

PERCEIVED IMPACT OF ROTATING SHIFT WORK ON HEALTH AND WELLBEING  
AMONG UNDERGROUND WORKERS

by

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## Abstract

Workers in the mining industry are exposed to several risks and hazards in the underground environment. Shift work is a common working arrangement in the mining industry and is associated with many adverse health outcomes. In Canada, there is limited research between rotating shift work in the minerals industry and the effects on health and wellbeing of workers, especially utilizing a qualitative design. This thesis aimed to understand the impact of rotating shift work on perceived health and wellbeing among some underground workers in Sudbury, Ontario.

This qualitative descriptive study utilized individual, semistructured interviews with a sample of underground workers ( $n = 12$ ) employed in Sudbury, Ontario. Interviews were digitally recorded, transcribed verbatim, and analyzed using Braun and Clarke's 2006 version of thematic analysis. Participants in this study perceived both advantages and disadvantages of working on a rotating shift schedule in relation to their health and wellbeing. Final themes that emerged from the data included: strong preference for the night shift, challenges associated with impact on personal wellbeing, advantages and disadvantages on work environment wellbeing, benefits and challenges of wellbeing external to work, strategies for coping with shift work, family advantages, challenges with partner relationships, challenges and opportunities in relationships with children, and strategies used to protect family wellbeing. The findings of this study may influence future research studies using a quantitative or mixed-method design, and larger samples.

Keywords: Underground mining, rotating shift work, health, wellbeing, qualitative interviews

## Co-Authorship Statement

### **Dr. Nancy Lightfoot**

Dr. Lightfoot is the supervisor of this thesis and provided guidance throughout this entire research project. She also provided ongoing advice, expertise and feedback in all stages of this research. Dr. Lightfoot will be listed as a co-author on the journal articles, when they are submitted for publication.

### **Dr. MacEwan and Dr. Lariviere**

Dr. MacEwan and Dr. Lariviere are the two committee members involved in this research project. Both members provided continuous feedback and expertise throughout this project. Both Dr. MacEwan and Dr. Lariviere will be given the opportunity to co-author the two articles for publication following the completion of this master's degree.

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## Chapter 1: Introduction

This qualitative study will take place in Sudbury, Ontario, a city that has been a ‘mining town’ for over 100 years and still remains host to ten active mines (Kramer et al., 2017; Ontario Mining and Exploration, 2017). Detrimental health outcomes have been associated with both shift work, (Costa, 2016; Gan et al., 2015; Grundy et al., 2017; Omid, Zare, Rad, Meshkani, & Kalantary, 2017; Parent, El-Zein, Rousseau, Pintos, & Siemiatycki, 2012) and mining (Del Bianco & Demers, 2013; Kramer et al., 2017; Mactaggart, McDermott, Tynan, & Gericke, 2015; Omid et al., 2017). Using individual, semi-structured interviews, this study will explore if, and how, some underground workers perceive their current rotating shift schedule to impact their health and wellbeing. The results of this study may have the ability to influence future research in the mining industry, such as conceptual scale development, or needs assessments (Sullivan-Bolyai, Bova, & Harper, 2005).

### 1.1 Literature Review

Kecklund and Axelsson (2016) defined shift work as work time arrangements outside of conventional daytime hours, and included fixed early morning, evening, and night work, as well as rotating shift work. Shift work is present in occupations throughout the world (Clendon & Walker, 2013; Gerber, Hartmann, Brand, Holsboer-Trachsler, & Pühse, 2010; Kawabe et al., 2015; Omid et al., 2017; West, Rudge, & Mapedzahama, 2016). This working arrangement is both common and necessary in order to meet the demands of a 24-hour society (Costa, 2016). Shift work has become an increasingly popular topic of interest for many researchers and a large volume of data has been published on health outcomes associated with this type of work schedule (Costa, 2010; Kecklund & Axelsson, 2016).

Shift work is common in the mining and minerals industry (Mactaggart et al., 2015; Omid et al., 2017; Williams, 2008), which are in and of themselves positively related with detrimental health outcomes (Del Bianco & Demers, 2013; Kramer et al., 2017; Mactaggart et al., 2015). Workplace accidents and injuries have been caused by explosions, poisonous gas leaks, mine collapses, flooding as well as mechanical errors. In addition, more miners are dying from occupational diseases related to mining, such as certain types of cancers (Del Bianco & Demers, 2013; Lightfoot, Berriault, Seilkop, & Conard, 2017). Mining activity has also been found to affect the social, physical, and economic environment, which has consequential effects on the health and wellbeing of the workers (Mactaggart et al., 2015). Therefore, not only are these workers exposed to highly hazardous work environments (Del Bianco & Demers, 2013; Kramer et al., 2017), they are also at risk for chronic health issues associated with shift work such as metabolic syndrome, gastrointestinal disorders, mental health issues, sleep problems as well as certain types of cancers (Costa, 2010; Kecklund & Axelsson, 2016; Wang, Armstrong, Cairns, Key, & Travis, 2011).

### **The Cost of Shift Work in Canada**

Wong and colleagues (2011) conducted a cohort study utilizing the Survey of Labour and Income Dynamics, an annual household income survey conducted by Statistics Canada. This survey follows a panel of participants over six years, with a new panel introduced every three years, creating a cross-sectional overlap (Statistics Canada, 2013). The sample includes working citizens between the ages of 16 to 65, with approximately 30,000 participants. The aim of this study was to examine trends in shift work and worker injury in Canada in order to compare the risk of injury by shift type. From 1996 to 2006, the number of worker injuries decreased from 415,000 to 356,300, a 27.9% decline. However, the rate of injury among night shift workers remained stable. During this same time period, the Canadian Labour force increased by 21.7%,

with almost half of this growth in non-regular shift work. The rate of women in the workforce also increased by 65.5%, which lead to an increase of women in rotating and night shift (94.5%), which may explain why the rate of injury among night shift workers remained stable. The risk of injury was higher among night shift and rotating shift workers. Women in rotating shift work reported the most difficulties in managing work-home conflict in comparison to men. In 2006, there were 2.7 million lost time injury compensation claims awarded in Canada. Wong et al. (2011) indicated that approximately 107,000 claims among men and 200,000 claims from women could be attributed to the high risk of injury associated with shift work. A weakness outlined in this study was that specific elements of shift work, such as length of shift, rotation direction, and rotation speed were not collected.

### **Shift Work and Health**

A strong association exists between shift work and negative health outcomes (Costa, 2010; Gan et al., 2015; Grundy et al., 2017, 2013; Knutsson & Boggild, 2010; Loudoun, Muurlink, Peetz, & Murray, 2014; Vallieres, Azaiez, Moreau, LeBlanc, & Morin, 2014). The following section includes studies that investigated the connection between different shift work arrangements and several health outcomes.

### **Shift Work and Metabolic Syndrome**

Metabolic syndrome is defined as a combination of metabolic abnormalities including centrally distributed obesity, decreased high-density lipoprotein cholesterol, elevated triglycerides, elevated blood pressure and hyperglycaemia (Eckel, Grundy, & Zimmet, 2005). These conditions are all relevant risk factors and are associated with type 2 diabetes and cardiovascular disease.

Karlsson and colleagues (2003) conducted a cross-sectional study in two pulp and paper mills in Sweden. Data were obtained from a previous study (Alfredsson et al., 2002). The sample

included 665 day workers and 659 shift workers. Data were collected through blood sampling, height, weight, waist/hip ratio, blood pressure and a questionnaire. Shift workers were twice as likely to have lower levels of high-density lipoprotein cholesterol (odds ratio (OR): 2.02, 95% CI: 1.24-3.28) in comparison to day workers. Shift workers also had higher levels of triglycerides in comparison to day workers 1.43 (95% confidence interval (CI): 1.13-1.82). There may have been a potential of selection bias, which could have underestimated the true prevalence of diabetes in shift workers (Karlsson et al., 2003).

De Bacquer and colleagues (2009) conducted a prospective cohort study to explore the association between shift work and the onset of metabolic syndrome in a representative sample of employees from several large companies in Belgium. This study was part of a larger study (Coetsier, De Backer, & De Corte, 1996). Data were collected at baseline between 1995 and 1998, and a second time between 2002 and 2003. Data collection involved a self-administered questionnaire, with questions pertaining to medical history, health behaviours, and subjective working conditions. Clinical examination by trained personnel were also used to obtain body mass index, waist circumference and blood samples. The cumulative incidence of metabolic syndrome in rotating shift workers was 32.7% (101/309) in comparison to 21.6% (263/1220) in day workers. The metabolic syndrome incidence rate in rotating shift workers (60.6 per 1000 person years) was increased in comparison with day workers (37.2 per 1000 person years) with an odds ratio (95% CI) of 1.77 (1.34-2.32). De Bacquer et al. (2009) observed increased incidence rates of elevated blood pressure, triglycerides and glucose levels, low high-density lipoprotein cholesterol and elevated abdominal obesity in shift workers compared to day workers. A limitation to this study was the lack of dietary information collected from the subjects

(De Bacquer et al., 2009). However, the longitudinal design was a major strength to the study as researchers were able to observe data from the same subjects over six years.

Gan and colleagues (2015) conducted a meta-analysis with the aim of summarising the epidemiological evidence to determine if an association between shift work and the risk of diabetes mellitus existed. Reports from 12 studies suggested there was a positive relationship between shift work and diabetes. Compared to individuals who had never been exposed to shift work, the risk of diabetes was increased by 9% for shift workers. After performing subgroup analyses by sex, study design, study location, occupation, shift schedule and other variables, shift work was associated with an increased risk of diabetes mellitus in most of the subgroups. The increased risk was more profound in the groups with rotating shift schedules, as well as male shift workers. The authors noted that one of the limitations of the study was that “different definitions of shift work exposure and diabetes mellitus outcome were used across the studies, which might have introduced heterogeneity into the studies’ results” (Gan et al., 2015, p. 76). However, the large sample size of data included in analysis is one of the study’s strengths.

A more recent systematic review was published with the aim of systematically summarizing the available evidence from longitudinal studies to analyze the effects of shift work on physiological risk factors for various metabolic disorders (Proper et al., 2016). A total of 22 studies were included. This review provided strong evidence for an effect of shift work on body weight gain, the risk of overweight, as well as impaired glucose tolerance. A strength of this study was the inclusion of longitudinal studies. The authors indicated that some caution should be used with interpreting some of the results as some of the studies did not utilize high-quality designs (Proper et al., 2016).

These published studies and reviews support findings that shift work is associated with an increased risk of metabolic syndrome. In addition, two of these studies found that rotating shifts have a more negative effect on metabolic syndrome (De Bacquer et al., 2009; Gan et al., 2015). Specifically, Gan et al. (2015, p. 75) stated in their article that “male shift workers should pay more attention to the prevention of diabetes”.

### **Shift Work and Gastrointestinal Health**

Digestive troubles are frequently reported by shift workers (Caruso, Lusk, & Gillespie, 2004; Kim et al., 2013; Knutsson & Boggild, 2010). Compared to workers employed on permanent day shift, shift workers tend to have an increase in gastrointestinal symptoms including abdominal pain, gas, diarrhea, constipation, nausea, vomiting, change in appetite, indigestion, and heart burn.

The following three studies, two cross-sectional studies and one systematic review, investigated an association between shift work and gastrointestinal symptoms and disorders.

A cross-sectional study was conducted in an American automobile plant to examine the relationship between shift work schedules and self-reported gastrointestinal symptoms, gastrointestinal medication use and gastrointestinal diagnoses (Caruso et al., 2004). Data were collected in a previous study (Lusk, Hagerty, Gillespie, & Caruso, 2002). A total of 343 workers participated in the study, where 225 of the sample were permanent day shift workers and 118 were permanent evening shift workers. The original study utilized a questionnaire which included some validated surveys (Marteau & Bekker, 1992; Walker, Sechrist, & Pender, 1987). However, the current study only analyzed data relevant to gastrointestinal outcomes and risk factors associated with gastrointestinal issues. Evening shifts were associated with slightly higher gastrointestinal symptoms and a three-fold increase in the odds of a worker having a gastrointestinal diagnosis, in comparison to day shift workers (Caruso et al., 2004). A major

strength of the study was controlling statistically for factors, such as demographic, lifestyle, stress and noise-related factors. However, history of shift work in the daytime workers was not addressed.

Knutsson and Boggild (2010) conducted a systematic review of international peer-reviewed articles that have been published on the relationship between shift workers and gastrointestinal symptoms and/or diseases between 1966 – 2009. A total of 20 articles met the inclusion criteria. Four out of six studies showed a significant association between shift work and gastrointestinal symptoms. Five out of six studies reported an association between shift work and peptic ulcer. The authors concluded with general judgement that shift workers appear to have an increased risk of gastrointestinal symptoms as well as peptic ulcer disease (Knutsson & Boggild, 2010). A drawback to this review was that some of the studies did not control for potential confounders, such as smoking, age, and socioeconomic status. Furthermore, authors indicated that the design of some of the studies utilized weak methodology (Knutsson & Boggild, 2010). However, the three cohort studies analyzed in this review had quite large samples, with one study comprising of 112,116 participants (Tüchsen, Jeppesen, & Bach, 1994).

Kim and colleagues (2013) conducted a cross-sectional study in a Korean hospital with the aim of estimating the prevalence of functional dyspepsia and irritable bowel syndrome (IBS) and investigate the predictive factors affecting the prevalence of these disorders. A total of 207 nurses and nursing assistants participated in the study, with 147 subjects working on a rotating shift schedule, and the remaining 64 subjects working day-shift only. Four validated surveys were used to collect data, including the Epworth Sleepiness Scale (Johns, 1991) and the Bowel Disease Questionnaire (Song, Jung, & Yeom, 2011). The prevalence of IBS was significantly higher in rotating shift workers [32.7% (95% CI, 26.3-39.1)] in comparison to day workers

[16.7% (95% CI, 11.6-21.8)]. The prevalence of functional dyspepsia did not significantly differ between the two groups. However, rotating shift workers with functional dyspepsia presented poorer sleep quality ( $p = 0.054$ ) and a higher stress level ( $p = 0.015$ ) in comparison to shift workers without functional dyspepsia. Similarly, rotating shift workers with IBS had poorer sleep quality ( $p = 0.001$ ), more frequent daytime sleepiness levels ( $p = 0.031$ ) and more severe stress ( $p = 0.017$ ) compared to those without IBS. A limitation to the study may include selection bias. The participants in this study consisted of nurses and nursing assistants at one hospital. The nursing profession is thought to be exposed to relatively high levels of occupational stress from the nature of work. Therefore, this may have influenced the generalizability of the results.

These three studies reviewed an association between shift work and gastrointestinal symptoms and disorders.

### **Shift Work and Mental Health**

Mental health can be defined as a state of well-being in which the individual realises his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community (Kelly, Considine, & Skehan, 2013; World Health Organization, 2001). An individual can experience a level of disturbed cognitive, emotional, behavioural and social problem without suffering a mental illness. Nevertheless, if mental issues do not resolve over time, these problems may develop into mental illness. It has been estimated that between eight- and ten-thousand employees in New South Wales, Australia minerals industry have experienced a mental illness (Kelly et al., 2013). The two following qualitative studies investigate the impact of the fly-in fly-out (FIFO) shift work lifestyle on the health and wellbeing of workers in this industry.

The first study, conducted within the Australian mining industry, aimed to explore the mental health issues relevant to resident mine workers to determine which problems were most

prevalent (Mclean, 2012). This qualitative descriptive study involved semi-structured interviews with nine men and one woman employed in the mining industry who were current or former FIFO employees. Both positive and negative aspects of the actual job itself were described. Overall, participants reported general job satisfaction. In contrast, participants identified that shift work, stressful tasks, and burnout were also experienced. Most participants admitted they were not comfortable with the idea of colleagues dealing with depression, but they also felt that the close relationships on-site meant that people were happy to support each other. Overall, participants expressed that commuting to work each day had more positive affects on lifestyle, rather than the previous FIFO lifestyle. The researcher stated one of the major strengths of the study was that the interviews took place on the worksite, often in the participants' vehicles or workspace, which could have increased the comfort level of the participant (Mclean, 2012). The small sample size and qualitative methods limit the transferability of findings beyond the mining community involved in the present study.

More recently, Gardner and colleagues (2018) conducted a qualitative descriptive study involving fly-in fly-out (FIFO) workers and partners of FIFO workers in Australia. There was a total of 60 participants, 34 of which were FIFO workers, and 26 participants were the partners of FIFO workers. Participants completed an email-based survey to answer a set of questions about how the FIFO lifestyle had an impact on their mental health and wellbeing. Mental health is still quite stigmatized and participants may have been reluctant to share sensitive information if they had been in a face-to-face interview (Kelly et al., 2013). However, a weakness of this method is that it did not allow for additional probing. Three main themes emerged from the data. The first theme identified many experiences of workers unable to adjust to work and home life, including the domestic role of being a father and partner. Second, for many participants, there were several

adverse mental health and wellbeing effects from the FIFO lifestyle. This included the worker being absent from significant family events, as well as the worker-partner relationship becoming strained and the feeling of being “disconnected” from one another. Many workers had feelings of isolation and loneliness and some admitted to suffering from anxiety and depression. The third theme that emerged from the data was about the lack of social support for the health and wellbeing outcomes associated with FIFO work. Many of the workers felt their workplaces did not spend enough effort educating the workforce on ways to deal with mental health issues. They also noted the “macho” culture in which participants would feel weak if they tried to get help.

According to Costa (2016), the persistent disruption of circadian rhythms and lack of sleep could also lead to chronic problems such as fatigue, mood disorders, neuroticism, as well as anxiety and depression. These two studies indicate that fly-in fly-out, a form of shift work, seem associated with mental health symptoms. Mental health issues also seem to be common in the mining industry (Kelly et al., 2013). Living with mental disturbances or illness could have an impact on perceived health and wellbeing.

### **Shift Work and Cancer**

In 2007, the International Agency for Research on Cancer identified that shift work that involves circadian disruption is probably carcinogenic to humans (Group 2A) (International Agency for Research on Cancer, 2010). Night shift work and subsequent exposure to light at night disrupts human biologic rhythms, resulting in circadian disruption, melatonin suppression, sleep deprivation and circadian gene deregulation (Fritschi et al., 2011; Fu & Lee, 2003; Papantoniou et al., 2015). Chronic disruption to circadian genes may lead to cell cycle deregulation and increased DNA damage replication errors, which could result in mutations, such as tumour growth (Sancar et al., 2010).

Much literature has been published involving shift work and cancer. Two of the following case-control studies have been conducted in Canada, while the third study was conducted in Spain. The results of these papers have demonstrated an association between shift work and cancer, for both men and women.

Parent and colleagues (2012) conducted a population-based case-control study in Montreal, Canada, to investigate whether night work was associated with an increased risk of certain types of cancers in Montreal men from several occupations. Data from this study were previously collected for the Montreal Multisite Case-Control Cancer study (Siemiatycki, Wacholder, Richardson, Dewar, & Gérin, 1987). A total of 3,137 cases were included in the study and were males between the ages of 35 and 70 and who had been diagnosed with a confirmed cancer between September 1979 and June 1985. A total of 533 controls were included in the study and were between the same age range, and lived in the same residential area, as the cases. Data collection was by questionnaire or interview, by telephone or in-person, to discuss the demographics of the subjects as well as detailed job descriptions in the subjects' working lifetime. The researchers calculated the cumulative index of night work exposure (Parent et al., 2012). Overall, results displayed an association of long-term night shift work (beyond 10 years duration) for cancers of the prostate, colon, bladder and for non-Hodgkin's lymphoma. A strength of this study was the investigation into many cancer sites to compare risks with working the night shift. However, the structured sections of the interview did not include detailed information about each shift worked, including types of shift, direction of shift, speed of shift and rest periods between shifts, therefore researchers were unable to describe specific shift characteristics that could potentially lead to an increased cancer risk.

Grundy and colleagues (2013) also conducted a population-based case-control study in Vancouver, British Columbia and Kingston, Ontario. A total of 1,134 cases and 1,179 controls were studied. Cases included women between the ages of 40 and 80, who had been diagnosed with breast cancer, while controls were cancer-free, and frequency-matched to cases by five-year age groups. The primary objective of this study was to investigate if there was a risk associated between long-term night shift work and breast cancer, in the general population. Methodology included a questionnaire involving questions about health history, health behaviours, menopausal status, and shift work status. A blood sample and data concerning cancer were also collected. There was an increased cancer risk among women employed in night shift work for 30 years or more across several occupations (OR = 2.23, 95% CI 1.12-4.45). However, no association was seen for shorter durations, [0 – 14 years (OR = 0.94, 95% CI 0.77-1.16)], and [15-29 years (OR = 0.97, 95% CI 0.68-1.38)]. A major strength of this study involved the use of a lifetime occupational history for participants to document the hours that they worked for day, evening and night shifts for each job (Grundy et al., 2013). This allowed researchers to capture both rotating and permanent night shifts. However, the questions did not involve the number of consecutive night shifts for each job.

More recently, Papantoniou et al. (2015) conducted a population-based case-control study in Spain. The study examined the association between night shift work and prostate cancer, while also including individual chronotype and severity levels of cancer. Data were previously collected from a larger study called the Multi-Case Control Spain study (Carlos III Health Institute, 2008). Cases were males between the ages of 27 to 85 and had confirmed diagnosis of prostate cancer ( $n = 1,095$ ). Controls were of the same age range, but were free of prostate cancer diagnosis ( $n = 1,388$ ). Data collection involved structured, face-to-face interviews with detailed

questions about shift work history, occupational history, and demographics. A validated survey was also administered (Juda, 2010). Clinical information from medical records was also collected. Odds ratios (OR) were slightly higher for rotating night (OR 1.16; 95% CI 0.92, 1.46) than for permanent night shift work (OR 1.10; 95% CI 0.85, 1.43). There was an observed adjusted OR of 1.38 (1.05, 1.81) for subjects that had been engaged in night shift work for 28 or more years, with a statistically significant trend ( $p$ -trend = 0.047). There was also a positive and statistically significant association found between night shift work and high-risk prostate tumours (RRR 1.40; 1.05, 1.86). Papantoniou et al. (2015) noted that although there was a large sample size, in stratified analyses the numbers were smaller, and may have lacked statistical power to detect significant associations and interactions. A strength of the study was the use of a population-based sample with a variety of occupations, which increased the external validity.

As demonstrated in these three studies, there appears to be an association between long-term night shift and an increased risk in cancer types relative to both men and women. According to Parent and colleagues (2012), long-term night shift (10 years or more) was associated with an increased risk of prostate, colon, and bladder cancer, and for non-Hodgkins lymphoma. Grundy and colleagues (2013) found long-term (30 years or greater) night shift work to be associated with greater cancer risk for women. More research needs to be conducted on specific shift arrangements and characteristics and gender.

### **Shift Work and Sleep**

The relationship between shift work and sleep has been reported in multiple studies (Hossain, Reinish, Kayumov, Bhuiya, & Shapiro, 2003; Paim et al., 2008; Vallieres et al., 2014). Shift work “perturbs the physiological homeostasis, due to the disturbance of the circadian rhythms of the psychophysiological functions, starting from the sleep/wake cycle” (Costa, 2016,

p. 21). Humans are diurnal creatures who are meant to be awake during the day and asleep at night and not the opposite. For shift workers, obtaining adequate sleep and staying awake at appropriate times often means challenging their internal biologic clock from the misalignment between shifts and circadian rhythms (Wright, Bogan, & Wyatt, 2013).

Hossain et al. (2003) conducted a cross-sectional study with employees working in an underground mine in Timmins, Ontario. The aim of the study was to detect if subjective fatigue severity could be used as an independent predictive tool to identify underlying sleep pathology in shift workers. The first phase of the study involved the administering of the Fatigue Severity Scale (Krupp, 1989) and the Epworth Sleepiness Scale (Johns, 1991). These surveys were given to 195 underground miners working a 10-hr rotating shift schedule to assess subjective fatigue and sleepiness. After the first phase was complete, 44 participants were selected based on severity levels of fatigue. Twenty-one most-fatigued (study group) and 23 least-fatigued (control group) miners then underwent various polysomnographic testing in a sleep laboratory. Fifteen of the 21 (71.4%) severely fatigued subjects displayed significant sleep pathology and polysomnographic features of various sleep disorders, such as obstructive sleep apnea, periodic limb movements disorder and bruxism. Compared with these results, only three of the 23 (13.0%) of the least-fatigued subjects had evidence of sleep disorders. Major strengths of this study include the use of validated surveys. However, researchers noted that a major limitation to the study was the non-random selection of subjects as well as the small sample size (Hossain et al., 2003).

More recently, Vallieres and colleagues (2014) conducted a case-control matched-pair study from previously collected data from a larger epidemiological study conducted in Canada. A total of 428 adults (18 years of age or older) participated in this study. This study aimed to

address the negative impacts of insomnia on perceived physical and psychological health of shift workers by comparing them to day workers. Each participant, both shift workers and day workers, were classified as “insomnia”, or “good sleepers”. Each shift worker ( $n = 209$ ) was paired with a day-time only worker ( $n = 209$ ) in with the same sleep classification, as well as age, gender and reported income. Six questionnaires were used to measure sleep and fatigue, including the Insomnia Severity Index (Morin, 1993), the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989), and others (Espie, Inglis, Harvey, & Tessier, 2000; Johns, 1991; Nicassio, Mendlowitz, Fussell, & Petras, 1985; Smets, Garsen, Bonke, & De Haes, 1995). Surveys were also used to assess psychological measures and health and lifestyle behaviours. The inclusion of many validated surveys was a major strength of this study. The results of this study suggested that insomnia had similar effects on night, day and rotating workers. All three groups (day, night and rotating) presented similar profiles, complaints of symptoms of anxiety, depression and fatigue, as well as consuming equal amounts of sleep-aiding medications. Sleepiness seemed to be associated with insomnia for rotating shift workers and quality of life for both rotating and night workers. According to the Vallieres and colleagues (2014), this study included questions that focused on difficulties sleeping at night only and failed to ask about insomnia on nights of “days off”, or during the day after working a night shift. In addition, authors also noted that although the Insomnia Severity Index is a validated survey, it has not been validated among the shift work population (Vallieres et al., 2014).

These two studies were conducted in Canada. Hossain and colleagues (2003) found that self-reported, severely fatigued shift workers were more likely to suffer from a sleep disorder compared to those that were least fatigued. Vallieres and colleagues (2014) found that insomnia seemed to contribute to chronic pain and other health issues, especially for rotating shift workers.

### **Shift Work, Wellbeing and Work-Life Balance**

According to Costa (2016), “shift workers frequently complain of irritability, nervousness and anxiety, in relation to more stressful working conditions and greater difficulties in family and social life”, which leads to the next topic of shift work and work-life balance (p. 24). Those engaged in shift work may be “frequently out of phase with society, as most family and social activities are arranged according to the day-oriented rhythms of the general population” (Costa, 2016, p. 25). However, some shift workers may embrace their work schedule and learn how to use daytime periods more productively.

The following studies have explored the relationship between shift work and some aspect of work-life balance.

Oldfield and Mostert (2007) conducted a cross-sectional study in South Africa, to test an explanatory structural model that portrays the ways in which job characteristics, ill health and work-home interference are related to determine why employees in the mining industry suffer from poor health and work-home interference. A sample of 320 subjects employed in the gold, platinum or phosphate mining industry were surveyed. High job demands and a lack of job resources were associated with exhaustion, somatic complaints and anxiety and insomnia, which in turn, were associated with negative interference from work to the private domain. A limitation of this study was that previous researchers view negative work-home interference as an outcome of ill health, and therefore could also be considered a stressor or mediator between job characteristics and ill health, where ill health is treated as a dependent variable (Oldfield & Mostert, 2007). A strength of this study was the use of multiple mine sites rather than focusing in on one site.

An ethnographic study was conducted in an American automobile manufacturing plant (Root & Wooten, 2008). In addition to observation and job shadowing techniques, 59 semi-

structured interviews were performed with employees of all positions. Of the participants, 70% were males between the ages of 20 and 60 years. The researchers aimed to explore how non-traditional work schedules affected work-family dynamics; specifically how time commitments at work affected a father's ability to participate in family activities. Fathers worried about missing extracurricular activities with their children and important developmental milestones in their children's lives because of their work schedule. Due to the uniqueness of the automotive plant, these findings are not transferable. One of the major strengths of this study was that it took place in an industrial setting, rather than the traditional corporate office, where work-family balance is less of an issue because of fixed schedules (Root & Wooten, 2008).

McPhedran et al. (2014) published a cross-sectional study to further investigate possible associations between resources sector work, mental wellbeing, and work-family issues. This study utilized data from the Household, Income and Labour Dynamics in Australia survey (Wilkins, 2017), and collected data from 375 employed, working age males, including 66 miners and 309 men in other occupations. Researchers aimed to compare variables including health, finances, employment, and interpersonal relationships (McPhedran & De Leo, 2014). The findings displayed that there were very few differences between outcomes on variables for miners relative to men in other occupations. Results did display that those employed in the mining industry worked longer hours per week (mean = 51.1 hours) in comparison to other occupations (mean = 42.7 hours) which was statistically significant ( $p < 0.01$ ). Longer working hours were independently associated with lower perceived relationship quality with both spouses and children. Researchers stated that a limitation of the study could include the possibility of "self-selection" into and out of the mining industry, based on perceived stressors and an inability

or ability to cope (McPhedran & De Leo, 2014). A strength of this study was the use of a validated survey.

As demonstrated in these studies, there appears to be some evidence to support the relationship between shift work and poor work-life balance outcomes. Oldfield and Mostert (2007) found that high job demands and lack of job resources in the mining industry had a negative effect on work-life balance. On the other hand, McPhedran and colleagues (2014) found that workers in the mining industry did not seem to suffer from poor work-life balance any more than those employed outside of the industry; however authors noted that long working hours in the mining industry were associated with lower perceived relationship quality with their family.

### **Shift Work and Health in the Industrial Setting**

The next two cross sectional studies have examined the relationship between shift work systems and health outcomes.

Kantermann and colleagues (2013) conducted a cross-sectional study in Belgium to examine the relationship between social jetlag and cardiovascular risk markers among three different shift systems: a fast clockwise shift, a slow counter-clockwise shift and day-time only shifts. Seventy-seven males employed in the same steel factory participated in this study. Participants completed an investigator-developed questionnaire, and the Munich Chronotype questionnaire (Juda, 2010). In addition, blood pressure, heart rate and pulse wave velocity were conducted on 63 of the subjects. In comparison to day-time workers, both groups of shift workers had more social jetlag (clockwise = 2.4 h, counter-clockwise = 2.8 h, day-time = 0.8 h,  $p = < 0.001$ ). In comparison to day workers, both shift work groups combined reported significantly more stomach upsets (+44.8%,  $p = 0.021$ ), digestion problems (+42.3%,  $p = 0.017$ ), and weight fluctuations (+38%,  $p = 0.008$ ). There were no statistically significant differences of

pulse wave velocity between the clockwise and counter-clockwise groups; however, there were three subjects with elevated pulse wave velocity found in the fast-clockwise shift, meaning they had an increased atherosclerotic risk. It is important to interpret these findings with caution due to the small sample size of each group. The use of pulse wave velocity could be a strength for the study, as it is non-invasive and time efficient test as it takes approximately 10 minutes to complete.

Karhula and colleagues (2016) in Finland investigated the effects of shift length and shift rotation speed in relation to perceived health and wellbeing in shift workers employed in nine pulp and paper or chemical factories. Three shift systems were compared in this study (12-hour fast-rotating, 8-hour fast-rotating and 8-hour slow-rotating shift). The cross-sectional study utilized a questionnaire that included questions about demographics; self-rated health; body mass index; smoking status; chronotype; and modified questions from the Standard Shiftwork Index (Barton et al., 1995). Employees in the 12-hour fast-rotating shift system were more satisfied with their current shift system ( $p < 0.01$ ), perceived work-life balance ( $p < 0.001$ ) and had better sleep quality ( $p = 0.003$ ) in comparison to both 8-hour rotating shift systems. Researchers (Karhula et al., 2016) noted that the cross-sectional design will require further longitudinal studies to confirm associations between shift work and sleep quality and work-life balance and satisfaction with shift system. A major strength to the study was the high response from males (91%).

These two cross sectional studies used an approach that involved the comparison between multiple shift arrangements. In the study conducted by Kantermann and colleagues (2013), researchers found that in comparison to permanent day shift workers, shift workers had more social jetlag ( $p = <0.001$ ). Karhula and colleagues (2016) had a different focus in their study and

found that shift workers perceived 12-hour forward rotating shift systems to be more satisfying and had a more positive impact on work-life balance and sleep, in comparison to the other 8-hour rotating shift systems.

### **Shift Work, Mining and Health**

One of the following studies utilized a qualitative descriptive approach, with a focus on fly-in fly-out (FIFO) and drive-in drive-out (DIDO) workers, towards understanding more about the health and wellbeing of workers in the mining industry. The other five studies utilized a cross-sectional design, one of which includes a prospective design phase, and investigate the ways in which shift work has an impact on the health and wellbeing of workers employed in the mining industry. Three of the following studies used surveys to collect data, while the fourth study used objective measuring tools, including taking blood pressure and blood samples.

Torkington et al. (2011) published a descriptive qualitative study that explored the psychosocial impacts and personal sources of support on long distance commuting miners in Australia. This study involved eleven current or former FIFO or DIDO employees, consisting of two females and nine males, between the ages of 20 to 59. Semi-structured interviews were conducted with the participants and followed by thematic analysis. Participants with young families reported worrying about illness or injury in the family while they were away, along with missing out on time with children. Most participants with a partner reported some negative impacts on their partner's life, such as the partner being upset or lonely and the stresses of parenting alone. The current FIFO/DIDO employees reported general satisfaction with their lifestyle, while former employees who had left the FIFO/DIDO lifestyle preferred to commute to work daily. The interviewer was also a general practitioner of some of the participants, which has been reported to improve interviews (Torkington et al., 2011). However, a limitation of the

study was the small sample size and qualitative methods such that the findings are not transferable.

Hossain and colleagues (2004) conducted a 2-phase study, involving 1) a prospective cohort, and 2) a cross-sectional design. This study, hosted in Timmins, Ontario, was conducted with shift workers at an underground mine, before and after, a planned change from an 8-hour to 10-hour shift schedule. The first phase involved the administration of a questionnaire at three different times, with a total of 58 subjects completing all three surveys. The questionnaire was researcher-developed and also included two validated surveys: the Epworth Sleepiness Scale (Johns, 1991) and the Fatigue Severity Scale (Krupp, 1989). The second phase of the study involved objective performance and sleep evaluations, which included: the 2-dimensional tracking and visual search test (Tevell & Burns, 2000), the Mackworth Clock test (Lichstein, Riedel, & Richman, 2000) and polysomnographic testing. A total of 20 subjects participated in this phase. The fast speed of initiating the new change from 8-hour to 10-hour shift schedule, limited the gathering of baseline objective data in the second phase (Hossain et al., 2004).

In the first phase, findings concluded that workers on the new 10-hour dayshift displayed a significant decline in sleep both 1-month, and 1-year post change of schedule (Hossain et al., 2004). More specifically, subjective measures of sleep duration after day shift significantly declined from the old schedule ( $6.7 \pm$  standard deviation (SD) 1.1), to then one month after the new schedule was implemented ( $6.2 \pm$  SD 1.1), and then finally, to one year on the new schedule change ( $5.6 \pm$  SD 1.0,  $p < 0.001$ ). Subjective sleep quality also declined after night shift, from before the schedule change ( $4.5 \pm$  SD 1.2), to ( $3.3 \pm$  SD 1.0,  $p < 0.001$ ) one year after the change. The second phase, which only took place after the new shift change, revealed that subjects on the new day shift had longer sleep periods at night ( $333.8$  SD 26.2,  $p < 0.001$ ) in comparison to

those that worked the night shift and slept during the day ( $291.0 \pm \text{SD } 53.1$ ). In the population of 500 shift workers at this particular mine site, a total of 4,400 hours was lost as a result of accidental injuries during the 1-year period before the shift schedule change. This number dropped to 2,206 hours for the one-year period after the shift schedule change. Hossain et al. (2004) concluded that based on the findings of this study, moving to a forward-rotating shift schedule, involving a night shift that does not include the entire night period, could have a significant benefit to shift workers, including more refreshing sleep, less performance impairment and a safer commute.

In 2014, a mixed-methods study was conducted in Ghana, with this specific paper focusing on the cross-sectional results (Amponsah-Tawiah, Leka, Jain, Hollis, & Cox, 2014). The study's primary objective was to examine psychosocial and physical hazards in the Ghanaian mining industry, and the relationship to the experience of quality of life, health and well-being of employees. A total of 307 non-management, male staff in selected mining companies participated in this study. Approximately 56.4% of the sample worked shift work. Participants were given a researcher-developed survey, with some sections including questions from validated surveys, including: the Copenhagen Psychosocial Questionnaire (Kristensen, Hannerz, Høgh, & Borg, 2005); as well as the Health Anxiety and Health Status sub-scales of the Health Orientation Scale (Snell, Johnson, Lloyd, & Hoover, 1991). Amponsah-Tawiah et al. (2014) indicated that high work demands and low control at work had a negative effect on employee's self-rated health ( $\beta = 0.168, p < 0.01$ ). In addition, researchers found that there was a significant finding that highlighted that older employees ( $\geq 41$  years) said they experienced better health and wellbeing compared to the younger workers ( $\beta = -0.223, p < 0.01$ ) (Amponsah-Tawiah et al., 2014).

Loudoun and colleagues (2014) conducted a large, matched-pair cross-sectional study involving mine and energy workers, working some form of shift work (nights, rotating or FIFO/DIDO), as well as their partners. This study utilized data from an Australian matched-pairs study to assess the influence of age, control over work schedule and tasks, and the relationship between sleep disturbances. The perceptions of partners about their shift worker's job and contribution to the household and sleep disturbances was also examined. A total of 2,640 mine and energy workers, with 1,829 partners, completed the survey. Survey questions involved some single items from: the Standard Shiftwork Index (Barton et al., 1995), Household, Income and Labour Dynamics in Australia survey (Wilkins, 2017), Morningness-Eveningness Questionnaire (Horne & Östberg, 1976), and Mini-International Personality Item Pool survey (Donnellan, Oswald, Baird, & Lucas, 2006). The use of questions from validated surveys helps strengthen this study. Loudoun et al. (2014) concluded that low control over shift schedule was associated with more sleep disturbances in older workers ( $\geq 50$ ), while younger workers were not affected by this ( $F=11.983, p < 0.001, r^2 = 0.284$ ). Results showed that partner perceptions of their shift worker's work-life balance and employment also predicted sleep disturbances in the shift workers ( $F=17.67, p < 0.001, r^2=0.27$ ). This study sample only included current energy and miner workers, such that the respondents in this study could have caused a "healthy worker effect" (Li & Sung, 1999) and therefore could be missing important results from those that have left the industry.

Bernardes Souza and colleagues (2015) conducted a cross-sectional study in Brazil, with the objective to evaluate the association between lifetime exposure to shift work and blood pressure, glucose levels, anthropometric variables, body composition and heart rate variability. A total of 438 Brazilian men, aged 20 to 55, operators of iron ore extraction in four different mines

participated in this study. All participants worked on a rotating shift schedule. There was a positive association between lifetime shift work and negative cardiac regulation ( $p = 0.017$ ), higher blood pressure ( $p = 0.023$ ) and lower insulin resistance ( $p = 0.006$ ). A major strength of the study was the use of objective measures to obtain results, for example, the use of blood samples to determine glycaemia, as well as the use of electrocardiography to assess cardiac autonomic regulation. On the other hand, a limitation to the study was that personal behaviour factors, such as eating habits, physical activity levels, sleep, smoking, and others, were not collected (Bernardes Souza et al., 2015). These factors could have been useful in determining potential mediators of the associations found.

More recently, a study to determine the relationships between shift work and health-related effects as well as shift workers' satisfaction was conducted in the mining industry in Iran (Omidi et al., 2017). The researchers performed a cross-sectional study and compared shift workers (mean age= 29 years) to non-shift workers (mean age= 30 years) employed in the mining industry. A total of 259 workers participated in the study. Participants were asked to complete the Survey of Shift Workers (Zamanian, Dehghani, & Mohammady, 2012). Shift workers had lower subjective levels of life satisfaction ( $p = 0.003$ ), family satisfaction ( $p = 0.005$ ) and a higher reporting of fatigue ( $p = 0.001$ ) and sleep disorders ( $p = 0.001$ ) in comparison to daytime only workers. However, a limitation of the study was that the researchers did not specify the gender of the workers, therefore making the results of the study more difficult to generalize.

As demonstrated through these studies, there appears to be a mix of results from the impact of shift work on health and wellbeing outcomes in the mining industry. In two of these studies, results indicated that high work demands and low control at work and over shift

schedules, lead to poorer subjective health outcomes (Amponsah-Tawiah et al., 2014). Omidi and colleagues (2017) also reported adverse health outcomes associated with shift work, including lower subjective levels of life satisfaction, higher reporting of fatigue and sleep . Bernardes Souza et al. (2015) utilized objective measures and found a positive association with a higher lifetime shift work exposure and negative cardiac regulation, higher blood pressure and lower insulin response. In addition to these negative findings, some positive outcomes were observed. Hossain and colleagues (2004) reported that a forward-rotating shift schedule, involving less night hour work, could lead to more refreshing sleep, less performance errors and a safer commute for shift workers. Lastly, Torkington et al. (2011) found that current fly-in fly-out and drive-in drive-out workers actually reported general satisfaction with their lifestyle, even though there were some negative effects on their work-life balance.

### **Addressing the Gap**

It has been demonstrated through this review that much health-related literature exists about shift work as well as mining. This review offers evidence that there is a strong association between shift work and adverse health outcomes. This review also displayed that the combination of shift work and mining is also associated with poorer health outcomes.

While there have been several studies involving shift work and health outcomes, as well as the combination of shift work and mining, it appears there are still gaps in the literature. For instance, there is limited research on the association between rotating shift work, mining and health outcomes, utilizing a qualitative approach, especially in Canada. As such, this study investigates how workers perceive rotating shift work to impact their health and wellbeing in the underground mining industry in Sudbury, Ontario. As stated by Omidi et al. (2017), “further

studies are needed to investigate and identify the effects of shift work on workers' health and satisfaction in mining industries" (p. 24).

It is also important to recognize that health-related studies have been conducted in the mining industry in northern Ontario in the past (Berriault, Lightfoot, Seilkop, & Conard, 2017; Hossain et al., 2004, 2003; Kramer et al., 2017; Legault, Clement, Kenny, Hardcastle, & Keller, 2017; Lightfoot et al., 2017). However, the large majority of these studies have been quantitative. This study will be a unique addition to the mining literature in northern Ontario as it will be using a qualitative approach. This study has addressed a gap outlined in this review by using individual, semi-structured interviews with 12 underground workers employed in Sudbury, Ontario, to explore how rotating shift work is perceived to impact their health and wellbeing.

## **Conclusion**

This review of the literature offers evidence of association between shift work and negative health outcomes, such as metabolic syndrome, gastrointestinal problems, mental health issues, sleeping problems, as well as certain types of cancer (i.e., prostate, colon, bladder, non-Hodgkin's lymphoma, and breast cancer). In addition, shift work may affect an individual's perceived work-life balance and family wellbeing. Although the literature demonstrates poor health outcomes related to shift work, it is still a common and necessary working arrangement in order to meet the demands of a 24-hour society. Future research should continue investigating health outcomes associated with shift work, as well as interventions that may help reduce the risk of adverse health outcomes associated with this work arrangement.

This review also reported on studies that had been conducted in the mining industry in various countries. Multiple hazards can be found in the mining industry, for example, explosions, poisonous gas leaks, fires, mine collapse, flooding, among others (Del Bianco & Demers, 2013;

Kramer et al. 2017). Underground miners are also developing occupational disease related to mining, such as certain types of cancer (Del Bianco & Demers, 2013; Lightfoot et al., 2017). Studies outlined in this review involved shift workers employed in the mining industry. Some health outcomes experienced by these workers included: mental health issues (Torkington et al., 2011), excessive fatigue and sleep problems (Hossain et al., 2003), work-life balance issues (Loudoun et al., 2014), poorer self-rated health (Amponsah-Tawiah et al., 2014), metabolic abnormalities (Bernardes Souza et al., 2015), and cancer (Lightfoot et al., 2017).

## 1.2 Purpose of Study

The purpose of this study was to gain a deeper understanding of the experiences of underground workers about the perceived impact of rotating shift work on health and wellbeing.

## 1.3 Research Funding

Funding for this study was obtained from the Goodman School of Mines for the Master of Arts Interdisciplinary Health Scholarship. Funding was also received from the William Shaver Masters Scholarship in Mining Health and Safety. Lastly, funding was also provided by the Occupational Health and Wellness Award, through the Centre for Research in Occupational Safety and Health.

## 1.4 Research Context

This study took place in Greater Sudbury, Ontario. In 2016, the population of Greater Sudbury was 164,689 (Statistics Canada, 2017), a population size that classifies Sudbury as a small urban city in northeastern Ontario (Organisation for Economic Co-operation and Development, 2018). Kramer et al. (2017) reported in a recent qualitative case study that Sudbury has been classified as a ‘mining town’ for over 125 years and to date, is still host to ten

active mines in the Greater Sudbury area, therefore making it an appropriate research setting (Ontario Mining and Exploration, 2017).

## 1.5 Research Question and Operational Definitions

This study sought to answer the following research question:

“What is the experience of rotating shift work on perceived health and wellbeing in some underground workers in Sudbury, Ontario? “

In this study, rotating shift work was defined as “shifts rotate or change according to a set schedule” (Canadian Centre for Occupational Health and Safety, 2017). Health is defined as a “state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity” (World Health Organization, 2018). Lastly, a definition provided by the Canadian Index of Wellbeing (2016) will be used to define wellbeing as, “the presence of the highest possible quality of life in its full breadth of expression focused on but not necessarily exclusive to: good living standards, robust health, a sustainable environment, vital communities, an educated populace, balanced time use, high levels of democratic participation, and access to and participation in leisure and culture” (p. 11).

## 1.6 Theoretical Framework

This research is situated within the postpositivist and interpretivist paradigm. This ontological stance assumes that truth is seen through a variety of lenses and that subjective experience affects the perception of the truth of reality (Tuck & McKenzie, 2015). The epistemological approach assumes that knowledge is influenced by our perceptions (Tuck & McKenzie, 2015). Throughout the interview process, it is understood that whatever information is shared from the participants, is not the absolute truth but rather the truth the participant creates from their own perceptions. This also includes what is said and understood by the researcher, as

the truth is created from their own perceptions as well (Tuck & McKenzie, 2015). Postpositivist researchers view inquiry as a series of logically related steps, believe in multiple perspectives from participants rather than a single reality, and adopt rigorous methods of qualitative data collection and analysis (Creswell, 2013).

To inform the theoretical framework of this thesis, two models will be utilized: the Effort-Reward Imbalance (ERI) Model (Siegrist, 2016) as well as the “Process-Person-Context-Time (PPCT) Model” (Bronfenbrenner & Morris, 2006).

In the second chapter of this thesis, the research objective was to understand if, and how, underground workers perceived rotating shift work to impact their health and wellbeing. Johannes Siegrist’s (2016) Effort-Reward Imbalance (ERI) Model was utilized. This model suggests that a failed reciprocity between effort and reward may cause recurring negative emotions as well as sustained stress response, which may result in subsequent adverse health outcomes, such as coronary heart disease and associated risk factors (Preckel, Meinel, Kudielka, Haug, & Fischer, 2007; Siegrist, 1996). The repeated activation of the stress response may lead to the development of stress-related mental and physical health disorders (Preckel et al., 2007; Siegrist, 2008).

According to Siegrist (2008), social reciprocity lies within the employment contract between a worker and employer. This outline specifies the tasks that must be performed in exchange with adequate awards. Rewards include money, esteem, career opportunities and job security. A failed reciprocity occurs when a “high cost and low gain” is experienced by a worker, which may result in adverse long-term health effects. Siegrist (2016) also postulates that a failed reciprocity may occur if a worker experiences one or more of the following conditions: “dependency”, “strategic choice” and “overcommitment”. Dependency occurs when a worker

has no alternative choice in the labour market, which is becoming more prevalent in the modern workforce as there is higher exposure to job instability, rapid technological changes, as well as growing competition. Second, strategic choice occurs when a worker accepts the “high-cost/low-gain” conditions in their employment for a certain time period, as they believe it could lead to potential job promotion in the future. Third, overcommitment can occur consciously or subconsciously, when a worker strives toward continuously high achievement because of their need for approval and self-esteem at work. In this condition, a worker may experience a perceptual distortion, where they inaccurately assess their “cost-gain” situation, where the worker may underestimate their demands and overestimate their own coping resources, which could lead to negative health consequences in the future (Siegrist, 2008).

In the third chapter of this thesis, the Process-Person-Context-Time Model (Bronfenbrenner & Morris, 2006) was utilized. In this chapter, the research aim was to understand if, and how, underground workers perceived rotating shift work to impact their family wellbeing. The PPCT model derives from the Bioecological Systems Theory, that is defined as an evolving theoretical system for the study of human development over time (Bronfenbrenner, 2001; Bronfenbrenner & Morris, 2006). According to Rosa and Tudge (2013), this theory postulates that researchers should study the settings in which a developing individual spends time and the relations with others in the same settings, as well as the personal characteristics of the individual, and those with whom one typically interacts. This model also considers the context in which the individual lives in and spends time, which includes institutional systems, such as economic, social, education, legal and political systems (Rosa & Tudge, 2013). This theory also includes the concept of time, which involves development over time as well as historical time. Lastly, an important concept that are considered in this theory are

‘proximal processes’, which are defined as the processes of progressively more complex reciprocal interaction between an evolving individual and the persons, objects and symbols in its immediate environment (Bronfenbrenner & Ceci, 1993; Tudge et al., 2016). This theory incorporates a 4-element model, involving synergistic interconnections and will be utilized in this thesis: 1) proximal processes, , 2) person characteristics, 3) context and, 4) time, and is also known as the PPCT model (Tudge et al., 2016).

## 1.7 Reflexivity

Reflective practice has occurred prior to the study commencing. Reflexivity acknowledges the role of the researcher as a participant in the process of knowledge construction and not merely an outside-observer of a phenomenon (Patnaik, 2013). This process involves a personal reflection on past experiences, biases, prejudices and orientations that may influence the interpretation and approach to the study.

Having gained previous work experience in a mining setting may have an influence on the interview process and the interpretation of findings in this study. I have previously been employed as a wellness coordinator for a large mining company in Sudbury. During this time, I have spoken with many workers about their experiences with shift work. Many workers shared narratives about the negative impacts that rotating shift work has had on their sleeping habits, eating habits, and daily lives. However, occasionally some workers would share that shift work “suited them” and they did not have any complaints about their rotating schedule. In addition, I have read many articles about shift work and have attended conferences where lecturers have spoken about the negative effects associated with shift work. It is important as a researcher to stay open-minded and recognize that future participants may have both positive and negative

experiences related to their health and wellbeing while working shift work, even though I have learned of mostly negative outcomes associated with this working arrangement.

It is also important to reflect on my gender, culture, and professional background and how these might influence my position on the topic and my relationships with the participants (Patnaik, 2013). I recognize that I am not a representative of the participants in this study. I am an English-speaking, Caucasian female with a Bachelor's degree in Physical and Health Education with a concentration in Health Promotion. I have gained some work experience in the mining industry as a confined space attendant in a mining smelter complex. My primary responsibility was to ensure that all workers who entered a confined space were following health and safety requirements. I was exposed to working two weeks of continuous 12-hour night shifts. Although the position paid well, I did not enjoy working at night. I was always tired and felt as though my body was not functioning normally. In addition, the 12-hour shift interrupted daily activities that I would normally enjoy, such as exercising and socializing with friends and family. I also experienced a near-miss car accident one morning after working eight consecutive 12-hour night shifts. I was extremely fatigued and lost concentration while driving and I almost rear ended a car that had stopped on a busy highway. Thankfully, a co-worker was in the car with me and yelled to get my attention. I was able to swerve onto the shoulder of the highway just in time, to avoid crashing into the stopped car. This was a very frightening experience. Although my position in this job was only temporary, I formed a negative opinion about working shift work.

I will share a brief background about my work experience to give some context and attempt to build some rapport before commencing the interview, in order to make the participant feel as comfortable as possible.

## 1.8 Methodology

This qualitative descriptive study utilized individual semi-structured interviews with 12 underground workers to explore how these workers perceived rotating shift work to impact their health and wellbeing.

### **Study Design**

As defined by Neergaard et al. (2009), a qualitative descriptive approach is “a rich, straight description of an experience or an event” (p. 2). This approach can be useful in health studies and allows the researcher to generate a focused summary and understanding of health-related experiences (Willis, Sullivan-Bolyai, Knafel, & Cohen, 2016). The goal of a qualitative descriptive approach is to stay close to the surface of data while capturing all of that experience. The scientific rigor is a reflection of a researcher’s ability to achieve this goal (Sandelowski, 2000). Qualitative descriptive studies may have the ability to influence future research, such as conceptual scale development, or needs assessments (Sullivan-Bolyai et al., 2005).

As with other qualitative approaches, there are some disadvantages outlined in the literature with the use of qualitative description. Neergaard et al. (2009) described qualitative descriptive studies as being one of the least theoretical of the qualitative approaches. Sandelowski (2000) stated that the analytical process in qualitative descriptive studies may be more subjective, as descriptions depend on the researcher’s perceptions, inclinations, sensitivities and sensibilities. Neergaard et al. (2009) also criticized this approach for having a lack of rigour and for being flawed in judging its credibility.

Although this approach has been criticized, this is a good place to start the proposed research as this design is useful for first time qualitative researchers (Creswell, Hanson, Clark Plano, & Morales, 2007). Various strategies will be utilized to increase the validity and

credibility of these issues (Alshenqeeti, 2014; Drisko, 1997; Shenton, 2004), including the outlining of researcher reflexivity and the use of other researchers in the coding process (Creswell, 2013).

## Participants

A total of 12 underground workers participated in this study ( $n = 12$ ). Table 1 summarises the demographic information of the 12 participants involved in this study.

**Table 1: Demographics of interviewed participants**

Participant	Age	Job title	Marital status	Length of time in Mining (years)	Length on current shift rotation (years)	Length of shift (hours)	Current shift rotation
P1	57	Production miner	Married	37	8.5	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P2	27	Development miner	Single	7	7	10.5	Slow rotating: 5-4-5-5 (N-N-N-N-N--4 OFF--D-D-D-D-D--5 OFF)
P3	35	N/A	Single	18	8	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P4	39	Support miner/ Material coordinator	Married	13	6.5	10.5	Slow rotating: 4-5-5-4-6 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D-D)
P5	42	Production miner	Married	18	16	10.5	Slow rotating: 6-5-4-5-5 (A-A-A-A-A--5 OFF--D-D-D-D--5 OFF--A-A-A-A-A)
P6	53	Welder	Married	25	5	10.5	Slow rotating: 5-5-4-5-5-4 (D-D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D--4 OFF)
P7	30	Production miner	Married	11	6.5	10.5	Slow rotating: 4-5-5-4-6 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D-D)
P8	34	Production miner	In relationship	12	2.5	10.5	Slow rotating: 4-5-5-5-5-4 (D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D--4 OFF)
P9	40	Development miner	Married	18	6.5	10.5	Slow rotating: 4-5-5-4-4 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D-D)
P10	37	Development miner	Married	18	8	10.5	Slow rotating: 6-5-4-5-5 (D-D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D)
P11	31	Heavy equipment mechanic	In relationship	10	5.5	10.5	Slow rotating: 4-5-5-3-6 (D-D-D-D--5 OFF--N-N-N-N-N--3 OFF--D-D-D-D-D)
P12	37	Support Miner	Married	11.5	3	10.5	Slow rotating: 6-5-4-5-5-3 (D-D-D-D-D--5 OFF--A-A-A-A--5 OFF--D-D-D-D-D--3 OFF)

*Note.* A- afternoon shift, D- day shift, N- night shift, OFF- day off

Slow rotating- Four to ten shifts in a row of the same time period (Whiting, 2012)

Fast rotating- Up to three shifts in a row of the same time period (Whiting, 2012)

Example of P1's schedule:

P1 works two day shifts, and then gets the following third day-time period off, but has to work that same day for the night shift. P1 then continues to work three consecutive night shifts. P1 then receives four days off from work. P1 then works three consecutive days shifts, then receives the fourth day-time period off, but then works that same day for the night shift, for a total of two consecutive night shifts. P1 receives five days off work. P1 then works two day shifts, receives the third day-time period off, and then works the same day for the night shift, and works a total of two consecutive night shifts. P1 then receives five days off.

## **Sampling**

The concept of purposeful sampling refers to the process of selecting individuals and sites for study as they can purposefully provide in-depth information of relevance to the research question and study purpose, and is often used in qualitative research (Creswell, 2013; Milne & Oberle, 2005). Therefore, purposeful sampling was utilized in this study.

A typical sample size for a qualitative descriptive study may be as few as 3 to 5 persons, and can range up to about 20 participants (Magilvy & Thomas, 2009). Therefore, it is fitting for the study that aimed for a sample size of approximately 12 to 15 participants. This study also utilized snowball/chain sampling, which is defined as identifying cases of interest from people who know people who know what cases are information-rich (Creswell, 2013, p. 158; Robinson, 2014). All selected participants will have to meet the inclusion criteria that follow.

## **Inclusion and Exclusion Criteria**

Candidates for this study had to be English-speaking and of any age who were employed in the underground mining setting in Sudbury, Ontario. These candidates must have worked full-time hours, which is defined by Statistics Canada (2011) as “persons who usually work 30 hours or more per week, at their main or only job”. The participants also had to be working on a rotating shift schedule, which is defined as “shifts rotate or change according to a set schedule” (Canadian Centre for Occupational Health and Safety, 2017). Candidates had to be employed in their current rotating shift schedule for at least one year, as this requirement has been utilized in

other shift work studies related to health and wellbeing (Guo et al., 2015; van Amelsvoort, Schouten, Maan, Swenne, & Kok, 2000; Wong, Smith, Ibrahim, Mustard, & Gignac, 2016).

To gain a full perspective of how rotating shift work is perceived to impact health and wellbeing, part-time, casual, on-call or those on a fixed day, fixed afternoon, or a fixed night schedule, were excluded from this study. To reduce the probability of themes emerging throughout the interviews on an entirely different phenomenon, such as experiences of living with chronic illness, this study excluded individuals who were on leave of absence from work (Dekkers-Sánchez, Wind, Sluiter, & Frings-Dresen, 2010).

### **Recruitment**

Some participants in this study were recruited through the United Steelworkers (USW) Local 6500 Union in Sudbury, Ontario, with the special assistance of a Workplace Safety and Insurance Board work representative. The representative organized an oral presentation of this research study to be given to a group of supervisors from a local mining company, with the goal of these supervisors informing their workers about this study. In addition, a recruitment poster was created and uploaded to multiple social media platforms including Facebook, Twitter and LinkedIn. Interested candidates were able to contact the primary investigator directly by telephone or email.

Approximately 25 candidates were interested in participating in this research study. Unfortunately, many of these individuals were unable to participate as they did not meet the inclusion criteria. For instance, some individuals were employed in the fly-in fly-out mining industry. Other interested individuals who did not qualify for the study were either employed on permanent or fixed shifts, rather than rotating, or these individuals did not work full-time in an

underground setting. Lastly, some interested candidates were not employed in their current position for at least one year.

### **Ethics Approval**

Ethics approval for this study was obtained from the Laurentian University Research Ethics Board (Appendix A).

### **Interviews**

This study utilized semi-structured interviews with nine open-ended questions (Appendix B), followed by demographic questions (Appendix B). The interviews took place at a location most convenient for the participant, with options including local libraries, the participant's home, as well as a local mining union hall. Each participant received a \$20 gift card at the start of the interviews, as well as a personal thank you card. An incentive was provided to increase the likelihood of participation by adding additional motivation (Robinson, 2014), and to show participants appreciation of their personal time.

Before commencing all interviews, the primary investigator provided a thorough explanation of the study and reminded participants that the study was strictly voluntary and that they could withdraw at any time. All participants provided verbal, as well as signed consent before participating in this study.

Interviews can be considered an intrusion into a participant's private life with regard to time allotted and level of sensitivity of questions (Cohen, Manion, & Morrison, 2007) and therefore, it is important as a researcher to make ethical considerations prior to conducting a study. The participants in this study may discuss personal health matters and there was the potential for participants to become emotional, as well as disclose any mental health issues.

Therefore, resources for local mental health agencies were available on the study information sheet, which were provided to the participants (Appendix C).

## 1.9 Conclusion

In Canada, there is research that has studied the impact of shift work on the health and wellbeing of workers, however these studies are mostly quantitative. This qualitative descriptive study aimed to understand the impact of rotating shift work on perceived health and wellbeing in some underground workers in Sudbury, Ontario. A sample of full-time, underground workers ( $n = 12$ ) underwent individual, semistructured interviews. Interviews were digitally-recorded, transcribed verbatim and analyzed using Braun and Clarke's 2006 version of thematic analysis. Participants perceived both advantages and disadvantages of working rotating shift work on their health and wellbeing. The following two chapters will discuss the findings of this study in more detail. The final chapter of this study will discuss study findings in relation to other shift work studies, as well as health research conducted in the mining industry.

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## Chapter 2:

### **Perceived Impact of Rotating Shift Work on Health and Wellbeing among Underground Workers in Sudbury, Ontario**

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## Abstract

**Background:** Several studies have been published in the areas of shift work and mining, but limited qualitative research has been conducted about the influence of rotating shift work in mining on perceived health outcomes in Canada.

**Objective:** The aim of this study was to understand the impact of rotating shift work on perceived health and wellbeing in some underground workers.

**Methods:** A qualitative descriptive study design, based on 12 semi-structured interviews was conducted. Interviews were digitally-recorded, transcribed verbatim, and data were analyzed thematically.

**Results:** Five themes emerged from the data: 1) strong preference for the night shift, 2) challenges associated with impact on personal wellbeing, 3) advantages and disadvantages on work environment wellbeing, 4) benefits and challenges of wellbeing external to work, and 5) strategies for coping with shift work.

**Conclusions:** There were both perceived advantages and disadvantages of working on a rotating shift schedule in an underground setting. Rotating shift work is perceived to have an effect on the health and wellbeing of underground workers. Further research is needed to improve the health and wellbeing of underground workers in the mining industry.

**Keywords:** occupational health, qualitative, minerals industry, rotating shift work

## Background

### Shift Work and Health

Research examining health outcomes associated with shift work is not a new area of interest (Cunningham, 1989; Monk, 1988; Palenciano, Gonzalez, Santullano, Rodriguez, & Montoliu, 1996; Simon, 1990). A variety of quantitative study designs have been utilized to examine the effects of shift work (De Bacquer et al., 2009; Grundy et al., 2013; Paim et al., 2008; Thun et al., 2014). An examination of previous studies reveals a strong association between shift work and adverse health conditions, including metabolic syndrome, gastrointestinal issues, mental health issues, some cancers, and sleep issues (Costa, 2010; Kecklund & Axelsson, 2016; Wang, Armstrong, Cairns, Key, & Travis, 2011).

Several studies have investigated the association between shift work and metabolic outcomes (De Bacquer et al., 2009; Gan et al., 2015; Karlsson, Knutsson, Lindahl, & Alfredsson, 2003). Karlsson and colleagues found that shift workers were twice as likely to have lower HDL-cholesterol (OR: 2.02, 95% CI: 1.24-3.28) and higher levels of triglycerides in comparison to daytime only workers (OR: 1.43, 95% CI: 1.13-1.82) (2003). De Bacquer et al. (2009) conducted a longitudinal prospective study and found that shift workers had increased rates of high blood pressure [1.31 (1.04 – 1.66)] , triglycerides [1.53 (1.22 – 1.92)] and glucose levels [1.56 (1.18 – 2.05)], low HDL-cholesterol [1.42 (1.02 – 1.99)] and elevated abdominal obesity [1.12 (0.88 – 1.42)] in comparison to daytime only workers.

Gastrointestinal issues are commonly reported among shift workers (Caruso, Lusk, & Gillespie, 2004; Costa, 2010; Kim et al., 2013; Knutsson & Boggild, 2010). Compared to workers employed on a permanent day shift, shift workers tend to report more gastrointestinal

symptoms, such as abdominal pain, gas, diarrhea, constipation, nausea, vomiting, change in appetite, indigestion, and heart burn.

Employees on a shift work schedule may be at risk for mental health issues and various studies have displayed varied mental health outcomes among shift workers (Ljoså et al., 2011; Thun et al., 2014). A longitudinal study using ( $n = 633$ ) nurses found that night work and rotating shift work was associated with slightly decreased mean depression scores [ $-0.91$  ( $p < 0.001$ )] and no significant change in mean anxiety scores [ $-1.16$  ( $p < 0.01$ )] over the two-year period (Thun et al., 2014). Another cross-sectional study, conducted in a Norwegian offshore petroleum plant, revealed that quantitative demands ( $p < 0.001$ ), support ( $p < 0.001$ ), and shift work-home interference ( $p < 0.001$ ) were independently associated with mental distress and these factors contributed to a large majority of the total explained variance (Ljoså et al., 2011). Shift schedules were only univariately associated with mental distress ( $\beta = 0.01$ , 95% CI  $-0.09$ - $0.11$ ). Although this study had a large sample ( $n = 1336$ ), the response rate was reported as low (56% response rate). This low response rate could be attributed to access to a web-based survey only. Researchers could have provided subjects with alternate means of survey completion (i.e., paper-based survey), as this may have increased the response rate (Greenlaw & Brown-Welty, 2009).

Evidence has been displayed in some case-control studies, which detected a strong association between long-term shift work and certain types of cancer (Grundy et al., 2013; Papantoniou et al., 2015; Parent, El-Zein, Rousseau, Pintos, & Siemiatycki, 2012). For example, Parent and colleagues found an association between long-term night shift work (beyond 10 years duration) and cancers of the prostate (OR: 2.68, 95% CI: 1.45, 4.95), colon (OR: 2.11, 95% CI: 1.13, 3.94), bladder (OR: 1.98, 95% CI: 1.05, 3.76), pancreas (OR: 2.43, 95% CI: 0.91, 6.47) and

non-Hodgkin's lymphoma (OR: 2.32, 95% CI: 1.03, 5.23) (2012). Evidence was weaker (beyond 10 years duration) among other cancer types, including lung (OR: 1.67, 95% CI: 0.90, 3.09), rectum (OR: 1.67, 95% CI: 0.77, 3.61), stomach (OR: 1.45, 95% CI: 0.64, 3.26), kidney (OR: 1.05, 95% CI: 0.39, 2.80) and esophagus (OR: 1.71, 95% CI: 0.59, 4.93). Although this study included a large sample ( $n = 3670$ ) of men employed across multiple professions, a limitation was that the questionnaire did not collect data on shift type (i.e., fixed, rotating) or other aspects of night work (i.e., direction and rate of shift rotation).

One of the most significant and immediate consequences of the sleep/wake cycle is sleep disturbance and/or daytime sleepiness (Baron & Reid, 2014). For example, Paim and colleagues (2008) found that 113 (35%) of shift workers in their cross-sectional study fit the criteria for insomnia, excessive sleepiness, snoring, sleep apnea, and limb movement. Hossain and colleagues (2003) conducted a cross-sectional study and reported findings of the presence of sleep disorders in highly fatigued shift workers utilizing various polysomnographic testing. Although the findings were significant between the most- and least-fatigued groups ( $p < 0.0001$ ), a limitation to the study was the small sample size ( $n = 44$ ).

This short review offers some evidence of the relationship between shift work and some adverse health outcomes. Further longitudinal cohort studies should be conducted with shift workers to calculate the rate at which new disease or conditions occur, as well as identify any other possible risk factors for disease (Hossain et al., 2003; Jacobsen, 2017; Oldfield & Mostert, 2007).

### **Mining and Health**

The underground mining and minerals industry can be a dangerous place of work. For example, during the "2009-2013 period, injury fatality rates for the mining sector were third in

Ontario with a rate of 10.4 fatalities per 100,000 workers” (Berriault, Lightfoot, Seilkop, & Conard, 2017, p. 220). Mine and refinery workers undertake complex work processes, which may expose them to several risks and hazards such as explosions, poisonous gas leaks, mine collapses, flooding, excessive noise, heat stress, poor visibility, dusty conditions and mechanical malfunctions (Amponsah-Tawiah, Leka, Jain, Hollis, & Cox, 2014; Berriault et al., 2017; Del Bianco & Demers, 2013; Kramer et al., 2017; Kurnia, Sasmito, & Mujumdar, 2014). In addition, underground workers are also at risk for various types of cancers (Del Bianco & Demers, 2013; Lightfoot, Berriault, Seilkop, & Conard, 2017). The following studies have been conducted in the mining and minerals industry on the health outcomes of these workers.

In Canada, some researchers have investigated the health outcomes related to shift work in the underground mine setting (Hossain et al., 2004, 2003; Legault, Clement, Kenny, Hardcastle, & Keller, 2017). A prospective cohort study reported that underground workers who recently changed from 8-hour shifts to 10-hour shifts displayed a significant decline in sleep quantity, as well as achieving less refreshing sleep and greater performance impairment on the job (Hossain et al., 2004). Legault and colleagues (2017) conducted a cross-sectional study among underground miners ( $n= 19$ ) on a rotating shift schedule in Sudbury, Ontario. Participants in this study were observed to experience significantly reduced sleep efficiency when compared to age-matched norms [30-39 year olds:  $z = -14.62$ ,  $p < 0.001$ ; 40 – 49 year olds:  $z = - 4.44$ ,  $p < 0.001$ ] as well as reduced total sleep time [30 – 39 year olds:  $z = -7.64$ ,  $p < 0.001$ ; 40 – 49 year olds:  $z = -3.19$ ,  $p < 0.001$ ]. However, the results should be interpreted with caution because of the small sample size (Legault, Clement, Kenny, Hardcastle, & Keller, 2017).

In Australia, the fly-in fly-out (FIFO) and drive-in drive-out (DIDO) mining industry has been investigated in a few studies (McClean, 2012; Perring, Pham, Snow, & Buys, 2014;

Torkington, Larkins, & Gupta, 2011). The FIFO/DIDO industry has been associated with high productivity demands and working in remote locations, and often living away from families and access to support services (McClean, 2012). This working arrangement has also been linked to social isolation, stress, and poor help-seeking behaviours (Carter, 2008; Lovell & Critchley, 2010). Although most of these studies explored how the FIFO and DIDO lifestyle may impact the health of workers (Carter, 2008; McClean, 2012; Perring et al., 2014; Torkington et al., 2011), the researchers also utilized qualitative approaches with small sample sizes, therefore potentially limiting the transferability of the findings.

The wellbeing and work-life balance of shift workers in the mining industry has also been examined (Amponsah-Tawiah et al., 2014; McPhedran & De Leo, 2014; Oldfield & Mostert, 2007; Omid, Zare, Rad, Meshkani, & Kalantary, 2017). One cross-sectional study conducted in the South African mining industry, found that high job demands and lack of job resources were associated with exhaustion, somatic complaints, anxiety and insomnia, which in turn was associated with negative interaction between work and home life (Oldfield & Mostert, 2007). A strength of this study was the use of multiple mining sites as well as relatively large sample ( $n = 320$ ). Nonetheless, a limitation of the study was the use of a researcher developed questionnaire, with only the use of some modified questions from other validated surveys (Banks et al., 1980; Maslach, Jackson, & Leiter, 1997).

### **Addressing the Gap in Research**

This brief review offers some evidence of the health-related literature that exists about shift work in various industries, with concentration in the mining industry. This review outlines various studies that have found an association between shift work and adverse health conditions such as metabolic syndrome, gastrointestinal issues, certain cancers, mental health issues, and

sleeping problems. In addition to shift work, much literature has been published on health effects of workers employed in the mining industry. However, there still appears to be gaps within the literature. For example, in Canada there is limited research about the association between rotating shift work in the mining industry and effects on health and wellbeing of workers, especially utilizing a qualitative approach. The aim of this study was to explore if, and how, some underground workers perceive their current rotating shift schedule to impact their health and wellbeing.

## Theoretical Framework

To inform this study, the “Effort-Reward Imbalance (ERI) Model” was utilized (Siegrist, 2016). The ERI Model proposes that insufficient reciprocity between efforts and rewards may elicit recurrent negative emotions and sustained stress responses, which may lead to subsequent adverse health outcomes, particularly coronary heart disease and associated risk factors (Preckel, Meinel, Kudielka, Haug, & Fischer, 2007; Siegrist, 1996). The recurrent activation of the stress response in the human body may lead to the development of stress-related mental and physical disorders (Preckel et al., 2007; Siegrist, 2008).

Social reciprocity lies at the core of the employment contract, which outlines the specific tasks that must be performed in exchange with adequate rewards (Siegrist, 2008). Such rewards include money, esteem, and career opportunities, including job security. As previously stated, a failed reciprocity occurs when there is a “high cost and low gain” experienced by a worker, which may lead to strong negative emotions as well as long-term health effects. Using this model, a failed reciprocity may occur if a worker experiences one or more of the following conditions: “dependency”, “strategic choice” and “overcommitment” (Siegrist, 2016).

Dependency is defined as “situations where workers have no alternative choice in the labour

market” (Siegrist, 2016, p. 82). Dependency is becoming more and more frequent in the modern workforce where there is a higher exposure to job instability, rapid technological changes, as well as growing competition. Strategic choice occurs when a person accepts the experience of “high-cost/low gain” in their employment for a certain time period, as they believe it could lead to a potential job promotion in the future. Lastly, overcommitment occurs either consciously, or subconsciously, when an individual strives toward continuously high achievement because of their need for approval and self-esteem at work. In this case, individuals may experience a perceptual distortion, where they inaccurately assess their “cost-gain” situation, where the individual may underestimate their demands and overestimate their own coping resources, while being unaware of their own contribution to this failed reciprocity (Siegrist, 2008).

## Methods

### **Ethical Approval**

Ethics approval for this study was obtained from the Laurentian University Research Ethics Board.

### **Research Design and Procedure**

This study utilized a qualitative descriptive approach, which has been described as “a rich, straight description of an experience or an event” (Neergaard, Olesen, Andersen, & Sondergaard, 2009, p. 2). This design was appropriate for this study as it allows the researcher to generate a focused summary and understanding of health-related experiences (Willis, Sullivan-Bolyai, Knafl, & Cohen, 2016). Qualitative descriptive studies may have potential to influence future research, for example, conceptual scale development, or needs assessments (Sullivan-Bolyai, Bova, & Harper, 2005).

Whereas quantitative researchers strive for randomly selected representative samples, qualitative researchers often use purposeful sampling (Mason, 2002; Milne & Oberle, 2005). This concept refers to the process of selecting individuals and sites for study as they can purposefully provide in-depth information of relevance to the research question and study purpose (Creswell, 2013; Milne & Oberle, 2005). Therefore, purposeful sampling, as well as snowball/chain sampling (i.e., participants would tell coworkers about the research study), was used in this study (Robinson, 2014).

Some participants in this study were recruited through a local mining steelworkers union in Sudbury, Ontario. Special assistance was provided from a Workplace Safety Insurance Board Work representative, who organized a presentation of the current study to a group of supervisors from a local mining company, with the goal of these supervisors informing their workers about the study. In addition, a recruitment poster was uploaded to multiple social media platforms including Facebook, Twitter and LinkedIn. Interested candidates were able to contact the researcher directly by telephone or email.

Approximately 25 candidates were interested in participating in this study. However, many of these individuals were unable to participate as they did not meet the inclusion criteria (Appendix D). For example, some individuals interested in participating were employed in the fly-in fly-out mining industry. Other interested candidates who did not qualify for the study were either employed on permanent or fixed shifts, rather than rotating, or these individuals did not work full-time in an underground setting.

A total of 12 participants were interviewed in this study ( $n= 12$ ). The inclusion and exclusion criteria can be found in Appendix D. Table 2 displays participant demographics.

**Table 2: Participant demographics**

Participant	Age	Job title	Marital status	Length of time in Mining (years)	Length on current shift rotation (years)	Length of shift (hours)	Current shift rotation
P1	57	Production miner	Married	37	8.5	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P2	27	Development miner	Single	7	7	10.5	Slow rotating: 5-4-5-5 (N-N-N-N-N--4 OFF--D-D-D-D-D--5 OFF)
P3	35	N/A	Single	18	8	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P4	39	Support miner/ Material coordinator	Married	13	6.5	10.5	Slow rotating: 4-5-5-4-6 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D-D)
P5	42	Production miner	Married	18	16	10.5	Slow rotating: 6-5-4-5-5 (A-A-A-A-A--5 OFF--D-D-D-D--5 OFF--A-A-A-A-A)
P6	53	Welder	Married	25	5	10.5	Slow rotating: 5-5-4-5-5-4 (D-D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D--4 OFF)
P7	30	Production miner	Married	11	6.5	10.5	Slow rotating: 4-5-5-4-6 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D-D)
P8	34	Production miner	In relationship	12	2.5	10.5	Slow rotating: 4-5-5-5-5-4 (D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D--4 OFF)
P9	40	Development miner	Married	18	6.5	10.5	Slow rotating: 4-5-5-4-4 (D-D-D-D--5 OFF--N-N-N-N-N--4 OFF--D-D-D-D)
P10	37	Development miner	Married	18	8	10.5	Slow rotating: 6-5-4-5-5 (D-D-D-D-D--5 OFF--N-N-N-N-N--5 OFF--D-D-D-D-D)
P11	31	Heavy equipment mechanic	In relationship	10	5.5	10.5	Slow rotating: 4-5-5-3-6 (D-D-D-D--5 OFF--N-N-N-N-N--3 OFF--D-D-D-D-D)
P12	37	Support Miner	Married	11.5	3	10.5	Slow rotating: 6-5-4-5-5-3 (D-D-D-D-D--5 OFF--A-A-A-A--5 OFF--D-D-D-D-D--3 OFF)

*Note.* A- afternoon shift, D- day shift, N- night shift, OFF- day off

Slow rotating- Four to ten shifts in a row of the same time period (Whiting, 2012)

Fast rotating- Up to three shifts in a row of the same time period (Whiting, 2012)

Example of P1's schedule:

P1 works two day shifts, and then gets the following third day-time period off, but has to work that same day for the night shift. P1 then continues to work three consecutive night shifts. P1 then receives four days off from work. P1 then works three consecutive days shifts, then receives the fourth day-time period off, but then works that same day for the night shift, for a total of two consecutive night shifts. P1 receives five days off work. P1 then works two day shifts, receives the third day-time period off, and then works the same day for the night shift, and works a total of two consecutive night shifts. P1 then receives five days off.

## **Data Collection**

The study utilized individual, semi-structured interviews with nine open-ended questions (Appendix B), followed by a demographic questionnaire. The interviews took place at the participant's location of choice, with options including local libraries, the participant's home, as well as a local mining union hall. Each participant received an incentive of a 20 dollar gift card.

Prior to the interview commencing, the researcher provided a thorough explanation of the study and reminded participants that the study was strictly voluntary and that they could withdraw at any time. All participants provided verbal and signed consent before participating in the study.

## **Data Analysis**

Each interview was digitally-recorded and then transcribed verbatim by the researcher. Thematic analysis was utilized to identify, analyze, and report patterns and/or themes within the data (Braun & Clarke, 2006). More specifically, an inductive and semantic approach was utilized. An inductive approach in data coding and analysis involves a "bottom-up" approach that is driven by what is in the data (Braun & Clarke, 2012). This approach allows themes identified in the data to vary in relation to the specific interview questions asked to the participants (Braun & Clarke, 2006). A semantic approach was also utilized in data coding and analysis (Braun & Clarke, 2006). This approach involves identifying themes from the data within explicit or surface meanings, rather than examine beyond what a participant says or what has been transcribed. Analysis was done by hand and was considered complete when saturation became clear across all interviews (Willis et al., 2016). Saturation refers to when a qualitative sample may be considered adequate when data inform existing findings, however do not add any new information (Mason, 2002; Milne & Oberle, 2005).

Braun and Clarke's (2006) version of thematic analysis involved a six-phase process. The first phase involved familiarization of the data and included immersing oneself into the textual data by reading and rereading. The second phase involved generating initial codes, which helped identify and provide a label that may be relevant to the research question. In the third phase, analysis began to shift from codes to the development of themes, which are described as "capturing something important about the data in relation to the research questions and represents some level of patterned response" (Braun & Clarke, 2006, p. 82). The fourth phase involved the process whereby developing themes are reviewed in relation to the coded data and entire data set. The fifth phase involved clearly defining and naming themes, while ensuring they had a singular focus and directly addressed the research question. Lastly, the sixth phase involved the production of the research report, to provide a compelling story based on the analysis.

## Findings

The 12 interviews included in this study lasted between 30 and 60 minutes and averaged 43 minutes. The participants were between the ages of 27 to 57 years and comprised 11 men and 1 woman. Nine participants were employed by the same mining company in Sudbury, Ontario, and of those participants, seven worked at the same mine site. The remaining three participants worked for another mining company.

After analyses, five themes emerged from the data: 1) strong preference for the night shift, 2) challenges associated with impact on personal wellbeing, 3) advantages and disadvantages on work environment wellbeing, 4) benefits and challenges of wellbeing external to work, and 5) strategies for coping with shift work.

### **Theme One: Strong preference for the night shift**

Many of the participants expressed a strong preference for working the night shift. Some participants revealed they were more of a “*night owl*” by nature and they felt more comfortable working at night. One participant (P3) said:

*“I think it’s just because I’m a night person... I find it easy, I stay more on a night schedule on my days off, so then all of a sudden when I have to switch back to day shift, I have a hard time with that”.*

Alternatively, other participants, all of whom had children living at home, felt as though it was impossible to get to sleep at a decent hour. For example, one participant (P9) shared:

*“Well night shift usually I’m sleeping. The kids are in school, everybody is gone so it’s like I catch up on my sleep. I come home, go to bed around 6:30 (am) and then I wake up around 2:00 - 2:30 (pm), so I get like a full sleep, as in if I’m day shift...I don’t always fall asleep right away, I don’t get as much sleep”.*

One of the participants had preference for the night shift as he preferred the work environment at night because there are less people, including management, on site which results in more of a relaxed and productive atmosphere. The participant (P10) shared:

*“Well I, I prefer, this is funny, I prefer day shift obviously, like for sleep schedule and stuff. But, day shift’s busy at the mine. So, when you’re on night shift especially even on the weekend, there’s nobody around.”*

## **Theme Two: Challenges associated with impact on personal wellbeing**

Participants were presented with issues they perceived would impact their personal wellbeing. A couple of the participants were frustrated about the inability to attend weekly courses, sporting events or other activities because they would conflict with their shift schedule. Three participants were “fed up” with working night shift mostly because it was having a

negative impact on their sleep quality, including two participants who were ready to leave shift work altogether because their sleep had been extremely impacted. Other participants revealed they felt shift work may have an impact on mental wellbeing. One participant (P8) revealed: “...*I got sleep apnea, I been through depression, anxiety. I been divorced. Not saying it’s all of shift work, but probably some of it. Absolutely.*” Some participants were unsure whether their mental health issues were caused by shift work, or from working in an underground setting, especially during the winter months. One participant (P7) stated: “*I notice I get a little more sad or a little more moody. My wife tells me when I’m night shift, I’m always grumpy.*”

Lastly, some of the participants shared their experiences of being extremely fatigued from lack of sleep, especially driving home after a night shift. One participant (P12) shared:

*“I mean I fell asleep and woke up, and I’m broad side in the road [truck was sideways on the road] and I’m like “Holy geez!” ... that was my last straw...I made an appointment for the doctor to get me a doctor’s note ‘cause I was like, “I’m, I’m gonna die”. And/or if I survive I might kill somebody else”.*

When working at a previous mine site, another participant could barely remember his commute home from work some mornings. He could not recall driving home and was worried something bad had happened without him being aware.

### **Theme Three: Advantages and disadvantages on work environment wellbeing**

Some participants expressed they worked in positive work environments mostly because of the strong relationships with their coworkers. They all felt this improved the morale at work. One participant (P2) referred to his relationships with his coworkers as a “*brotherhood*”.

Another participant (P12) stated:

*“Yeah, it’d be the guys, just uh the whole camaraderie. Everybody under there knows the dangers and you’re your brother’s keeper, you know it, you know at the end of the day, what we, the dangers there are associated with it.”*

Some participants worked for a company that provided a workplace wellness program.

One participant (P3) shared:

*“They brought in the \_\_\_\_\_ (workplace wellness program) to help us too, to give us some coping mechanisms and some strategies there and you know, things to help with our health and wellness that way too, so.”*

Although most of the workers liked their job, some participants felt that the physical work environment has been detrimental to their health. One participant (P5) shared: *“It’s dirty and its uh, there’s, you know, carcinogens in the air and stuff like that”*. Other participants expressed that they felt as though they were *“just a number”* to the company. For example, one worker (P1) expressed: *“I’m just a number there. And if you don’t get a group of people or a major catastrophe, where somebody or a couple people gets hurt, they don’t really care.”*

#### **Theme Four: Benefits and challenges of wellbeing external to work**

Some participants viewed their rotating schedule as having a positive impact on their relationship with their spouse. One participant (P9) felt the rotating schedule helps relieve his wife of family duties. He stated: *“I think it makes it better for all the obvious- like taking the kids to doctor’s appointments and stuff, takes a lot of pressure off my wife having to take time off”*.

Alternatively, other participants revealed that shift work had a negative impact on their relationship with their partner. One participant (P6) shared: *“When I’m night shift, I don’t see her”*. Another participant and his partner both work shift work and he revealed that they

occasionally get in to arguments because they are both exhausted and irritable after working the night shift.

Another benefit outlined by a few participants included saving money on daycare for their children. One participant (P9) shared: *“Yeah instead of paying whatever daycare was- a \$1000 bucks a month, well because I’m shift work, I’m only paying half of that right, because when I was off, the kids were home with me.”*

Rotating shift work had both positive and negative effects on the participants’ social lives. A few participants would spend time outside of work with coworkers on the same shift schedule as them. One participant (P1) shared: *“We snowmobile together, we go for bike rides, a motorcycle ride so, you get uh, hang around with the people on your shift on the same schedule you’re working”*. However, other participants revealed that they had friends that worked on different schedules than them, and one participant (P5) said: *“They’re still my friends, but because of different shift schedules, you can’t really hang out with them because it’s conflicting schedules”*

### **Theme Five: Strategies for coping with shift work**

Several participants shared a similar coping mechanism of “acceptance of the shift work lifestyle”. One participant (P4) stated: *“Like to me, it’s pretty straight forward, either you like it (shift work), or you don’t. You get into this game knowing what you’re getting into.”*. Another worker (P1), who has been mining for thirty-seven years, said: *“If you want to go mining, you gotta be willing to be going on shift”*.

Some of the participants adjusted their lifestyle behaviours to cope with shift work. A few participants found that exercise helped relieve stress and cope with shift work. One participant (P4) said: *“Uh, basically leading a healthy lifestyle. If you get frustrated at work,*

*going to the gym...working out your frustrations.*” Some participants chose to take vitamins, including Vitamin D, and spend more time outdoors. One participant stated: *“I started taking more vitamins. I find that helped... spend more time outside when you are off”*. A couple participants limited alcohol use during their shift runs as it would impact their sleep quality.

Napping was a common coping mechanism used by several participants. Some participants would nap at the workplace, and one participant (P6) shared:

*“So, you’ll eat, you’ll have idle conversation and then everybody kind of just close their eyes for 15-20 minutes. We don’t, we don’t stretch out, take our shoes off and that, we just kind of lean back, close our eyes and take a power nap”*.

Prioritizing sleep was another common coping strategy for dealing with shift work. Most of the participants shared that they would prioritize sleep before engaging in other commitments. One participant (P5) said:

*“I won’t make an appointment with anybody ‘til like, let’s say I gotta go to work at 3 (pm), I might make an appointment for 1:30 (pm)... sleep is first and everything else is secondary. ‘Cause well, I don’t want to retire and then drop dead a week later, right, you know?”*

## Discussion

The aim of this study was to report on the experiences of underground workers and their perceptions of rotating shift work on their health and wellbeing. After conducting thematic analysis, five themes emerged from the data: 1) strong preference for night shift, 2) challenges associated with impact on personal wellbeing, 3) advantages and disadvantages of work environment wellbeing, 4) benefits and challenges of wellbeing external to work, and 5) strategies for coping with shift work.

The “Effort-Reward Imbalance (ERI) Model” (Siegrist, 2016), which has been previously outlined, has informed the theoretical framework of this study. Participants in this study shared both positive and negative experiences of how shift work impacts their lives. Shift work can be considered an “extrinsic demand” and could be classified as the “effort” one puts into their work (Siegrist, 1996). The “demands” of working shift work are most prominent in the themes ‘challenges associated with impact on personal wellbeing’, ‘advantages and disadvantages on work environment wellbeing’ and ‘benefits and challenges of wellbeing external to work’. Although it is difficult to test this specific model, it could be speculated that if workers feel they are putting in high effort, such as working shift work, and receiving low reward, such as negative experiences of management, the ERI model suggested that this could lead to feelings of anger and demoralization, which could lead to negative health consequences in the long-term (Siegrist, 2008; Willis, O’Connor, & Smith, 2008).

Another aspect of the ERI model is ‘overcommitment’, which is considered as “intrinsic effort”, and refers to the ways in which the individual perceives or copes with their situation (Willis et al., 2008). This aspect of the model could be related to the theme, ‘strategies for coping with shift work’. In the case of overcommitment, an individual may experience a perceptual distortion, where they fail to see the imbalance between effort and reward, and therefore underestimate their demands, and overestimate their own coping resources, which could lead to adverse health outcomes (Siegrist, 2008).

### ***Strong preference for night shift***

It was evident in this study that most participants had a strong preference to working the night shift or later afternoon shift. For example, some participants expressed they felt like a “night owl” by nature, and consequently felt more comfortable working at night time. In these

instances, participants could be referring to their own personal chronotype (Papantoniou et al., 2015). Juda and colleagues (2013) concluded that participants with a “late” chronotype had worse sleep on morning-shift days in comparison to “earlier” chronotypes. Researchers also found that when on night shift, sleep was worse for “early” chronotypes in comparison to “later” chronotypes. It could be speculated that many of the participants in the current study might have “later” chronotypes. They expressed how they had better sleep quality during the day time, after a night shift, as well as experiences of poorer quality and shorter sleep durations at night time, before a day shift. Whether an individual has a late or early chronotype, a circadian misalignment may occur because the individual’s preferences for sleep and activity are at odds with the typical work week, or in this case, a rotating shift schedule (Baron & Reid, 2014).

### ***Challenges of impact on personal wellbeing***

Some participants in this study expressed how the rotating schedule had a negative impact on their sleep, especially when working on night shift. Consequently, some of the participants shared that they were leaving or planning to leave their current rotating schedule as they felt they could no longer cope with the sleep difficulties, which has been evident in other studies (Folkard & Tucker, 2003; Paim et al., 2008).

Other participants revealed that shift work may have an impact on their mental health. A combination of working shift work as well as lack of sunshine could lead to a negative impact on mental health (Bahn, 2013; Kelly, Considine, & Skehan, 2013). Mclean et al. (2012) conducted a qualitative descriptive study in Australia that displayed similar findings to this current study, including adverse effects of shift work and burn out. Although limited research has been published to date in Canada, there are current studies ongoing, such as the Mining Mental Health Study taking place in Sudbury, Ontario (Schwabe, 2019; Dillman, 2019).

Lastly, participants spoke about the dangers associated with working shift work, which included experiences commuting home after a night shift. These types of instances are not uncommon in jobs that involve shift work, especially night shift. A cohort study was conducted by Statistics Canada with the aim of examining trends in shift work and worker injury in order to compare the risk of injury by shift type (Wong, McLeod, & Demers, 2011). From 1996 to 2006, the number of worker injuries decreased from 415,000 to 356,000, a 27.9% decline. However, the rate of injury among night shift workers remained stable. Both women and men working night shift schedules have almost twice the risk of workplace injury compared to those working steady day-shift schedules. Therefore, the risk of injury occurring in the workplace is much higher while employees are working the night shift in comparison to those employed on a steady day-shift (Wong et al., 2011).

#### ***Advantages and disadvantages of work environment wellbeing***

This theme highlights the perceived experiences about the working environment and how it may affect one's health, wellbeing, and safety. A commonality found between some of the participants was that they felt they were part of a "brotherhood" and felt a strong camaraderie at work, which has also been reported in other qualitative studies conducted in the mining and industrial settings (Mclean, 2012; Root & Wooten, 2008).

Negative experiences of an unhealthy work environment and apathetic management also emerged from the data. It is clear in the literature that working in the underground mining industry exposes workers to highly hazardous work environments, such as mine gases, mine fires, excessive noise, heat stress, among others (Del Bianco & Demers, 2013; Kramer et al., 2017; Kurnia et al., 2014). In a mixed-method study conducted in the Ghanaian mining industry, findings concluded that poor general underground mine conditions, such as gases, fires, and

inadequate ventilation had a negative effect on the experience of wellbeing of the employees (Amponsah-Tawiah et al., 2014). These findings also indicated that as employees experienced higher demands and less control over their work, their general health and wellbeing worsened. Although the current study's qualitative design does not indicate the level of health of participants, the shared negative experiences could be related to having low control at work and could potentially lead to a lower perceived level of health (Karasek, 1979).

### ***Benefits and challenges of wellbeing external to work***

Participants shared personal narratives about shift work impacting their lives outside of work, specifically surrounding their home-life and social wellbeing. Some participants expressed how their schedule allowed them to care for their children on days off, which consequently reduced childcare costs and provided the availability to bring children to appointments during week days (Marshall, 1998; Williams, 2008). Contradictory to these findings, Root and Wooten (2008) found that fathers worried about missing extracurricular activities with their children and important developmental milestones in their children's lives because of their shift work schedule. However, based on the findings in this study, it can be interpreted that shift work impacts individuals differently. Although some participants expressed strong opinions about shift work negatively impacting their life, others were barely phased by their work schedule. McPhedran and colleagues (2014) discovered similar findings where workers in the mining industry did not seem to suffer from poor work-life balance any more than those employed outside of the industry.

Strained relationships with spouse and missing out on significant events with family and friends was also highlighted in this study. In a similar qualitative descriptive study, Gardner and colleagues (2018) aimed to investigate how the fly-in fly-out (FIFO) lifestyle impacted the

mental health of the workers and their partners. The FIFO lifestyle differs from workers commuting to work daily. However, some comparisons could be made as participants in the current study revealed that it was common for them to not see their spouse or children for many days, mostly while working the night shift.

### ***Strategies for coping with shift work***

The effects of shift work are individual in nature, and each individual chooses coping strategies that work best for them (Fullick et al., 2009). A common coping mechanism that emerged was the participant expressing acceptance of their shift work lifestyle. Individuals who continue to work shift work tend to become accustomed to adapting their lifestyles (Fullick et al., 2009). Shift workers tend to accept the various forms of disruption and desynchronization associated with shift work. This may be evident in the current study as many of the shift workers, who have accepted their lifestyle, have over ten years of experience in the mining industry. However, it is common for individuals who are unable to tolerate or cope with shift work to eventually leave the industry.

Many participants highlighted the importance of prioritizing sleep as well as the use of naps at specific times. Napping has been considered helpful for shift workers as it can aid in improving alertness and alleviate fatigue (Costa, 2003a). Ensuring good sleep hygiene is an important factor to counteract stress and improve tolerance to shift work. Lawson and Arber (2014) reported similar findings in a qualitative study among nurses working on rotating shifts, in which nurses ensured to prioritize sleep and give best efforts to get adequate sleep, especially before the first night shift.

## Strengths and Limitations

To strengthen the credibility of this study, the first interview was coded by the researcher and then by the thesis supervisor to ensure consensus among the themes emerging from the data (Creswell, 2013). To ensure dependability, this study was reported in detail, thereby informing any future researcher that wishes to use the same design (Shenton, 2004). This included detailed sections of the research design and implementation; detail of the data collection and reflective evaluation of the project in the thesis report. Lastly, to ensure confirmability, the researcher engaged in reflexive practice prior to the study commencing (Shenton, 2004).

Utilizing interviews, instead of a standard survey or questionnaire, allowed the researcher to explore narrative data that allows for further investigation into people's views in greater depth (Alshenqeti, 2014; Kvale, 2003). This study appears to be a unique study that will be added to the Canadian occupational health and mining literature.

With every research study, limitations can be found. The small sample size, qualitative methodology and participants that were recruited from one setting limits the transferability of the findings. Transferability could have been enhanced with more diversity in the sample, including gender, ethnicity and participants from a variety of companies. The use of social media as a recruitment strategy leads to a biased sample, as not all potential candidates have access to or use social media. Another limitation of this study could include possible selection bias, such as the "healthy worker effect", as those who were on a leave of absence were excluded from this study (Li & Sung, 1999).

## Study Implications and Future Research

The findings from this study may contribute to the occupational health literature in the mining industry. Based on these findings, many participants enjoyed working shift work.

However, the participants described ways in which they feel shift work impacts their health and wellbeing. It would be beneficial to conduct future research on the current state of underground workers' health in the same setting, especially utilizing a standard questionnaire and larger sample size, to help understand the specific health issues these workers face. This type of research could lead to more directed health and wellness policy and/or programming in the workplace, aimed at improving the health of these workers.

Some of the participants in this study expressed how they wanted their spouse to also participate in this study. Gardner and colleagues (2018) conducted a similar study which investigated how the fly-in fly-out lifestyle impacted the mental health of the workers and their partners. Future research could include perspectives of both the worker, as well as their spouse, or other important figures, such as organization employers or supervisors, to further investigate the impact of rotating shift work on perceived health and wellbeing in the minerals industry.

## Conclusion

This qualitative descriptive study aimed to capture the experiences of underground workers and the ways in which rotating shift work has an impact on health and wellbeing. After conducting 12 in-depth, individual interviews, five main themes arose from the data. The findings of this study indicated that there were both advantages and disadvantages of working on a rotating shift schedule in an underground setting. When analyzing the perceived disadvantages of working rotating shift work, it was evident that most of the examples that emerged indicated that shift work had a negative impact on one's personal health and wellbeing, as well as a negative impact on the relationship with their spouse or partner. As there is already a large quantity of evidence that shows an association between shift work and chronic health problems,

researchers should continue to investigate ways to improve the health of these workers, especially in this particular setting.

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## Chapter 3:

### **The Perceived Challenges and Benefits of Rotating Underground Shift Work on Family Wellbeing**

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## Abstract

**Background:** Underground workers are exposed to multiple hazards in the work environment. These workers are also at an increased risk of chronic health conditions associated with shift work. Some research indicates that shift work may have a negative impact on family wellbeing. Limited research has investigated the perceived impact of rotating shift work on family wellbeing for Canadian underground workers.

**Objective:** The aim of this study was to gain insight into the perceived impact of rotating shift work on family wellbeing in some underground workers in Sudbury, Ontario.

**Methods:** This qualitative descriptive study included semi-structured interviews with 12 underground workers. Interviews were digitally recorded, transcribed verbatim, and were analyzed thematically.

**Results:** Four themes emerged from the data: 1) family advantages, 2) challenges with partner relationships, 3) challenges and opportunities in relationships with children, and 4) strategies used to protect family wellbeing.

**Conclusion:** There were both perceived challenges and benefits of working a rotating shift schedule on family wellbeing. Future research is needed to improve the health and wellbeing of workers in the underground mining industry as well as the families of these workers.

**Keywords:** family wellbeing, rotating shift work, underground mining, minerals industry, qualitative

## Introduction

Underground mining operations are present in multiple countries (Gavin & Kelley, 1978; Hossain et al., 2004; Oldfield & Mostert, 2007; Robinson, Peetz, Murray, Griffin, & Muurlink, 2017). The underground mining environment exposes workers to several risks and hazards, such as: explosions, poisonous gas leaks, mine collapse, flooding, excessive noise and heat, etc. (Amponsah-Tawiah, Leka, Jain, Hollis, & Cox, 2014; Berriault, Lightfoot, Seilkop, & Conard, 2017; Del Bianco & Demers, 2013; Kramer et al., 2017; Kurnia, Sasmito, & Mujumdar, 2014). Underground workers are also at an increased risk of various occupational diseases related to mining, including various types of cancer (Del Bianco & Demers, 2013; Lightfoot, Berriault, Seilkop, & Conard, 2017). Multiple studies have been conducted in the mining and minerals industry to investigate the health and wellbeing of these workers (Bernardes Souza et al., 2015; Berriault et al., 2017; Dennie et al., 2018; Hossain et al., 2004; Legault, Clement, Kenny, Hardcastle, & Keller, 2017; Lightfoot et al., 2017; Loudoun, Muurlink, Peetz, & Murray, 2014).

In addition to the physical hazards, it is common for underground workers to be on some sort of shift schedule arrangement (Heiler, Pickersgill, & Briggs, 2000; Peetz & Murray, 2011), which appears also to carry health risks, such as chronic disease. Kecklund and Axelsson (2016) defined shift work as working time arrangements outside of conventional daytime hours, which includes fixed early mornings, evening, and night work, as well as roster and rotating shift work. Shift work has been associated with numerous adverse health outcomes, such as metabolic disturbances, gastrointestinal issues, sleep problems, mental health issues, and certain types of cancer (Costa, 2010; Kecklund & Axelsson, 2016; Wang, Armstrong, Cairns, Key, & Travis, 2011). In addition to physical health, there is some evidence of an association between shift work

and a negative influence on social and family wellbeing (Arlinghaus et al., 2019; Barton, Aldridge, & Smith, 1998; Simon, 1990; Strazdins, Clements, Korda, Broom, & D'Souza, 2006).

Wellbeing has been defined as “the presence of the highest possible quality of life in its full breadth of expression focused on but not necessarily exclusive to: good living standards, robust health, a sustainable environment, vital communities, an educated populace, balanced time use, high levels of democratic participation, and access to and participation in leisure and culture” (Canadian Index of Wellbeing, 2016, p. 11). Shift work may interfere with an individual’s wellbeing (Costa, 2010; Kecklund & Axelsson, 2016), as well as family wellbeing (Arlinghaus et al., 2019; Costa, 2016). Zuna et al. (2010) have described family wellbeing as “sense of wellbeing of the family, collectively and subjectively defined and informed by its members, in which individual and family-level needs interact” (p. 262). According to some researchers, common indicators of family wellbeing include: a family’s financial situation, parental employment, family members’ satisfaction with relationships among one another, as well as quality of family functioning (Gray, Qu, Stanton, & Weston, 2004; McKeown, Pratschke, & Haase, 2003). Shift work may interfere with how families function, especially depending on the individual’s family situation, for example marital status, number and age of children, or illness (Costa, 2016). Individual health issues associated with shift work, such as fatigue or sleeping problems (Baron & Reid, 2014), may also have the potential to disrupt the family wellbeing of a shift worker (Costa, 2016; R. R. Rosa, 1995; Sharma, 2009).

Some researchers have investigated the impact of shift work on family wellbeing in the minerals industry utilizing qualitative designs (Gardner, Alfrey, Vandelanotte, & Rebar, 2018; Lovell & Critchley, 2010; MacBeth, Kaczmarek, & Sibbel, 2012; Mclean, 2012; Torkington, Larkins, & Gupta, 2011). Lovell and Critchley (2010) held focus groups consisting of female

spouses of residential mine workers living in a rural city in Australia. The phenomenological study revealed that the participants' partners' rotating shiftwork schedule resulted in poorer family social lives and decreased community connectedness. Torkington et al. (2011) conducted a qualitative descriptive study and reported that fly-in fly-out (FIFO) and drive-in drive-out (DIDO) mining workers reported a negative impact on their family, such as concerns about playing less of a role in family life and being seen as an 'outsider'. Another additional qualitative descriptive study revealed that workers who had left the FIFO/DIDO industry reported greater satisfaction with having adequate time to spend with family and friends while working locally, compared to their previous FIFO/DIDO job (McClean, 2012). Lastly, Gardner et al. (2018) conducted a qualitative descriptive study involving FIFO workers and partners of FIFO workers. The researchers indicated that the participants were unable to adjust to work and home life, including the domestic role of being a father and partner.

Other researchers have utilized quantitative designs to investigate family wellbeing among workers in the mining industry (McPhedran & De Leo, 2014; Oldfield & Mostert, 2007; Peetz & Murray, 2011; Robinson et al., 2017). For example, McPhedran and colleagues (2014) conducted a cross-sectional study in Australia utilizing a nationally representative sample ( $n = 375$ ) to investigate whether men employed in the mining industry were more likely to experience poor mental health and relationship problems in comparison to men in other occupations. The researchers indicated that the two groups were comparable for mental health, emotional functioning, relationship satisfaction and work-family balance variables. However, there was an exception for one item, "Because of my family responsibilities, I have to turn down work activities/opportunities that I would prefer to take on" ( $p < 0.05$ ), on which mining workers had lower levels of work-family tension.

Robinson and colleagues (2017) conducted a cross-sectional study among Australian mine and energy workers ( $n = 1961$ ) and their spouses ( $n = 1798$ ) to investigate the relationship between working arrangements of mineworkers and behavioural issues in their children. The researchers indicated that all five measures (i.e., hyperactive, peer problems, emotional, conduct, prosocial) of mineworker 'working time' problems correlated strongly and significantly with all four mineworker assessments of negative child behavior. For example, as the worker's level of agreement with the statement, "My current working hours do not allow enough time at home" increases, the perceived level of hyperactivity in the child increases ( $p < 0.1$ ). Use of the Australian Coal and Energy Survey was a strength of this study, as this survey comprises multiple validated questionnaires (Peetz, Murray, & Muurlink, 2012). The sample included both long-distance commuting mineworkers as well as local mineworkers, however the specific shift type was not included in analyses and therefore was a limitation in this study.

### **Significance**

The combination of mining and shift work may have a negative impact on the wellbeing at the individual level, but can also potentially influence their family members (Arlinghaus et al., 2019; Strazdins et al., 2006). A large majority of research has focused on the wellbeing of families with a member employed in the fly-in fly-out or drive-in drive-out mining industry. Minimal research, if any, has utilized a qualitative design to investigate the perceived impact of rotating shift work on family wellbeing in underground workers that reside and work locally. Therefore, this study aims to answer the research question: "What is the perceived impact of rotating shift work on family wellbeing in some underground workers in Sudbury, Ontario?"

## Theoretical Framework

This study was informed by the Bioecological Systems Theory (Bronfenbrenner, 1993). Bronfenbrenner (2001; Bronfenbrenner & Morris, 2006) defined the bioecological model as an evolving theoretical system for the study of human development over time. This theory specifies that researchers should study the settings in which a developing individual spends time and the relations with others in the same settings, as well as the personal characteristics of the individual (and those with whom one typically interacts) (Rosa & Tudge, 2013). Lastly, this theory looks at development over time and the historical time in which individuals live as well as the varied mechanisms that drive development, which are known as ‘proximal processes’. This theory incorporates a 4-element model, involving synergistic interconnections and consist of: 1) proximal processes, 2) person characteristics, 3) context and, 4) time, and is also known as the PPCT model (Tudge et al., 2016).

This theory includes two propositions. The first proposition states that in both the early stages and throughout the entire life course, human development takes place through processes of progressively more complex reciprocal interactions between the individual and other persons, objects and symbols in the immediate environment (Bronfenbrenner & Ceci, 1993; Rosa & Tudge, 2013). The second proposition states that the form, power, content and direction of proximal processes that affect development vary systematically as a joint function of the characteristics of the developing person, the environment in which processes take place, the nature of the developmental outcomes, and the social continuities and changes that occur throughout the life course (Bronfenbrenner & Morris, 2006).

## Methods

Ethics approval for this study was obtained from the Laurentian University Research Ethics Board.

This study utilized a qualitative descriptive study design with a sample of underground workers employed in Sudbury, Ontario. Candidates for this study had to be English-speaking workers employed full-time (Statistics Canada, 2011) in an underground setting. Candidates had to be employed on a rotating shift schedule (Canadian Centre for Occupational Health and Safety, 2017) for at least one year, as this requirement has been used in other shift work studies related to health and wellbeing (Guo et al., 2015; van Amelsvoort, Schouten, Maan, Swenne, & Kok, 2000; Wong, Smith, Ibrahim, Mustard, & Gignac, 2016). Individuals working part-time, casual, on-call or those on a fixed day, fixed afternoon or fixed night schedule were excluded from this study. Lastly, individuals on a leave of absence from work were also excluded from this study (Dekkers-Sánchez, Wind, Sluiter, & Frings-Dresen, 2010).

Participants were recruited through a local mining union, with the assistance of a Workplace Safety and Insurance Board worker representative. The representative organized a presentation of the current study to a group of supervisors from a local mining company, with the goal of these supervisors informing their workers about the study. Additionally, recruitment posters were created and placed on social media platforms, including Facebook, Instagram and LinkedIn. A phone number and email address were provided for interested candidates so they could contact the researcher directly.

The method of data collection involved the use of individual, semi-structured interviews. An interview guide was utilized (Appendix B), with nine semi-structured questions, followed by demographic questions. Interviews were conducted at the participant's location of choice, with

options including local libraries, the participant's home, as well as a local mining union. All interviews were audio-recorded and then transcribed verbatim by the primary researcher. Data analysis involved Braun and Clarke's (2006) version of thematic analysis, which included a six-step procedure.

To increase the validity of this study, the first interview was coded by the principal investigator then coded by the supervisor to ensure consensus among the themes emerging from the data (Creswell, 2013). The principle investigator also engaged in the process of reflexivity prior to the study beginning which ensured confirmability in the study (Shenton, 2004).

## Results

A total of 12 underground workers participated in this study, which comprised 11 males and one female. Table 3, displayed below, summarizes participant demographics. After analysis, four themes emerged from the data: 1) family advantages 2) challenges with partner relationships, 3) challenges and opportunities in relationships with children, and 4) strategies used to protect family wellbeing.

**Table 3: Summary of participant demographics**

Participant	Age	Job title	Marital status	Length of time in Mining (years)	Length on current shift rotation (years)	Length of shift (hours)	Current shift rotation
P1	57	Production miner	Married	37	8.5	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P2	27	Development miner	Single	7	7	10.5	Slow rotating: 5-4-5-5 (N-N-N-N-N--4 OFF--D-D-D-D-D--5 OFF)
P3	35	N/A	Single	18	8	10.5	Fast rotating: 5-4-5-5-4-5 (D-D-N-N-N--4 OFF--D-D-D-N-N --5 OFF -- D-D-N-N --5 OFF)
P4	39	Support miner/ Material coordinator	Married	13	6.5	10.5	Slow rotating: 4-5-5-4-6 (D-D-D-D--5 OFF--N-N-N-N--4 OFF--D-D-D-D-D)
P5	42	Production miner	Married	18	16	10.5	Slow rotating: 6-5-4-5-5 (A-A-A-A-A--5 OFF--D-D-D-D--5 OFF--A-A-A-A-A)
P6	53	Welder	Married	25	5	10.5	Slow rotating: 5-5-4-5-5-4 (D-D-D-D-D--5 OFF--N-N-N-N--5 OFF--D-D-D-D-D--4 OFF)
P7	30	Production miner	Married	11	6.5	10.5	Slow rotating: 4-5-5-4-6

							(D-D-D-D—5 OFF—N-N-N-N—4 OFF—D-D-D-D-D)
P8	34	Production miner	In relationship	12	2.5	10.5	Slow rotating: 4-5-5-5-4 (D-D-D-D—5 OFF—N-N-N-N—5 OFF—D-D-D-D—4 OFF)
P9	40	Development miner	Married	18	6.5	10.5	Slow rotating: 4-5-4-4 (D-D-D-D—5 OFF—N-N-N-N—4 OFF—D-D-D-D)
P10	37	Development miner	Married	18	8	10.5	Slow rotating: 6-5-4-5-5 (D-D-D-D-D—5 OFF—N-N-N-N—5 OFF—D-D-D-D-D)
P11	31	Heavy equipment mechanic	In relationship	10	5.5	10.5	Slow rotating: 4-5-5-3-6 (D-D-D-D—5 OFF—N-N-N-N—3 OFF—D-D-D-D-D)
P12	37	Support Miner	Married	11.5	3	10.5	Slow rotating: 6-5-4-5-3 (D-D-D-D-D—5 OFF—A-A-A-A—5 OFF—D-D-D-D—3 OFF)

*Note.* A- afternoon shift, D- day shift, N- night shift, OFF- day off

Slow rotating- Four to ten shifts in a row of the same time period (Whiting, 2012)

Fast rotating- Up to three shifts in a row of the same time period (Whiting, 2012)

Example of P1's schedule:

P1 works two day shifts, and then gets the following third day-time period off, but has to work that same day for the night shift. P1 then continues to work three consecutive night shifts. P1 then receives four days off from work. P1 then works three consecutive days shifts, then receives the fourth day-time period off, but then works that same day for the night shift, for a total of two consecutive night shifts. P1 receives five days off work. P1 then works two day shifts, receives the third day-time period off, and then works the same day for the night shift, and works a total of two consecutive night shifts. P1 then receives five days off.

### **Theme One: Family advantages**

Many of the participants revealed that there were multiple benefits associated with their current job and shift schedule that had a positive impact on their family's wellbeing. A few participants expressed they were well compensated working in the mining industry and that they were able to provide a financially comfortable life for their family. One participant (P7) shared:

*"I'm blessed to be an upper-middle class person...I am able to provide a wicked life for my family".*

The rotating schedule was helpful when young children had appointments and some participants would utilize their days off to tend to these tasks. This would relieve the spouse from having to take time off from their job. One participant (P9) stated:

*“It’s nice having the five days off during the week ‘cause I also like, the kids have dentist appointments or doctors appointments. I can take them and she (wife) doesn’t have to take time off work.”*

The current rotating schedule was also helpful as it significantly reduced the amount of daycare expenses for many participants. One worker (P9) shared:

*“Yeah instead of paying whatever daycare was- a \$1,000 bucks a month, well because I’m shift work, I’m only paying half of that right, because when I was off, the kids were home with me.”*

### **Theme Two: Challenges with partner relationships**

Some participants in this study expressed that working on a rotating shift schedule created some challenges in their relationship with their partner or spouse. Some participants reported on not having enough time to spend with their spouse. One worker (P9) said: *“When I’m night shift, I don’t get to see her (wife).”* Two participants had been through a divorce and revealed that they felt that shift work might have contributed to the relationship ending. One worker (P5) shared:

*“Uh... I do have a 15-year-old which I had from a previous relationship. I think maybe shift work helped to...uh, wreck that relationship possibly...uh, I think for a relationship is in...kind of on shaky ground...someone working shift work, and the other person isn’t...well it gives one person opportunity to uh, you know, seek other mates [laughs]... ‘cause you’re not there a lot, right?”*

There were other participants in this study whose partner also worked shift work. They said this made it more difficult to spend time together and occasional arguments would be started especially when both partners were exhausted and irritable from working. One participant

explained how his wife would tell him that his attitude or temper would change with lack of sleep, but he was unable to see the changes in his mood. The participant (P12) shared:

*“As much as I probably say that like I’m fine, uhm, I’ve seen it like just like tiffs we’ve had or whatever and it’s, I’m not fine... it’s taken her (wife) to bring it to my attention because I don’t see it...as much as I say “Nah, it doesn’t affect me, lack of sleep. I can power through everything”. Yeah, me personally function, yes. But attitude-wise or temper-wise or anything...no, I guess not”.*

Another participant (P11), whose partner also worked shift work, said:

*“I send a text message to her, “Hey, don’t forget to take the garbage out”. And then you come home from work, you’re exhausted, I want to lay down for 5 minutes...she’s on night shift, I’m on day shift...and the garbage is still in the house, like are you kidding me? ...By the end of a 4-5 day run, you’re both tired and bitchy and, yeah. And something like that happens, you just lose it.”*

### **Theme Three: Challenges and opportunities in relationships with children**

Working on a rotating shift schedule proved to have both perceived challenges and opportunities in relationships with children. Missing out on important family events and special holidays was reported by multiple participants. One participant (P7) shared:

*“Uh... If I’m working days, I don’t really get to eat supper with my family. We eat at different times, you know?”*

Although not directly associated with shift work, one underground worker (P9) shared the following statement:

*“The only thing that I don’t like about working underground is if like a family emergency happens it could be a while before I can get home kinda thing...that’s not as*

*simple as leaving where you're working right? You're underground- you gotta wait for the cage, get up, get home. 'Cause I work an hour away from home"*

Some participants reported that their children would miss them when they were working their night shift runs. One participant (P5) shared:

*"\_\_\_\_\_ (child's name), the 7-year-old. She'll actually cry and say "oh, I miss daddy". But it's kind of nice because um, we all get to miss each other, right?"*

During the summer months, when children were not in school, participants took advantage of travelling more with the children, especially during their long runs off. One participant (P1) shared:

*"But in summer time when they were outta school, beautiful! Like I get five days off so you could do a little bit more, like go on a short trip or you know, go camping a little bit further than you'd be able to with only two days off because you got 5 days off...soo uhh, summer time was fantastic with the kids."*

#### **Theme Four: Strategies used to protect family wellbeing**

Participants in this study utilized different coping mechanisms to ensure the wellbeing of their families. A commonality expressed by many participants was having a supportive spouse to help care for the family's wellbeing. Many participants reported that their spouse would take responsibility for caring for the children and managing the household when they were at work. This allowed the participants to focus on working their shifts and getting adequate time for sleep, without worrying about family responsibilities. One participant (P7) stated:

*"For me, it's not so bad because uh, my wife helps out lots. But she's a PSW and she gets to choose her shifts...so that kind of helps out lots ... like if I'm night shift, uh, I'll tell her like,*

*you gotta get up and put the kids off to the bus, you know what I mean? But if she's working, then I'll wake up a little earlier than I normally do, I'll cook supper, like you make it work."*

Another common coping strategy included participants prioritizing their days off to spend with their family. For instance, some participants made effort to attend family time meals whenever possible. One participant (P1) stated:

*"... at our house we made a point of having supper together, when on day shift or when I'm off. When the kids were growing up, we would sit down at the table and eat together."*

Other participants would aim to spend quality time with their families on their actual weekends off (i.e., Saturday and Sunday). One of responses (P5) were:

*"I do have actual two real weekends off a month, so, er, where I can go do stuff with family, what not, ski trips, snowboard trips, uh, camping in the summer, fishing."*

Another coping mechanism used to help maintain the family's wellbeing included having supportive family members and friends outside of the household that would assist in caring for the children, such as bringing children to sporting events or other activities. This would help reduce the stress on the participants and their partners while they were at work. One participant (P10) shared:

*"So he (participant's brother) helps us out. My wife's parents. Her mom is retired... Uh, and we've got a couple of friends on each team that like, are from the area. So, if need be, we get helped out."*

## Discussion

The aim of this paper was to explore how some underground workers perceive rotating shift work to impact their family wellbeing. After analyses, four themes emerged from the data:

1) family advantages, 2) challenges with partner relationships, 3) challenges and opportunities in relationships with children, and 4) strategies used to protect family wellbeing.

Bronfenbrenner's Bioecological Systems Theory, which has been previously outlined, has informed the theoretical framework of this study (1993). According to Strauss (as cited in Anfara & Mertz, 2015, p. 2), theory provides a model or map of why the world is the way it is, and aims to clarify and explain some aspect of how the world works. Theory also provides a structured interpretation or model for investigating and understanding a problem and may help explain or predict the relationship between variables (Sunday, 2008). Utilizing the Process-Person-Context-Time (PPCT) model, researchers could interpret one's perceptions as an outcome of their development (Bronfenbrenner & Morris, 2006). For example, rather than focusing solely on the individual and their personal characteristics, one must also consider other aspects of their life, such as personal relationships, home environment, work environment, community, economy, etc. This theory provided the theoretical framework to better understand how and why an individual may perceive rotating shift work to impact their health and wellbeing.

The four themes that emerged from this study can be related back to the PPCT model. First, one must recognize the 'proximal processes' that take place, which involve interactions between individual and the environment over time, and are primary mechanisms involved in producing human development (Bronfenbrenner & Morris, 2006). The next component is 'person characteristics', which helps to recognize that an individual's development will be partially determined by their own personal characteristics, as these traits are very influential in shaping development. This also includes characteristics of other persons that the developing individual typically interacts with, such as spouse, children, coworkers, etc. Third, one must

consider ‘context’ as this can foster or interfere with development of the individual, for example, the individual’s family environment, workplace, community, etc. Context also includes the overarching institutional systems, such as economic, social, education, legal and political systems, in which all have an impact on the developing individual (Rosa & Tudge, 2013). Lastly, the concept of ‘time’ must be recognized as an individual’s development occurs over the life course and is influenced by varied conditions and events that occur throughout one’s life.

### ***Family advantages***

Some literature suggested there is an association between shift work and negative outcomes related to family wellbeing (Arlinghaus et al., 2019; Strazdins et al., 2006). Alternatively, participants in this study shared multiple perceived advantages associated with their work schedule on improving their family’s wellbeing. Some participants in this study revealed that they felt they were well compensated in their job and were able to provide an improved standard of living for their family. A phenomenological study conducted in Australia also reported the benefits of increased financial support with a spouse working in the mining industry, resulting in less stressful lives (Lovell & Critchley, 2010). A cross-sectional study conducted in Australia found that mine workers reported higher income and less financial stress in comparison to men in other occupations (McPhedran & De Leo, 2014). Marshall et al. (1998) also reported that shift work itself can sometimes lead to an increase in pay.

Participants also explained how their rotating schedule would help mitigate the need for daycare, or at least cut down significantly on the amount of daycare needed. Reduced day care costs have been highlighted in Canadian literature (Duncan & Pettigrew, 2012; Marshall, 1998). Participants in this study also reported having a spouse who also worked shift work, which has been described as ‘tag-team parenting’ (Hattery, 2001). There may be a disadvantage for shift

working parents to take on additional childcare responsibilities. For example, some shift workers may overextend themselves out of guilt for their lack of availability, which may increase individual fatigue and cause further negative impact on personal wellbeing (Simon, 1990).

### ***Challenges with partner relationships***

A common problem experienced by some participants in this study was the lack of time with spouses or partners (Finn, 1981; Simon, 1990). Opposing work schedules can result in one partner sleeping while the other is awake and productive. Participants in this study did not share any intimate details about their relationships. However, some participants did reveal that they had been divorced and have also had partners who did not support their shift work schedule. Some partners of shift workers may object to their partner's shift work hours, while others may accept the shift work as important in achieving the couple's mutually acceptable goals, such as financial security (Sharma, 2009; Weston, Qu, & Soriano, 2002).

Some participants in this current study revealed that both they and their spouses worked on shift work schedules. High stress and family burden may be intensified when both partners in a relationship work shift work (Beermann & Nachreiner, 1995; Costa, 2016), which could result in a negative impact on marital relations. As mentioned, some parents do "tag-team" parenting, which results in less time spent alone as a couple (Hattery, 2001). Lovell and Critchley (2010) interviewed women with a male shift working partner in the mining industry. Some couples would take turns watching the children on their time off, but this would result in the couple not spending enough alone time together.

### ***Challenges and opportunities in relationships with children***

Some literature showed there to be patterns of negative experiences when one or both parents work a shift work schedule (Arlinghaus et al., 2019; Barton et al., 1998; Strazdins et al.,

2006). For example, Strazkins et al. (2006) conducted a cross-sectional study in Canada and reported that families with fathers working a nonstandard schedule displayed worse family functioning and more hostile and ineffective parenting in comparison to families where both parents worked regular day-time hours. Barton et al. (1998) conducted a cross-sectional study to compare children's wellbeing between day-working and shift working fathers. The researchers indicated that the daughters of shift workers reported significantly poorer perceptions of academic competence compared to daughters of day workers. In addition, daughters of shift working fathers reported higher overall levels of depression, more negative mood, and more interpersonal problems in comparison to sons of shift working fathers.

Some studies have been conducted to investigate the wellbeing of children with parents employed in the mining industry (MacBeth et al., 2012; Torkington et al., 2011) with most of these studies investigating the fly-in fly-out (FIFO) and drive-in drive out (DIDO) lifestyle. In Australia, a qualitative descriptive study was conducted with FIFO/DIDO workers, who reported missing out on quality time with their children, and being unable to see their children grow up (Torkington et al., 2011). Alternatively, Macbeth et al. (2012) found that young boys had a generally positive and healthy relationship with their FIFO/DIDO father, especially because they felt their father was more "present" when he was home from work.

### ***Strategies used to protect family wellbeing***

According to Fullick et al. (2009), shift workers may become desynchronized from their family's habits and routines, which may lead to dissatisfaction with the amount of time spent with the family. Many participants in this study shared various coping strategies utilized to help ensure the wellbeing of their families. Researchers have noticed that a shift worker's coping

mechanisms are neither universally “good” or “bad” coping processes, but merely strategies that work better or worse for individuals, based on their needs (Fullick et al., 2009; Lazarus, 2013).

Participants in this study expressed how they would prioritize their time off to be with spouse and children. An ethnographic study conducted in an automobile plant in the United States found that workers would also prioritize spending time with their children, but participants felt certain shift rotations would inhibit this (Root & Wooten, 2008). For example, some workers would request time off to help coach their child in a sport; however, if they were denied the time off, some participants would take independent action, such as calling in sick to work so they could attend a child’s sport event (Root & Wooten, 2008).

Participants in this study spoke highly about their spouses and how having a supportive spouse has been helpful with coping with shift work. A qualitative descriptive study conducted with fly-in fly-out mine workers in Australia revealed similar results (Torkington et al., 2011). For example, the workers expressed how having an independent and resilient partner was considered helpful, especially when there were children in the home. According to Costa (2003), family support toward shift work can have either a positive or negative influence on the wellbeing of the worker. Supporting attitudes and assistance from these friends and family members has been shown to help enhance shift work adaptability and tolerance.

Based on this study’s findings, it is evident that the participants perceived their rotating shift schedule to impact their family’s wellbeing. Future research utilizing larger samples and a quantitative design should be conducted to investigate if, and how, family wellbeing is impacted by rotating shift work. More specifically, research should investigate which specific shift schedules have the most and least impact on the wellbeing of the family (Karhula et al., 2016).

As limited family wellbeing research in the mining industry in Canada has been conducted, it would be beneficial to continue research in this area.

## Implications for Practice

Some workers in this study revealed how they would save on daycare costs by watching their children when they were off work, even if that meant losing sleep before a night shift. From a health perspective, workers should consider prioritizing sleep above anything else, such as caring for children or domestic duties (Imes & Chasens, 2019). It may be beneficial for shift workers to search for other daycare options. Workers should also plan domestic duties around their shift schedule and ensure they do not complete any tasks at the cost of sleep (Health and Safety Executive, 2006). A fit and healthy worker will likely be more resistant to stress and illness and may have better chances of adapting to shift work (Fullick et al., 2009; Harrington, 2001; Health and Safety Executive, 2006).

Some of the participants in this study expressed that their family members would miss them while on shift work. A few participants revealed that they have also had past relationships with a partner who had not been supportive of their shift work schedule. A shift worker should ensure to talk with their family about their experiences of working shift work, to allow their family to understand the problems they may face, (i.e., lack of sleep, fatigue) (Costa, 2010; Health and Safety Executive, 2006). This communication between family members may assist in creating a more supportive and considerate family environment.

Some practical strategies that might improve family wellbeing could be implemented at the company and/or management level. For example, training and education about the risks of shift work along with different coping strategies could be implemented to improve the health of not only the shift worker, but the family's wellbeing as well (Arlinghaus et al., 2019; Imes &

Chasens, 2019). On-site wellness workshops or presentations could be provided to the workers. In addition, email, mail or access to a website, with educational articles and sources on how to cope with a family member working shift work, could also be provided to the shift workers' families.

It is important to note that the range of workers and their social and family life is so diverse that there is no "one size fits all" preventative strategy (Arlinghaus et al., 2019). Coping strategies will be individual in nature based on the worker's priorities and needs (Fullick et al., 2009; Lazarus, 2013). Therefore, further research needs to be conducted utilizing larger samples to investigate if there is a larger problem that exists in relation to rotating shift work and family wellbeing present in the underground mining industry. It is also recommended that additional future studies be conducted involving both the shift worker and their spouse, to investigate family wellbeing from both perspectives, especially in Canada.

## Conclusion

This qualitative descriptive study aimed to gain an understanding of how some underground workers perceive rotating shift work to impact their family wellbeing. Twelve individual, semi-structured interviews were conducted with underground workers that work and live in Sudbury, Ontario. After analyses, four themes emerged from the data. The participants in this study perceived there to be both advantages and disadvantages of their rotating schedule and its impact on family wellbeing. Future research should be conducted in the mining industry in Canada, to further investigate the impact of rotating shift work on the wellbeing of both the individual worker, as well as their family members, especially utilizing larger samples and a mixed methods design.

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## Chapter 4: Discussion

This final thesis chapter includes the following: a summary and discussion of research findings, discussion and application of theoretical models, a commentary about researcher reflexivity, the study strengths and limitations, and, lastly, recommendations for future research and practice.

This research study involved individual, semi-structured interviews with rotating shift workers employed in the underground mining industry in Sudbury, Ontario. This study provided an opportunity for workers to share their perceptions about working rotating shift work and reveal ways in which they perceived their health and wellbeing to be affected. After conducting 12 interviews, it became evident that these participants shared similar experiences. Participants in this study perceived there to be both advantages and disadvantages of their rotating shift schedule. Most of the workers expressed that they enjoyed their work schedule, however, they also recognized that shift work had adverse effects on their personal wellbeing and relationships with their partners, children and friends. There were some participants who felt they could no longer cope with shift work and admitted to wanting to switch work schedules or leave the industry all together. The majority of participants revealed that they had learned how to accept and cope with shift work and they would practice different strategies to improve their shift work tolerance. This qualitative descriptive study may be valuable to the underground mining industry as it provides anecdotal evidence that there is a perceived impact on the health and wellbeing among some underground workers in Sudbury, Ontario, of which the union and industry should be aware.

The findings in this study also offer novel evidence that some participants employed in the mining industry perceive there to be multiple benefits associated with their rotating shift

schedule. Much of the literature included in this thesis have investigated the association between shift work and a number of adverse health conditions (Costa, 2010; Kecklund & Axelsson, 2016). Limited Canadian studies have investigated the positive outcomes associated with working shift work, especially utilizing a qualitative design. According to Waddel and Burton (2007), there is strong evidence to indicate that working is generally good for physical and mental health and wellbeing, in comparison to worklessness. For instance, employment is important in obtaining adequate resources to allow a person to live and participate in today's society (Waddel & Burton, 2007). In addition, work can be central to an individual's identity, social roles and social status. Furthermore, although an individual working shift work may be at risk for various chronic health problems associated with shift work, the individual may perceive that the benefits associated with being employed outweigh these potential costs.

#### 4.1 Summary of Research Findings

The findings in this thesis align with previous qualitative studies conducted that involved the perceptions of workers in the mining industry and the impact on perceived health and wellbeing (Gardner, Alfrey, Vandelanotte, & Rebar, 2018; Mclean, 2012; Perring, Pham, Snow, & Buys, 2014; Torkington, Larkins, & Gupta, 2011). Many of these studies involved the perspectives of fly-in fly-out (FIFO) and drive-in drive-out (DIDO) workers. It can be argued that local workers' lives can be comparable to those who work in the FIFO/DIDO industry (Arlinghaus et al., 2019). Both FIFO/DIDO workers, as well as local workers, experienced being away from their families for multiple days at a time, therefore, these workers may temporarily abandon parental roles as they focus on working, sleeping, and eating (Arlinghaus et al., 2019).

Each of the themes identified throughout this research study has been independently discussed as it relates to previous findings in the literature.

### **Strong preference for the night shift**

Most of the participants in this study expressed that they had a strong preference to working the night shift or the late afternoon shift. For example, some participants explained that they felt like a “night owl” by nature, and, therefore, felt more comfortable working at nighttime. These participants could be referring to their own personal chronotype (Papantoniou et al., 2015). Chronotype is an individual characteristic that describes the circadian phase and correlates with diurnal preference (Papantoniou et al., 2015; Roenneberg et al., 2007), meaning that circadian clocks entrain differently in every individual, with differences between the extreme early and late chronotypes spanning up to 12 hours (Juda, Vetter, & Roenneberg, 2013). Juda et al. (2013) indicated that participants with a “late” chronotype experienced worse sleep on morning-shift days in comparison to “earlier” chronotypes. In addition, when participants were working the night shift, sleep was worse for “early” chronotypes in comparison to “later” chronotypes (Juda et al., 2013). Similar to these findings, many participants in this study experienced better sleep quality during the day, after completing a night shift, as well as experiences of worse quality and shorter sleep durations at nighttime, before a day shift. Regardless of an individual having a late or early chronotype, a circadian misalignment may still occur because the individual’s preferences for sleep and activity conflict with their rotating shift schedule (Baron & Reid, 2014). Lastly, similar to findings in this study, Nunes and colleagues (2018) reported that participants enjoyed the night shift simply because there were less people in the workplace, which resulted in a quieter and more relaxed environment.

### **Challenges associated with impact on personal wellbeing**

Participants shared experiences of dealing with sleep difficulties, extreme fatigue, and mental health issues, which may have been influenced by personal chronotype. Multiple studies

have reported an association between shift work and sleep problems (Hossain, Reinish, Kayumov, Bhuiya, & Shapiro, 2003; Paim et al., 2008; Vallieres, Azaiez, Moreau, LeBlanc, & Morin, 2014). For example, Paim and colleagues (2008) reported that among a sample of shift workers ( $n=327$ ), 35% fulfilled the criteria for insomnia, excessive sleepiness, snoring, sleep apnea, and limb movement. These workers ( $n=114$ ) then underwent polysomnographic testing and researchers concluded that 90 subjects met the criteria for obstructive sleep apnea, limb movements, or both (Paim et al., 2008). Hossain et al. (2003) reported findings of the presence of sleep disorders in highly fatigued shift workers using various polysomnographic testing. Furthermore, Vallieres and colleagues (2014) investigated the impact of insomnia on quality of life, as well as work and lifestyle habits of shift workers. The researchers indicated that all three groups (day, night, and rotating) presented similar profiles, symptoms of anxiety, depression and fatigue, as well as consuming equal amounts of sleep-aiding medication. However, sleepiness seemed to be associated with insomnia for rotating shift workers and quality of life for both rotating and night shift workers (Vallieres et al., 2014). A few participants in this current study reported that they could no longer cope with lack of sleep, and therefore were planning to switch to day shift or leave the industry all together, which has been reported in the literature (Akerstedt, Nordin, Alfredsson, Westerholm, & Kecklund, 2010; Paim et al., 2008).

Mental health problems have been reported in multiple studies conducted in the mining industry, specifically in Australia (Considine et al., 2017; Gardner et al., 2018; Mclean, 2012; McPhedran & De Leo, 2013, 2014). Kelly et al. (2013) estimated that between eight- and ten-thousand employees in New South Wales, Australia minerals industry experienced a mental illness. Mclean et al. (2012) found that resident mining shift workers reported general job satisfaction, but also identified that shift work, stressful tasks, and burnout were also

experienced. Gardner and colleagues (2018) reported that fly-in fly-out (FIFO) workers experienced feelings of isolation and loneliness, and suffered from anxiety and depression. In addition, Considine et al. (2017) reported that among the group of coal miners ( $n= 1457$ ), there were significantly higher levels of psychological distress in comparison to a national data set ( $p < 0.001$ ). It could be speculated that a combination of working shift work, as well as experiencing lack of sunlight for days, could have a negative influence on mental health and wellbeing of workers in this industry (Bahn, 2013; Kelly et al., 2013).

### **Advantages and disadvantages on work environment wellbeing**

Participants in this study shared their experiences working in the underground environment, and how they felt they were part of a “brotherhood”, as well as feeling strong camaraderie at work. Additional studies conducted in the mining (McClean, 2012) and industrial settings (Root & Wooten, 2008) have also reported a sense of camaraderie and positive relationships with coworkers.

The underground work environment exposes workers to potential hazards, such as mine gases, dusts, mine fires, excessive heat and noise, among others (Del Bianco & Demers, 2013; Kramer et al., 2017; Kurnia, Sasmito, & Mujumdar, 2014). Participants in this study shared experiences of working in a dirty and dusty work environment, and how they felt this may be impacting their health and wellbeing. Amponsah-Tawiah et al. (2014) reported that poor underground mine conditions, such as gases and inadequate ventilation, had a negative impact on the wellbeing of the workers in the Ghanaian mining industry. The researchers also indicated that high demands and less control at work lead to a decrease in health and wellbeing (Amponsah-Tawiah et al., 2014). Alternatively, McClean et al. (2012) reported that mine workers in their study

discussed management in positive terms, such as feeling appreciated by their supervisors. Perring and colleagues (2014) also reported on positive management at fly-in fly-out mining camps.

### **Benefits and challenges of wellbeing external to work**

According to Costa (2016), “shift workers frequently complain of irritability, nervousness and anxiety, in relation to more stressful working conditions and greater difficulties in family and social life” (p. 24). Those engaged in shift work may work on the opposite schedules as those in society, which may conflict with their lives outside of work. Based on the findings in this study, it can be interpreted that shift work affects each individual differently, based on a the individual’s needs and priorities (Fullick et al., 2009). Participants in this study reported missing out on important events with family and friends and strained worker-spouse relationships.

Gardner et al. (2018) reported similar findings in a qualitative study involving interviews with fly-in fly-out (FIFO) workers and their spouses. This study differs from the current study as FIFO workers sleep and live out of town for days at a time, however, some comparisons could be made as participants in this current study revealed that it was common to not see their partner or children for days, especially while working the night shift.

Oldfield and Mostert (2007) conducted a cross-sectional study ( $n=230$ ) to investigate why employees in the mining industry suffer from poor health and work-home interference. The researchers concluded that high job demands in addition to lack of resources, were associated with exhaustion, somatic complaints, anxiety, and insomnia, which resulted in negative work-to-home interference (Oldfield & Mostert, 2007). Alternatively, McPhedran et al. (2014) indicated that employees in the mining industry experienced similar levels of work-life balance in comparison to workers in other occupations. To evaluate work-life balance, participants had to share their level of agreement with statements such as, ‘Because of the requirements of my job, I

miss out on home or family activities that I would prefer to participate in’, ‘Because of the requirements of my job, my family time is less enjoyable and more pressured’, and ‘Because of my family responsibilities, the time I spend working is less enjoyable and more pressured’ (McPhedran & De Leo, 2014).

### **Strategies for coping with shift work**

Shift work impacts individuals differently, and each individual who chooses to cope will utilize strategies that work best for them (Fullick et al., 2009). Participants in this study reported on the acceptance of their shift work lifestyle, which made it easier for them to cope with shift work. According to Fullick and colleagues (2009), individuals who continue to work shift work more often become accustomed to adapting their lifestyles. Nunes et al. (2018) framed shift work as a “chronic condition” because these workers are exposed to multiple issues associated with shift work and must learn to cope until they quit or retire. Therefore, it is common that shift workers accept their condition and learn to manage in the best possible way. As previously stated, those who are unable to cope or tolerate shift work, often decide to leave the industry (Akerstedt et al., 2010; Paim et al., 2008).

Shift workers engage in certain behaviours that help them manage the effects of shift work (Fullick et al., 2009; Nunes et al., 2018). Similar to this study’s findings, other studies have noted that shift workers often use napping at certain times to help reduce fatigue, especially before a night shift (Lowson & Arber, 2014; Nunes et al., 2018). According to Costa (2003), ensuring good sleep hygiene is important in managing stress and improving shift work tolerance. Participants in this study reported on engaging in physical activity, taking vitamins, and limiting alcohol consumption during their shift runs. Nunes and colleagues (2018) reported on similar coping mechanisms among shift workers in a variety of occupations, such as nurses, doctors, and

security personnel. Participants also emphasized the importance of attending family and social events, and would switch shifts with coworkers, even if that meant interfering with their sleep routine (Nunes et al., 2018).

### **Family advantages**

Some studies have found an association between shift work and adverse outcomes related to family wellbeing (Arlinghaus et al., 2019; Barton, Aldridge, & Smith, 1998; Simon, 1990; Strazdins, Clements, Korda, Broom, & D'Souza, 2006). However, participants in this study expressed that there were some advantages of working shift work on family wellbeing. Similar to this study's findings, Lovell and Critchley (2010) reported on the benefits of an increase in financial support with a spouse working in the mining industry. McPhedran et al. (2014) also reported that mine workers with higher income had less financial stress in comparison to men in other occupations. According to Marshall (1998), shift work itself can sometimes lead to an increase in pay.

Participants in this study revealed that shift work would help eliminate the need for childcare, or significantly reduce the amount of childcare needed. Shift workers have reported on this benefit in some Canadian literature (Duncan & Pettigrew, 2012; Marshall, 1998). It is important to note that although workers save on daycare expenses, there could be negative consequences on their personal wellbeing. Parents who are shift workers may overextend themselves, out of guilt for their lack of availability (Finn, 1981; Simon, 1990). This could result in an increase in individual fatigue, and result in a further negative impact on their own wellbeing.

### **Challenges with partner relationships**

Some of the participants in this study revealed certain challenges they experienced with their partners, with the perception that shift work may be a contributing factor in this conflict. For instance, participants in this study expressed how they would rarely have enough time to spend with their spouse, which has also been reported in some literature (Finn, 1981; Simon, 1990). Although not mentioned in this particular study, Simon et al. (1990) reported that a shift worker's partner may experience resentment or frustration as a result of having to take primary responsibility for family duties and tasks, while the shift worker is working.

When both partners in a relationship work shift work there may be consequences on both their relationship and the family wellbeing (Beermann & Nachreiner, 1995; Costa, 2016). There were participants in this current study who had a partner also engaged in shift work. Hattery (2001) coined the term "tag-team parenting" when both parents work shift work. The lack of alone time for couple intimacy is a common problem among shift workers (Finn, 1981; Simon, 1990). Researchers in Australia interviewed women with a male shift working partner employed in the mining industry and revealed that some couples would take turns caring for their children on their days off to reduce the cost of daycare (Lovell & Critchley, 2010). This would result in the couple not having enough alone time together. Sharma (2009) and Weston et al. (2002) reported that some partners of shift workers may object to their partner's shift work hours, while others may accept the shift work as important in achieving the couple's mutual goals, such as financial security.

### **Challenges and opportunities in relationships with children**

Research has been conducted in the mining industry to investigate the relationship between shift working parents and the wellbeing of their children (MacBeth, Kaczmarek, & Sibbel, 2012; Robinson, Peetz, Murray, Griffin, & Muurlink, 2017; Torkington et al., 2011).

Torkington et al. (2011) indicated that FIFO/DIDO fathers would miss out on quality time with their children as well as miss important childhood milestones. For local workers, extended work hours (i.e., 12-hour shifts) can impact family wellbeing (Sharma, 2009). Participants in this current study reported missing out on important family events and holidays. Sharma (2009) reported that extended hours could affect ‘full fathering’, meaning that fathers miss out on time and important events in their children’s early lives. Participants in the current study also expressed that their rotating shift schedule was beneficial in the summer months as they could spend more time travelling with their children when they were out of school. Costa (2016) indicated that shift workers may be forced to learn how to use daytime periods most effectively. For instance, Macbeth et al. (2012) indicated that young boys experienced positive and healthy relationships with their FIFO/DIDO father, as they felt their father was more “present” when he was home from work. Ljosa et al. (2011) indicated similar findings in that participants perceived there to be ample time with their families when they were home from working on an offshore oil rig.

There is some evidence to support the relationship between shift working parents and adverse outcomes on the wellbeing of children (Arlinghaus et al., 2019; Barton et al., 1998; Strazdins et al., 2006). Barton and colleagues (1998) conducted a cross-sectional study to compare children’s wellbeing outcomes between day-working and shift-working fathers. The researchers indicated that daughters of shift workers reported significantly poorer perceptions of academic competence in comparison to the daughters of the day-working fathers (Barton et al., 1998). Strazkins and colleagues (2006) reported that families with fathers working a nonstandard shift schedule displayed worse family functioning, more hostility and ineffective parenting in comparison to families where both parents work regular day-time hours.

## **Strategies used to protect family wellbeing**

Participants in this study shared various coping mechanisms used to assist in ensuring their family's wellbeing. Family wellbeing has been described as a "sense of wellbeing of the family, collectively and subjectively defined and informed by its members, in which individual and family-level needs interact" (Zuna, Summers, Turnbull, Hu, & Xu, 2010, p. 262). According to some researchers, common indicators of family wellbeing may include: a family's financial situation, parental employment, family members' satisfaction with relationships among one another, as well as quality of family functioning (Gray, Qu, Stanton, & Weston, 2004; McKeown, Pratschke, & Haase, 2003).

It is common for shift workers to become desynchronized from their family's routines, which could lead to dissatisfaction with the amount of time spent with the family (Fullick et al., 2009). Researchers should recognize that despite the difficulties faced by both the shift worker and their families, workers and their families were able to develop strategies to help deal with these challenges (Arlinghaus et al., 2019). Participants in this current study expressed that having a supportive spouse or partner was helpful in ensuring their family wellbeing. Similarly, Torkington et al. (2011) reported that fly-in fly-out (FIFO) mine workers with a supportive, resilient, and independent spouse was helpful to maintain the family's wellbeing while the worker was out of town. Participants in this current study also disclosed that other family members and friends would assist in caring for the children when both the shift worker and spouse were working. Costa (2003) indicated that support and assistance from friends and family members may help enhance the shift worker's adaptability and tolerance to shift work.

## **4.2 Theoretical Framework**

### **4.2.1 Epistemology**

This study is situated within the postpositivist and interpretivist paradigm. From this ontological stance, one assumes that the truth is seen through a variety of lenses and that subjective experience affects the perception of the truth of reality (Tuck & McKenzie, 2015). Postpositivists view inquiry as a series of logically related steps and believe in multiple perspectives from participants (Creswell, 2013). It is understood that whatever information was shared from participants in this study is not the absolute truth, but rather the truth the participant creates from their own perceptions. This also includes what is said and understood by the researcher, as the truth is created from their own perceptions as well (Tuck & McKenzie, 2015).

#### **4.2.2 Theoretical Models**

##### ***Effort-Reward Imbalance Model***

To assist in understanding how workers perceive rotating shift work to impact their health and wellbeing, the “Effort-Reward Imbalance (ERI) Model” was used (Siegrist, 2016). The ERI model posits that a failed reciprocity between efforts and rewards may cause recurring negative emotions and sustained stress responses, which result in triggering of adverse health outcomes, particularly coronary heart disease and associated risk factors (Preckel, Meinel, Kudielka, Haug, & Fischer, 2007; Siegrist, 1996). Repeated activation of the stress response could lead to the development of stress-related mental and physical disorders (Preckel et al., 2007; Siegrist, 2008).

Social reciprocity lies within the employment contract, which outlines the specific tasks and demands required of the worker, as well as the expected outcome of rewards (Siegrist, 2008). Rewards include money, esteem, career opportunities, and job security. When utilizing the ERI model, a failed reciprocity may occur if the worker experiences one or more of the following conditions: “dependency”, “strategic choice” and “overcommitment” (Siegrist, 2016).

Dependency occurs when a worker has no alternative choice in the labour market. Strategic choice occurs when the worker accepts the experience of “high-cost/low-gain” in their job over time, as they believe it could lead to a job promotion. Lastly, overcommitment occurs when a worker aims for high achievement in their position, as they have personal needs of approval for self-esteem. However, these individuals may experience a perceptual distortion. For example, a worker may inaccurately assess their “cost-gain” situation, in which the worker would underestimate their demands and overestimate their own coping strategies (Siegrist, 2008).

### ***Process-Person-Context-Time Model***

To assist in understanding how workers perceive rotating shift work to impact their family wellbeing, the “Process-Person-Context-Time (PPCT) Model” was utilized (Bronfenbrenner & Morris, 2006). This model originates from the Bioecological Systems Theory (Bronfenbrenner, 1993). According to this theory, researchers must study the settings in which a developing person spends time and the relations with others in the same settings, as well as the personal characteristics of both the individual and those with whom they typically interact (Rosa & Tudge, 2013). This theory incorporates the concept of time, both in the past and present, as well as the varied mechanisms that drive development, which are known as ‘proximal processes’. This theory utilizes a four-element model to assist with understanding human development, and includes: 1) proximal processes, 2) person characteristics, 3) context and, 4) time (Tudge et al., 2016).

### **4.2.3 Theory in Application**

#### ***Effort-Reward Imbalance Model***

Participants in this study perceived there to be both challenges and benefits associated with their rotating shift schedule on their health and wellbeing. When utilizing the ERI model,

shift work can be considered an “extrinsic demand” and can be classified as the “effort” an individual puts into their work (Siegrist, 1996). When reviewing the themes from this current study, “demands” associated with working shift work were most prominent in the themes ‘challenges associated with impact on personal wellbeing’, ‘advantages and disadvantages on work environment wellbeing’ and ‘benefits and challenges of wellbeing external to work’. According to the ERI model, if a worker feels they are putting in high effort, (i.e., working shift work), and receiving low reward, (i.e., frustration with management), as a result, the worker may begin to experience feelings of anger and demoralization, which could lead to adverse health consequences in the long term (Siegrist, 2008; Willis, O’Connor, & Smith, 2008).

As previously stated, a failed reciprocity may occur because of “overcommitment”, which is considered “intrinsic effort”, and refers to the ways a worker perceives or copes with their situation (Willis et al., 2008). This condition could be related to the theme ‘strategies for coping with shift work’. In this case, participants in this study revealed various coping mechanisms used to deal with working shift work. However, the concept of overcommitment occurs when an individual experiences a perceptual distortion, in which they fail to see the imbalance between effort and reward, and therefore could impact their health and wellbeing in the future (Siegrist, 2008).

### ***Process-Person-Context-Time Model***

Participants in this study perceived there to be both positive and negative outcomes from their rotating shift schedule on family wellbeing. The Process-Person-Context-Time (PPCT) Model can be utilized to help explain the four themes that emerged from the third chapter in this research study. The themes that emerged from the data included: 1) family advantages, 2) challenges with partner relationships, 3) challenges and opportunities in relationships with

children, and 4) strategies used to protect family wellbeing. When analyzing these themes, first one must acknowledge the ‘proximal processes’ that take place (Bronfenbrenner & Morris, 2006). This involves dynamic and synergistic interactions among individual and the environment over time. Next, one must consider ‘person characteristics’, as these traits help to partially determine individual development. This also considers the characteristics of other individuals one interacts with, such as spouse, children, coworkers, etc. The ‘context’ in which the individual lives in and spends their time (i.e., home, workplace, etc.), is also important in understanding human development. Context also includes the influence of rules and laws defined by the employer, such as rules that must be followed in the workplace as well as the shift arrangement that must be worked. Context can also be viewed in a much broader lens, and must consider institutional systems, such as economic, social, education, legal and political systems, in which the developing individual is influenced by (Rosa & Tudge, 2013). Lastly, the concept of ‘time’ must be considered, as an individual’s development occurs throughout the life course, depending on conditions and events that occur.

### 4.3 Reflexivity

According to Rice and Ezzy (1999), reflexivity is an acknowledgement of the role and influence of the researcher on the research project. The researcher is subject to the same critical analysis and scrutiny as the research project itself (Carolan, 2003). Prior to conducting interviews with participants, I reflected upon past experiences, biases, prejudices, and orientations that I believed might have influenced interpretations as well as the approach I used in this study. For instance, I reflected on past experiences working night shift and how I have gained a negative perspective on shift work. I also reflected on my position as a wellness coordinator for a mining company and how some of the workers shared both positive and

negative perceptions about shift work. This next section involves personal reflection throughout the research process, including interviews with participants and the overall analysis.

As previously stated, I have gained experience working in the mining industry as a wellness coordinator. This position provided me with a general understanding of the mining process as well as a glimpse of environments in which employees would work, (i.e., underground, office setting, mining smelter complex, etc.). I was given a tour of one of the underground mines in Sudbury, Ontario. This job experience was one of the main reasons I had chosen to investigate the health and wellbeing of underground workers. This previous work experience was helpful when conducting interviews as I was somewhat familiar with some of the mining terms used, such as some types of mining equipment or areas in the mine (i.e., lunchroom/refuge station). Although I gained some experience in the mining industry, I was still aware that I was no expert, and I had to remain open-minded and as objective as possible when conducting the interviews.

Throughout this research study, I was employed as a Graduate Teaching Assistant for a professor in the School of Social Work at Laurentian University. This was a unique opportunity as I had very little knowledge about social work education and practice. Fortunately, I was able to attend one of the courses titled “Basic Intervention Skills in Social Work Practice”. This class provided information about the foundations of qualitative interviewing. I learned the importance of the physical setting in which an interview should take place as well as several precautionary measures to ensure my own personal safety. I gained knowledge on how to build rapport and explain confidentiality to participants. Attending this class assisted in providing me the confidence to conduct individual interviews as well as providing a safe place to practice this skill with other students.

Prior to conducting the first interview, I was feeling very anxious and excited at the same time. The important paperwork and audio-recorders had been prepared and I was ready to begin. Upon arrival of the first participant, we made brief introductions and conversation. Once the interview began, I started to feel more confident. The interview lasted approximately 1-hour and I felt mentally exhausted. After the interview was complete and I had said farewell to the participant, I began to reflect on the interview. I began to feel doubtful about the interview and questioned myself: “Did I ask too many probing questions? Was I imposing my opinions on the participant? Did I gather sufficient rich data?”. This type of self-critique was important in the reflexive process as I had started to examine the interview and reflected upon how I may have influenced the research process (Dowling, 2006; Patnaik, 2013).

After the first interview was conducted, I began to transcribe the interview. Next, my thesis supervisor read the transcript and provided me with valuable advice. I was informed to “listen more and speak less.” I had come to the realization that my first interview was more of a conversation between both myself and the participant. This type of conversation was more familiar with me as I had always had jobs where I converse with people, help others, and provide my opinion in various situations. For example, as a wellness coordinator, I had to be outgoing and always creating conversations surrounding health or other areas. I then began to acknowledge that I had to “let go” of my past experiences and take on a new role as a researcher. I learned that I needed to take a step back and practice active listening and speak less in future interviews. Understanding my own attitude and views would allow the focus of the remaining research to be on the participants (Patnaik, 2013).

Reflexivity is a continuous process of reflection by a researcher on their own values and recognizing, examining and understanding how their social background, location and

assumptions affect their research practice (Hesse-Biber, 2007; Palaganas, Sanchez, Molintas, & Caricativo, 2017). At the beginning of the interview process I would introduce myself as a Master's student studying at Laurentian University. I would explain to the participants that I was interested in learning more about their perceptions about working shift work. I would also explain that I had previously been employed as a wellness coordinator for a mining company. By revealing my wellness background to participants, I feel that they may have chosen to withhold certain health information with fear that I may judge them, (i.e., if they were a smoker). In my past work experiences, some people have informed me that they believe I will "judge" them for their perceived unhealthy habits based on my position as health advocator. Therefore, in future research, I may keep this information to myself rather than share with participants.

A challenge of reflexivity may be managing the emotions of the research participants (Palaganas et al., 2017). However, it is argued that total detachment throughout the interview process is unrealistic and can hinder the research process (Palaganas et al., 2017). Throughout the research interviews, I would experience strong feelings of empathy toward some of the participants. For instance, there were some participants who were very unhappy with their jobs, mostly because of shift work. After one of the interviews was complete, with recorders turned off, a participant revealed that they wished they could return to school to pursue another career. They also stated that continuing education was no longer possible as they had a family to care for. When these personal feelings would arise, I would let the participants know I sympathized with them, however, I ensured to stay objective and not impose my opinions to try and help the individual.

Through reflexivity, a researcher acknowledges the changes brought about in themselves as a result of the research process, and how these changes have affected the research process

(Palaganas et al., 2017). After conducting interviews, I have gained a new respect for underground workers. One of the participants in this study shared their opinion that they believed that people who are born and raised in Sudbury, Ontario, tend to feel “blasé” towards underground miners. It was at that moment that I realized I had a previous perception towards workers in the mining industry without having a true understanding of the work they do. Underground workers work thousands of feet underground, in extremely dark, dirty and dusty work environments. The temperatures become incredibly hot underground and some workers perceive it to be quite unpleasant. Some jobs are tedious and repetitive, while others work in high-danger work zones and are physically demanding. Some workers explained how they experienced near-miss situations where they could have been seriously injured or killed. It was particularly surprising when one worker sounded very nonchalant and stated how he was accepting of how dangerous his job really was. I have always heard the saying, “miners are tough”, but I did not truly understand until hearing the stories from some of the participants.

This entire research experience has been incredible and informative. After conducting an interview, some of the participants would stay and discuss more about their personal experiences in the mining industry. At this point, we had finished the interview and the recorders were off. This was unfortunate because some of the participants would continue to share more experiences about their personal lives. However, I was grateful that I had helped to create a positive rapport and safe space for sharing information about their personal lives. Overall, this experience provided an entirely new perspective about these workers and I am very grateful they shared their stories with me.

## 4.4 Study Strengths and Limitations

The aim of this study was to explore if, and how, some underground workers perceived their rotating shift schedule to impact their health and wellbeing. One of the gaps evident within the Canadian mining literature is the limited qualitative studies investigating the perceptions of workers in the mining industry. Therefore, a strength of this study is addressing one of the gaps within the literature as well as providing a unique study to the Canadian occupational health and safety literature.

Rather than utilizing a standard survey or questionnaire, the use of qualitative interviews allowed the researcher to explore narrative data that provided further insight into the participants' perceptions in greater depth (Alshenqeeti, 2014; Kvale, 2003). An additional strength to this study was the variety of participants included in this study (Creswell, 2013). A qualitative sample with a wide age range, different relationship status, and varied occupations allows the researcher to gain broader insight into a topic (Creswell, 2013).

With every research design comes limitations. The small sample size, qualitative methodology and participants recruited from one setting limits the transferability of the findings. However, transferability could have been enhanced if the sample had included more diversity, such as gender, ethnicity, and participants from a variety of companies. In addition, the use of social media in the recruitment process may lead to a biased sample as not all potential candidates have access to or use social media. Lastly, a potential selection bias may also be present in the current study, such as, the "healthy worker effect" (Li & Sung, 1999).

According to Lincoln and Guba (1985), ensuring credibility is one of the most important factors in establishing trustworthiness within qualitative research (Shenton, 2004). Therefore, to ensure credibility of this study, the first interview was coded by the researcher, and then the

thesis supervisor to ensure consensus among the themes emerging from the transcript (Creswell, 2013). Furthermore, tactics were used to encourage honesty from the participants (Shenton, 2004). Participants in this study were given opportunities to retract any statements throughout the interview as well as the permission to refuse to participate in the study at any time. Therefore, this study included participants who were willing to share their personal experiences.

To warrant dependability, this study was reported in detail, therefore, informing future researchers who wish to utilize the same design (Shenton, 2004). This study comprised of detailed sections of the research design and implementation; detail of the data collection as well as a reflective evaluation of the project. Lastly, to ensure confirmability, the researcher engaged in reflexive practice prior to and after the study was conducted (Shenton, 2004).

#### 4.5 Recommendations for Future Research and Practice

When undertaking the investigation of the perceived experiences of rotating shift workers on health and wellbeing, it is evident that there are some areas that require further research. Based on the findings in this study, it is evident that there is a perceived impact on health and wellbeing among some underground workers in Sudbury, Ontario. As this current study utilized a qualitative approach, it would be beneficial to conduct future research on the current state of underground workers' health in the same setting using a mixed-methods approach with a larger sample size. For example, future research could include a sample of shift workers and their spouses, and involve both qualitative interviews as well as a standardized survey, to further help understand the specific health issues these workers face.

Some of the participants involved in this study requested that their spouse also be considered for this study. In Australia, Gardner and colleagues (2018) conducted a similar study which investigated how the fly-in fly-out lifestyle impacted the mental health of the workers and

their partners. Future research should investigate the perspectives of both the shift worker, and their spouse, or children, to further understand the perceived effects of shift work. It may also be beneficial to study the perspectives of other important figures, such as supervisors and employers, to further investigate the impact of rotating shift work on perceived health and wellbeing in the mining industry, especially in Canada.

After analysis of this study, it became apparent that some participants perceived rotating shift work to have an impact on their family wellbeing. Future research utilizing larger samples in addition to using a validated survey or questionnaire, should be conducted to further investigate family wellbeing of shift workers in the mining industry. In addition, researchers should also investigate which specific shift schedules have the most and least impact on the wellbeing of the family (Karhula et al., 2016). To date, it appears as though limited family wellbeing research has been conducted within the minerals industry in Canada and therefore it would be advantageous to continue research in this area.

The small sample size and qualitative methodology leads to lack of transferability of these findings. However, based on the findings in this study, future practical recommendations can still be provided.

With the goal of improving the health and wellbeing of shift workers, some changes could be implemented at the employer level. Very few participants in this study stated that the company they worked for provided a workplace wellness program. It may be beneficial for employers to provide training and education about the impacts of shift work as well as achievable coping strategies to help with managing symptoms associated with shift work (Arlinghaus et al., 2019; Health and Safety Executive, 2006). A fit and healthy worker may be

more resistant to stress and illness and may develop an increased tolerance to shift work (Fullick et al., 2009; Harrington, 2001; Health and Safety Executive, 2006).

In addition to the adverse effects shift work has on an individual, many of the participants in this study also disclosed that their rotating shift schedule had an impact on family wellbeing. Employers should therefore consider training and education for not only the workers, but the family members as well (Arlinghaus et al., 2019). For example, in Australia a group of health professionals created a support website titled “Mining Family Matters” (Ranford & Anderson, 2010) with the aim of helping families cope with a family member employed in the mining, gas and oil industry (Arlinghaus et al., 2019). This free website provides educational material and other resources to help families balance work and family life, especially for those employed in the fly-in fly-out industry.

Some participants in this study explained how they would save on the cost of daycare as they would take responsibility for their children while they were off work, even if that meant they would lose sleep before working a night shift. However, from a health perspective, these workers should consider prioritizing their sleep above anything else (Imes & Chasens, 2019). If possible, shift workers should choose other daycare options for their children. In addition, shift workers should plan domestic duties around their shift schedule and aim to complete these tasks outside of their sleep schedule (Health and Safety Executive, 2006). Obtaining sleep is important for the wellbeing of shift workers (Costa, 2003a).

It is common for there to be some family conflict among shift workers and their family members (Costa, 2016). For instance, some of the participants in this study revealed that they had past relationships with a partner who was not supportive of their shift work schedule. Other participants shared that their young children would miss them during their shift runs. For an

individual working shift work, it is important to talk with family members about their experiences working shift work, which may help family members understand the problems they may face (i.e., lack of sleep, fatigue, changes in mood) (Costa, 2010; Health and Safety Executive, 2006). Communication between the shift worker and their family members may help foster a more supportive and considerate family environment, which may also help improve the shift workers' tolerance with shift work (Costa, 2003a).

Arlinghaus et al. (2019) indicated that the range of workers and their social and family lives are so diverse that there is no "one size fits all" preventative strategy. Therefore, the coping strategies implemented by the workers will be individualized based upon the worker's priorities and needs (Fullick et al., 2009). Providing workers with a variety of tools and resources may empower workers to try different coping strategies that may ultimately help improve their own personal health and family wellbeing.

As previously stated, when workers feel as though they can no longer tolerate or cope with shift work, it is likely they will leave the industry (Akerstedt et al., 2010; Paim et al., 2008). It is also important to mention that some workers may be exempt from shift work, especially if it involves night work (Costa, 2003b). Examples of conditions that may exempt an individual from working shift work, includes: chronic sleep disturbances, severe gastrointestinal disease, ischaemic heart disease and severe hypertension, insulin-dependent diabetes, thyroid and suprarenal pathologies, epilepsy, chronic anxiety and depression, chronic renal impairment, malignant tumours and pregnancy. However, according to Costa (2003), advances in clinical diagnosis, pharmacology and rehabilitation, have lead to improved treatment of some of these aforementioned conditions. These advancements could allow workers to remain on shift work

permanently, especially in cases where being transferred to a day shift may be problematic for a company, or in a case where an individual may have personal resistance to changing their job.

## 4.6 Conclusions

This thesis aimed to explore the perceived impact of rotating shift work on health and wellbeing among underground workers in Sudbury, Ontario. After reviewing the mining literature in Canada, it appears as though very few qualitative studies have been undertaken that have investigated the perceived health status of these workers. This current study has filled this gap and will be a unique addition to the Canadian occupational health and safety literature.

Based on these findings, it is evident that the participants perceived there to be challenges and benefits related to their health and wellbeing while working on a rotating shift schedule in the underground environment. Many of the participants revealed that they enjoyed working shift work, however they also admitted that shift work does have an impact on their health and wellbeing, as well as an impact on their family wellbeing. Researchers are becoming more aware of the adverse health conditions among workers in the mining industry (Berriault, Lightfoot, Seilkop, & Conard, 2017; Considine et al., 2017; Dillman, 2019; Gardner et al., 2018; Lightfoot, Berriault, Seilkop, & Conard, 2017). Although this study cannot say for certain that shift work is the cause of all perceived health issues outlined in this study, it can assist in providing the foundation for future research to continue in this industry to help improve the health of these workers.

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## Appendix A – Laurentian University Ethics Approval

**APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS**

Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New <input checked="" type="checkbox"/> / Modifications to project / Time extension	
<b>Name of Principal Investigator and school/department</b>	Chelsea Villeneuve, Leigh MacEwan, SW, Michel Lariviere, Human Kinetics, co-investigators, supervisor Nancy Lightfoot, CRaNHR
<b>Title of Project</b>	Exploring the Impact of Rotating Shift Work on Health and Wellbeing in Underground Workers
<b>REB file number</b>	6013945
<b>Date of original approval of project</b>	October 3 <sup>rd</sup> , 2018
<b>Date of approval of project modifications or extension (if applicable)</b>	January 14, 2019
<b>Final/Interim report due on:</b> <i>(You may request an extension)</i>	October 3 <sup>rd</sup> , 2020
<b>Conditions placed on project</b>	Please note that annual reporting <b>on the due date</b> is required as a condition of ongoing LUREB approval.

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate LU REB form. In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best wishes in conducting your research.

A handwritten signature in blue ink that reads "Rosanna Langer". The signature is fluid and cursive, with the first name "Rosanna" and the last name "Langer" clearly legible.

Rosanna Langer, PHD, Chair, *Laurentian University Research Ethics Board*

## Appendix B – Interview Guide and Demographic Questions

### *Interview Guide*

1. Tell me about your current job and what is it exactly that you do?
2. What do you like?
3. What don't you like?
4. Does shift work affect your life outside of work?
  - Tell me more about\_\_\_\_\_.
  - Can you describe \_\_\_\_\_ in more detail?
5. Does your rotating schedule affect your sleep?
  - How?
  - Can you go into more detail about \_\_\_\_\_?
6. How does shift work effect your life?
7. What helps you to deal with working shift work?
  - Why?
  - How?
8. Do you have any suggestions for your company to improve your health and wellbeing at work?
9. Is there anything else you would like to add?

### *Demographic Questions*

1. How old are you?
2. What is your current marital status?
3. Do you have children?
  - If yes: Do your children currently live at home?
4. How long have you worked in the mining industry?
5. How long have you worked in your current position?
6. What is your current shift schedule for this job?
7. Which shift schedule do you prefer to work?
8. How long have you worked this schedule?

## Appendix C – Letter of Information and Consent Form

Letter of Information/Consent Form**Title of Research Project:**

“Exploring the Impact of Rotating Shift Work on Health and Wellbeing in Underground Workers”

**Principal Investigator of this study:**

Chelsea Villeneuve, Student in Master of Interdisciplinary Health program, School of Rural and Northern Health, Laurentian University, Sudbury, Ontario.

**Email:** cvilleneuve@laurentian.ca

**Purpose of the Research:**

The purpose of this research study is to explore the impact of rotating shift work on health and wellbeing of underground workers. Participants will be individually interviewed and may describe physical, emotional, mental, social, financial, or other areas of their personal lives. The goal of the research is to better understand the experiences of working shift work with anticipation of the results to inform the value of wellness policy and/or programming in the mining industry.

**Description of the Research:**

Research has shown that working shift work, as well as being employed in the underground mining industry, may increase the risk of a number of associated negative health issues.

If you consent to an interview, you will be audio recorded during the interview and after that the information will be typed. Audio recordings will be erased permanently once typed, and no identifying information will be kept in the typed information. Fictional names will be used instead of your real name.

**Potential Discomforts/Inconvenience:**

We do not anticipate there being any discomforts or inconveniences associated with participation in this study. However, there is still the potential that you may feel uncomfortable, embarrassed or upset in talking about your thoughts or experiences. You do not need to discuss or answer any questions that make you feel uncomfortable or that you do not want to answer. In the case that you become upset or need medical attention, please see a list below of mental health providers. If you do not participate in the study, it will in no way affect the future research relationships with the research team.

## **Mental Health Resources**

- Crisis Intervention Services
  - 705-675-4760 or 1-877-841-1101
- Ontario Mental Health Helpline
  - 1-866-531-2600
- Employee Family Assistant Program
  - Contact James Joudrey – 705-698-9613

## **Potential Benefits:**

If you agree to participate in this study you will receive a \$20.00 gift card before the interview begins. In addition, you have the opportunity to describe your experiences working shift work, with the potential of results of this study informing future wellness policy and/or programming in your workplace.

## **Confidentiality:**

By signing this consent form, at the time of the interview, you agree to participate in this study that explores how you feel shift work impacts your personal health and wellbeing. Ensuring your privacy and confidentiality is our primary concern. No personal information about who you are will be given to anyone or be published. Only group information will be summarized and fictional names will be used in the results.

There will be exceptions to confidentiality including: potential harm to self or others, child abuse, abuse from health care practitioner, and court order/subpoenas. If threat is immediate, the researcher will call 911.

The results produced from this study, including the audio recordings, will be locked and stored in Centre for Research in Occupational Safety and Health research lab in the Ben Avery building, on the Laurentian University campus. All of the typed information will contain fictional names. These typed documents will be stored on a password protected computer and in a location that has been approved by Laurentian University. Following the typing of the audio recordings, they will be permanently erased. Upon completion of this research study, all transcripts will be deleted.

## **Participation:**

Participation in this study is strictly voluntary and you have the right to withdraw at any time without penalty or consequence. In addition, you are able to retract any statements throughout the interview if you wish.

## **Information about the study results:**

You will be given a summary of the study's results as well as website links to any published academic articles.

## **Interview Process:**

Chelsea Villeneuve, the primary investigator of this study, will be performing the interviews. Interviews will be conducted at an agreed upon location in Sudbury, such as the United

Steelworkers Local 6500 hall, a participant's home or a local public library, and will last approximately 60 minutes. This study is aiming to recruit approximately 12-15 participants.

If you have any further questions or concerns, please contact:

Chelsea Villeneuve

[cv\\_villeneuve@laurentian.ca](mailto:cv_villeneuve@laurentian.ca)

**Toll-Free: 1-888-206-5795**

**Research Project Supervisor:**

Dr. Nancy Lightfoot

[nlightfoot@laurentian.ca](mailto:nlightfoot@laurentian.ca)

**1-800-461-4030 Extension 3972**

This study has been reviewed and approved by the Laurentian University Research Ethics Board on October 3<sup>rd</sup>, 2018. If you have any concerns or questions about your rights as a participant or about the way the study is conducted, you may contact:

Research Ethics Officer

Laurentian University Research Office

Telephone: 705-675-1151 ext. 3213 or toll free at 1-800-461-4030

Email: [ethics@laurentian.ca](mailto:ethics@laurentian.ca)

**Please sign below at time of interview:**

*I agree to participate, as described, in this study.*

Participant Signature: \_\_\_\_\_

*As a participant in this study, I agree to be audio recorded during the interview*

Participant Signature: \_\_\_\_\_

Name of Study Participant (please print): \_\_\_\_\_

Date: \_\_\_\_\_

If you wish to receive a summary of the research findings at the end of the study, please include your email address below:

\_\_\_\_\_

Thank you very much.

## Appendix D – Inclusion and Exclusion Criteria

### **Participants**

Below are the inclusion criteria for this study:

- Individuals must be English-speaking
- Individuals must be working full-time hours (30 hours or more per week) in an underground setting (Statistics Canada, 2011)
- Must be on a rotating shift schedule for at least one year (van Amelsvoort, Schouten, Maan, Swenne, & Kok, 2000)

Below are the exclusion criteria for this study:

- Individuals working part-time, casual, on-call or those on a fixed day, fixed afternoon, or fixed night schedule
- Individuals on a leave of absence from work (Dekkers-Sánchez, Wind, Sluiter, & Frings-Dresen, 2010)