Leppamaki, Partonen, & Lonnqvist, 2002). It would seem reasonable, then, to predict that exercise could assist in managing the health-related consequences of shiftwork, although investigation in shiftwork populations specifically is scant. Courtney et al. (2010) reported lower physical activity levels in 341 health-compromised paramedics compared to community samples; and one other shiftwork study reported decreased fatigue and sleepiness in nurses following an exercise intervention (Harma, Ilmarinen, Knauth, Rutenfranz, & Hanninen, 1988a;
which suggests that exercise may be beneficial but lacking in shiftwork populations. In order to extend present knowledge, there is a need to first broadly assess levels of exercise behaviour in shiftwork populations, and examine relationships with other behavioural indices. This might provide some basis upon which to potentially prescribe specific exercise guidelines around the disrupted sleep-wake cycle in these workers.

Whilst discussion so far has focussed on individual variables, organisational parameters of shift scheduling also have potential to influence worker health. A systematic review of 26 intervention studies (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008) identified that fast rotations (e.g. three or four consecutive shifts) and forward rotating rosters (morning, afternoon, night) produced beneficial outcomes on measures of sleep and fatigue. Work-life balance, and organisational effectiveness were also improved when workers could influence their own work hours. Other investigators have found elevated fatigue levels in paramedics working extended shifts (Courtney et al. 2010) and increased risk of accidents and health problems in the work place (Dembe, Erickson, Delbos, & Banks, 2005; Smith, Macdonald, Folkard, & Tucker 1998). Nightwork is considered especially problematic in terms of circadian adjustment and tolerance, and is associated with episodes of involuntary sleep and increased sleepiness at work that extends to days off work (Akerstedt, 1998; Pallesen, et al. 2010; Sallinen & Kecklund, 2010). Clearly, organisation-determined parameters of shiftwork have considerable potential to impact on levels of experienced occupational distress.

The present investigation examined physical and mental health variables in shift-working paramedics employed by Rural Ambulance
Victoria (RAV). These workers participate in shiftwork as part of a normal career structure and it was expected that many would be working the forward rotating ‘10/14’ roster: two ten-hour dayshifts, followed by two fourteen-hour nightshifts and four days off (commencing after the second nightshift). This structure has existed for at least 30 years in the ambulance sector and grew from the need to provide 24-hour emergency services to the community. Drawing on the literature reviewed here, it was suspected that this shiftwork roster (in particular the requirement to work nightshift) could pose a significant health risk for these paramedics.

This study aims to address the lack of data with respect to the mental and physical health of rural paramedic shiftworkers. Comparisons to general population and other shiftwork samples (where available) will be enabled, permitting a clearer understanding of the potential risks and needs faced by this group of workers. Statistical comparison with our previous study in metropolitan-based workers (utilising an identical methodology; Courtney et al. 2010) will investigate rural-urban differences on study variables. In addition, our earlier study observed significant associative relationships amongst study variables, and identified mental health, sleep quality and exercise as key predictors of fatigue by regression analysis. These relationships will be re-examined in this rural sample with a view to informing potential interventional strategies.

The following hypotheses were formulated:

1. Rural paramedic shiftworkers will report poorer sleep quality and elevated levels of fatigue, depression, anxiety, and stress compared to non-paramedic reference samples.
2. Fatigue in rural paramedic shiftworkers will be positively correlated with depression, anxiety, and stress, but negatively correlated with level of exercise and sleep quality; and that at least some of these variables will explain a significant amount of variance in chronic fatigue scores.

3. No significant age or gender difference will be detected on indices of mental health or chronic fatigue.

4. There will be no statistically significant differences between rural and metropolitan paramedics (Courtney et al. 2010) on the major study variables.

Method

Participants

Emergency ambulance paramedics were recruited from RAV; an organisation established in March 1999 as part of the rationalization of existing rural ambulance services (University of South Australia, 2003). RAV has recently merged with Ambulance Victoria and delivers pre-hospital emergency treatment and medical transport to people in regional, rural and remote Victoria (RAV, 2008). Participation was voluntary and limited to active personnel who routinely worked a forward rotating 24-hour roster cycle that included a nightshift component (identified as either 10/14 or ‘other’). It was expected that many of the paramedics meeting inclusion criteria would be working the 10/14 roster discussed previously. A sample of 128 participants was required to satisfy planned analyses based on a moderate effect size ($r = .30$), a significance level of .05, and a power of .80 (Cohen, 1992).
Completed surveys were returned by 150 paramedics, or around 27-percent of the paramedics employed by RAV and estimated to meet inclusion criteria. The response by gender of 117 males (73.5%) to 31 females (26.5%) equates to a 2.8 to 1 male to female ratio. Gender demographics for operational personnel were not available from RAV during the collection period. Fifty-percent of respondents worked the 10/14 roster structure, and the remaining fifty-percent worked a forward rotating shiftwork roster with a night time component (other).

Materials

Shiftwork. A modified form of the Standard Shiftwork Index (SSI; Barton et al. 1995) was administered, which comprises a battery of instruments to assess shiftwork-related outcomes in workers. SSI measures of psychological distress and sleep were substituted with instruments considered more satisfactory, and a measure of physical exercise added (see following sections). The SSI Chronic Fatigue Scale (CFS) conceptualises fatigue as a general tiredness and lack of energy irrespective of whether an individual has not had enough sleep or has been working hard, and which persists even on rest days and holidays. A score ranging from 10 to 50 is produced, with higher scores indicating more fatigue. Barton et al. (1995) found the validity and internal reliability of the CFS (α from .91 to .93) to be satisfactory in a sample of shiftwork nurses and industrial workers.

CFS data were selected from four previous shiftwork studies for statistical comparison, as normative data has not been established in community samples. To examine hypothesis 1, three non-paramedic samples comprising mostly nurses were selected. Barton et al. (1995)
published CFS scores for 1532 shiftwork nurses (mean age 33.2 years; 91.8% female) and 332 industrial workers (mean age 39.2; 6.9% female). Ruggiero (2003) reported CFS data from 142 female shiftwork nurses aged from 28 to 63 years ($M = 44.9$, $SD = 8.3$). Iskra-Golec, Folkard, Marek, and Noworol (1996) reported CFS data from female shiftwork nurses, but in a more restricted age range of 20 to 32 years ($M = 25.96$, $SD = 3.75$).

Data from our earlier study of paramedics in metropolitan Melbourne (age range 23 to 61, $M = 40.00$, $SD = 8.50$; Courtney et al., 2010) was used to examine hypothesis 4.

**Quality of sleep.** Quality of sleep was assessed using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI generates component scores for seven domains of sleep quality that are summed to obtain a maximum achievable score of 21, indicating the highest level of sleep disturbance. The PSQI was normed on 52 healthy, 34 depressed and 62 sleep disordered participants and demonstrated sufficient internal reliability ($\alpha = .83$) and validity (Buysse et al. 1989).

Although normative data for statistical comparison was again limited, three non-paramedic data sets were selected to examine hypothesis 1. The authors of the PSQI (Buysse et al. 1989) published scores for a control group of 52 healthy sleepers comprising 40 males and 12 females aged 24 to 83 ($M = 59.9$). Piperno & Francis (2008) also collected local community data from 84 males and 138 females aged 18 to 66 ($M = 32.5$, $SD = 13.5$). The study by Ruggiero (2003) has already been described and produced PSQI scores in a sample of shiftwork nurses. Data from Courtney et al. (2010) was also adopted to examine hypothesis 4.
Depression. The Depression Anxiety Stress Scales 21 (DASS21) were used to measure the emotional states of depression, anxiety and stress (Lovibond & Lovibond, 1995). Seven items on each of the three scales were summed to obtain an overall score for each state. The psychometric properties of the DASS21 were found to be satisfactory by Henry and Crawford (2005) in a non-clinical population \((N = 1,794)\). Alpha values for reliability are: Depression 0.81; Anxiety 0.73; Stress 0.81 (Lovibond & Lovibond, 1995).

Normative data for the DASS is limited, but three studies were located for statistical comparison. A study that closely matched census data for the Australian population (Taylor, Lovibond, Nicholas, Cayley, & Wilson, 2005) published DASS scores for 219 males and 272 females \((\text{age } M = 42.3, SD = 17.7)\). Henry and Crawford (2005) published DASS scores for 979 female and 815 male members of the general UK population \((\text{age } M = 41.0, SD = 15.9)\). Normative data from the DASS manual was also selected (Lovibond & Lovibond, 1995) which is derived from six samples comprising 1044 males and 1870 females aged 17 to 69 years. Data from Courtney et al. (2010) was again used to address hypotheses 4. Categorical data were also compared to the National Survey of mental Health and Wellbeing (Australian Bureau of Statistics [ABS], 2007) for the 12-month prevalence of affective and anxiety disorders, which is assessed in accordance with the International Classification of Diseases – Tenth Revision, or ICD-10.

Physical activity. Estimates of physical activity were obtained using the International Physical Activity Questionnaire – Short Form (IPAQ; Craig et al. 2003). IPAQ data was reported as the ratio of the work metabolic rate for each type of activity to the resting metabolic rate (termed METs) derived
as follows: Walking = 3.3 METs, Moderate Physical Activity = 4.0 METs, and Vigorous Physical Activity = 8.0 METs. MET-minutes/week were calculated by multiplying the duration (in minutes) and frequency (in days) of each activity type by its corresponding MET value. Results were summed to obtain a total score based on median values. Craig et al. (2003) found the validity the IPAQ to be acceptable in a 12-country study, and reported reliability correlations of around 0.8.

Two community studies were located for statistical comparison. Craig et al. (2003) published data for the IPAQ - Short Form for a community sample comprising 1974 males and females across 12 countries. Participants ranged in age from 18 to 65 with a predominantly middle aged mean in each sample. Scores from a local community sample (Piperno & Francis, 2008) were also considered useful. Participant demographics are described in the previous section. Data from Courtney et al. (2010) was used to address specific hypotheses in shiftwork samples.

**Procedure**

Approval to undertake this study was provided by the Faculty of Science, Technology and Engineering Human Ethics Committee, La Trobe University, and the RAV Executive and Research Governance Committee (Medical Standards Committee). RAV managed the internal distribution of 560 surveys to 28 rural Branches during July 2008. Industry visibility was enhanced through announcements and reminders on the RAV intranet. Participation was voluntary and required about 25 minutes completion time, with participants mailing surveys directly to the investigators anonymously in reply-paid envelopes. Statistical analyses were performed using SPSS version 15.0
Results

Distributions of all variables were judged adequate in terms of normality, linearity and homoscedacity. Data were also examined for outliers, missing values and data entry errors. Corrections were made in accordance with common statistical practice, or in accordance with data cleaning instructions for specific measures. For selected between-group analyses, group means were calculated from pre-existing datasets by summing demographic data and dividing by the number of groups. The limitations of this technique are discussed later in the manuscript.

Mean global sleep quality scores are shown in Table 1 along with data from the four reference groups. A single sample $t$-test found significantly poorer sleep quality for rural paramedics compared to a group mean derived from two community samples; $t (146) = 13.78, p < .001, d = 1.4$. Rural paramedics also reported significantly poorer sleep quality than a sample of female shiftwork nurses, again based on a single sample $t$-test; $t (146) = 4.47, p < .001, d = .39$. Seventy-percent of the rural sample received a global score greater than five; the cutoff score used to identify ‘poor’ sleepers. Although the percentage of poor sleepers was almost identical between rural and metropolitan paramedics (Courtney et al. 2010) an independent samples $t$-test found significantly poorer sleep quality in the rural cohort; $t (477) = -2.88, p = .004, d = .29$. No significant difference was detected on the basis of roster type, $t (145) = .65, p = .52$. Internal consistency using Cronbach’s alpha was estimated as .80 based on individual items (per Buysse et al. 1989).

**TABLE 1**
Mean scores for chronic fatigue are shown in Table 2. A single sample t-test revealed significantly higher fatigue scores for the rural sample compared to a group mean calculated from three other non-paramedic shiftwork samples, $t(147) = 4.56, p < .001, d = .39$. Independent samples t-tests showed no significant differences in chronic fatigue between genders, $t(144) = -.138, p = .17$; roster type, $t(146) = .71, p = .48$; or rural versus metropolitan location (Courtney et al. 2010), $t(484) = -.75, p = .46$. The internal consistency of the 10 item scale was estimated as .90 using Cronbach’s alpha.

**TABLE 2**

Mean scores obtained on the DASS21 scales are shown in Table 3. A single sample t-test found significantly higher scores for the rural sample compared to a group mean calculated from three community samples for depression, $t(149) = 3.97, p < .001, d = .51$; anxiety, $t(148) = 2.32, p = .02, d = .25$; and stress, $t(149) = 5.59, p < .001, d = .53$. Rural and metropolitan (Courtney et al. 2010) paramedic samples were also compared using an independent samples t-test, however no significant differences were detected for scores of depression, $t(489) = -.88, p = .38$; anxiety, $t(488) = -.77, p = .44$; or stress, $t(489) = .24, p = .81$. Internal consistencies based on Cronbach’s alpha were .86 for the depression scale, .81 for the anxiety scale, and .84 for the stress scale.

**TABLE 3**

Table 4 shows the percentage distribution of DASS21 scores by clinical severity (Lovibond & Lovibond, 1995) for the rural paramedics. Rates were above the normal range for depression (42.7%, $n = 64$), anxiety (26.0%, $n = 39$) and stress (39.3 %, $n = 59$). Table 5 shows the
same analyses for the metropolitan comparison sample (Courtney et al. 2010). An independent samples $t$-test found no significant sex difference for scores of depression; $t$ (146) = 1.02, $p = .31$, anxiety, $t$ (145) = -.25, $p = .80$; or stress, $t$ (146) = -.12, $p = .90$. Likewise, no significant differences were found on the basis of roster type for depression, $t$ (148) = 1.14, $p = .26$; anxiety, $t$ (147) = 1.81, $p = .07$; or stress, $t$ (148) = .76, $p = .45$.

**TABLES 4 & 5**

Rural paramedics reported a global median score of 2034 MET-minutes/week on the IPAQ – Short Form. This represented 19-percent less physical activity than participants in a 12-country study (Craig et al. 2003; 2514 median MET-minutes/week) and 13-percent less than a local community sample (Piperno & Francis, 2008; 2346 median MET-minutes/week). Rural paramedics reported only 2.5-percent less physical activity than their metropolitan colleagues (2088 MET-minutes/week; Courtney et al. 2010). Internal consistency using Cronbach’s alpha was estimated as .79 based on subscale scores.

The data were further analysed for correlations amongst variables, and to address hypotheses posited for the study (Table 6). Chronic fatigue was found to have a significant association of moderate to large size with all variables except age.

**TABLE 6**

Multiple linear regression was employed to determine the role of the six major study variables in predicting chronic fatigue. No a priori hypothesis was made to determine the order of predictor variables, so a direct method was adopted. The six study variables produced an adjusted $R^2$ of .43 for the prediction of chronic fatigue, $F (6, 125) = 17.11, p < .001$. 
Sleep quality was the most important variable ($\beta = .43, p < .001$), followed by depression, $\beta = .25, p = .03$, and to a lesser extent age, $\beta = -.0.16, p = .02$. The remaining variables did not contribute significantly to the model: total METs, $\beta = -.08, p = .26$, anxiety $\beta = .03, p = .81$, and stress, $\beta = .0.09, p = .46$.

**Discussion**

To our knowledge, this is the first investigation in the literature reporting psychobehavioural correlates of fatigue in rural paramedic shiftworkers. The most significant findings were elevated levels of fatigue and depression, and poor quality sleep in these emergency healthcare workers. Consistent with the first hypothesis, analyses identified poorer sleep quality and higher levels of fatigue, depression, anxiety, and stress in the cohort compared to non-paramedic reference samples. The second hypothesis was partially supported as significant correlations were observed amongst all study variables, except for the association between fatigue and increasing age. Sleep quality explained the greatest variance in fatigue scores, followed by depression and age. As predicted by the third hypothesis, no significant age or gender differences were detected on any outcome variable. Finally, the fourth hypothesis was also partially supported as rural paramedics reported poorer sleep quality than their metropolitan counterparts (Courtney et al. 2010) contrary to predictions.

Poor quality sleep is a well-established outcome of shiftwork, and consistent with this premise, only 30-percent of paramedics in this study were categorised as ‘good sleepers’. As such, the majority of this group suffered severe difficulties in at least two domains of sleep, or moderate difficulties in more than three (Buysse et al. 1989). Although rural workers
reported significantly poorer sleep quality than their metropolitan counterparts, from a categorical viewpoint, the percentage of good and bad sleepers was identical for both groups. The significant difference in sleep quality between rural paramedics and community-based normative data serves as a useful comparison in the absence of a control group (Sterud et al. 2006), and serves to highlight the level of sleep disruption in the rural sample. Given that sleep has been identified as a potential index of health problems in ambulance shiftworkers (Sterud et al. 2006) the present findings may be symptomatic of further problems in these workers.

Likewise, elevated fatigue is strongly associated with shiftwork, and causally linked to sleep disruption by many authors (e.g. Barton et al. 1995). The present findings are consistent with those of our earlier study in a metropolitan sample (Courtney et al. 2010), and given that both groups participated in a near-identical rotating shiftwork roster (and nightshifts), we assert that several elements of the shift schedule place workers at increased risk of sleep loss and fatigue. Note that no statistical differences were detected on study variables between paramedics working the 10/14 and ‘other’ rosters, so a similar level of shiftwork exposure was assumed.

Early morning shifts, quick returns and the nightshifts are particularly problematic in terms of sleep loss and fatigue (Sallinen & Kecklund, 2010). For those working the 10/14 roster, the 7am dayshift limits the opportunity for sleep, as workers need to wake early enough to prepare for the day and then commute to branch. The pairing of two 14-hour nightshifts requires a quick return and imposes a strong exposure to these hours, and the intervening rest period is likely to be reduced by travel time, difficulty sleeping during the day, and social factors. The extended shift lengths
worked by this group would also contribute to elevated fatigue (Sallinen & Kecklund, 2010), and contrasts with recommendations to limit shifts of more than 10 hours to specific work functions where fatigue is minimised at an organisational level (e.g. Smith et al. 1998). Although not specifically investigated here, the relationship between extended shifts and increased workplace accidents (Dembe et al. 2005; Paley et al. 1998) is relevant to ambulance work, which depends on accurate clinical decision-making and advanced driving skills at any time during a shift.

Comparison with data derived from community samples indicates a poor level of mental health in the paramedic sample. In terms of clinical relevance, over 12-percent of the sample reported Severe to Extremely Severe levels of depression; rates consistent with previous reports (Bennett et al. 2004; Courtney et al. 2010) and well above those reported in the general population (Lovibond & Lovibond, 2004). Clinically significant elevations were also found on measures of anxiety and stress, at a level similar to the metropolitan comparison cohort. By comparison, the ABS (2007) reported a 12-month population prevalence of 6.2-percent for affective disorders, and 14.4-percent for anxiety disorders in the Australian community. While the assessment of mental health in shiftworkers is often limited by variations in psychometrics and non-specific diagnostic categories, the DASS21 represents a well-validated instrument in both clinical and non-clinical populations (Henry & Crawford, 2005). On this basis, we suggest that, as an occupational group, paramedic shiftworkers may be at increased risk of developing clinical levels of depression, anxiety and stress. These findings extend those of our earlier study using identical methodology (Courtney et al. 2010) and support previous concerns
regarding mental health in this occupational sector (e.g. Bennett et al. 2004; Sterud et al. 2008).

Paramedics reported lower levels of physical activity compared to community samples, but very similar rates to their metropolitan colleagues (Courtney et al. 2010). It is possible that shiftwork imposes a lifestyle that limits the opportunity for regular exercise and prohibits a commitment to team-oriented sporting activities. Whilst empirical measurement of exercise behaviours in shiftworkers is lacking, these findings extend those of the metropolitan reference sample (again using an identical measure) and add further weight to an observed trend toward lower physical activity in the ambulance sector. Associations between exercise and other study variables are discussed further on.

A major aim of the study was to examine the data for relationships amongst variables and identify predictors of fatigue. Previous shiftwork investigations have established associations of similar magnitude to the present findings between fatigue and each of depression, anxiety and sleep quality, using comparable assessment instruments (Courtney et al. 2010; Ruggiero, 2003). In particular, the significant (though relatively weak) association between exercise and fatigue extends novel findings in the metropolitan reference sample, and is also consistent with decreased fatigue following an exercise intervention in nurses (Harma et al. 1988a; 1988b). Exercise is also associated reduced fatigue in general populations (Leppamaki et al. 2002) and the present associative evidence suggests that physical activity might be similarly beneficial in reducing fatigue for shiftworkers.
Regression analyses identified sleep quality and depression to be the strongest predictors of fatigue amongst the study variables, and to a lesser extent increasing age. Our earlier study (Courtney et al. 2010) found these same independent variables to explain almost identical variance in chronic fatigue scores (43 vs. 42-percent for the rural group). On the basis of these analyses, and when considered alongside the strong bivariate correlations between chronic fatigue, depression and sleep quality (in both samples), it is clear that these variables are important and related measures of functioning for paramedic shiftworkers. Using the same methodology, Ruggiero (2003) also identified depression and sleep to be the strongest predictors of fatigue in shiftwork nurses.

The negative association between age and fatigue in the regression model suggests that younger workers suffer higher fatigue, although the contribution was relatively small. Younger age was also found to predict fatigue in a large national study in Sweden (Akerstedt, et al. 2002), however other shiftwork studies have failed to establish any association (e.g. Ruggiero, 2003). While the present findings are consistent with the argument that circadian changes with advancing age older could be beneficial for shiftworkers (Harma, 1996), the age of workers was strongly related to years of shiftwork, so it is more likely that older workers self-selected to remain in service on the basis of adaptive sleep behaviours that counter work related fatigue (see Boivin et al. 2007).

Despite regular narrative suggesting poorer health outcomes in female shiftworkers, gender was not significantly associated with any of the outcome variables. Previous empirical studies have similarly failed to observe significant findings (Courtney et al. 2010; Ruggiero, 2003) and a
review of 49 ambulance studies (Sterud et al. 2006) concluded that the influence of gender remains poorly understood. The additional domestic responsibilities presumed to contribute to increased fatigue levels in females (Harrington, 2005) may be influenced by culture and demographics (e.g. marital status) and would therefore require specific investigation. A process of self-selection (Boivin, et al. 2007) is again likely to produce fewer detectable gender differences and might be the most plausible explanation here. The current findings contribute further empirical validation that gender may not be a reliable predictor of chronic fatigue or other outcomes in paramedic shiftworkers.

The most significant findings in this study were elevated levels of fatigue and depression, and poor quality sleep in paramedic shiftworkers. Initial evidence also suggests that paramedics engage in a lower level of physical activity than reference groups. Almost identical levels of association were evident between variables in the rural sample and those reported by Courtney et al. (2010) in a metropolitan cohort. Organisational parameters are likely to influence health outcomes in ambulance workers, which in turn creates a responsibility for organisational management (Bennett et al. 2004; Van der Ploeg, 2003). Workplace monitoring programs (e.g. of mental health) would be useful to confirm the prevalence and trends for these important domains of functioning. Subsequent responses could be derived from a cognitive-behavioural approach and include custom-designed group workshops and individual counselling as well as workplace psychoeducation. This would require individuals to comply with monitoring and take responsibility for personal change, which may prove
problematic in some instances. Specific advice regarding sleep hygiene and exercise would seem appropriate for this paramedic group.

Further organisational dimensions include the shift system worked by this group. Although fast and forward rotating rosters are more beneficial for workers (Bambra et al. 2008) it is well established that extended shifts and nightshifts result in significant fatigue (e.g. Pallesen, et al. 2010) as detected in the current sample. Previous authors have suggested an organisational focus on fatigue management, including the allocation of breaks on nightshift, regulation of overtime, and staff training programs (Hussey et al. 2001). Some flexibility offered in self-scheduling has also proven beneficial for health, work-life balance, and organisational effectiveness through reduced absenteeism (Bambra et al. 2008), although the associated difficulties for a large organisation are acknowledged.

The present study addressed several of the methodological concerns raised by previous reviews of literature in the field. We investigated a single occupational group working a known roster system, and scores were reported against relevant reference groups wherever possible (Harma & Kecklund, 2010; Sterud, 2006). The cross-sectional methodology limits any evaluation of causality, so longitudinal investigations would be useful in further exploring relationships between the key variables. The generalisation of findings is also limited given that the study investigated a group of workers from a single ambulance service. Shiftwork studies are also limited by the self-selecting nature of workers, however the possibility of this effect has been highlighted in the relevant sections. As highlighted previously in the results section, group means were derived from pre-existing datasets for statistical comparison with the present findings. This
technique is not statistically complex and should be considered a limitation to the relevant between-group comparisons.

To conclude, this study examined variables related to physical and mental health and well-being in rural paramedics and extends the investigation of the same parameters in metropolitan based workers. The combined findings add further weight to suggest that paramedics are at particular risk for increased levels of occupational fatigue and depression (regardless of age or gender) and poor quality sleep. The sample also reported less physical activity than reference groups, which has the potential to be associated with negative health outcomes. Organisational attention may assist with several domains of functioning in these workers, and contemporary psychological treatment modalities have much to offer in this respect. However integrated interventions for the negative sequela of shiftwork remain relatively unexplored and would be a useful focus for future studies.
References


and work hours in relation to disturbed sleep and fatigue in a large

Allen, J. (2010). Determinants of mental health and well-being in rural
communities: Do we understand enough to influence planning and


and Wellbeing: Summary of Results, December 2007 (No. 4326.0).
Canberra, Australian Capital Territory: Author.

work. American Journal of preventative Medicine, 34, 427-434.

(1995). The standard shiftwork index: A battery of questionnaires for
assessing shiftwork-related problems. Work & Stress, 9, 4-30.

of mental health problems among UK emergency ambulance workers.

schedules. Sleep Medicine, 8, 578-589.


Dembe, A. E., Erickson, J. B., Delbos, R. G., & Banks, S. M. (2005). The impact of overtime and long work hours on occupational injuries and


Table 1

*Mean Global Score obtained on the PSQI for Rural and Metropolitan Paramedics, and Selected Reference Samples*

<table>
<thead>
<tr>
<th>Study</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAV paramedic sample(^a)</td>
<td>8.45</td>
<td>3.77</td>
</tr>
<tr>
<td>Courtney et al. (2010)(^b)</td>
<td>7.48</td>
<td>3.21</td>
</tr>
<tr>
<td>Buysse et al. (1989)(^c)</td>
<td>2.67</td>
<td>1.70</td>
</tr>
<tr>
<td>Piperno &amp; Francis (2008)(^d)</td>
<td>5.66</td>
<td>3.00</td>
</tr>
<tr>
<td>Ruggiero (2003)(^e)</td>
<td>7.06</td>
<td>3.42</td>
</tr>
</tbody>
</table>

Note: Global PSQI >5 = poor sleep quality

\(^aN = 147. \(^bN = 332. Missing respondent data. \(^cControl group, N = 52. \(^dCommunity sample, N = 247. \(^eFemale shiftwork nurses, N = 142.
Table 2

*Mean Scores for Chronic Fatigue in the Metropolitan and Urban Paramedic Samples and Data Obtained From Non-Paramedic Shiftwork Studies*

<table>
<thead>
<tr>
<th>Study</th>
<th>Gender</th>
<th>Sample Size</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAV paramedic sample</td>
<td>Male</td>
<td>116</td>
<td>29.01</td>
<td>8.95</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>30</td>
<td>31.50</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>148</td>
<td>29.51</td>
<td>8.76</td>
</tr>
<tr>
<td>Courtney et al. (2010)</td>
<td>Male</td>
<td>239</td>
<td>28.79</td>
<td>8.80</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>98</td>
<td>29.03</td>
<td>9.03</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>338</td>
<td>28.86</td>
<td>8.84</td>
</tr>
<tr>
<td>Rugierro (2003)*</td>
<td>Female</td>
<td>142</td>
<td>26.68</td>
<td>9.24</td>
</tr>
<tr>
<td>Barton et al. (1995)</td>
<td>Male</td>
<td>422</td>
<td>24.77</td>
<td>7.41</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>1429</td>
<td>25.12</td>
<td>7.63</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>1864</td>
<td>25.04</td>
<td>7.58</td>
</tr>
<tr>
<td>Iskra-Golec et al. (1996)*</td>
<td>Female</td>
<td>96</td>
<td>26.97</td>
<td>-</td>
</tr>
</tbody>
</table>

*aSamples comprised only female participants. b12-hour shift rotation sample, no standard deviation supplied. cMissing respondent data.*
Table 3

*Mean Scores for Depression, Anxiety and Stress in the Rural and Metropolitan Paramedic Samples, and Normative Data from Non-clinical Studies*

<table>
<thead>
<tr>
<th>Study</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>RAV paramedics&lt;sup&gt;a&lt;/sup&gt;</td>
<td>9.53</td>
<td>9.28</td>
<td>5.28</td>
</tr>
<tr>
<td>Courtney et al. (2010)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.77</td>
<td>8.54</td>
<td>4.83</td>
</tr>
<tr>
<td>Lovibond &amp; Lovibond (1995)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.34</td>
<td>6.97</td>
<td>4.70</td>
</tr>
<tr>
<td>Henry &amp; Crawford (2005)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.66</td>
<td>7.74</td>
<td>3.76</td>
</tr>
<tr>
<td>Taylor, et al. (2005)&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5.06</td>
<td>7.57</td>
<td>3.41</td>
</tr>
</tbody>
</table>

<sup>a</sup>N = 149. <sup>b</sup>N = 342. <sup>c</sup>N = 2914. <sup>d</sup>N = 1,794. <sup>e</sup>N = 491.
Table 4

*Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity among Rural Paramedics*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extremely Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>57.3%</td>
<td>15.4%</td>
<td>15.4%</td>
<td>5.4%</td>
<td>6.7%</td>
</tr>
<tr>
<td></td>
<td>(n = 86)</td>
<td>(n = 23)</td>
<td>(n = 23)</td>
<td>(n = 8)</td>
<td>(n = 10)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>73.8%</td>
<td>5.4%</td>
<td>12.1%</td>
<td>4.0%</td>
<td>4.7%</td>
</tr>
<tr>
<td></td>
<td>(n = 110)</td>
<td>(n = 8)</td>
<td>(n = 18)</td>
<td>(n = 6)</td>
<td>(n = 7)</td>
</tr>
<tr>
<td>Stress</td>
<td>60.6%</td>
<td>12.8%</td>
<td>12.8%</td>
<td>10.1%</td>
<td>4.0%</td>
</tr>
<tr>
<td></td>
<td>(n = 91)</td>
<td>(n = 19)</td>
<td>(n = 19)</td>
<td>(n = 15)</td>
<td>(n = 6)</td>
</tr>
</tbody>
</table>

*Note. N = 150.*
### Table 5

**Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity among Metropolitan Paramedics (Courtney et al. 2010)**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Normal</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
<th>Extremely Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depression</td>
<td>63.9%</td>
<td>13.8%</td>
<td>12.0%</td>
<td>4.7%</td>
<td>5.6%</td>
</tr>
<tr>
<td></td>
<td>(n = 217)</td>
<td></td>
<td>(n = 47)</td>
<td>(n = 41)</td>
<td>(n = 16)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>75.4%</td>
<td>8.2%</td>
<td>12.0%</td>
<td>1.8%</td>
<td>2.6%</td>
</tr>
<tr>
<td></td>
<td>(n = 257)</td>
<td></td>
<td>(n = 28)</td>
<td>(n = 41)</td>
<td>(n = 6)</td>
</tr>
<tr>
<td>Stress</td>
<td>60.7%</td>
<td>14.7%</td>
<td>12.9%</td>
<td>7.6%</td>
<td>4.1%</td>
</tr>
<tr>
<td></td>
<td>(n = 207)</td>
<td></td>
<td>(n = 50)</td>
<td>(n = 44)</td>
<td>(n = 26)</td>
</tr>
</tbody>
</table>

*Note. N = 341. Missing respondent data on some variables.*
Table 6

_Correlations Between Scores Obtained on the PSQI, DASS21 and IPAQ in the Rural Paramedic Sample_

<table>
<thead>
<tr>
<th>Measure</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
<th>PSQI</th>
<th>IPAQ</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Fatigue</td>
<td>0.51**</td>
<td>0.41**</td>
<td>0.49**</td>
<td>0.56**</td>
<td>-0.19**</td>
<td>-0.10</td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>0.73**</td>
<td>0.76**</td>
<td>0.38**</td>
<td>-0.15</td>
<td></td>
<td>0.19*</td>
</tr>
<tr>
<td>Stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSQI</td>
<td>0.44**</td>
<td>-0.13</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPAQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.15</td>
<td>0.02</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

_Note: N = 341. Missing respondent data on some variables. *p < .05, two-tailed. **p < .01, two-tailed._
Chapter 4: A Path Model of Health Outcomes in Ambulance Paramedic Shiftworkers: Testing the role of Individual Circadian Differences and Mental Health

James Courtney
School of Psychological Science, La Trobe University, Australia

Associate Professor Andrew Francis
Division of Psychology, RMIT University, Australia

Professor Susan Paxton
School of Psychological Science, La Trobe University, Australia

Manuscript prepared for peer review and publication
Abstract

This study tested a theoretically driven path model of shiftwork outcomes in paramedic shiftworkers. The potential predictive role of individual circadian differences on shiftwork tolerance (as assessed by distal health outcomes) formed the major focus. Informed by our previous research, specific mediating pathways for indices of mental health were also tested. Participants comprised 492 paramedics (360 male, 130 females, 2 missing) who completed a modified version of the Standard Shiftwork Index. Overall, a range of fit indices found the model to be a good fit to the data. Furthermore, a significant proportion of variance was explained in all outcome variables. Improved health status was predicted by morningness, although the path coefficients were small. Flexibility of sleeping habits and vigorousness in overcoming drowsiness were stronger predictors of health status. Depression was predictive of fatigue levels, while anxiety and stress (to a lesser extent) were predictive of physical health outcomes. The findings suggest that flexible/vigorous types may better tolerate shiftwork, and that indices of mental health may be useful indicators of health status and later dysfunction. Further testing in other shiftwork samples was recommended.
A Path Model of Shiftwork Outcomes in Ambulance Paramedic Shiftworkers: Testing the role of Individual Circadian Differences and Mental Health.

Recent population analyses show a growing trend towards shiftwork in the community, with around 17-percent of the Australian workforce (1.4 million employees) working ‘non-standard’ hours (Australian Bureau of Statistics [ABS], 2006a). By occupation, healthcare providers such as doctors, nurses, and ambulance paramedics were highly represented (ABS, 2003; ABS, 2006b). Of this group, growing research evidence suggests that paramedic shiftworkers may experience more occupational health problems than other healthcare workers and the general community (Courtney, Francis, & Paxton, 2010a; Courtney, Francis, & Paxton, 2010b). A recent systematic review of 49 ambulance studies identified high rates of fatigue, poor sleep and other health problems in personnel (Sterud, Ekeberg, & Hem, 2006), and particular concerns have also been raised about an increased prevalence of mental health disorders (Bennett, Williams, Page, Hood, & Woollard, 2004). Given that paramedics play a critical role in delivering essential emergency health services to the community, this empirical data suggests the need to further investigate factors that may influence service-delivery as well as occupational safety.

While adverse health effects have been consistently reported in shiftwork populations, individual differences are also evident and generally operationalised as shiftwork tolerance. For example, some workers report serious adverse health effects after a brief period of shiftwork whilst others tolerate many years without health compromise (Harma, 1993; Tamagawa, Lobb, & Booth, 2007). The present study extends our previous work that examined predictors of fatigue in paramedic samples (Courtney et al.
and investigates individual differences in shiftwork tolerance through measures of sleep quality, chronic fatigue, mental health, and longer-term physical health in these cohorts. A model of shiftwork is proposed that aims to elucidate those individual factors most likely to predict shiftwork tolerance in this group, and in turn inform potential avenues to promote the health status of these workers.

Several parameters are thought to influence adjustment or tolerance to shiftwork schedules. Circadian arguments are prominent as shiftworkers incur regular disruption to the normal phase relationships between endogenous circadian rhythms (such as the body temperature and sleep-wake cycles) and imposed work-rest schedules (Barger, Wright, Hughes, & Czeisler, 2004). For example, the requirement to work at night when one would usually be asleep contrasts with the circadian down-regulation of body temperature and alertness rhythms that would typically occur at that time. The work-rest cycle is a strong social synchroniser of human circadian rhythms, which along with other stimuli such as light, noise, and social activity acts to align the circadian clock with the exogenous 24-hour day (Cain, Rimmer, Duffy, & Czeisler, 2007; Tankova, Adan, & Buela-Casal, 1994). For those working ‘regular’ hours, this produces a rhythm where peak activity occurs somewhere between 08:00 and 22:00 (Harma, 1993). For shiftworkers, a misalignment of phase occurs that is associated with health-related problems including sleep disruption, decreased alertness, elevated levels of fatigue, and poorer cognitive performance (Barger, et al. 2004; Costa, 2003); by implication putting these workers at higher risk for poorer occupational performance and workplace mishap.
Morningness – eveningness chronotype

The ability to adapt to disturbances imposed on the preferred sleep-wake cycle (e.g. by night work) is thought to be at least partially dependent on the individual differences reflected by chronotype (Natale & Alzani, 2001). The morningness-eveningness dimension refers to the individual variability observed in chronotype; describing the phase or timing of a given circadian rhythm (e.g. body temperature) and, in turn, individual preference for the timing of activities (see Kerkhof, 1985 & Tankova et al. 1994 for a detailed review). Although dimensional, extreme chronotypes have been categorised as either morning-types ('larks') or evening-types ('owls'). Larks are more active in the first part of the day, retire to bed early in the evening and wake spontaneously and early in the morning feeling refreshed. In contrast, owls are more active in the second part of the day, stay up later in the evening and rise later in the morning feeling tired (Cavallera & Giudici, 2008; Natale & Alzani, 2001).

Initial evidence linking shiftwork tolerance to chronotype strongly suggested that evening-types might be more suitable for shiftwork (e.g. Folkard, 1987a), while morning-types ceased shiftwork at a disproportionate rate due to poor tolerance of the circadian disturbances imposed (Kerkhof, 1985; Monk, 1990). In support of this notion, Adan (1992) found that, when allowed to self-select work rosters, night workers tended towards eveningness and morning workers towards morningness. However, subsequent empirical investigation failed to support these predictions, in fact suggesting the opposite. i.e. associations have been established between evening typology and greater sleep difficulties, elevated fatigue and poorer psychological and physical health in shiftwork.
populations (e.g. Barton et al. 1995) although effect sizes are sometimes small (e.g. Kaliterna, Vidacek, Prizmic, & Radosevic-Vidacek, 1995). Even from an epidemiological perspective, evening types were 2.5 times more likely to report poor health and excessive daytime sleepiness, but consistent with Adan’s (1992) findings, also more likely to be involved in night work (Paine, Gander, & Travier, 2006). The sum of this evidence suggests that while evening-types have been more highly represented in some shiftwork studies (potentially through their own volition in terms of choosing a shift cycle which ‘matches’ their preferred sleep-wake scheduling), chronotype may not in fact confer any level of shiftwork tolerance for these individuals as initially predicted. Ongoing research efforts are indicated to clarify the association between chronotype, work schedules and health outcomes, but have been notably absent over the past decade (Cavallera & Giudici, 2008).

Rhythm stability and amplitude

In addition to measures of phase, Folkard, Monk & Lobban (1979) posited that the stability and amplitude of circadian rhythms might also help to explain why some individuals adjust more readily to the disruptions caused by shiftwork. These parameters are commonly assessed as two independent factors using the Circadian Type Inventory (Folkard, 1987b). The first factor (flexible-rigid) assesses rhythm stability in the context of sleeping habits. Rigid-types find it more difficult to sleep at unusual hours, and prefer to eat and sleep at regular times, while flexible-types are more able to stay awake and function at odd times of the day or night. The second dimension (languid-vigorous) assesses rhythm amplitude or strength. Languid types report difficulty overcoming drowsiness, feel lethargic after reduced sleep, and prefer to work at normal times of the day.
Again, vigorous-types exhibit contrasting qualities (Di Milia, Smith, & Folkard, 2005; Folkard et al. 1979). Vigorous and flexible-types appear to adjust more readily to changes imposed on the circadian system on a number of psychological (subjective alertness, need for sleep) and physiological (oral temperature, renal excretion) measures, suggesting better adaptation to shiftwork (Folkard, et al. 1979; Harma, 1993).

Empirical evidence gathered in shiftwork populations has generally supported an association between these circadian parameters and shiftwork tolerance. Rigidity of sleeping habits has been consistently associated with poorer sleep, reduced alertness, poorer health, and psychosomatic and gastrointestinal complaints (Kaliterna et al. 1995; Tucker & Knowles, 2008). By contrast, flexibility has been negatively correlated with chronic fatigue (Iskra-Golec et al. 1995) and sleep disturbance (Ognianova, Dalbokova, & Stanchev, 1998), and also found to be predictive of those who both tolerate and choose to work night shifts (Humm, 1996; Tamagawa, et al. 2007). Languidity has been associated with higher fatigue levels, poorer mental health, gastrointestinal symptoms, poorer well-being, lower alertness, and poor adjustment generally (Iskra-Golec, Marek, & Noworal, 1995; Ognianova et al. 1998; Tucker & Knowles, 2008). The weight of this evidence supports the argument that vigorous-flexible types may potentially show a higher tolerance to the circadian disruption created by shiftwork (e.g. Di Milia, et al. 2005).

The influence of age and gender

While much has been written about the potential influence of age and gender on the response to shiftwork, the predictive value of these individual variables is still debated at a theoretical level. Furthermore, empirical
investigations often report inconclusive findings (e.g. Di Milia, Smith, & Folkard, 2004). A ‘healthy worker effect’ is thought to create a bias in shiftwork samples towards those that best cope and remain in shiftwork (see Boivin, Tremblay, & James, 2007). Consistent with this hypothesis, our previous studies (Courtney et al. 2010a, 2010b) failed to detect significant influence of age or gender on any of the response variables in the present data set. Consequently, individual differences based on circadian parameters form the major focus of the current study, and age and gender will not be further investigated here.

Models of shiftwork

In light of evidence suggesting robust associations between shiftwork and adverse health outcomes, several theoretical models have been offered (but few tested) to conceptualise variables involved and potential causal paths (Smith et al. 1999). The notion that shiftwork leads to disrupted sleep and long-term health problems is common to most explanations, with additional moderating and mediating influences (e.g. individual differences) proposed by various researchers (see Smith et al. 1999 for a comprehensive review). Empirical testing of these theories commenced with a model of shiftwork proposed by Barton et al. (1995a) and statistical path analysis based on a large shiftwork sample. Barton’s model posited that specific features of the shiftwork schedules disrupt biological rhythms, sleep and family life, and that situational and individual differences act to moderate adverse effects. Acute disturbances result in longer-term effects on mental and physical health in a defined temporal order. Despite ongoing modifications and testing of this model (namely Barton, Spelten, Totterdell, Smith, & Folkard, 1995b; Smith et al. 1999) a focus on narrower theories
and specific health outcomes under known shiftwork conditions has been called for, in order to inform interventions sensitive to the needs of a particular occupation (Harma & Kecklund, 2010; Taylor, Briner, & Folkard, 1997).

Consistent with these suggestions, the present work aimed to test a theoretical model of shiftwork in a specific shift system, as shown in Figure 1. The model was informed by existing theoretical work in the field and our previous empirical investigations in two paramedic samples (Courtney et al. 2010a; Courtney et al, 2010b) that established poorer mental health and sleep quality, and higher levels of fatigue than reference groups. Our model is similar to that proposed by Barton et al. (1995a; 1995b) and Smith et al. (1999) as features of the organisation and individual are predicted to contribute to disturbed sleep and then more distal adverse health outcomes. Specifically, these effects are predicted in temporal order such that acute changes (disturbed sleep) lead to short-term outcomes (fatigue, lowered psychological health) and then chronic physical health outcomes. Individual factors are predicted to moderate these effects as proposed by Smith et al. (2005). These latter pathways are shown as dotted lines in Figure 1.

Our model also extends previous work by testing additional parameters and considering alternative paths. Previous investigators have assessed psychological health outcomes via indices of anxiety, psychological ill-health, emotional problems (Barton 1995a, 1995b; Smith et al. 1999) or have excluded psychological health altogether (Smith et al. 2005). Based on our earlier work (Courtney et al. 2010a, 2010b) and existing evidence for an association between shiftwork and chronic mental health problems
(Tucker & Knowles, 2008), individual paths for depression, anxiety, and stress have been placed in the present model as shown in Figure 1.

The following hypotheses were formulated:

1. Eveningness will be significantly associated with poorer sleep quality and elevated chronic fatigue.

2. Vigorous-flexible typology will be significantly associated with lower levels of fatigue, depression, anxiety, and stress, and better quality sleep.

3. The proposed path model (Figure 1) will demonstrate a statistically acceptable fit to the data, and also support the temporal ordering of short-term outcomes that culminate in more serious long-term chronic effects on health and well-being.

Method

Participants

Emergency ambulance paramedics were recruited from the Metropolitan Ambulance Service (MAS) and Rural Ambulance Victoria (RAV) in Victoria, Australia. Although the paramedics were drawn from independent services, their work role was considered to be identical (MAS, 2008). Participation was voluntary and limited to active personnel who routinely worked a forward rotating 24-hour roster cycle with a nightshift component (identified as ‘10/14’ or ‘other’). It was expected that most paramedics meeting this criteria would be working the 10/14 roster: two ten-hour dayshifts, followed by two fourteen-hour nightshifts and four days off (commencing after the second nightshift). A sample of 128 participants was required to satisfy planned analyses based on a moderate effect size ($r = .30$), a significance level of .05, and a power of .80 (Cohen, 1992).
Completed surveys were returned by 492 respondents (150 RAV and 342 MAS). Tables 1 and 2 show the demographics for the final sample.

Materials

A modified form of the Standard Shiftwork Index (SSI; Barton et al. 1995a) was administered. This instrument does not produce a global score but comprises a battery of instruments aimed at assessing shiftwork-related outcomes in workers. The scales were originally classified as general variables (demographics, features of a shift system), moderator variables (differences between individuals that may moderate the impact of shiftwork), and outcome variables (problems experienced by workers). To define the path model, we further classified the scales into moderator and mediator variables. Moderators were considered to influence the direction and/or strength of an association between a predictor and dependent variable, and to exist at the same level as the predictor variable. Mediators were placed between predictor and dependent variables as an additional pathway that transmits the effect of the predictor variable on an independent variable in a potentially causal chain (Baron & Kenny, 1986; MacKinnon, Fairchild, & Fritz, 2007). The final model was based on a selection of original SSI scales (individual circadian variables, measures of physical health) and alternative measures of mental health and sleep quality, described and classified as follows.

Predictors

Individual circadian measures included in the original SSI, and representing relatively stable aspects of circadian timing, were tested for their potential predictive role by examining the moderating influence of each in the path model.
**Morningness/Eveningness.** The Composite Morningness Scale (CMS; Smith, Reilly, & Midkiff, 1989) was used to assess morningness-eveningness chronotype. The scale comprises 13 items related to morning activities, morning affect and eveningness. The psychometric properties are considered acceptable as all inter-item correlations are positive and moderate to high, and the alpha coefficient is 0.87, which allows the calculation of a single score. Individual items are scored from 1 to 4 or 5, and the direction of scoring varies across items. A composite score of 22 and below indicates an Evening-Type; 23 to 43 an Intermediate-Type; and 44 and above a Morning-Type.

**Circadian type.** The Circadian Type Inventory (CTI; Folkard, 1987b) was used to assess the stability and amplitude of circadian rhythms, which comprises 30 items and two subscales or factors. Factor one measures the ability to overcome drowsiness via the dimension Languidity/Vigorousness (LV; alpha .73 to .79; Barton et al. 1995a). Factor two measures the Flexibility/Rigidity of sleeping habits (FR; alpha .79; Barton et al. 1995a). The questionnaire is scored from Almost Never, Seldom, Sometimes, Usually and Almost Always. On both factors, high scores indicate a tendency towards the first of the two labels describing the dimension (i.e. languid types or flexible types). Test–retest correlations for FR and LV were reported as 0.35 and 0.51 respectively in a nine-year longitudinal study of 61 shiftworkers (Kaliterna, Vidacek, Radošević-Viadacek, & Prizmic, 1993).

**Mediators**

Specific indices of mental health were added to the SSI to assess the mental health status of the samples (see Courtney et al. 2010a & 2010b). These indices were tested in the path model for their mediating influence on
outcome variables. The Depression Anxiety Stress Scales 21 (DASS21; Lovibond & Lovibond, 1995) were selected to measure the emotional states of depression, anxiety and stress. Seven items on each of the three scales were summed to obtain an overall score for each state. The psychometric properties of the DASS21 were found to be satisfactory by Henry and Crawford (2005) in a non-clinical population ($N = 1,794$). Alpha values for internal consistency are: Depression 0.81; Anxiety 0.73; Stress 0.81 (Lovibond & Lovibond, 1995).

**Outcomes**

**Quality of sleep.** Quality of sleep was assessed using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI generates component scores for seven domains of sleep quality that are summed to obtain a maximum achievable score of 21, indicating the highest level of sleep disturbance. The PSQI was normed on 52 healthy, 34 depressed and 62 sleep disordered participants and demonstrated sufficient internal reliability ($\alpha = .83$) and validity (Buysse et al. 1989).

**Chronic fatigue.** The SSI Chronic Fatigue Scale (CFS) was specifically developed by Barton et al. (1995a) for this instrument and conceptualises fatigue as a general tiredness and lack of energy irrespective of whether an individual has not had enough sleep or has been working hard, and which persists even on rest days and holidays. A score ranging from 10 to 50 is produced, with higher scores indicating more fatigue. Barton et al. (1995a) found the validity and internal consistency of the CFS ($\alpha$ from .92 to .93) to be satisfactory in a sample of shiftwork nurses and industrial workers.
Physical health. The physical health questionnaire was also specifically constructed for the SSI and comprises two subscales that measure cardiovascular and gastrointestinal disorders, as both are thought to be prevalent in shiftworkers (see Knutsson & Bogild, 2010; Puttonen, Harma, & Hublin, 2010). Each scale comprises nine items selected from a range of existing health measures. Participants are asked to rate how frequently they experience symptoms, such as heart palpitations and digestive difficulties on a four-point scale from almost never to quite seldom, quite often and almost always. A total score is computed for each scale by summing the individual scores, with a higher score indicating poorer physical health on either measure. Alpha values for the cardiac scale range from .69 to .79, and for the gastrointestinal scale from .85 to .87 (Barton et al. 1995a; Smith et al. 1999).

Analyses

The present analyses were guided by ‘The Ten Commandments of Good Structural Equation Modeling Behaviour’ (Thompson, 1998). Statistical analyses and tests of the hypothesised path model were conducted using PASW Statistics 18 (SPSS inc., 2010) and AMOS 18 (Arbuckle & Wothke, 2009). The overall fit of the path model was determined by several fit indices as follows. The chi-square test of overall model fit (Joreskog, 1977) was used to test the hypothesis that the fit between the predicted model and the data is not significantly worse than the fit between a saturated model and the data. A non-significant chi-square test and small value generally indicate a good fit of the model to the data. The goodness of fit index (GFI; Tanaka & Huba, 1985) was used to determine the proportion of variance in the sample variation-covariance matrix accounted for by the
model. GFI values range from 0 to 1, and values that exceed .9 are generally considered to indicate a good model.

The root mean square error of approximation (RMSEA; Browne & Cudeck, 1992) was used as a measure of absolute fit and assesses badness of fit of a model per degree of freedom. Values of .05 or less indicate a good fit, and .08 or less an adequate fit. The lower and upper ends of a 90 percent confidence interval may also be reported for this estimate (LO 90 and HI 90 respectively). Studies by Browne and Cudeck (1993) showed that the RMSEA performs well as an index of practical fit. The Tucker-Lewis coefficient (Tucker & Lewis, 1973) was also used to compare the proposed model against the null model, and measures the extent to which observed covariances are due to common factors. A value of .90 or greater is considered to indicate a reasonable fit, and above .95 an excellent fit (Bohrnstedt, 2010).

Procedure

Approval to collect data from rural paramedics was provided by the RAV Executive and Research Governance Committee (Medical Standards Committee). RAV managed the internal distribution of 560 surveys to 28 rural Branches during July 2008. For the metropolitan study, Ambulance Employees Australia (AEA) managed the distribution of 930 surveys to 93 MAS Branches across Melbourne between July and November 2006. No further arrangements were entered into with AEA. Industry visibility was enhanced by each organisation through internal announcements and reminders. Participation was voluntary for both groups and the survey took around 25 minutes to complete. Completed responses were sent directly to the researchers.
Results

Distributions of all variables were judged adequate in terms of normality, linearity and homoscedacity. Data were also examined for outliers, missing values and data entry errors. The demographic data reported in Table 1 and Table 2 is included here for completeness, and to underpin the representative nature of the sample, however these variables will not attract further statistical treatment.

Internal consistencies based on Cronbach’s alpha were calculated for all measures. Alpha values for the DASS21 scales were .90 (depression), .79 (anxiety) and .88 (stress). Internal consistency of the 10-item chronic fatigue scale was estimated as .95. Based on individual items (per Buysse et al. 1989) the PSQI produced an alpha value of .82. Alpha values for the individual circadian scales were: LV (.76), FR (.79), M/E (.88). Finally, alpha values for the measures of physical health were .82 (GI) and .79 (cardiac).

Table 3 shows descriptive statistics for the major study variables, while Table 4 reports the mostly significant correlations amongst these variables. Correlational analyses generally indicated that morningness (CMS score; versus eveningness) was associated with better psychological and physical health, as was greater flexibility of circadian rhythms (CTI; versus rigidity); whereas greater languidness (CTI; versus vigorousness) was associated with poorer physical and mental health. Positive associations were also observed between all response variables, indicating that poorer psychological health was also associated with poorer physical health. From a categorical perspective, 17.5% of the sample were definite Evening-Types (n = 84), only 2.7% definite Morning-Types (n = 13), and the remaining majority Intermediate-Types (n = 384; 11 missing or inadequate
responses). Consistent with previous discussion and the focus of the study, age and gender (showing relatively weak and mostly nonsignificant associations with other study variables) were excluded from further analyses.

The proposed path model (Figure 2) provides an adequate fit to the data as demonstrated by the individual model statistics. The individual factors of morningness-eveningness and circadian type predicted responses on all distal outcome variables; namely sleep, fatigue and mental health. Furthermore, all three indices of mental health were predictive of medium to long-term outcomes, and the temporal ordering of variables was sustained.

The nonsignificant chi-square test indicates a good overall fit for the model; $\chi^2 (19, N = 492) = 29.34$, $p = .06$. A good to excellent fit is also indicated by the three specific indices selected for the analyses; GFI = .989; RMSEA = .033 (LO .000, HO .056); TLI = .987.

Discussion

This study tested a theoretically derived model examining pathways between individual circadian factors, psychological and behavioural mediators, and shiftwork-related health outcomes in ambulance paramedics. Congruent with recommendations from the literature to focus on specific health outcomes in known shiftwork conditions in order to address the needs of a particular occupation (e.g. Harma & Kecklund, 2010), we tested our model in a well-defined shift system and specific occupational group. All three hypotheses were supported by the findings. Eveningness was significantly associated with poor quality sleep and higher levels of chronic fatigue, supporting the first hypothesis. The second
hypothesis, that a vigorous-flexible typology would be associated with lower chronic fatigue, lower scores on all three indices of mental health, and better quality sleep was also supported. Finally, the theoretical model proposing that individual circadian-timing factors would predict long-term health variables via intermediary variables of sleep, fatigue and mental health was also supported by path analysis and was an acceptable fit to the data.

The notion that shiftwork tolerance can be predicted from individual circadian differences was investigated by examining the association between chronotype, circadian typology, and more distal health outcomes in a causal model. While eveningness chronotype was originally posited to confer an increased level of tolerance to shiftwork schedules (Folkard, 1987a) the present study observed a contrary outcome by observing significant associations between eveningness and poorer health outcomes. Chronotype was placed as an exogenous variable in the model with direct paths to sleep quality and chronic fatigue consistent with theoretical predictions and past research. While negative and significant regression weights were observed for both paths, these coefficients indicate only a relatively small influence toward eveningness as a predictor variable. These findings are consistent with previous causal models examining the role of chronotype as a predictor in shiftwork models (Smith et al. 1999; Smith et al. 1995) as well as associations observed by Barton et al. (1995a) between eveningness and generally poor health outcomes in shiftworkers.

From a categorical perspective, only a very small percentage of participants were morning-types, and a relatively larger number evening-types. This is wholly consistent with Kerkof’s (1985) conclusion that
Individual Circadian Differences

morning-types may cease shiftwork due to poor tolerance, and Adan’s (1992) report that not one participant classified as morning-type chose night work in a self-selected shift roster. Furthermore, Paine et al. (2006) found that definite evening-types were more likely to be involved in night work in a large epidemiological study. One possible interpretation of these findings is that morning-types may in fact cease shiftwork, leaving a majority of intermediate-types and a smaller number of evening-types. This notion would be supported by the epidemiological distribution of morningness-eveningness established by Paine et al. (2006) who found that around 25 percent of the general population report either a morning or evening-type preference. Adopting this distribution, the present sample is clearly underrepresented by morning chronotype which also supports the premise that shiftworkers may self-select to work irregular hours based on their resources and ability to cope (see Boivin, Tremblay, & James, 2007; Knutsson & Akerstedt, 1992), thus producing a ‘survivor’ population. Given, the thus restricted distribution of the chronotype dimension, this of course creates some difficulties for interpretation of health outcomes in morning-types as a categorical group. However, the present findings appear to be congruent with previous literature both through the low representation of morning-types in the sample, and in the positive associations found between morningness-eveningness typology (dimensionally) and adverse health outcomes; although chronotype is of small predictive value in the path model.

Circadian typology appeared to be of more predictive value in the present data. The notion that flexible-vigorous types may better tolerate shiftwork (e.g. Di Milia, et al. 2005) was supported through the significant
associations observed between circadian typology and all other indices of functioning in the model. Parameters linked to sleep functioning are of prime interest to most shiftwork investigations, and flexibility was highlighted as a significant predictor of better quality of sleep though a relatively large direct path coefficient. The negative correlation between flexibility and chronic fatigue is also consistent with previous findings (e.g. Iskra-Golec, 1995), although this contribution showed a smaller direct path coefficient than for sleep quality indicating less influence.

Languidness has been associated with a wide range of adverse health outcomes suggestive of poor shiftwork tolerance (see review by Tucker & Knowles, 2008), and specifically, higher fatigue levels and mental health problems in some studies (Ognianova et al. 1998). The significant correlations observed between languidness and all outcome variables supports the notion that this personality dimension may indicate poorer tolerance to shiftwork, although any predictive value must be considered in conjunction with the relatively small path coefficients observed in the model. The association between languidness and the three indices of mental health is novel; especially the relatively strong direct path coefficient to depression, as elevated levels of depression (and chronic fatigue) were reported in our previous publications for this paramedic cohort (Courtney et al. 2010a, 2010b). Pending further verification, this observation extends our previous analyses by adding languidness to sleep quality and depression as important predictors of chronic fatigue, which is relevant from both a clinical and organisational perspective. On a dimensional scale, our findings suggest that vigorousness and flexibility may be beneficial personality characteristics in terms of shiftwork tolerance, though not predictive.
Examining the path model in a more holistic manner, the range of fit statistics selected for the analyses consistently suggest that the model provides a good to excellent fit to the data in the paramedic sample. Furthermore, the hypothesised temporal ordering of short to longer-term adverse health outcomes finds support, and the variance explained in each of the major variables is substantial, which contrasts with early criticisms that explained variances are generally low (between 4 to 10 percent) in many studies (Nachreiner, 1998). This outcome is encouraging and heuristic given the complexity and range of parameters under consideration. Strong associations were observed in the hypothesised directions between sleep quality, fatigue and mental health, and then physical health outcomes. Consistent with the vast majority of related literature, this again confirms the prime importance of sleep as a central determining factor in a complex multifactorial response to shiftwork, and especially longer-term outcomes on mental and physical health (e.g. Akerstedt, Kecklund, & Gillberg, 2007).

One advantage of conducting a path analysis, rather than examining a series of multiple regression procedures, is that both direct and indirect paths can be measured between variables (Barton et al. 1995b). Of particular note, the indirect paths via the indices of mental health highlight the potential role of mental health status in the workforce as a predictor of more distal adverse health outcomes. The paths from anxiety to the physical health measures are amongst the strongest in the model, and are consistent with those reported by Smith et al. (1999); especially the stronger path between anxiety and cardiovascular symptoms. While there appears to be growing concern about increased rates of cardiac disease (Puttonen et al. 2010) and gastrointestinal disorders (Knutsson & Bogild,
2010) in shiftworkers, the underlying mechanisms remain relatively unexplored and warrant further investigation. Together with the significant correlations, and our earlier findings (Courtney et al. 2010a; 2010b), the present model suggests that mental health monitoring may hold at least some predictive value for the medium and longer-term health of shiftworkers.

Several of the methodological concerns associated with shiftwork research, and specifically path modelling, were addressed in the present study. In particular, data relate to a single occupational group working a known roster system, (Harma & Kecklund, 2010) and the model was theoretically driven from past empirical research and focused on defined health outcomes (Taylor et al. 1997). Despite this methodological attention, the cross-sectional nature of the study remains a limiting factor, so longitudinal investigations would be beneficial. Furthermore, while the fit of the path model to the data was found to be more than acceptable, it is highly likely that alternative models and explanations are possible. The generalisation of findings is also limited given that the study investigated a group of workers from a single ambulance service, however adoption of our model by future investigators would further test the proposed pathways. Shiftwork studies are also limited by the self-selecting nature of workers, which has been discussed in the relevant sections.

In conclusion, the present work has found support for a causal model predicting direct and indirect effects of individual difference variables on adverse health outcomes generally associated with shiftwork. Our findings extend and clarify previous evidence regarding the association between individual differences and shiftwork tolerance. Consistent with previous
studies, morning-types were underrepresented in the sample possibly due to intolerance of shiftwork, although this hypothesis was not tested. While evening-chronotype was more represented, and associated with adverse health outcomes, the mostly small coefficients observed in the path model suggest only limited influence. Similarly, the path coefficients for circadian type suggest that flexible-vigorous typology could be beneficial for shiftworkers, though not predictive of tolerance. Despite relatively small contributions from individual difference variables, the path model provides a good fit to the data and considerable variances were explained in the major outcome variables. Finally, in addition to a causal pathway for the shiftwork-illness relationship, the model also highlights potential avenues for clinical intervention at a range of temporal points, especially the additional pathways via indices of mental health, which contribute novel findings to the field.
References


Folkard, S. (1987b). Circadian Type Inventory. Sheffield, United Kingdom: University of Sheffield, Department of Psychology.


Paper presented at the annual meeting of the U.S. Department of Education, Office of Special Education Programs Project Directors' Conference, Washington, DC.


Table 1

*Age, Gender, and Marital Status of Respondents*

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Gender</th>
<th>Marital status</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>40.02</td>
<td>9.21</td>
<td>21 - 61</td>
</tr>
</tbody>
</table>

*Note:* N = 492. Missing respondent data on some variables. M = Married or Partnered, D = Divorced or Separated, W = Widowed, S = Single.
Table 2

*Type of Shift Structure Worked, Years on Present Roster, and Total Years of Shiftwork Service*

<table>
<thead>
<tr>
<th>Shift structure</th>
<th>Years on present roster</th>
<th>Years of shiftwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/14(^a)</td>
<td>348 142</td>
<td>8.35 7.07 .01 - 36.70</td>
</tr>
</tbody>
</table>

*Note: N = 492. Missing respondent data on some variables.*

\(^a\)Two twelve-hour day shifts followed by two fourteen-hour nightshifts.
Table 3

*Mean Scores, Variability and Range for Major Study Variables*

<table>
<thead>
<tr>
<th>Measure</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morningness – Eveningness</td>
<td>36.80</td>
<td>6.83</td>
<td>17 – 53</td>
</tr>
<tr>
<td>Languidness - Vigorousness</td>
<td>45.36</td>
<td>8.36</td>
<td>18 – 70</td>
</tr>
<tr>
<td>Flexible – Rigid</td>
<td>44.81</td>
<td>8.62</td>
<td>22 – 67</td>
</tr>
<tr>
<td>Sleep Quality</td>
<td>7.78</td>
<td>3.41</td>
<td>0 – 18</td>
</tr>
<tr>
<td>Chronic Fatigue</td>
<td>29.06</td>
<td>8.82</td>
<td>10 – 50</td>
</tr>
<tr>
<td>Depression</td>
<td>9.00</td>
<td>8.77</td>
<td>0 – 42</td>
</tr>
<tr>
<td>Anxiety</td>
<td>4.97</td>
<td>5.82</td>
<td>0 – 42</td>
</tr>
<tr>
<td>Stress</td>
<td>13.79</td>
<td>9.28</td>
<td>0 – 42</td>
</tr>
<tr>
<td>GI Symptoms</td>
<td>14.59</td>
<td>4.96</td>
<td>0 – 31</td>
</tr>
<tr>
<td>Cardiac Symptoms</td>
<td>10.81</td>
<td>3.17</td>
<td>0 – 27</td>
</tr>
</tbody>
</table>

Note: N = 492. Missing data on some variables.
Table 4  
**Correlations Amongst Major Study Variables**

<table>
<thead>
<tr>
<th>Measure</th>
<th>LV</th>
<th>FR</th>
<th>CF</th>
<th>D</th>
<th>A</th>
<th>S</th>
<th>Sleep</th>
<th>Cardiac</th>
<th>GI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME</td>
<td>-.56***</td>
<td>.04</td>
<td>-.31***</td>
<td>-.19**</td>
<td>-.19**</td>
<td>-.17**</td>
<td>-.24*</td>
<td>-.09</td>
<td>-.18**</td>
</tr>
<tr>
<td>LV</td>
<td>-.42**</td>
<td>.46**</td>
<td>.31**</td>
<td>.34**</td>
<td>.36**</td>
<td>.29**</td>
<td>.20**</td>
<td>.30**</td>
<td></td>
</tr>
<tr>
<td>FR</td>
<td>-.42**</td>
<td>-.29**</td>
<td>-.24**</td>
<td>-.34**</td>
<td>-.38**</td>
<td>-.22**</td>
<td>-.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CF</td>
<td>.54**</td>
<td>.38**</td>
<td>.45**</td>
<td>.53**</td>
<td>.33**</td>
<td>.36**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>.62**</td>
<td>.67**</td>
<td>.41**</td>
<td>.37**</td>
<td>.34**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>.67**</td>
<td>.34**</td>
<td>.56**</td>
<td>.40**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>.40**</td>
<td>.36**</td>
<td>.39**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep</td>
<td></td>
<td>.30**</td>
<td>.39**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td></td>
<td></td>
<td></td>
<td>.44**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. Basic structure of the proposed path model, ordered temporally from left to right. Dotted lines indicate predicted moderator pathways.
Figure 2. Path model showing individual path coefficients and $R^2$ values for each variable.
Addendum to Manuscripts: Data Screening Procedures

Given that the manuscripts presented in Chapters’ 3 to 5 of this thesis were written for publication, some detail relevant to data screening was omitted for the sake of brevity. This addendum describes the procedures used to inspect and clean the data used in the three preceding studies.

Identification of outliers

Stem and leaf plots were produced for each of the scales in order to visually identify outliers. Where outliers were found, the data scoring and input procedure was replicated to identify any errors. This commenced at the original response on the survey document, recalculation of the scale, followed by an inspection of the data spreadsheet for data entry errors. Only a few outliers were identified and these were related to typographical errors at the time of data entry.

Missing data

While data cleaning guidelines for each instrument were consulted where available, limited information was available for most of the measures. There appeared to be no systematic pattern to missing data either for variables or respondents, so missing data was deemed to be missing at random. The number of cases affected for each specific measure is identified in the following text along with the procedures adopted.

Physical exercise. A specific document titled Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire was available as a .pdf document on the website for this instrument at (see http://www.ipaq.ki.se/ipaq.htm). In accordance with these instructions, if data was missing or ‘don’t know’ was checked as the response, the case
was removed in total from analyses. Furthermore, only values of 10 or more minutes of activity were included in the calculation of summary scores, and responses of less than 10 minutes recoded to zero. In an attempt to normalise distributions, values greater than 180 minutes for Walking, Moderate, and Vigorous times were truncated to equal 180 minutes. Finally, maximum values for outliers were determined by removing cases where the sum of the three activity levels exceeded 16 hours. These procedures resulted in the removal of exercise data for two of the MAS participants ($N = 342$) and 13 of the RAV participants ($N = 150$).

**Chronic Fatigue.** In the absence of specific guidelines, items not checked on the chronic fatigue scale (CFS; Barton et al. 1995) resulted in the CFS data being removed from analyses for four participants from the MAS dataset ($N = 342$), and two participants on the RAV dataset ($N = 150$), as a total score could not be calculated.

**Indices of Mental health.** The DASS21 (Lovibond & Lovibond, 1995) produces three scores for the emotional states of depression, anxiety and stress based on responses to seven items on each scale. Again, in the absence of specific guidelines, individual scales were removed if an item was not completed. (Note that a total score was not calculated here by combining the three scales). This resulted in data being absent on all three scales for one MAS participant who did not complete the DASS21 ($N = 342$), and the anxiety scale was removed for one RAV participant ($N = 150$).

**Sleep quality.** The PSQI (Buysse et al. 1989) produces a total score based on seven component scores. Given that the total score was adopted for analyses, sleep data for individual cases were removed if missing items
precluded the computation of any underlying component score. However, where component scores could be determined, these were left in the SPSS data spreadsheets for potential future analyses. This procedure resulted in the inability to determine a total score for ten of the MAS participants ($N = 342$), and three of the RAV participants ($N = 150$).

Chapter 4: Path modelling. While the procedures described above were considered satisfactory for the analyses conducted in chapters’ 2 and 3, the more advanced statistical treatment undertaken for the development of a predictive path model necessitated a more complex approach to missing data. Indeed, some of the required output was not available to the researchers from AMOS 18 (Arbuckle & Wothke, 2009) unless missing values were managed. A range of theoretical approaches can be argued for methods of treating missing data (see Downey & King, 1998; Hawthorne & Elliott, 2005), however the reliance on a specific software product for previous data treatment and analyses (i.e. SPSS version 18; SPSS inc., 2010) resulted in the imputation of missing values using SPSS Missing Value Analysis (version 7.5). This approach is based on the expectation maximization (EM) method, as described on page 41 of the Product Manual for the SPSS Missing Values Analysis module, and derived from the specific academic references contained therein. ‘For the EM procedure, a distribution is assumed for the partially missing data, and inferences are based on the likelihood under that distribution. Each iteration consists of an E step and an M step. The E step finds the conditional expectation of the ‘missing’ data, given the observed values and current estimates of the parameters. These expectations are then substituted for the ‘missing’ data. In the M step, maximum likelihood estimates of the parameters are computed as though
the missing data had been filled in. ‘Missing’ is enclosed in quotation marks because the missing values are not being directly filled, but, rather, functions of them are used in the log-likelihood.’

These procedures resulted in the replacement of missing data for the instruments already described as well as the following additional measures, which were unique to Chapter 4.

*Morningness/Eveningness.* The Composite Morningness Scale (CMS; Smith Reilly, & Midkiff, 1989) produces a total score derived from a 13-item scale. Missing data was imputed for 11 cases on this measure (N = 492) due to incomplete or uninterruptable responses.

*Circadian type.* The Circadian Type Inventory (CTI; Folkard, 1987) assesses the stability and amplitude of circadian rhythms via 30 items and two subscales. Data was imputed for 23 cases on the Flexible/Rigid dimension, and 25 cases on the Languid/Vigorous dimension due to incomplete or uninterruptable responses.

*Physical health.* The physical health questionnaire constructed for the SSI (Barton et al. 1995) was used to assess gastrointestinal and cardiac symptomatology via two independent scales comprising nine items each. Data was imputed for two cases on the cardiac scale and four cases on the gastrointestinal scale due to incomplete or uninterruptable responses.

*Examination of normality.*

For each variable, the assumptions of normality were assessed, using three procedures. First, visual inspection of the histograms and normal Q-Q plots was conducted to determine the shape of the distribution. Second, the critical cut-off levels for skewness (+0.215) and kurtosis (7.037 to 0.48) were determined. Third, skewness was divided by standard error and the
result considered normal if the computed value fell within the +2 to -2 range (Coakes & Steed, 2001). Based on these criteria, the distribution of the scales was deemed acceptable and as expected for both urban and rural paramedic samples. The CFS, PSQI, CMS, and CTI produced normal distributions. The DASS21, IPAQ, and measures of cardiac and gastrointestinal health were positively skewed but representative of the distribution in the general population.
References


Folkard, S. (1987). *Circadian Type Inventory*. Sheffield, United Kingdom: University of Sheffield, Department of Psychology.


Chapter 5: General discussion

This final chapter comprises a general discussion and synthesis of findings from the three preceding empirical investigations. Given that these studies were written for publication, there was a necessary conciseness and brevity in relation to the material included in each. In the present chapter, the opportunity is therefore taken to expand discussion on specific topics, and to present analyses and/or data that were previously excluded or considered less relevant in the context of the focused empirical manuscripts. At the same time, it is not intended to restate the individual discussions that accompany each of the studies. This chapter also offers the first opportunity to discuss and compare differences between the metropolitan and rural samples.

A short summary of the rationale for the present research is provided first, followed by additional demographic data pertinent to the samples represented in Studies 1 and 2. This section also includes further discussion regarding potential rural-urban differences. Subsequent sections discuss the theoretical and practical implications of this work overall by considering the combined outcomes of Studies 1 and 2 together, and then the path model presented in Study 3. Methodological limitations that apply to the investigation of shiftwork generally are then reviewed and compared to the methodology underpinning the present work. Next, limitations of the research in general are discussed followed by the potential direction of future research in this area. Finally, conclusions that can be drawn from this body of research are presented.
Summary of research rationale

The central focus of this thesis was chronic fatigue and mental health in paramedic shiftworkers. As discussed in detail in the general introduction, the notion that shiftworkers suffer from sleep loss and elevated fatigue is widely acknowledged in the shiftwork literature (see Akerstedt, Kecklund, & Gillberg, 2007; Akerstedt, 1998; Sallinen & Kecklund, 2010). Furthermore, there is substantial evidence to conclude a causal relationship between these variables. Indeed, reference is often made to sleep loss and fatigue as a single outcome in the literature (e.g. Baldwin & Daugherty, 2004). While past investigations specific to ambulance paramedics are limited, at least one study observed elevated fatigue at a level considered to pose a significant risk of work disability and sick leave in personnel (Van Der Ploeg, 2003).

With past investigation in mind, the aims of the present research were two-fold. Studies 1 and 2 aimed to determine sleep behaviours, levels of fatigue and indices of mental health in largely untested ambulance paramedic populations. Study 3 aimed to contribute to the broader theoretical literature shiftwork literature by developing and testing a model for health and shiftwork. The model incorporated several individual circadian variables thought to be involved in response to shiftwork, as well as novel pathways for indices of mental health. It was intended that through wide publication, the sum of the findings would advance contemporary knowledge, contribute to the development of workplace and individual interventions, and also stimulate ongoing research investigation.
Expanded detail of study samples

Studies 1 and 2 both investigated shiftwork-related health variables in emergency ambulance paramedics using a modified version of the Standard Shiftwork Index (SSI; Barton et al. 1995), as detailed in the methods section for each investigation. Data collection commenced in July 2006 for Study 1 and July 2008 for Study 2. Apart from this timeframe, the major point of difference between studies was the geographical locations of the samples: metropolitan (or urban) vs. rural respectively. In addition to increasing the overall sample size for statistical analyses in Study 3, the inclusion of both metropolitan and rural based paramedics eliminated any potential for geographical bias, was important in encompassing the broader occupational group, and was consistent with the stated aims and rationale of the thesis. Furthermore, this approach permitted the analysis of potential rural-urban differences, and also enabled the examination of shiftwork outcomes in a cohort comprising only rural workers. The methodological approach underpinning each study was identical, including the method of data collection and scoring. Both studies set out to investigate individual responses to shiftwork and to also compare data to reference samples and population means wherever possible.

Demographic data

Additional demographic data that was not documented in previous chapters is shown for the metropolitan sample in Table 1 and rural sample in Table 2. A predominantly middle-aged mean is apparent for both cohorts, most of whom are married or partnered. On average, the rural group reported working more years on the present roster system, more years of shiftwork overall, and a less homogenous roster structure than the
metropolitan workers. Despite these demographic differences, analyses based on major study variables failed to detect any significant differences between cohorts, except for poorer sleep quality in the rural workers. Although the relevant statistics and discussion are included in Study 2 and will not be revisited here, the similar nature of the data for both cohorts permitted the rural and metropolitan samples to be collapsed into one larger sample for the path analyses presented in Study 3. Additionally, no significant differences were detected on any of the study variables between participants working the 10/14 roster and those that indicated ‘other’. This latter structure clearly lacks some definition, but inclusion criteria ensured that participants worked a night shift component, which infers a forward rotating shiftwork structure given that no permanent night shift positions or backward rotating structure existed in either ambulance services. Although this represents a study limitation, no statistical between group differences were detected between groups as noted.

Urban-rural job role differences

As part of the research rationale, potential differences in occupational demands were investigated between the metropolitan and rural samples, although these particulars were not included in the empirical papers produced for each study. It was determined that the work role of rural-based paramedics (Rural Ambulance Victoria; RAV) was considered to be essentially identical to that of their metropolitan peers (Metropolitan Ambulance Service; MAS) by the parent organisations (MAS, 2008). Despite this, workplace statistics were examined for both groups to establish if any differences could be detected. During the 2007 – 2008 period, RAV responded to 176,930 incidents (an event to which one or more ambulances
are dispatched; RAV, 2008) and employed 766 staff for this purpose. Over the same period, MAS responded to 309,389 incidents and employed 1322 ‘operational’ staff (MAS, 2008). This corresponds to 231 incidents per RAV paramedic and a strikingly similar 234 incidents per MAS paramedic.

Driving times were also examined as a further parameter that could potentially contribute to differences in the rural and metropolitan work roles. Again for the 2007–2008 period, RAV reported 90\textsuperscript{th} percentile response times of 26 minutes while MAS reported a shorter 16.5 minutes. It is likely that this difference results from the greater distances travelled in responding to rural calls, which could potentially contribute to greater fatigue for RAV paramedics given the similar number of average incidents attended over the year.

*Urban-rural mental health differences*

The empirical literature relating to urban-rural differences on specific indices of mental health was also examined. Whilst no previous studies were located that specifically address the question of whether rural paramedics are at increased risk of mental health disorders, it seems reasonable to suggest that their level of risk would be commensurate with the general rural community. In the Australian population the prevalence of mental health conditions has been assessed as roughly equivalent across rural and metropolitan areas (Caldwell, Jorm, & Dear, 2004; Judd et al. 2002), although the methodologies responsible for producing these estimations have been heavily criticised (Allen, 2010; Fraser et al. 2002). Of particular concern is the higher suicide rate in rural communities (compared to the metropolitan population), since mental health disorders
are one of the strongest risk factors for suicidal behaviour (Caldwell, Jorm, & Dear, 2004; Fraser, et al. 2002).

Deficiencies in the existing data supported the need for ongoing investigation to assess the mental health status of paramedics generally, and to specifically determine if rural ambulance workers are at increased risk. With reference to the analyses and conclusions drawn in Study 2, no significant differences were detected on indices of mental health between metropolitan and rural cohorts in this body of research. While it was therefore concluded that rural location did not pose additional risk with regard to mental health for this paramedic sample, additional risk was determined for both rural and metropolitan workers as detailed in the associated studies.

**Theoretical and practical implications of Studies 1 and 2**

*Sleep quality, depression and fatigue*

As reported in Studies 1 and 2, multiple linear regression procedures identified that sleep quality (measured with the Pittsburgh Sleep Quality Index; Buysse et al. 1989) and depression (measured with the DASS21 scales; Lovibond & Lovibond, 1995) were the strongest predictors of chronic fatigue in both the rural and metropolitan cohorts. While the association between sleep behaviours and chronic fatigue is well established, the contribution of mental health in this context is novel and also holds implications for future theoretical conceptualisations of the shiftwork–illness relationship. In sum, poor sleep quality and depression should both be considered as important variables in the explanation of chronic fatigue, and subject to confirmation, potential predictors of chronic fatigue and the longer-term health and well-being of workers. The theory underpinning
such associations posits that any reduction in a causal risk factor (i.e. sleep quality and depression) can reduce the intensity and frequency of a distal problem or outcome (i.e. fatigue) by breaking the developmental sequence (Kraemer et al. 1997). This premise is more evident in the model proposed for Study 3.

**Practical implications**

The practical implications of the foregoing apply to prevention and intervention in the workplace, and the adoption of practical strategies at an individual level. Drawing on the work of Kraemer et al. (1997), prevention strategies aimed at reducing causal risk factors could encompass educational programs that inform better sleep hygiene practices, as well as psychoeducation around the recognition of depressive symptomatology by individuals. Contemporary psychological theory and practice has much to offer in this respect. In terms of intervention, the monitoring of sleep quality and depression in the workplace (potentially using online assessment) could form a useful intervention strategy by identifying those most at risk of chronic fatigue. Nevertheless, while strategies derived from theoretical and empirical knowledge can be well specified, they rely on participation and responsibility for change by individual workers. Once again, psychological methods of behavioural change may prove useful in facilitating these types of individual interventions.

**Contribution to theoretical knowledge**

It is also worth noting that the findings regarding sleep quality, depression, and fatigue discussed in this section make a significant and novel contribution to the shiftwork literature. While previous investigations have raised concerns about an increased prevalence of mental health
problems in ambulance personnel generally (e.g. Bennett, Williams, Page, Hood, & Woollard, 2004), none were detected that examined associative relationships or causal pathways with other variables. Possibly the most similar study was that of Ruggiero (2003) who also found that sleep quality (and depression) contributed significantly to chronic fatigue (also using the Standard Shiftwork Index Chronic Fatigue Scale; Barton et al. 1995a) in a smaller sample of female shiftwork nurses on mixed rosters.

*The role of Physical activity*

The level of physical activity undertaken by paramedics in both cohorts was assessed and compared to community-based reference data. Findings suggest that paramedics might participate in a lower percentage of exercise when compared to reference samples, possibly due to the demands of shiftwork rostering (although this hypothesis was not directly examined). Significant negative associations were also hypothesised between chronic fatigue and physical exercise in both studies. The rationale here was drawn from the growing evidence in the general community that has established and actively promoted physical activity as a means to improve overall health and well-being (World Health Organisation, 2006). One older empirical study has also demonstrated reduced fatigue following an exercise intervention in a shiftwork nurse cohort (Harma, Ilmarinen, Knauth, Rutenfranz, & Hanninen, 1988a; 1988b).

*Outcomes of analyses*

Directed by the specific hypotheses, multiple linear regression analyses determined that physical activity explained a significant amount of the variance in chronic fatigue scores for the metropolitan sample. Although the beta value was relatively small ($\beta = -.14, p < .001$), this finding was
not replicated in the rural cohort ($\beta = -0.08, p = .26$). Rural paramedics also reported 2.5-percent less physical activity than metropolitan workers. Significant bivariate correlations were observed between physical exercise and major study variables in the metropolitan cohort that were not detected in the rural sample. While the reason for this group difference was uncertain, the significant negative associations observed in both studies between level of physical activity and chronic fatigue scores (metropolitan $r = -.27, p < .001$; rural $r = -.19, p < .001$) suggests that exercise plays at least some role in worker fatigue.

**Practical implications**

It seems reasonable to conclude that an increase in physical activity may assist in reducing adverse health outcomes, and specifically chronic fatigue, certainly in the metropolitan sample. This notion is supported by the general literature as already discussed, and the nature and size of the associations observed with outcome variables in the present study to some degree. The lesser role of physical activity in rural workers was unexpected and remains uncertain, but may be a useful avenue to pursue in future research.

**Contribution to theoretical knowledge**

Past investigation of physical activity in shiftworkers is almost non-existent despite solid theoretical grounds for such work (e.g. WHO, 2006). While the present findings can only be considered as initial, they are also novel to the field of shiftwork and have established data specific to two discrete samples. The associations observed in the metropolitan group were more consistent with theoretical predictions, while those in the rural group were either not detected or limited to small effects and potential trends.
However, this work provides normative data for comparison with future work, and analyses that may prove useful to theoretically driven hypotheses and investigations of exercise behaviours in future shiftwork samples.

**Individual differences related to age and gender**

The observation that some individuals tolerate shiftwork better than others has generated both theoretical debate and empirical investigation of potential underlying parameters. The conceptualisation of shiftwork tolerance is discussed in detail in Study 3, but is generally assessed through a variety of adverse health outcomes in workers (Tamagawa, Lobb, & Booth, 2007). The potential influence of age and gender has attracted consistent attention, but solid conclusions remain elusive as discussed in the general introduction. The findings of the present research failed to detect significant or consistent differences on major study variables by gender, and only small differences by age for specific variables, discussed as follows.

**Outcomes of analyses**

The bivariate associations reported in Studies 1 and 2 show significant positive but weak associations between age and depression of similar magnitude (metropolitan $r = .17$, $p < .001$; rural $r = .19$, $p < .05$). This contrasts with population prevalence data, which suggests that younger age groups experience higher rates of affective disorders (Australian Bureau of Statistics [ABS], 2007). Given that a significant association was also observed between age and years of shiftwork (metropolitan $r = .81$, $p < .01$; rural $r = .78$, $p < .01$), this lends some support to the notion that increasing age (or indeed greater exposure to shiftwork) is associated with poorer psychophysical tolerance (Costa, 2003).
The potential contribution of age to chronic fatigue was also examined in the regression analyses for both studies. While age was not significant in the regression model for the metropolitan cohort, a relatively small but significant contribution was detected for the rural sample ($\beta = -0.16, p = 0.02$).

**Practical and theoretical implications**

Regression analyses in both studies indicated that quality of sleep and depression were the more potent predictors of chronic fatigue in both rural and metropolitan samples. As such, although increasing age may play a minor role in shiftwork tolerance, any contribution is subsumed to a large extent by other variables that should attract the bulk of attention in terms of workplace interventions. Gender similarly appears to be of little predictive value within the current methodological paradigm.

**Theoretical and practical implications of shiftwork model (Study 3)**

**Theoretical summary and rationale**

Studies 1 and 2 focussed on variables associated with and (theoretically) preceding fatigue, which itself was identified as both a significant short-term outcome for workers, and one that may also develop chronicity. Consequently, it was deemed plausible that a conceptualisation of predictor and outcome variables, and associated pathways, could be developed. For example, depression could be tested for any mediating effects on a sleep to fatigue pathway in accordance with the model posited by Baron and Kenny (1986). Likewise, variables can be identified and tested for potential moderating effects. The basis of these effects are discussed in the relevant sections of the thesis.
Based on previous theoretical work and empirical outcomes, a model of health outcomes for shiftworkers was proposed and tested in Study 3. The model tested both the mediating and moderating effects of specific variables in a pre-defined temporal order. Several attempts at modelling adverse outcomes in shiftworkers had been generated by the same research group in the 1990s, and three of the models were tested on the same data (Barton et al. 1995a; 1995b; Smith et al. 1999). The next major conceptualisation (that considered similar variables) was proposed by Smith et al. (2005) and tested the impact of individual differences on sleep and fatigue outcomes in a shiftwork cohort. So in sum, few models of the shiftwork–illness relationship exist. The majority of theoretical work on shiftwork models arose during the 1980s (e.g. Rutenfranz, 1981; Monk, 1988), progressed during the 1990s through some empirical testing by a particular group, and then largely ceased apart from the noted exception.

**Advances to existing theory**

In light of the preceding historical review, the present model represents a significant contribution to the shiftwork literature. Specific theoretical advances were determined in relation to the role of mental health, and existing knowledge regarding the role of individual differences was strengthened in the findings. Like previous conceptualisations (e.g. Barton et al. 1995a), the model proposed a causal chain whereby shiftwork negatively impacts on sleep quality, which leads to chronic fatigue and eventually adverse physical health outcomes. Individual circadian parameters were placed as moderators in the model and indices of mental health tested for mediating effects (see Figure 1, Chapter 3 and associated method section).
Individual circadian differences

Without restating previous material in detail, analyses of individual circadian differences in the model showed that flexible/vigorous typology was the stronger predictor of shiftwork tolerance as previously suggested by Di Milia, Smith, and Folkard (2005). While evening chronotype was associated with poor health outcomes generally, the path coefficients suggested only a small influence on distal outcomes. This latter observation contrasts with earlier opinions regarding chronotype (Folkard, 1987) but is consistent with later empirical findings (Barton et al. 1995a). Furthermore, morning-types were largely absent from the samples, which wholly reflects the previous literature (Adan, 1992; Kerkhoff, 1985). While these findings are useful at a theoretical level, it may prove somewhat difficult and restrictive (if not illegal) to employ individuals based on individual circadian differences alone. As such, the practical implications may be limited to the identification of individuals known to be at increased risk of adverse outcomes and the administration of appropriate interventions and/or education.

Indices of mental health

Arguably, the most novel outcome of the theoretical model was the specification of individual pathways for depression, anxiety, and stress. These mental health variables not only represented outcome variables in their own right, but also mediated distal responses. The contribution of depression on chronic fatigue has already been sufficiently discussed, however the theoretical model (Figures 1 and 2, Study 3) portrays well a simple mediation model (Baron and Kenny, 1986) between sleep quality, depression (as mediator) and chronic fatigue. The variance explained in
chronic fatigue according to the overall model was very acceptable at around 49-percent.

While the model also resulted in relatively high $R^2$ values for indices of anxiety and stress, covariations amongst these variables are likely to be at least partially responsible. The direct pathway from anxiety to cardiac symptoms is noteworthy as it is amongst the strongest in the model. This is not surprising form a pathophysiological perspective and psychologists have previously identified anxiety as a univariate risk factor for readmission to hospital following cardiac surgery using the DASS21 (Oxlad, Stubberfield, Stuklis, Edwards, & Wade, 2006). While this research established an association between anxiety and cardiac health in medical patients, anxiety has not previously been specified in a shiftwork model using such a well-known and validated measure such as the DASS21 (Lovibond & Lovibond, 1995).

**Temporal ordering of variables**

A further aspect of the model that extends theoretical knowledge is the successful temporal ordering of variables. While this arrangement was derived from earlier models, the relative placement of the indices of mental health was novel. Other investigators have tested the languid-vigorous dimension as a mediator between sleep and fatigue (Barton et al. 1995a) rather than a mediator as in the present representation. The sizeable $R^2$ values determined for the majority of the variables adds further support for conceptualisation and theoretical underpinnings of the model. Overall, the acceptable fit of the model contributes to contemporary knowledge of shiftwork outcomes and particularly highlights the consideration and important role of mental health outcomes for workers.
Methodological review

Concerns regarding the methodological underpinnings of past shiftwork investigation have been compared with the present methodology for each of the empirical studies in the thesis. Given that editorial requirements have narrowed the extent of commentary to some degree, this more general discussion allows further elaboration around this important topic.

Exposure to shiftwork

A recent editorial by Harma & Kecklund (2010) documented a range of contemporary concerns related to methodological drawbacks in shiftwork investigation. The assessment of shiftwork exposure (the type and quantity of shiftwork that an individual has worked) attracted particular criticism and was deemed to be inferior in many studies. Calls were made for individual monitoring of shiftwork exposure in study samples in the face of ever-changing job roles and shift systems. In sum, it was recommended that future research efforts should specify the particular shift system under investigation, the amount of night shift, starting times, and the speed and direction of rotation. The authors also noted that while large study samples are attractive to researchers, they have also been associated with poorer assessment or only estimations of shiftwork exposure in many cases.

The methodology used in the present research addressed the concerns regarding exposure assessment almost completely. Over 70-percent of the combined sample worked an identical shift structure (the 10/14 roster), or indicated working a forward-rotating system that included night shift (the ‘other’ roster’), and all were ambulance paramedics with an identical job specification. Furthermore, no significant differences were
detected between the rural and metropolitan samples that would influence findings, and the samples were not limited to one gender (as is often the case in the many shiftwork nurse samples, for example, Iskra-Golec, Marek, & Noworol, 1995; Ruggiero, 2003). The homogeneity of the sample on these variables is rare in the shiftwork literature, and was not evident in any of the past studies of ambulance paramedics. As such, the present findings are likely to be more representative of the health status of the paramedic samples when compared to similar measures of health reported by past investigators.

**Normative comparisons**

Methodological criticisms have also been raised regarding a lack of comparison with normative data in most of the past shiftwork investigations (e.g. Harma & Kecklund, 2010; Sterud, Ekeburg, & Hem, 2006). Whilst the present methodology has attempted to address this limitation by selecting appropriate reference groups for statistical comparison wherever possible, this represents a challenge in itself. Assessment instruments used to measure health outcomes vary widely across the shiftwork literature, as do conceptualisations of the specific health complaints. For example, the assessment and reporting of depression ranges from a categorical (e.g. clinical level of depression; Bennett, et al. 2004), to a dimensional approach (e.g. Ruggiero, 2003). The reporting of dimensional and clinical data in the present work was possible for indices of mental health, and sleep quality to a lesser degree (i.e. good and bad sleepers). However, reporting and comparison of the remaining measures was limited by the methodologies of past researchers and available data.
Longitudinal methodology

The general lack of longitudinal investigation and over-representation of cross-sectional investigation has been an acknowledged concern in the shiftwork literature for some time (e.g. Taylor et al. 1997). The association limitations are discussed further on. Clearly, the present studies are based on cross-sectional methodology, however a longitudinal investigation of the metropolitan cohort was conducted two-years after the initial data collection in July 2008. This work was deemed excessive to the requirements of the present thesis and will be published separately in due course.

Models of shiftwork

As already discussed, the pathways and mechanisms that influence the effects of shiftwork on health outcomes have been conceptualised through path models. In a review by Taylor, Briner, & Folkard (1997), these past efforts were criticised for being too broad and conceptual in nature, and for comprising too many variables and interrelationships that limited the practical benefit of findings. These authors specified several recommendations for future research that were adopted for Study 3 in particular. The present model was narrower than past attempts, in that a focus was maintained on a limited range of health parameters. Theoretically derived pathways tested the moderating influence of individual circadian differences and the mediating effect of mental health variables on other outcome variables in a defined shift system and for a single occupational group. As discussed by Harma and Kecklund (2010), this information is necessary in order to select the most appropriate point of intervention or prevention, which may be psychosocial, behavioural or physiological in
origin. The practical and/or clinical implications of the present findings follow.

Limitations

Reliance on participants’ self-report data can be considered a methodological limitation in the present research as such an approach introduces the possibility of reporter bias (Donaldson & Grant-Vallone, 2002).

It is possible for example that those paramedics most disgruntled or affected by shiftwork chose to participate by completing the survey instrument, potentially producing type-1 errors in the analyses. While recognising this limitation, alternative methods that may increase the validity of findings are expensive and time consuming (e.g. clinical interviews, observations, and formal testing) so survey data remains an efficient means of obtaining a broad range of information from a large sample (see Baldwin & Daugherty, 2004 for further discussion).

The lack of a control group represents a further limitation. In the context of the present research, this would require the assessment and statistical comparison with a group of ambulance paramedics working ‘regular’ or daytime hours. As no such group exists, this was not possible. As such, one cannot draw causal statements to the effect that shiftwork rostering leads to the poor health outcomes observed on study variables (Taylor, et al. 1997). For example, work-related stress may stem from the nature of ambulance work itself rather than shiftwork per se. Furthermore, the investigation of shiftworkers is limited by a process of natural selection, whereby those who are able to cope best with the associated challenges remain, and those that suffer most cease this form of work (see Boivin,
Tremblay, & James, 2007). However, on this basis, it is more likely that adverse health effects are underestimated in the samples (Taylor et al. 1997).

Additional confounding variables should also be acknowledged that were neither assessed nor controlled for in any of the studies. The shiftwork literature makes some reference to factors such as diet, smoking, alcohol and drug use, coping styles and social support (and possibly more), all of which could be associated with the major study variables examined here. As it is clearly not possible to assess and analyse every component of human functioning, the empirical investigations in the thesis were focused on variables considered to be the most potent and relevant to the scope of the work undertaken. This decision was also informed by the direction and outcomes of prior work in the field. However, a range of additional parameters would be relevant to future research.

Several factors contributed to the validity of the present findings. The researchers were familiar with the assessment instruments (including the specification of modifications to the SSI; Barton et al. 1995a) and well versed in scoring and data analysis generally. Furthermore, Studies 1 and 2 sampled two discrete cohorts with a two-year intervening period, both resulted in acceptable response rates, and both produced remarkably similar outcomes in terms of demographics and health status across samples. The homogenous nature of the sample also contributed positively to the research methodology as already discussed.

Final conclusion and implications for future research

The current body of research identified several important factors related to the health status of workers in two paramedic samples, which is
potentially generalisable subject to future investigation and confirmation. Consistent with past research, poor sleep quality and chronic fatigue was observed for both cohorts. These findings not only establish clinically important data in the ambulance sector, but also suggest the need for urgent organisational attention to fatigue management in the workplace. As well as the elevated scores of depression observed in both samples, depression emerged as a significant predictor of fatigue. The significant role of depression, and its association with other indices of health, offers new information to the shiftwork literature and again raises the need for workplace prevention and intervention strategies. Moreover, these findings suggest that depression in shiftworkers warrants specific ongoing investigation, and that future conceptualisations regarding the shiftwork-illness pathway should incorporate the role of this mental health variable.

While the influence of physical exercise was inconsistent and smaller than expected, the present results suggest that paramedics engage in lower levels of physical activity than community groups, and that engagement in exercise may assist in alleviating chronic fatigue, at least to some degree. Rather than further quantifying levels of physical activity, future investigation based on exercise interventions in shiftworkers would be a useful way in which to proceed (see Sallinen & Kecklund, 2010). A control group would be relatively simple to incorporate in the study design of an intervention program, which was identified as a limitation in the current work as well as the shiftwork literature generally.

The model of shiftwork and health proposed in Study 3 confirms the temporal ordering of major health responses suggested by previous models, and advances contemporary knowledge by positing new pathways and
associations, especially with regard to mental health. The results suggest that depression, anxiety and stress should be considered as distinct indices of mental health (rather than being collapsed into a single affective disorder or response) and ordered temporally with specific pathways and mediating associations. Flexible-vigorous typology was also found to predict a degree of tolerance to shiftwork, although the practical application of this knowledge may be limited to the identification of those at increased risk rather than for employment screening purposes. Replication and empirical testing of this model in future samples would be useful in determining the generalisability of the underlying concepts.

To conclude, research for this thesis has been conducted over a four-year period. The methodology and focus is consistent with many of the concerns and suggestions raised only recently in a special issue of The Scandinavian Journal of Work, Environment, and Health (Volume 36, 2010). The several publications contained therein suggested a focus on risk assessment, and a better understanding of the shiftwork to illness pathway in order to aid detection of problems, and specify prevention and treatment measures. The present findings have much to offer in this respect and should also underpin the theoretical approach taken by future research efforts.
References


Fraser, C., Judd, F., Jackson, H., Murray, G., Humphreys, J., & Hodgins, G. A. (2002). Does one size really fit all? Why the mental health of rural


Table 1

*Age, Gender, and Marital Status of Respondents*

<table>
<thead>
<tr>
<th>Service</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Marital status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>MAS*a</td>
<td>40.00</td>
<td>8.50</td>
<td>23 – 61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAV*b</td>
<td>42.40</td>
<td>10.29</td>
<td>21 – 61</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note:* Missing respondent data on some variables. M = Married or Partnered, D = Divorced or Separated, W = Widowed, S = Single. *aN = 342. *bN = 150.
Table 2
Type of Shift Structure Worked, Years on Present Roster, and Total Years of Shiftwork Service

<table>
<thead>
<tr>
<th>Service</th>
<th>Shift structure</th>
<th>Years on present roster</th>
<th>Years of shiftwork</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10/14⁹</td>
<td>Other</td>
<td>M</td>
</tr>
<tr>
<td>MAS⁵</td>
<td>268</td>
<td>67</td>
<td>7.94</td>
</tr>
<tr>
<td>RAV⁹</td>
<td>75</td>
<td>75</td>
<td>9.29</td>
</tr>
</tbody>
</table>

Note: Missing respondent data on some variables.

⁹To twelve-hour day shifts followed by two fourteen-hour night shifts. ⁵N = 342. ⁹N = 150.
Appendix A

Standard Shiftwork Index (SSI)

Battery of Measures Administered to Participants
La Trobe University
School of Psychological Science

Shiftwork Survey

This is a confidential survey.

Please read the Project Information Statement before you begin.

When you have completed the survey, please return it to the researchers using the reply paid envelope provided.
Section 1: Your general biographical information

Please answer the following questions as accurately as possible. Please note that the information you give will be treated in strictest confidence.

a) Which roster do you work? **10/14** □  Other □ (please specify) __________________________

b) What time of day or night are you filling out the questionnaire: __________________________

c) Age: ________

d) Sex: Female □  Male □  *(tick one)*

e) How long have you worked in your present shift system? _____ years _____ months

f) How long altogether have you been working shifts? _____ years _____ months

g) Are you:  
(a) Married/Living with a partner ________  
*(tick one)*  
(b) Separated/Divorced ________  
(c) Widowed ________  
(d) Single ________
Section 2: Your sleep

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.

1. During the past month, when have you usually gone to bed at night?

   **USUAL BED TIME**

2. During the past month, how long (in minutes) has it usually take you to fall asleep each night?

   **NUMBER OF MINUTES**

3. During the past month, when have you usually gotten up in the morning?

   **USUAL GETTING UP TIME**

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)

   **HOURS OF SLEEP PER NIGHT**

5. During the past month, how often have you had trouble sleeping because you...

   (Please circle the appropriate answer)

   For each of the remaining questions, indicate the one best response. Please answer all questions.

<table>
<thead>
<tr>
<th></th>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Cannot get to sleep within 30 minutes</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Wake up in the middle of the night or early morning</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. Have to get up to use the bathroom</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d. Cannot breathe comfortably</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Cough or snore loudly</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>f.</td>
<td>Feel too cold</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>g.</td>
<td>Feel too hot</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>h.</td>
<td>Had bad dreams</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>i.</td>
<td>Have pain</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

j. Other reason(s), please describe:

________________________________________________________________________

How often during the past month have you had trouble sleeping because of this reason(s)?
(Please tick the appropriate box)

<table>
<thead>
<tr>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

4. During the past month, how would you rate your sleep quality overall?
(Please tick the appropriate box)

- Very good ☐
- Fairly good ☐
- Fairly bad ☐
- Very bad ☐
5. **During the past month, how often have you taken medicine (prescribed or 'over the counter') to help you sleep?**

Not during the past month  
Less than once a week  
Once or twice a week  
Three or more times a week  

☐  ☐  ☐  ☐

6. **During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?**

Not during the past month  
Less than once a week  
Once or twice a week  
Three or more times a week  

☐  ☐  ☐  ☐

9. **During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?**

No problem at all  
Only a very slight problem  
Somewhat of a problem  
A very big problem  

☐  ☐  ☐  ☐

10. **Do you have a bed partner or roommate?**

No bed partner or roommate  
Partner/roommate in other room  
Partner in same room, but not same bed  
Partner in same bed  

☐  ☐  ☐  ☐
11. **If you have a roommate or bed partner, ask him/her how often in the past month you have had...** (Please circle the appropriate answer)

<table>
<thead>
<tr>
<th></th>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Loud snoring</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Long pauses between breaths while asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. Legs twitching or jerking while you were asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d. Episodes of disorientation or confusion while asleep</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

12. **Other restlessness while you sleep: please describe**

How often during the past month have you experienced this? (Please check the appropriate box)

<table>
<thead>
<tr>
<th>Not during the past month</th>
<th>Less than once a week</th>
<th>Once or twice a week</th>
<th>Three or more times a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
Section 3: Fatigue

The following items relate to how tired or energetic you generally feel, irrespective of whether you have had enough sleep or have been working very hard. Some people appear to ‘suffer’ from permanent tiredness, even on rest days and holidays, while others seem to have limitless energy. Please indicate the degree to which the following statements apply to your own normal feelings. *(Circle one number for each).*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Not at all</th>
<th>Some what</th>
<th>Very Much So</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>I generally feel I have plenty of energy</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(b)</td>
<td>I usually feel drained</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(c)</td>
<td>I generally feel quite active</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(d)</td>
<td>I feel tired most of the time</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(e)</td>
<td>I generally feel full of vigour</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(f)</td>
<td>I usually feel rather lethargic</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(g)</td>
<td>I generally feel alert</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(h)</td>
<td>I often feel exhausted</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(i)</td>
<td>I usually feel lively</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(j)</td>
<td>I feel weary much of the time</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
**Section 4: Your health and well-being**

Please indicate how frequently you experience the following, by circling the appropriate number:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>How often is your appetite disturbed?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(b)</td>
<td>How often do you have to watch what you eat to avoid stomach upsets?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(c)</td>
<td>How often do you feel nauseous?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(d)</td>
<td>How often do you suffer from heartburn or stomach-ache?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(e)</td>
<td>How often do you complain of digestion difficulties?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(f)</td>
<td>How often do you suffer from bloated stomach or flatulence?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(g)</td>
<td>How often do you suffer from pain in your abdomen?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(h)</td>
<td>How often do you suffer from constipation or diarrhoea?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(i)</td>
<td>How often do you suffer from heart palpitations?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(j)</td>
<td>How often do you suffer from aches and pains in your chest?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(k)</td>
<td>How often do you suffer from dizziness?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(l)</td>
<td>How often do you suffer from sudden rushes of blood to your head?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(m)</td>
<td>Do you suffer from shortness of breath when climbing the stairs normally?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(n)</td>
<td>How often have you been told that you have high blood pressure?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(o)</td>
<td>Have you ever been aware of your heart beating irregularly?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(p)</td>
<td>Do you suffer from swollen feet?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(q)</td>
<td>How often do you feel 'tight' in your chest?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(r)</td>
<td>Do you feel you have put on too much weight since beginning shiftwork?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(s)</td>
<td>Do you feel you have lost too much weight since beginning shiftwork?</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
# Section 5: Stress and anxiety

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.

*The rating scale is as follows:*

0  Did not apply to me at all  
1  Applied to me to some degree, or some of the time  
2  Applied to me to a considerable degree, or a good part of time  
3  Applied to me very much, or most of the time

<table>
<thead>
<tr>
<th></th>
<th>Statement</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I found it hard to wind down</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>I was aware of dryness of my mouth</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>I couldn’t seem to experience any positive feeling at all</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>I experienced breathing difficulty (eg, excessively rapid breathing,</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>breathlessness in the absence of physical exertion)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I found it difficult to work up the initiative to do things</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>I tended to over-react to situations</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>I experienced trembling (eg, in the hands)</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>I felt that I was using a lot of nervous energy</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>I was worried about situations in which I might panic and make a fool of</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>myself</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I felt that I had nothing to look forward to</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>I found myself getting agitated</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>I found it difficult to relax</td>
<td>0</td>
</tr>
<tr>
<td>13</td>
<td>I felt down-hearted and blue</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>I was intolerant of anything that kept me from getting on with what I</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>was doing</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>I felt I was close to panic</td>
<td>0</td>
</tr>
<tr>
<td>16</td>
<td>I was unable to become enthusiastic about anything</td>
<td>0</td>
</tr>
<tr>
<td>17</td>
<td>I felt I wasn’t worth much as a person</td>
<td>0</td>
</tr>
<tr>
<td>18</td>
<td>I felt that I was rather touchy</td>
<td>0</td>
</tr>
<tr>
<td>19</td>
<td>I was aware of the action of my heart in the absence of physical exertion</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(eg, sense of heart rate increase, heart missing a beat)</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>I felt scared without any good reason</td>
<td>0</td>
</tr>
<tr>
<td>21</td>
<td>I felt that life was meaningless</td>
<td>0</td>
</tr>
</tbody>
</table>
## Section 6: The type of person you are

Please **tick** the response for **each** item that best describes you.

<table>
<thead>
<tr>
<th>(a) Considering only your own &quot;feeling best&quot; rhythm, at what time would you get up if you were entirely free to plan your day?</th>
</tr>
</thead>
<tbody>
<tr>
<td>05.00 - 06.30 a.m.</td>
</tr>
<tr>
<td>06.30 - 07.45 a.m.</td>
</tr>
<tr>
<td>07.45 - 09.45 a.m.</td>
</tr>
<tr>
<td>09.45 - 11.00 a.m.</td>
</tr>
<tr>
<td>11.00 - 12.00 (noon)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(b) Considering only your own &quot;feeling best&quot; rhythm, at what time would you go to bed if you were entirely free to plan your evening?</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.00 - 09.00 p.m.</td>
</tr>
<tr>
<td>09.00 - 10.15 p.m.</td>
</tr>
<tr>
<td>10.15 p.m. - 12.30 a.m.</td>
</tr>
<tr>
<td>12.30 - 01.45 a.m.</td>
</tr>
<tr>
<td>01.45 - 03.00 a.m.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(c) Assuming normal circumstance, how easy do you find getting up in the morning?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all easy</td>
</tr>
<tr>
<td>Slightly easy</td>
</tr>
<tr>
<td>Fairly easy</td>
</tr>
<tr>
<td>Very easy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(d) How alert do you feel during the first half hour after having awakened in the morning?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all alert</td>
</tr>
<tr>
<td>Slightly alert</td>
</tr>
<tr>
<td>Fairly alert</td>
</tr>
<tr>
<td>Very alert</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(e) During the first half hour after having awakened in the morning, how tired do you feel?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very tired</td>
</tr>
<tr>
<td>Fairly tired</td>
</tr>
<tr>
<td>Fairly refreshed</td>
</tr>
<tr>
<td>Very refreshed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(f) You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is 7.00 - 8.00 a.m. Bearing in mind nothing else but your own &quot;feeling best&quot; rhythm, how do you think you would perform?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would be in good form</td>
</tr>
<tr>
<td>Would be in reasonable form</td>
</tr>
<tr>
<td>Would find it difficult</td>
</tr>
<tr>
<td>Would find it very difficult</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(g) At what time in the evening do you feel tired and, as a result, in need of sleep?</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.00 - 09.00 p.m.</td>
</tr>
<tr>
<td>09.00 - 10.15 p.m.</td>
</tr>
<tr>
<td>10.15 p.m. - 12.30 a.m.</td>
</tr>
<tr>
<td>12.30 - 01.45 a.m.</td>
</tr>
<tr>
<td>01.45 - 03.00 a.m.</td>
</tr>
</tbody>
</table>
(h) You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day, and considering only your own "feeling best" rhythm, which ONE of the four testing times would you choose?

<table>
<thead>
<tr>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>08.00 - 10.00 a.m.</td>
</tr>
<tr>
<td>11.00 a.m. - 01.00 p.m.</td>
</tr>
<tr>
<td>03.00 - 05.00 p.m.</td>
</tr>
<tr>
<td>07.00 - 09.00 p.m.</td>
</tr>
</tbody>
</table>

(i) One hears about "morning" and "evening" types of people. Which ONE of these types do you consider yourself to be?

- Definitely a morning type
- More a morning than an evening type
- More an evening than a morning type
- Definitely an evening type

(j) When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time?

- Before 06.30 a.m.
- 06.30 a.m. - 07.30 a.m.
- 07.30 - 08.30 a.m.
- 08.30 a.m. or later

(k) If you always had to rise at 06.00 a.m., what do you think it would be like?

- Very difficult and unpleasant
- Rather difficult and unpleasant
- A little unpleasant but no great problem
- Easy and not unpleasant

(l) How long a time does it usually take before you "recover your senses" in the morning after rising from a night's sleep?

- 0-10 minutes
- 11-20 minutes
- 21-40 minutes
- More than 40 minutes

(m) Please indicate to what extent you are a morning or evening active individual?

- Pronounced morning active (morning alert and evening tired)
- To some extent, morning active
- To some extent, evening active
- Pronounced evening active (morning tired and evening alert)
Section 8: Circadian type

The following questions are concerned with your daily habits and preferences. Please indicate what you prefer to do, or can do, and not what you may be forced to do by your present work schedule or routine.

Please work through the questions as quickly as possible. It is your immediate reaction to the questions that we are interested in, rather than a carefully deliberated answer. There are no 'right' or 'wrong' answers to any of the questions. For each question we simply want you to indicate which of the five alternatives best describes you, or your preferences, by circling the appropriate number.

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Almost never</th>
<th>Seldom times</th>
<th>Usually</th>
<th>Almost always</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a)</td>
<td>Do you tend to need more sleep than other people?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(b)</td>
<td>If you are feeling drowsy can you easily overcome it if you have something to do?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(c)</td>
<td>Do you find it fairly easy to get to sleep whenever you want to?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(d)</td>
<td>Can you miss out a night's sleep without too much difficulty?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(e)</td>
<td>Do you find it difficult to 'wake-up' properly if you are awoken at an unusual time?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(f)</td>
<td>If you had to do a certain job in the middle of the night do you think you could do it almost as easily as at a more normal time of day?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(g)</td>
<td>Do you find it easy to 'sleep in' in the morning if you got to bed very late the previous night?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(h)</td>
<td>If you go to bed very late do you need to sleep in the following morning?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(i)</td>
<td>Can you easily keep alert in boring situations?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(j)</td>
<td>Are you fairly unaware as to what time it is?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(k)</td>
<td>If you are tired do you have difficulty keeping awake even though you need to?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(l)</td>
<td>Do you enjoy working at unusual times of day or night?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(m)</td>
<td>Do you feel sleepy for a while after waking in the morning?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(n)</td>
<td>Do you get up later than normal when you are on holiday?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(o)</td>
<td>If you have a lot to do can you stay up late to finish it off without feeling too tired?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>(p)</td>
<td>Does the time of day have a large effect on your mood and abilities?</td>
<td>Almost never</td>
<td>Seldom</td>
<td>Sometimes</td>
<td>Usually</td>
</tr>
<tr>
<td>(q)</td>
<td>Do you find it as easy to work late at night as earlier in the day?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(r)</td>
<td>If you have to get up very early one morning do you tend to feel tired all day?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(s)</td>
<td>Do you ‘nod-off’ if you are listening to, or watching a boring programme?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(t)</td>
<td>Can you easily go to sleep earlier than normal to ‘catch up’ on lost sleep, e.g. after several late nights?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(u)</td>
<td>Do you have no strong preference as to when you sleep?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(v)</td>
<td>Can you manage with only a few hours sleep each night for several days in a row without too much difficulty?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(w)</td>
<td>Do you find it fairly difficult to overcome tiredness even in a challenging situation?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(x)</td>
<td>Would you be just as happy to do something in the middle of the night as during the day?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(y)</td>
<td>Do you rely on an alarm clock, or someone else, to wake you up in the morning?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(z)</td>
<td>Do you get to sleep fairly quickly when you have gone to bed earlier than normal?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(a')</td>
<td>Do you go to parties, or have evenings out with friends, if you have to get up early the following morning?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(b')</td>
<td>Do you need a cup of coffee or tea to wake up properly after you have been asleep?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(c')</td>
<td>Are there particular times of day when you would avoid doing certain jobs if you could?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>(d')</td>
<td>If you could do so, would you rather wait for half-an-hour or so after waking in the morning before eating a large breakfast?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
Section 8: Physical activity

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

When a question asks you about how much time you have spent doing a certain activity there are different methods in which you can answer. For example, within the last 7 days if you were to spend one and a half hours performing a vigorous physical activity such as aerobics, you can answer in hours (e.g. 1.5 hours), minutes (e.g. 90 minutes), or hours and minutes (e.g. 1 hour and 30 minutes).

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   ____ days per week

   □ No vigorous physical activities → Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

   ____ hours per day

   ____ minutes per day

   □ Don’t know/Not sure
Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ days per week
   
   [ ] No moderate physical activities ➔ **Skip to question 5**

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

   _____ hours per day
   _____ minutes per day
   
   [ ] Don’t know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

   _____ days per week
   
   [ ] No walking ➔ **Skip to question 7**
6. How much time did you usually spend walking on one of those days?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

____ hours per day

____ minutes per day

☐ Don’t know/Not sure
Appendix B

Project Information Statement
INVITATION TO PARTICIPATE IN A RESEARCH PROJECT
PROJECT INFORMATION STATEMENT

Project Title
Coping with shiftwork: Behavioural measures in the health and community services sector.

Investigators:

• James Courtney
  Student Researcher: Bachelor of Applied Science Psychology (Honours)

• Associate Professor Andrew Francis
  Project Supervisor

Dear Prospective Participant,

You are invited to participate in a research project being conducted by RMIT University. This information sheet describes the project in straightforward language, or 'plain English'. Please read this sheet carefully and be confident that you understand its contents before deciding whether to participate. If you have any questions about the project, please ask one of the investigators.

Who is involved in this research project? Why is it being conducted?
The current research project is being conducted by James Courtney as part of the requirements for the Bachelor of Applied Science Psychology (Honours) program at RMIT University. This research is being conducted under the supervision of Dr Andrew Francis, and has been approved by the RMIT Human Research Ethics Committee, and the LHMU – Ambulance Section.

Why have you been approached?
This study is investigating a range of measures in personnel related to working a 24 hour shiftwork roster. Personnel who normally work shiftwork, including a night time component in their roster structure are invited to participate.

What is the project about? What are the questions being addressed?
This study aims to investigate the impact of shiftwork across several areas of functioning in health and community services personnel. We are particularly interested in personnel who regularly work shiftwork that incorporates a night time component. This specific roster structure offers advantages over previous shiftwork research that sometimes includes poorly defined shift structures and/or shifts that vary widely. The study aims to identify variables that are thought to modify a person's response to shiftwork along with the personal impact of this lifestyle. In addition, the study aims to measure the level of physical activity of shift workers.

If I agree to participate, what will I be required to do?
If you agree to participate in this study, you will be asked to complete a questionnaire that should take about 25 minutes of your time. You are welcome to inspect the questionnaire prior to making a decision as to whether or not you wish to participate. Responses will remain anonymous as no identifying information is required.
The questionnaire is called the Modified Standard Shiftwork Index. The items are mainly answered by selecting from a scale of options that require responses to questions about you in the following categories:

1. **A set of questions about your general biographical information.**
   An example of the type of item in this section is: ‘How long have you worked in your present shift system?’

2. **Your sleep and fatigue**
   An example of the type of item in this section is: ‘How do you feel about the amount of sleep you normally get?’

3. **Your health and well-being**
   An example of the type of item in this section is: ‘How often is your appetite disturbed?’

4. **Your social and domestic situation**
   An example of the type of item in this section is: ‘In general how much does your shift system interfere with the sort of things you would like to do in your leisure time (e.g. sport activities, hobbies, etc.)?’

5. **Coping**
   An example of the type of item in this section is: ‘In general, to what extent does working shifts cause you problems with sleep?’

6. **The type of person you are**
   An example of the type of item in this section is: ‘Assuming normal circumstance, how easy do you find getting up in the morning?’

7. **Physical Activity Questionnaire.**
   An example of the type of item in this section is: ‘During the last seven days, how often did you walk for at least 10 minutes at a time?’

**What are the risks or disadvantages associated with participation?**

It is not anticipated that your involvement in this study would pose any risks above what you would experience in day-to-day life. However, if you are concerned about your responses to any of the questionnaire items or if you find participation in the project distressing, you should contact Dr Andrew Francis as soon as convenient. Dr Francis will discuss your concerns with you confidentially and suggest appropriate follow-up, if necessary.

**What are the benefits associated with participation?**

Whilst there are no direct benefits to you in choosing to participate in this study, your participation will assist in improving our understanding of the response to shiftwork amongst different individuals, as well as the personal outcomes of shiftwork amongst personnel in the health and community services sector.

**What will happen to the information I provide?**

The information provided by you will be held under lock and key on secure premises at RMIT University, Bundoora West Campus. The only individuals with access to this information are the researcher and the research supervisor. The findings from this study may be presented at conferences or published in scientific journals, however only group data will be presented; individual data will not be used. The collected data will be stored for a minimum of five years, and then destroyed.
Follow up study
The last page of the questionnaire invites you to register interest in a potential follow up study to develop practical ways to assist shift workers to cope with this lifestyle. Any personal contact details supplied would be separated from your questionnaire (which would be rendered anonymous), and held under lock and key on secure premises at RMIT University to ensure confidentiality. Participation in this potential extension to the project is still welcome whether or not you register interest on the initial questionnaire.

What are my rights as a participant?
As a participant, you have the right to withdraw your participation at any time, without consequence. You also have the right to have any unprocessed data retrieved and destroyed, provided that it can be reliably identified. You also have the right to have any of your questions answered at any time. Individual consent is implied through return of the questionnaire.

Whom should I contact if I have any questions?
If you have any questions, you should contact Dr Andrew Francis on 9925 7782. Alternatively, you can send questions via email to andrew.francis@rmit.edu.au.

What other issues should I be aware of before deciding whether to participate?
There are no other issues relating to your participation.

Yours Sincerely,

James Courtney
Grad.Dip. Behavioural Sciences
Dip.App.Sc. (Medical Radiography)
Student Researcher
B.App.Sc. Psychology (Honours)

Dr Andrew Francis
B.Bsc (Hon), Ph.D (La Trobe)
DipHSc (Herbal Medicine, ACNM)
Associate Professor

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745.

Details of the complaints procedure are available from the above address.
Appendix C

Letter to Team Manager
Dear Team Manager,

I am writing to ask for your assistance with the distribution and return of the enclosed questionnaires, which form the basis of a shiftwork research project being conducted by RMIT University and La Trobe University. The study aims to investigate a range of behavioural measures in personnel who work a 24-hour shiftwork roster. Personnel who normally work shiftwork, including a night time component in their roster structure are invited to participate - the 10/14 roster being an ideal example. Participation in the study will assist in improving our understanding of the impact and response to shiftwork amongst different individuals. The long term aim is to develop coping mechanisms for personnel who routinely work shift rosters.

The project has the support Ambulance Employees Australia (LHMU – Ambulance Section) and the RAV Medical Standards Committee. Additional copies of the questionnaire will be made available in electronic format via the intranet.

The package contains the following documents:

1. An information sheet that describes the project, which should be read by personnel before deciding whether to participate;

2. The questionnaire, which should take about 25 minutes to complete;

3. Reply paid envelopes for return of the questionnaires directly to me.

I am hoping that you could assist with the project by distributing the questionnaire to personnel at your Branch. The packages can be mailed back via the normal postal system. Feel free to contact me if you have any queries about the project, and I do hope that I am able to gain your support with the collection of data.

Kind regards,
Appendix D

Ethics Approvals

1. RMIT University
2. La Trobe University
3. Rural Ambulance Victoria Medical Standards Committee
6th June 2006

James Courtney
26 Dingley Dell Road
North Warrandyte VIC 3113

Dear James

SETNAPP 11 – 06 COURTNEY Coping with shiftwork: Behavioural measures in the health and community services sector

Thank you for submitting Application for Human Ethics Approval.

Some required changes to your application for Ethics approval for your project titled: Coping with shiftwork: Behavioural measures in the health and community services sector, were brought to your attention in a memo dated, April 10, 2006. You have addressed all of the issues raised in that memo appropriately. Therefore, you may consider your project, as it is described in your revised application APPROVED for a period of three years from the date on this letter.

Please note the following information, which pertains to all HREC approved projects:

- Projects are normally approved for a period of three years from the date of this letter, but this is conditional on the receipt of annual reports. If your work is completed within twelve months a final report, only is required. The relevant forms are available from the Human Research Ethics Committee website. The address for this is: http://www.rmit.edu.au/council/hrec

- If, as you proceed with your investigation you find reason to amend your research method, you should advise the Chair of the RMIT University Human Research Ethics Committee (Portfolio of Science, Engineering & Technology Sub Committee) and seek approval of the proposed changes. If you decide to discontinue your research before its planned completion you must also advise the Chair of the Sub-Committee of the circumstances.

- In the event of any adverse effects on subjects, or unforeseen events, which may affect the ethical acceptability of your project, you should immediately report to the Chair of the Sub-Committee.

- Also we were recently advised that any research data, which identifies people and that is stored in electronic form, should be held on CD, Zip Disk or diskette. It should not be stored on a computer that is connected to the web or to a network.

Let me take this opportunity to wish you all the best with your research. If any issues regarding ethics arise during the running of the project, please do not hesitate to contact the Chair of the Sub-Committee.

Yours faithfully,

Julie Barnett
Secretary, SET Portfolio
HREC Sub-committee (Non Biomedical)

cc: Dr Jo Neece, Chair SET Portfolio HREC Sub-Committee (non Biomedical)
Andrew Francis SOHS RMIT University
MEMORANDUM

TO: Professor S Paxton/Mr J Courtney (Postgraduate Student), School of Psychological Science
FROM: Ms K. Collins, Secretary (Research Ethics), Faculty of Science, Technology and Engineering
SUBJECT: Application FHDEC07/R71: Coping with shiftwork: Behavioural measures in the health and community services sector
DATE: 26 February 2008

Your application to the Faculty Human Ethics Committee, in relation to the abovementioned project, has been reviewed, out-of-session, by members of the Committee. The project complies with the National Health and Medical Research Council's *National Statement on Ethical Conduct in Research Involving Humans* and with University guidelines on *Ethics Approval for Research with Human Subjects*. Accordingly, your project has been granted approval for the period 20 February 2008 to 31 October 2009.

Please note that your application has been reviewed, out-of-session, by the FHDEC. The decision to approve your application will need to be ratified by the full HEC and consequently approval for your project may be withdrawn or conditions of approval altered. However, your project may commence prior to ratification of the approval decision. You will be notified if the approval status of your project is altered.

The following standard conditions apply to your project:

- **Complaints.** If any complaints are received or ethical issues arise during the course of the project, researchers should advise the Secretary of the FHDEC on telephone (03) 9479 3698;

- **Limit of Approval.** Approval is limited strictly to the research proposal as submitted in your application while taking into account the conditions and approval dates advised by the FHDEC;

- **Variation to Project.** As a consequence of the previous condition, any subsequent variations or modifications you may wish to make to your project must be notified formally to the FHDEC. This can be done using the appropriate form *Application for Approval of Modification to Research Project* which is available on the internet at [http://www.latrobe.edu.au/www.rts/ethics/hecindex.htm](http://www.latrobe.edu.au/www.rts/ethics/hecindex.htm). If the FHDEC considers that the proposed changes are significant, you may be required to submit a new application form for approval of the revised project;

- **Progress Reports.** You are required to submit a Progress Report annually (if your project continues for more than 12 months) and at the conclusion of your project. The form is available on the internet. When completed, the form should be returned to the Secretary of the FHDEC. Failure to submit a progress report will mean approval for this project will lapse. An audit may be conducted by the HEC at any time.

If you have any queries on the matters mentioned above or require any further clarification please contact me on telephone 9479 3698 or at email address k.collins@latrobe.edu.au

Kaye Collins
From: "Walker, Tony" <tony.walker@rav.vic.gov.au>
To: "James Courtney" <james.courtney@rmit.edu.au>
Date: 26/07/2006 17:20:11
Subject: RE: Research

Hi James

I am pleased to advise that your application to undertake this research project has been approved by the RAV Executive and Research Governance Committee (Medical Standards Committee).

We would be pleased to take up your offer to nominate an associate researcher to the project. If you contact Kath Brown (General Manager Human Resources) on (03) 5338 5252 she can assist with an appropriate organisational nominee.

Donna Fotheringham, Administrative Assistant, Clinical and Education Services can assist with the process for distribution of surveys to RAV branches and can be contacted on (03) 5338 5315.

If I can be of any further assistance please don't hesitate to contact me.

Kind regards

Tony Walker

--------------------------------------------------------
Tony Walker ASM MACAP
Manager Operations
Rural Ambulance Victoria

Locked Bag 9000
BALLARAT MAIL CENTRE
Tel: (03) 5338 5305
Fax: (03) 5338 5311
Email: tony.walker@rav.vic.gov.au
Web: www.rav.vic.gov.au
Appendix E

Typeset version of Study 1

Caring for the Carers: Fatigue, Sleep, and Mental Health in Australian Paramedic Shiftworkers

James A. Courtney,1 Andrew J.P. Francis,2 and Susan J. Paxton1

1 School of Psychological Science, La Trobe University, Australia
2 Discipline of Psychology, RMIT University, Australia

This study investigated fatigue, sleep quality, mental health and physical activity in paramedic shiftworkers. Although limited, previous studies have established high fatigue levels and poor health in this sector from shiftwork rostering and occupational demands. A modified version of the Standard Shiftwork Index was completed by 342 paramedics (243 male and 98 females). Single sample t tests found significantly higher levels of fatigue, depression, anxiety, and stress, and significantly poorer sleep quality than reference samples. Paramedics also reported less physical activity than community samples. Depression and sleep quality explained the greatest amount of variance in fatigue scores, followed by level of exercise. No differences were detected in levels of depression or fatigue on the basis of gender. The findings suggest that ambulance paramedic shiftworkers are at particular risk for increased levels of fatigue and depression (regardless of age or gender) and poor quality sleep. Organisational intervention was suggested.

Keywords: shiftwork, fatigue, sleep quality, ambulance, paramedic, depression

Recent population analyses show a growing trend towards shiftwork in the community, with around 17% of the Australian workforce (1.4 million employees) working ‘nonstandard’ hours (Australian Bureau of Statistics [ABS], 2006a). By industry, healthcare providers such as doctors, nurses, and ambulance paramedics were among those most highly represented (ABS, 2003; ABS, 2006b). As shiftwork is widely acknowledged to adversely impact multiple domains of biopsychosocial functioning, it is important to determine the consequences for these workers given their vital role in the community. The present work focuses on ambulance paramedic shiftworkers who provide 24-hour pre-hospital emergency treatment and medical transport, typically through rotating rosters and nightshifts (Pease & Raether, 2003).

It is well established that shiftworkers experience significant sleep loss and fatigue, particularly those working at night (Akerstedt, 1998; Sallinen & Kecklund, 2010). While studies have assessed doctors and nurses in this respect, the investigation of ambulance paramedics is limited, despite concerns about occupational health problems in these workers (Bennett, Williams, Page, Hood, & Woolard, 2004). In a study of 123 Dutch ambulance workers (Van der Ploeg & Kleber, 2003) the authors considered 10% of respondents to be at risk of sick leave or work disability through elevated fatigue levels. Another study of paramedics rostered to a dispatch centre (Hussey, Baker, & Holmes, 2001) also reported elevated fatigue in workers, especially for staff working consecutive 14-hour nightshifts. However, a broader review (Sterud, Ekeburg, & Hem, 2006) failed to establish reliable prevalence rates for fatigue in ambulance workers, pointing to methodological limitations such as small...
and nonrepresentative samples, and a lack of comparison with population norms in existing studies. Along with existing evidence, this suggests the need for further investigation to establish clearly the prevalence and predictors of fatigue in this occupational sector.

Concerns have also been raised about mental health disorders in ambulance workers. In a mental health survey of 560 UK ambulance workers (Bennett et al., 2004), nearly 10% of respondents reported clinical levels of depression, and 22% clinical levels of anxiety. The authors considered these figures to represent general prevalence rates, but noted a lack of comparison with normative data. Although ambulance work is considered stressful, the assessment of stress in personnel is limited and often based on temporal changes in physiological markers and small samples (e.g., Aasa, Kalezic, Lyskov, Angquist, & Barnekow-Bergkvist, 2006). A nationwide study of Norwegian ambulance personnel (Sterud, Hem, Ekeberg, & Lau, 2008) identified significant organisational and occupational stressors for workers, but did not assess psychological stress. Based on the existing evidence, Sterud et al. (2006) concluded that up to 20% of ambulance personnel might suffer from mental health problems. As emergency care relies on critical decision-making and the peak cognitive functioning of staff, further investigation is required to establish levels of psychopathology, and to determine risk levels based on statistical comparisons with normative data.

Age, gender and physical exercise have been identified as potential predictors of shiftwork-related heath outcomes. The role of gender is poorly understood, given that most studies report inconclusive findings (e.g., Ashberg, Kecklund, Akerstedt, & Gamberale, 2000). Bennett et al. (2004) failed to establish any relationship between gender and depression or anxiety in 560 UK-based emergency ambulance workers, but cautioned that females were under-represented in the sample. Experienced shiftwork investigators have proposed that females may suffer from higher sleep problems and chronic fatigue through the difficulties encountered in combining irregular working hours with additional domestic and family obligations (Costa, 2003; Harrington, 2001), although robust empirical support for this relationship is still lacking. It is possible that female (and male) shiftworkers self-select to work irregular hours, based on their resources and ability to cope (Boivin, Tremblay, & James, 2007), and that factors related to occupational status and culture might contribute to inconsistent findings and limit the broader predictive value of gender. This highlights the need for ongoing investigation and sound methodology to establish the potential role of gender in determining shiftwork related outcomes.

Contrasting opinions also exist as to whether increasing age either ameliorates or compounds adverse health outcomes in shiftworkers. Changes in sleep-stage physiology and disruption to the sleep-wake cycle have been cited as potential health risks for shiftworkers aged 40 years and older (Costa, 1996; Monk, 1994; Ognianova, Dalbokova, & Stanchev, 1998). The alternative position is that humans require less sleep with advancing age, which infers that age might act as a protective factor for older shiftworkers (Harma, 1996). These arguments are based on robust circadian theory, but empirical investigations have nevertheless failed to establish age as a clear predictor of shiftwork-related health outcomes (e.g., Ruggiero, 2003). One possibility is that a process of 'self-selection' occurs for shiftworkers generally, resulting in a cohort with adaptive sleep behaviours (Boivin et al., 2007; Knutsson & Akerstedt, 1992). Given the lack of empirical evidence for either circadian argument, further evidence is required to establish whether age is a predictor of health outcomes per se in shiftworkers, or whether other (possibly behavioural) parameters might be more influential.

Several investigators have posited that physical exercise may mediate individual responses to shiftwork (e.g., Atkinson & Davenne, 2006); however, only one shiftwork study was located that reported decreased fatigue and sleepiness in nurses following an exercise intervention (Harma, Ilmarinen, Knauth, Rutenfranz, & Hanninen, 1988a; 1988b). Physical exercise is known to alleviate depressive symptoms for individuals with seasonal affective disorder, and reduce morning fatigue and the need for sleep (Leppamaki, Partonen, & Lonnqvist, 2002). Regular physical activity also plays a protective role for a wide range of health domains in the general community (World Health Organization, 2006) and a substantial amount of evidence supports the beneficial effect of exercise on mood states; particularly depression (Byrne & Byrne, 1993). On this basis, it seems reasonable to predict that exercise could assist in managing the health-related consequences of shiftwork. Given the lack of prior research for this variable, there is a need to first establish levels of exercise behaviour in shiftwork populations, examine relationships with other behavioural indices, and then potentially develop specific exercise recommendations for these workers.

While discussion so far has focused on variables associated with the individual worker, organisational shift scheduling can also influence outcomes. A systematic review of 26 organisational intervention studies (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008) identified that fast rotations (e.g., three or four consecutive shifts) and forward rotating rosters (morning, afternoon, night) produced positive effects on sleep and fatigue. Work–life balance, and organisational effectiveness were also improved when workers
could influence their own work hours. Other investigators have associated extended shifts (more than 8 hours) with elevated fatigue, and increased risk of accidents and health problems in the workplace (Paley, Price, Tepas, 1998; Pallesen et al., 2010). Nightwork is considered to be particularly problematic in terms of adjustment and tolerance, and is associated with episodes of involuntary sleep and increased sleepiness at work that extends to days off (Akerstedt, 1998; Sallinen & Kecklund, 2010). Clearly organisation-determined parameters have considerable potential to mediate sources of occupational distress.

While these investigations provide useful knowledge, many studies are methodologically limited by a lack of attention to the specific characteristics of the shift roster. This confounds the assessment of shiftwork exposure in a given sample and remains one of the most limiting factors in shiftwork research (Harma & Kecklund, 2010). These concerns, along with several other methodological issues, were highlighted in a review of health outcomes in ambulance workers (Sterud et al., 2006). Although evidence was found across 49 studies to suggest high rates of fatigue, psychopathology, poor sleep and other health problems in ambulance workers, no clear conclusion could be established because of the many small, loosely defined and nonrepresentative samples. Sterud et al. (2006) advocated strongly for the reporting and comparison of larger sample ambulance data against population norms.

The present investigation examines shiftwork related health variables in paramedics working for the Metropolitan Ambulance Service (MAS) in Melbourne, Victoria. These workers participate in shiftwork as part of a normal career structure and typically work a ‘10/14’ roster: two 10-hour dayshifts, followed by two 14-hour nightshifts and four days off (commencing after the second nightshift). This structure has existed for at least 30 years in MAS and grew from the need to meet inclusion criteria (MAS, 2006/2007; S. Mcghie, personal communication, September 12, 2006). The response by gender of 243 males (71%) to 98 females (29%) was consistent with the 2.5 to 1 male to female ratio for operational personnel (MAS, 2006/2007), therefore producing a gender representative sample. Eighty per cent of respondents worked the 10/14 roster and the remainder worked a roster with a nightshift rotation.

**Method**

**PARTICIPANTS**

Emergency ambulance paramedics were recruited from the MAS in Melbourne, Victoria. Participation was voluntary and limited to active personnel who routinely worked a 24-hour roster cycle with a nightshift component. It was expected that most paramedics meeting this criteria would be working the 10/14 roster previously described. A sample of 128 participants was required to satisfy planned analyses based on a moderate effect size ($r = .30$), a significance level of .05, and a power of .80 (Cohen, 1992).

Completed surveys were returned by 342 respondents, or around 35% of the 990 paramedics estimated to meet inclusion criteria (MAS, 2006/2007; S. Mcghie, personal communication, September 12, 2006). The response by gender of 243 males (71%) to 98 females (29%) was consistent with the 2.5 to 1 male to female ratio for operational personnel (MAS, 2006/2007), therefore producing a gender representative sample. Eighty per cent of respondents worked the 10/14 roster and the remainder worked a roster with a nightshift rotation.

**MATERIALS**

**Shiftwork**

A modified form of the Standard Shiftwork Index (SSI; Barton et al., 1995) was administered, which comprises a battery of instruments to assess shiftwork-related outcomes in workers. Measures of psychological distress and sleep were substituted with instruments considered more satisfactory, and a measure of physical exercise inserted (see following sections). A Chronic Fatigue Scale (CFS) was specifically constructed for the SSI, which conceptualises fatigue as a general tiredness and lack of energy irrespective of whether an individual has not had enough sleep or has been working hard, and which persists even on rest days and holidays. A score ranging from 10 to 50 is produced with a higher score indicating more fatigue. Barton et al. (1995) found the validity and internal reliability of the CFS ($\alpha$ from .91 to .93) to be satisfactory in a sample of shiftwork nurses and industrial workers.

CFS data was selected from three previous shiftwork studies for statistical comparison, as normative data has not been established in community samples. Barton et al. (1995) published chronic fatigue scores for 1532 shiftwork nurses (mean age 33.2 years; 91.8% female) and 332 industrial workers (mean age 39.2; 6.9% female). Ruggiero (2003) reported data based on 142 female shiftwork nurses aged from 28 to 63 years ($M =$
44.9, $SD = 8.3$). Iskra-Golec, Folkard, Marek, and Noworol (1996) also reported fatigue data on female shiftwork nurses, but in a more restricted age range of 20 to 32 years ($M = 25.96, SD = 3.75$).

**Depression**

The Depression Anxiety Stress Scales 21 (DASS21) were used to measure the emotional states of depression, anxiety and stress (Lovibond & Lovibond, 1995). Seven items on each of the three scales were summed to obtain an overall score for each state. The psychometric properties of the DASS21 were found to be satisfactory by Henry and Crawford (2005) in a nonclinical population ($N = 1,794$). Alpha values for reliability were: Depression 0.81; Anxiety 0.73; and Stress 0.81 (Lovibond & Lovibond, 2004).

Normative data for the DASS is limited, but three studies were located for statistical comparison. A study that closely matched census data for the Australian population (Taylor, Lovibond, Nicholas, Cayley, & Wilson, 2005) published DASS scores for 219 males and 272 females (age $M = 42.3, SD = 17.7$). Henry and Crawford (2005) also published DASS scores for 979 female and 815 male members of the general UK population (age $M = 41.0, SD = 15.9$). Normative data from the DASS manual (Lovibond & Lovibond, 2004), derived from six samples comprising 1,044 males and 1,870 females aged 17 to 69 years, was also selected for comparison to the current sample.

**Quality of Sleep**

Quality of sleep was assessed using the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The PSQI generates component scores for seven domains of sleep quality that are summed to obtain a maximum achievable score of 21, indicating the highest level of sleep disturbance. The PSQI was normed on 52 healthy, 34 depressed and 62 sleep-disordered participants and demonstrated sufficient internal reliability ($\alpha = .83$) and validity (Buysse et al., 1989).

Although normative data for statistical comparison was again limited, the authors of the PSQI (Buysse et al., 1989) published scores for a control group of 52 healthy sleepers comprising 40 males and 12 females aged 24 to 83 ($M = 59.9$). Piperno and Francis (2008) also collected local community data from 84 males and 138 females aged 18 to 66 ($M = 32.5, SD = 13.5$). Ruggiero’s study of shiftwork nurses has already been described and also produced PSQI scores in a sample of shiftwork nurses.

**Physical Activity**

Estimates of physical activity were obtained using the International Physical Activity Questionnaire — Short Form (IPAQ; The International Consensus Group for Physical Activity Measurement). IPAQ data was reported as the ratio of the work metabolic rate for each type of activity to the resting metabolic rate (termed METs) derived as follows: Walking = 3.3 METs, Moderate Physical Activity = 4.0 METs, and Vigorous Physical Activity = 8.0 METs. MET-minutes/week were calculated by multiplying the duration (in minutes) and frequency (in days) of each activity type by its corresponding MET value. Results were summed to obtain a total score based on median values. Craig et al. (2003) found the validity the IPAQ to be acceptable in a 12-country study, and reported test-retest reliability correlations of around 0.8.

Only two studies were identified as suitable for statistical comparison. Craig et al. (2003) published data for the IPAQ — Short Form for a community sample comprising 1,974 males and females across 12 countries. Participants ranged in age from 18 to 65, with a predominantly middle-aged mean in each sample. Scores from a local community sample (described above; Piperno & Francis, 2008) were also considered useful.

**Procedure**

Ambulance Employees Australia (AEA) managed the distribution of 930 surveys to 93 MAS Branches across Melbourne between July and November 2006. Awareness of the study was enhanced through announcements and reminders, and the survey was also made available on the AEA intranet. Participation was voluntary and the survey took around 25 minutes to complete. This study was not limited to AEA members; however, AEA membership was reported to be at 90% for paramedics at the time of data collection (S. McGhie, personal communication, September 12, 2006). No further arrangements were entered into with AEA. Statistical analyses were performed using SPSS version 15.0.

**Results**

Distributions of all variables were judged adequate in terms of normality, linearity and homoscedacity. Data were also examined for outliers, missing values and data entry errors. Corrections were made to the IPAQ in accordance with specific data cleaning instructions that resulted in the removal of 15 cases due to missing respondent data.

Mean scores for chronic fatigue are shown in Table 1. An independent samples $t$ test found no significant gender difference; $t(335) = –.23, p = .82$. A single sample $t$ test found significantly higher chronic fatigue scores in the paramedic sample compared to a group mean calculated from the three other shiftwork studies also shown in Table 1; $t(337) = 6.56, p < .001, d = .36$. The internal consistency of the 10 item scale was estimated as .94 using Chronbach’s alpha.
Mean scores obtained on the DASS21 scales are shown in Table 2. An independent samples t test found no significant gender difference on scores of depression; t(338) = 1.60, p = .11. Table 3 shows the percentage distribution of scores by clinical severity for the paramedic sample in accordance with data published in the DASS Manual (Lovibond & Lovibond, 1995). The paramedic sample reported rates above the normal range for depression (36.1%, n = 123), anxiety (24.6%, n = 84) and stress (39.3%, n = 134). Single sample t tests found the paramedic sample reported poorer mental health relative to group means derived from the three nonclinical community samples (Table 2) on all three scales; depression, t(340) = 6.70, p < .001, d = .41, anxiety, t(340) = 3.07, p < .001, d = .16, and stress, t(340) = 9.30, p < .001, d = .55. Internal consistencies based on Chronbach’s alpha were .90 for the depression scale, .73 for the anxiety scale, and .88 for the stress scale.

Paramedics reported a total median score of 2088 MET-minutes/week on the IPAQ — Short Form. This represented 14% less physical activity than participants in a 12-country study (Craig et al., 2003; 2514 median MET-minutes/week) and 11% less than a local community sample (Piperno & Francis, 2008; 2346 median MET-minutes/week). Internal consistency using Chronbach’s alpha was estimated as .78 based on subscale scores.

Mean PSQI global scores are shown in Table 4 along with data from the three reference groups. Seventy-two per cent of the paramedic sample reported a global score greater than five; the cutoff score used to identify bad sleepers. A single sample t-test found significantly

| TABLE 1 |
| Mean Scores for Chronic Fatigue in the Paramedic Sample and Data Obtained From Other Shiftwork Studies |
| Study | Gender | Sample size | M | SD |
| Paramedic sample | Male | 239 | 28.79 | 8.80 |
| | Female | 98 | 29.03 | 9.03 |
| | Combined | 338 | 28.86 | 8.84 |
| Barton et al., (1995) | Male | 422 | 24.77 | 7.41 |
| | Female | 1429 | 25.12 | 7.63 |
| | Combined | 1864 | 25.04 | 7.58 |
| Iskra-Golec et al. (1996) | Female | 96 | 26.97 | — |

Note: a: Female shiftwork nurses; b: 12-hour shift rotation sample, no standard deviation supplied; c: Missing respondent data.

| TABLE 2 |
| Mean Scores for Depression, Anxiety and Stress in the Paramedic Sample, and Normative Data from Nonclinical Studies |
| Study | Depression | M | SD | Anxiety | M | SD | Stress | M | SD |
| Present work | 8.77 | 8.54 | 4.83 | 5.25 | 13.85 | 9.14 |
| Lovibond & Lovibond (1995) | 6.34 | 6.97 | 4.70 | 4.91 | 10.11 | 7.91 |
| Henry & Crawford (2005) | 5.66 | 7.74 | 3.76 | 5.90 | 9.46 | 8.40 |
| Taylor, et al. (2005) | 5.06 | 7.57 | 3.41 | 5.13 | 8.18 | 8.40 |


| TABLE 3 |
| Percentage Distribution of Mean Scores for Depression, Anxiety and Stress by Clinical Severity Among Paramedics in the Present Study |
| Scale | Normal | Mild | Moderate | Severe | Extremely severe |
| Depression | 63.90% (n = 217) | 13.80% (n = 47) | 12.00% (n = 41) | 4.70% (n = 16) | 5.60% (n = 19) |
| Anxiety | 75.40% (n = 257) | 8.20% (n = 28) | 12.00% (n = 41) | 1.80% (n = 6) | 2.60% (n = 9) |
| Stress | 60.70% (n = 207) | 14.70% (n = 50) | 12.90% (n = 44) | 7.60% (n = 26) | 4.10% (n = 14) |

Note: Missing respondent data on some variables.
higher scores in paramedics (indicating poorer sleep) compared to a group mean derived from two community samples; \( t(331) = 18.82, p \leq .001, d = 1.17 \). Paramedics also reported significantly poorer sleep than a sample of female shiftwork nurses again based on a single sample \( t \) test; \( t(331) = 2.40, p = .017, d = .13 \). Internal consistency using Chronbach's alpha was estimated as .84 based on individual items (per Buysse et al., 1989).

The data were further analysed for correlations amongst variables, and to address study hypotheses (Table 5). Chronic fatigue was found to have a significant association of moderate to large size with all variables except age.

Multiple linear regression determined the extent to which the six major study variables predicted chronic fatigue. No a priori hypotheses were considered to determine the order of predictor variables, so a direct method was adopted. The six study variables produced an adjusted \( R^2 \) of .42 for the prediction of chronic fatigue; \( R(6, 315) = 39.66, p < .001 \). Depression was the most important variable (\( \beta = .34, p < .001 \)), followed by global sleep quality (\( \beta = .32, p < .001 \)) and total METs (\( \beta = -.14, p = .001 \)). The remaining variables did not contribute significantly; anxiety, \( \beta = .004, p = .94 \), stress, \( \beta = .10, p = .08 \); age, \( \beta = -.07, p = .12 \). Squared semi-partial correlations were also determined for each of the significant predictor variables: depression \( s^2_r = .06 \), global sleep quality \( s^2_r = .08 \), and total METs \( s^2_r = .02 \).

### TABLE 4
Mean Global Score Obtained on the PSQI in the Present Study, and Published Studies of Nonclinical Norms

<table>
<thead>
<tr>
<th>Study</th>
<th>( M )</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramedic sample(^a)</td>
<td>7.48</td>
<td>3.21</td>
</tr>
<tr>
<td>Buysse et al. (1988)(^b)</td>
<td>2.67</td>
<td>1.70</td>
</tr>
<tr>
<td>Piperno &amp; Francis (2008)(^c)</td>
<td>5.66</td>
<td>2.97</td>
</tr>
<tr>
<td>Ruggiero (2003)(^d)</td>
<td>7.06</td>
<td>3.42</td>
</tr>
</tbody>
</table>

Note: Global PSQI > 5 = poor sleep quality.
\(^a\)N = 332. Missing respondent data. \(^b\)Control group, \( N = 52 \).
\(^c\)Community sample, \( N = 247 \). \(^d\)Female shiftwork nurses, \( N = 142 \).

### TABLE 5
Intercorrelations Between Scores Obtained on the IPAQ, DASS, and PSQI in the Paramedic Sample

<table>
<thead>
<tr>
<th>Measure</th>
<th>Depression</th>
<th>Anxiety</th>
<th>Stress</th>
<th>PSQI</th>
<th>IPAQ</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Fatigue</td>
<td>.56**</td>
<td>.37**</td>
<td>.43**</td>
<td>.51**</td>
<td>-.27**</td>
<td>.03</td>
</tr>
<tr>
<td>Depression</td>
<td>.55**</td>
<td>.62**</td>
<td>.42**</td>
<td>-.19**</td>
<td>.17**</td>
<td>.10</td>
</tr>
<tr>
<td>Anxiety</td>
<td>.63**</td>
<td>.36**</td>
<td>-.13*</td>
<td>.10</td>
<td>.01</td>
<td>.08</td>
</tr>
<tr>
<td>Stress</td>
<td></td>
<td>.39**</td>
<td>-.13*</td>
<td>.01</td>
<td>-.03</td>
<td></td>
</tr>
<tr>
<td>PSQI</td>
<td></td>
<td></td>
<td></td>
<td>-.13*</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td>IPAQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.03</td>
<td></td>
</tr>
</tbody>
</table>

Note: \(^* p < .05, \text{two-tailed.} \)\(^** p < .01, \text{two-tailed.} \)
need to investigate variables in relation to a given shift system as recommended by Harma and Kecklund (2010). The methodology adopted for the present study addressed these latter concerns as the majority of the sample worked an identical shift system and all worked nightshift. As such, we suggest that the CFS scores reported by paramedics are representative of occupational fatigue levels as an outcome of a specific shiftwork system. This data may be useful for statistical comparison in future studies.

From an organisational perspective, the shift structure worked by the paramedic group is ‘fast and forward rotating’ which are two important elements of beneficial shift scheduling predicted by circadian theory (see Bambra et al., 2008). Despite this, the delivery of 24-hour services split over two extended shifts (rather than three shorter shifts) is likely to contribute significantly to accrued worker fatigue and imposes a high and potentially unsustainable demand on cognitive functioning in a challenging work environment, particularly during the fourteen-hour nightshifts (Sallinen & Kecklund, 2010).

Mental health measures in this Victorian paramedic group demonstrated elevated scores on each of the DASS scales compared to reference data. This was expected given that previous studies in ambulance personnel have estimated a 20% prevalence for psychopathology (Sterud et al., 2006). Of specific concern, over 10% of paramedics reported Severe or Extremely–Severe levels of depression. Bennett et al. (2004) reported a similar prevalence rate for depression in ambulance workers, although these findings were based on the category of ‘probable clinical depression’ (indicating the presence of a mood disorder).

Existing prevalence rates for psychopathology in the ambulance sector are limited by variations in psychometric assessment tools and nonspecific psychopathologies. This study established elevated levels of depression, anxiety and stress using a measure that has been validated in both clinical and non-clinical populations. The influence of variations in demographic variables is also small on the DASS21 (Henry & Crawford, 2005). Given the homogenous nature of the paramedic sample in terms of shiftwork exposure, the findings provide initial normative data for ambulance workers that may be more representative than existing datasets. Despite methodological differences, our findings are consistent with previous concerns (e.g. Bennett et al., 2004) and suggest that Victorian metropolitan paramedic shiftworkers are at increased risk of developing mood disorders compared to the general population.

Paramedics reported lower levels of physical activity compared to community samples. It is possible that shiftwork rostering for these paramedics imposes a lifestyle that limits the opportunity for regular exercise and prohibits a commitment to team-oriented sporting activities. No existing studies of physical activity in ambulance workers were located, so the present data is novel in this respect. Given that empirical measurement of exercise in shiftworkers is lacking generally, these findings should be treated as initial. Nevertheless, given the well-demonstrated positive associations between exercise and health generally (World Health Organization, 2006), these findings provide impetus for further investigation and potential organisational intervention. Associations between exercise and other study variables will be discussed in subsequent sections.

Although poor quality sleep is a well-established outcome of shiftwork, only 30% of paramedics were categorised as ‘good sleepers’, which infers that the majority of the group suffered severe difficulties in at least two domains of sleep, or moderate difficulties in more than three (Buysse et al., 1989). No previous investigations of sleep in ambulance workers were located; so these findings contribute initial normative data. Despite paramedics reporting poorer sleep than the shiftwork reference sample (Ruggiero, 2003), the latter group comprised female nurses rostered to permanent rather than rotating shifts which limits a direct comparison between studies. Paramedics also reported significantly poorer sleep than a local community-based sample. This is a useful finding, given the lack of control group for the current study (Sterud et al., 2006) and, we would suggest, may provide some indication of the level of shiftwork-related sleep disruption in the paramedic sample.

Several elements of the paramedic roster are associated with sleep disturbance and potentially contribute to the present findings of poorer health in the sample. Early morning shifts, quick returns and nightshifts are all problematic in this respect (Sallinen & Kecklund, 2010). The 7 am dayshift limits the opportunity for sleep, as workers need to wake early enough to prepare for the day and then commute to branch. The pairing of two 14-hour nightshifts requires a quick ‘turnaround’ that results in a strong exposure to night work, and the intervening period for rest is likely to be reduced by travel time, difficulty sleeping during the day, and social factors. Given that sleep is thought to be a marker of further health problems in ambulance shiftworkers (Sterud et al., 2006) the poor sleep reported by most paramedics is an important finding in this study.

A major interest of the study was to examine the data for associations amongst variables and identify predictors of fatigue. While previous analyses are limited in ambulance workers, investigations in other shiftwork groups (Ruggiero, 2003) report associations between fatigue, and depression, anxiety, and sleep quality of similar magnitude to those reported here. The signifi-
cant association between exercise and chronic fatigue is novel from an occupational perspective, but is consistent with decreased fatigue following an exercise intervention in nurses (Harma et al. 1988a; 1988b). Exercise has also been associated with a reduction in fatigue in general populations (Leppamaki et al., 2002) and there was no reason to suspect that paramedic shiftworkers would differ in this respect.

The results of the regression analyses demonstrate the significance of depression, sleep and exercise amongst the study variables as predictors of fatigue. Ruggiero (2003) also identified depression and sleep to be the strongest predictors of fatigue in shiftwork nurses using comparable assessment instruments. Other investigation of these variables is limited to demographic reports and bivariate associations, and the role of physical activity for shiftworkers is underrepresented, as already discussed. As such, the current study extends the work of Ruggiero (2003) albeit in a different occupational group, and highlights the role of depression, sleep disruption and exercise in this Victorian metropolitan paramedic sample.

While contrasting arguments have been offered regarding the relevance of age to shiftwork adaption, no significant association was found between age and fatigue in the current sample, congruent with past empirical studies (e.g., Ruggiero, 2003). The demographics of the current sample (age and shiftwork years) were broad enough to permit detection of any potential relationship, but even a fine-grained analysis based on upper quartile data produced nonsignificant results. Our findings are not inconsistent with the explanation of self-selection, whereby individuals who cope (more or less) with shiftwork remain and those that suffer do not (Boivin et al., 2007; Knutsson & Akerstedt, 1992), but clearly do not directly inform this hypothesis.

Despite regular literature narrative suggesting poorer health outcomes in female shiftworkers, gender failed to predict differences in depression or fatigue in the current sample. Previous studies of shiftworkers have also failed to observe differences on the basis of gender (Ashberg et al., 2000) and a review of 49 ambulance studies (Sterud et al., 2006) concluded that the influence of age and gender remains poorly understood. Contrasting arguments are drawn from presumed additional responsibilities for females in domestic, social, parenting and marital domains that lead to increased fatigue levels (Harrington, 2001). The impact of these responsibilities may be influenced by culture and demographics (e.g., marital status) and would require specific investigation. A process of self-selection (Boivin et al., 2007) in both male and female workers is again likely to produce fewer detectable gender differences and might be the most plausible explanation here. The paramedic sample was representative in terms of gender, so the current findings contribute initial empirical validation that gender may not be a reliable predictor of chronic fatigue or other outcomes in shiftworkers as previously assumed.

The most significant findings in this study were elevated levels of chronic fatigue and depression, and poor quality sleep in paramedic shiftworkers. Initial evidence also suggests that paramedics might engage in a lower level of physical activity than reference groups. Organisational parameters are known to influence health outcomes in ambulance workers, which in turn creates a responsibility for organisational management (Bennett et al., 2004; Van der Ploeg & Kleber, 2003). Workplace monitoring programs would be useful to confirm the prevalence and trends for these important domains of functioning. Subsequent responses could include custom-designed workshops and individual counselling as well as workplace psychoeducation. This would require individuals to comply with monitoring and take responsibility for personal change, which may prove problematic in some instances. Specific advice regarding sleep hygiene and exercise would seem appropriate for the paramedic group.

Further organisational dimensions include the shift system worked by this group. Although fast and forward rotating rosters are more beneficial for workers (Bambra et al., 2008) it is well established that extended shifts and nightshifts result in significant fatigue (e.g., Pallesen et al., 2010) as detected in the current sample. Previous authors have suggested an organisational focus on fatigue management, including the allocation of breaks on nightshift, regulation of overtime, and staff training programs (Hussey et al., 2001). Some flexibility offered in self-scheduling has also proven beneficial for health, work–life balance, and organisational effectiveness through reduced absenteeism (Bambra et al., 2008), although the associated difficulties for a large organisation are acknowledged.

The present study addressed several of the methodological concerns raised in a systematic review of ambulance worker health (Sterud et al., 2006). Scores were compared to normative data wherever possible, and examining a specific roster system enhanced known exposure to shiftwork. The assessment instruments were considered to be psychometrically robust, although scores were not always comparable to previous studies. The cross-sectional methodology limits any evaluation of causality, so longitudinal investigations would be useful in further exploring associations among the key variables. The generalisation of findings is also limited given that the study investigated a group of workers from a single ambulance service. Shiftwork studies are limited by the self-selecting nature of workers; however, the possibility of this effect has been highlighted in the relevant sections.
To conclude, this study examined variables related to health and wellbeing in Victorian metropolitan paramedics working a homogenous rotating shift structure that incorporated a nightshift component. Our findings suggest that these paramedics are at particular risk for increased levels of occupational fatigue and depression (regardless of age or gender) and poor quality sleep. The sample also reported less physical activity than reference groups, which may be associated with negative health outcomes. Organisational attention may assist with several domains of functioning in these workers, and contemporary psychological treatment modalities have much to offer in this respect. However, integrated interventions for the negative sequela of shiftwork remain relatively unexplored and would be a useful focus for future studies.

References


