Shift Work: The difference is night and day. Do fewer rotations between day and night shift reduce sick time and improve performance in police officers?

Shift Work: The difference is night and day. Do fewer rotations between day and night shift reduce sick time and improve performance in police officers?

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Abstract

This study explores the relationship between shift schedule and health/productivity outcomes in policing. More specifically this research will explore whether a schedule with fewer rotations from day shift to night shift will result in differences in certain outcomes such as sick time usage and productivity when compared to a schedule with more frequent rotations from day shift to night shift.

Police work involves responding to stressful situations and managing those situations effectively in a very short period of time. The resolution of these situations often has lasting effects on the people and communities that are involved. It is in the public interest that police have the training and support needed to manage these situations effectively. One of the most challenging aspects of police work is the schedule. Most police work involves some manner of shift work in which police officers rotate between day and night shifts on a regular basis.

The focus of this research is on the frequency of switching between day and night shift. Is a 12-hour shift schedule with fewer rotations between day shift and night shift more advantageous than a schedule with more frequent rotations? Our hypothesis is that a schedule with one monthly rotation between day and night shift will result in less sick time and better productivity than a schedule which rotates twice a month. This study was quasi experimental in design and analyzed aggregate data from a New Jersey State Police Station which worked both schedules in recent years. Results of this study showed that that NJ State Troopers who rotated from day shift to night shift monthly utilized less sick

time and had greater productivity than NJ State Troopers who rotated from day shift to night shift biweekly. This is the first study of its kind to compare frequency of shift rotation from day shift to night shift in a standard 12-hour shift schedule. Most research to this point has focused on shift length. The significance of this research is that it is in the public interest to have police who are in optimum physical, mental and emotional health since these factors will affect their interactions with the general public. In the current environment where the relationship between the police and the general public is strained, having an optimal shift schedule may alleviate some of the stressors associated with police work and reduce some of the undue tension between police and the communities they serve.

Dedication

I would like to dedicate this thesis to all the men and women of law enforcement who work tirelessly around the clock to keep us safe, often to the detriment of their own health and well-being, while trying to navigate the tricky waters of work, home and all other aspects of their lives.

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I would like to thank my family for their support, especially my wife Lauren and my daughter Paige. Without their constant enthusiasm and tireless support, I simply would not have been able to complete this project. I would also like to acknowledge the tree that didn't hit me.

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Chapter I

Introduction

> "It is totally reprehensible that the cops we expect to protect us, come to our aid, and respond to our needs when victimized should be allowed to have the worst fatigue and sleep conditions of any profession in our society." William C. Dement, M.D., Ph.D.

The introduction of the compressed work week (CWW) has been steadily increasing with the advent of the twenty-four-hour world we are all experiencing. Technological and industrial advances have made it possible, profitable and in many cases necessary to increase production at a rate never seen in modern history. The industries involved in this 24-hour work cycle are almost too long to list. Shipping and transport services such as Amazon, UPS and FedEx operate around the clock allowing people to have almost instantaneous access to goods and services. Other examples are chemical and manufacturing plants, long haul freight airlines, mining operations, hospitals, police/fire and other emergency services. Technology has made it possible and often necessary to conduct business not only globally, but around the clock. This has led to a dramatic spike in non-standard work schedules, also known as shift work schedules, to ensure necessary coverage.

What exactly is shift work?

So, what exactly are we talking about when we refer to shift work or non-standard work hours? Shift work (SW) can be defined as an arrangement of work hours that uses two or more teams to cover the time needed for production (Natvik et al., 2010). It

includes anything other than the typical daytime hours worked between 7:00am and 6:00pm (Grosswald, 2003). Shift workers have a defined schedule that starts and ends at a certain time, to provide continuous and often round the clock coverage. Shift may vary in length, but typically fall into the parameters of three 8-hour shifts, or two 12-hour shifts.

Shift work in Policing

One service occupation where shiftwork is necessary is emergency services such as Police/Fire/EMS. There are nearly 18,000 law enforcement agencies and 800,000 police officers in the U.S (Scism, 2017). The negative effects of night and rotating shift work on police officers is especially significant because of the relationship that police have with the public and the communities they serve. Police are charged with maintaining order and protecting the public at large. They are often required to make split second decisions that have a lasting and immediate impact on the lives of people they encounter. Any negative physical and psychological effects that a shift schedule have on the police can easily trickle down to their interactions within the communities that they patrol. Police officers are often put into stressful situations where they make decisions with outcomes that could affect their own health and safety and the public. Vila (2006) describes in plain language that like the rest of society, police are more likely to crash cars, make bad decisions and be cranky when they are tired. However, unlike the general public, tired and cranky cops are especially problematic because of the scope of their duties and powers.

Although we do not generally associate mental illness with police work, there is a prevalence of mental illness in law enforcement. Mental illness is the leading cause of

early retirement in police officers (Summerfield, 2011). It is widely known that law enforcement has relatively high rates of suicide compared with the general public. This is generally believed to be due to the rigors of the job, the stress associated with seeing traumatic events on a regular basis and their proximity to firearms. There is evidence to suggest that this may be related to working shift work, especially for female officers. In a 2008 study on the relationship between shift work and suicidal ideation among police officers, Violanti et al. (2008) reported an increase in suicidal ideation related to increased working hours. Most notably, among women in law enforcement, as the number of work hours increased, so did suicidal ideation.

Because of the inherent dangers of shift work, the Federal Government has stepped in to control the work schedules of many industries such as truck drivers, commercial pilots, train conductors, nuclear power plant operators and medical residents. This type of regulation has been proved beneficial. However, they have not yet stepped in to monitor and regulate working hours in law enforcement, and police officers often push their own physical limits with normal working hours and overtime. In fact, data on police working hours with regard to overtime is scarce (Vila, 2000). To provide an idea of the scope of this problem, local media outlets have often reported on extreme cases where police officers work up to 3000 hours of overtime a year, for several consecutive years (Vila, 2006). In one example, the Boston Police Dept. in 2005 began enforcing a long-standing rule that officer could not work more than 96 total hours per week. That equates to 7 straight days of more than 13 hours. Within 6 months, 85 officers had been disciplined for violating this rule. Whether voluntary or involuntary, police officers often push themselves beyond what would be considered pragmatic and safe.

Unfortunately, the consequences of negative interactions between the police and the public can be catastrophic. We have seen the recent escalation of tension between law enforcement and the public, exemplified in such recent events as the murder or George Floyd, which ignited a firestorm of protests and confrontation between law enforcement and the public that lasted well into the fall of 2020. Those confrontations created a great deal of tension between police officers and the public and a huge expenditure of resources. In a 2011 study on sleep disorders, health and safety in police officers, Rajaratnam et al. (2011) found that of those officers who screened positive for any sleep disorder, 34.1% reported having uncontrolled anger towards a citizen or suspect. This compared with 28.5% of those who did not screen positive for sleep disorder. In the same study, of those who screened positive for a sleep disorder, 11.2% had received citizen complaints, compared with 9.4% of those who did not screen positive for a sleep disorder.

This stress and anxiety have been exacerbated by the current Covid-19 epidemic. Although the threat of biological hazards has long been present (HIV, Hepatitis C, fentanyl exposure) Covid-19 has added a new dynamic to the dangers of policing. More police officers died in 2020 and 2021 from Covid-19 alone than were killed in the line of duty during the entirety of 2019 (ODMP, 2022). For this reason and many others, it is crucial that reasonable measures be taken to put police officers in a position to perform at an optimal level and make sound lawful decisions including a review of shift schedules. In a hypothetical but not unlikely scenario, a bad call by a cop which was exacerbated by negative physiological and psychological effects of shift work, could result in nationwide protests which could not only lead to other safety hazards, but in the time of Covid-19,

increased health implications as well. Research has even shown that sleep deprivation can impact brain function. fMRI brain scans have shown that sleep deprivation can alter the connectivity between the prefrontal cortex and amygdala which controls emotional regulation, especially to aversive stimuli (Yoo et al., 2017). Optimal brain function is crucial to law enforcement. It is for these reasons and countless others that we investigate all areas that could improve performance in policing, one of these being a comprehensive review of shift schedules.

Circadian Rhythm: The Body's Clock

There are significant challenges that arise with a schedule that conflicts with our body's natural biological rhythm. Research has demonstrated that humans have not evolved to work nonstandard shift schedules, as our own biology has adapted to changes with the light cycle. This internal regulatory clock is called our circadian rhythm. It has evolved as we have evolved over tens and hundreds of thousands of years (Wright, Bogdan, & Wyatt, 2012). Challenging the body's natural tendency to be awake during daylight hours and to sleep at night can cause circadian misalignment where our bodies natural sleep/wake cycle no longer line up with the light cycle. One possible result of this is that our bodies are no longer able to follow a pattern of day wakefulness followed by night sleepiness.

Realignment of our circadian clock can take several weeks which is especially problematic for rotating shift workers because by the time their bodies begin to adjust to one shift, they rotate to another (Bambra, Whitehead, Sowden, Akers, & Petticrew, 2008). It has been estimated that it takes one day per hour of shift change to adjust to a new schedule (Price, 2011). For example, adjusting from a day shift (6am-6pm) to a night

shift (6pm-6am) would take twelve days, one day for every hour of the change (Villa et al., 2002). This has created large body of controversy for shifts that rotate too frequently from day to night. According to current research, police officers are half as likely to get enough sleep (at least 7 hours) at night and more than twice as likely to get far too little (less than 6.5 hours) sleep, when compared to other shift workers. This sleep deprivation can affect everything from cognitive function to reaction time. When reaction time measured by pupil dilation was analyzed in a sample of police officers using the FIT Workplace Safety Screener, they were found to have a failure rate six times higher than found among shift workers at heavy industrial plants. (Vila et al., 2000).

The Origins of Shift Work

The concept of shift work arose during the late nineteenth and early twentieth century during the industrial revolution. Bright, artificial light made it possible for factories to remain open long after nightfall (Phillips & Houghton, 2007). Instead of working six or seven shorter workdays weekly, the concept of weekends evolved. People were able to work for longer periods of time during the week and enjoy leisure time on Sunday. This leisure eventually drifted into Saturday as well, which became the modern-day weekend. After World War II, there was a growing need for round-the-clock workers in many industries. Once it became expected that certain professions would have 24-hour coverage, various industries had to find ways to produce this coverage. For example, nurses began working twelve-hour shifts in the 1970's during a national nursing shortage to ensure round the clock coverage. Now, over 75% of hospital nurses work twelve-hour shifts (Townsend, 2013).

It is estimated that as much as 15-20% of the full-time work force in the United States, work shift work schedules. That includes the 8 million that regularly work overnight, and the 20 million who start work unusually early, between 2:30 and 7:30 am (Barger et al., 2012). In families with two working parents and children under the age of 15, 51% include at least one parent working non-standard shifts (Grosswald, 2003). Most relevant to the current investigation, it is estimated that at least 2.5% of the U.S. workforce work on a rotating shift schedule where the hours rotate between day and night shift in the case of 12-hour shifts, or day, evening and night shift in the case of 8-hour shifts (Kalmbach, Pillai, Cheng, Arnedt, & Drake, 2015).

12 Hour shift: Advantages to Shift Work

There are also numerous advantages to shift work schedules. Some of the advantages include increased industrial production and constant coverage for the industries that require such coverage. For example, it is crucial to have Police/Fire/EMS coverage outside of normal working hours. One of the most prevalent shift schedules used in policing is a 12-hour rotating shift schedule in which two 12-hour shifts provide 24-hour coverage. The utility of this schedule lies partially in its simplicity. There are only two daily shifts to manage and supervise and find coverage for to provide 24-hour coverage as opposed to 8-hour shifts which require managing three shifts per day, or 10-hour shift which creates overlap. Ironically there is a large body of research that supports 10 hour shifts as the most beneficial for workers, particularly law enforcement (Bell et al., 2015).

Some of the advantages reported by shift work employees include fewer workdays which translates to more time with family and friends. In a study of 924 BASF

chemical plant workers, Yong et al. (2010) utilized a measure call the Work Ability Index (WAI) to investigate if there were differences in workplace satisfaction and work performance between workers on different 12-hour shift schedules. This self-administered questionnaire utilizes scores tallied from seven dimensions to arrive at a total score between 7 and 49. The higher the score, the higher perceived work ability. Demographic information such as age and gender were also collected. The researchers found that working night and rotating 12-hour shifts produced no significant difference in scores on the Work Ability Index (WAI) from day shift workers and that workers enjoyed having more time off and fewer commutes to and from work (which also saved on commuting costs). As with all self-report questionnaires social desirability bias cannot be ruled out. Some workers may answer a certain way out of concern that their responses if disclosed would reflect negatively on them in the workplace.

Similarly, Karhula et al. (2016) studied sleep and work/life satisfaction in 599 predominantly male Finnish industrial employees working a combination of 8- and 12-hour rotating day/night shifts. Scandinavian nations are notorious for their research on shift work as much of their industry relies on it. These workers were given a questionnaire addressing demographics, self-rated health and sleep habits. What they found was that 12-hour rotating shift workers slept better and perceived better work life balance than their 8-hour counterparts. Again, as with all self-reports, biased reporting cannot be ruled out.

The 12-hour Shift: Disadvantages in shift schedules

Other studies have found that 12-hour workdays especially those that include rotating or night shifts can have negative effects on performance, accident risk and

increased sleep disturbances. In 2008 study of sleep and fatigue in shift workers at an Australian mining and smelting operation, 20 shift workers were monitored for a 14-day period. They were working a 12-hour shift schedule of two-day shifts, two-night shifts, and four days off also known as a fast rotation. They wore an activity monitor, kept a sleep diary and took a psychomotor vigilance task (PVT) before and after each shift. Post-shift fatigue was significantly greater than pre-shift fatigue, night shift fatigue was significantly higher than day shift fatigue, and cognitive performance declined on days three and four compared to days one and two (Baulk et al., 2008). In a meta-analysis of sleep loss and fatigue, Akerstedt and Wright (2009) point out that night shifts can have pronounced negative effects on sleep, work performance and accident risk. Errors in tasks such as meter reading peak during the night shift (Bjerner, Holm & Swennson, 1955). Data from car manufacturers indicate a 30-50% increase in accident risk at night (Smith, Folklard & Poole, 1994). In fact, limiting medical interns to 16 consecutive hours of work and 60 hour of work per week dramatically cut down on medical errors (Lockley et al., 2004).

In a review of observational studies on shift schedules, Sallinen and Kecklund (2010) observed that shifts greater than 16 hours and weekly working hours greater than 55 hours result in reduced sleep in the same way that quick returns to work did. Twelve-hour shifts have also been associated with increased sick time when compared to eight-hour shifts. In fact, hospital workers scheduled for 12-hour shifts have been shown to be 24% more likely to miss that shift than those scheduled for eight-hour shifts.

The prevailing body of research is mixed on whether a 12-hour shift schedule is more beneficial or detrimental to the shift worker. Research has shown that workers like

longer shifts because it gives them more days off. Research has also shown that a longer shift can risk fatigue, safety and performance issues especially during the later hours. These detriments become even more pronounced during night shifts and rotating shifts. More research is needed to determine whether the advantages of a 12-hour schedule vary by job function or person to person. Age can be a factor. In a study of workers at a steel-rolling mill, Rosa et al. (1996) found that of those working night shifts, workers over age 40 slept an average of 1.2 hours per night less than workers under the age of 40. Given changes in sleep duration with aging, this may not be directly related to shift work.

Research has shown that people tend to sleep less as they enter middle age, however it also suggests that older night shift workers may not be as well rested as their younger counterparts. A laboratory study of neurobehavioral performance in younger (<35 years old) and older (>45 years old) shift workers demonstrated that the older shift workers had lower average cognitive performance at the end of the shift than the younger group, and significantly lower cognitive performance at the end of the night shift than the younger group (Kandelaars et al., 2006). The declining performance in 12-hour shifts as people age was also supported by research conducted by Reid and Dawson in 2001. In this laboratory study simulating neurobehavioral performance in 12-hour shifts between young and old shift workers, a group of young (mean age 21.2 years) shift workers were compared to a group of older (mean age 43.9 years) shift workers. Both groups completed a simulated shift work schedule of two consecutive 12-hour day shifts followed by two consecutive 12-hour night shifts. Performance for the older subjects was consistently lower than for the younger subjects and there was a significant difference between older and younger subjects across the shift. This was most pronounced during

the first night shift when both groups had been awake significantly longer due to the schedule change. In addition, younger subjects were able to maintain their performance throughout both day and night shift better than the older subjects. It should be noted that baseline performance differences between the age groups were not accounted for.

Time between shifts is also critical. Night and early morning shifts associated with quick returns to work result in shortened sleep and increased sleepiness (Sallinen & Kecklund, 2010). Tucker et al. (1998) found that in a sample of British Industrial workers working 12-hour shifts, those that had at least 24 hours between consecutive shifts reported slightly higher levels of alertness and longer sleep, as well as lower chronic fatigue. Similarly, in a study of train conductors, Roach et al. (2003) found that those who had less than twelve hours between shifts reported sleep lengths of 3.1-7.9 hours. Those who had at least 24 hours between shifts never reported sleeping less than 6.8 hours.

12 Hour Shift Conclusions

It is still unclear whether 12-hour shifts are more beneficial or detrimental overall. There is research demonstrating the adverse effects of extended shifts such as decreased reaction time, alertness and performance as well as increases in drowsiness fatigue and work-related accidents. There is also evidence suggesting the long-term negative health impacts of 12-hour shifts. There are also studies suggesting that 12-hour shifts are beneficial to the health and well-being of workers, increasing sleep quality and alertness, as well as lowering commuting costs and increasing time spent at home with family and friends. There are other studies that indicate no significant difference at all between 12-hour shifts and other shifts of different lengths. Clearly the ongoing debate into whether

12-hour shifts are a good thing, a bad thing, or not really a thing at all is inconclusive and further investigation is needed. The reality is that 12-hour shifts are very prevalent in industrialized nations and warrant further investigation.

Loudon and Hawley (2001) point this out based on reviewing literature on the growth of the 12-hour shift in the Australian economy. Employers talk about how 12-hour shifts are a "win win" situation for employers and employees because they increase free time for employees and reduce travel time and travel costs due to fewer working days which results in increased worker morale and a better quality of life outside of the workplace. Loudon asserts that there is little doubt that profitability and productivity are the primary concerns of corporations, not the quality of life of its employees. Twelve-hour shifts offer considerable cost savings for employers when compared to 8-hour shifts. Some of the reasons for this are fewer startup and shutdown procedures and minimizing administrative costs of designing rosters. Fewer shifts also reduce the need for overtime costs and fewer opportunities for absenteeism by workers. In fact, a managerial review of Australian work scheduling showed that only 11% of the reasons for work schedule design were employee focused. The other reasons were related to things like cost, productivity, customer service, increased capacity, increased sales/growth, all of which clearly focus on the employer (Loudon & Hawley, 2001).

Shift Work Disorder

Shift work disorder (SWD) is classified as a circadian rhythm sleep disorder that is marked by excessive sleepiness during waking hours, and difficulty falling or staying asleep (Wright, Bogdan, & Wyatt, 2012). Researchers have estimated that at least 10% of workers on night or rotating shifts are suffering from shift work disorder. This number is

likely drastically underestimated due to the lack of adequate screening tools (Barger et al., 2012). The minimal criteria for shift work sleep disorder are either insomnia or excessive sleepiness that are temporally associated with working during the non-habitual sleep phase (Drake et al., 2004).

In a study of 2570 workers in the Detroit area, Drake et al. (2004) found that 32.1% of night and 26.1% of rotating shift workers met the criteria for shift work sleep disorder (SWSD). However, the study also found that 18% of day workers reported one of these symptoms. The true prevalence of SWSD was approximately 10% of night shift workers. It should be noted that there could be numerous other reasons for these symptoms, some of which may have nothing to do with shift schedule and more to do with individual differences and tolerances.

It should also be noted that although excessive sleepiness and insomnia are the two most reported symptoms of shift work disorder, these symptoms are not unique to shift work and are common to patients with many other disorders, so researchers need to be aware of this. This is one of the limitations of studying the effects of shift work. It is not always easy to identify which negative factors are being caused by the adversity of shift work and which are being caused by other factors. Future research should focus on developing screening tools for these assessments. Therefore, efforts must be made to differentiate between those that are suffering from excessive sleepiness or insomnia due to shift work, and those who are presenting similar symptoms for other reasons such as problems at home or other health problems (Drake, Roehrs, Richardson, Walsh, & Roth, 2004). This will take time since the study of shift work related disorders is a relatively new field as shift work itself is a relatively new phenomenon.

There is recent evidence to suggest the predictability of shift work disorders based on individual sleep reactivity. In a study by Kalmbach et al. (2015), 96 normal sleeping non-shift workers were examined over a period of three years. These workers were screened for any pre-existing sleep disorders and were classified as either high or low sleep reactivity. A year into the study the workers were changed to a rotating shift schedule. They were then assessed for shift work disorder. What was found was that highly sleep reactive individuals were five times more likely to develop shift work disorder than those with low sleep reactivity. There were 18 new cases of shift work disorder after switching to rotating shifts, which was 18.8% of the original sample. Interestingly, almost 90% of the workers who developed shift work disorder were identified initially through the screening process as being high risk (Kalmbach et al., 2015). This research suggests that there may be ways to predict those mostly likely to react negatively to different shift schedules and develop interventions to assist them.

This research also demonstrates the significant effect that rotating shift work can have on a population of normal sleepers who might otherwise never have had problems if they stuck to their daytime work schedules. The study also showed an elevation in symptoms of depression and anxiety in shift workers who met the criteria for shift work disorder. Although baseline sleep reactivity did not correlate directly with depression and anxiety, it was shown that shift work disorder did act as a mediator between sleep reactivity and depression/anxiety (Kalmbach et al., 2015).

These symptoms are more acute in night and rotating shift workers than in day workers. Night workers are shown to be in a state of chronic sleep debt, where they are constantly trying to play “catch-up” and often never do. There is also often a reduction in

sleep efficiency and mean total sleep time for night and rotating shift workers. Not only are shift workers getting less sleep, the sleep that they do get is not as beneficial. In fact, rotating shift workers who exhibited both insomnia and excessive sleepiness missed work significantly more often than day shift workers with the same symptoms (Drake et al., 2004). Of the participants who screened positive for at least one sleep disorder, Rajaratnam et al. (2011) found that 26% reported absenteeism in the preceding month compared with 20.9% of those who screened negative for sleep disorder. One of the topics this research explored was the relationship between shift schedules and absenteeism.

Shift Work and Sickness Absence/Productivity

The relationship between shift work and sick absence is drawing a lot of interest in contemporary research. There are many reasons for this. One of the most obvious is that sick time costs money. One factor that contributes to sick absence is obesity. The average obese worker costs 27.4 % more than their normal weight counterparts for a myriad of reasons (Goetzel et al., 2012). The cost of employee related absenteeism in the US has been estimated at $ 225 billion annually (Stewart et al., 2003). When a shift worker calls out sick, their productivity is negated. This may require operating short staffed in many cases or calling in another worker to substitute for the absent worker. These “last minute” substitution often require payment at an increased or overtime rate due to union and other contractual obligations. Working short staffed can also result in safety concerns. This again adds to cost. Therefore, it makes sense that employers try to find ways to reduce sick absence including scheduling changes.

Another industry that utilizes shift work is the airline industry. This allows the airline industry to operate basically a 24/7 schedule. Pilots, ground crew and air traffic controllers are all essential to making sure an airline operates smoothly and ensure that they meet their stringent safety standards and remain profitable. Absent workers can jeopardize both. The research on shift work and sickness absence is mixed and evolving. In a Dutch study of airline ground crew, Van Drongelen et al. (2017), examined a group of 7562 employees working a day schedule, a two shift (12hr) schedule and a three shift (8hr) schedule. Using archival data between 2005 and 2009 they were able to compare the relationship between shift schedule and sick absence. They also analyzed the relationship between shift work and long-term sick absence which was defined as greater than 7 consecutive sick days. The average sick time was 26 days per worker and the average worker age was 45.4 years.

The results of the analysis did not show an increased association between shift work and sick absence when compared with day work. In fact, there was a negative relationship between shift workers and sick absence when compared with day workers. Only workers who transferred into a schedule that included night shifts from a day shift schedule showed an increase in long term sick absence. In fact, married employees and those with children had a reduced risk of long-term sick absence. This may be counter intuitive since there is other research showing that work-family conflict increases sick time due to responsibilities at home after a shift. There is a case to be made that shift work can lead to better outcomes than day work. It should be remembered that these results are not necessarily generalizable to other occupations that utilize shift work schedules. As was previously mentioned, The Netherlands and Scandinavian nations

utilize more shift work than other parts of the world, so workers may be more socio-culturally and physiologically suited to it. This sample was also more than 80% male and did not consider the role that gender differences may play.

There is currently little research on the gender differences between men and women with regard to shift work. This is no doubt due in part to shift work being historically male dominated in many fields except for nursing which is a historically female dominated field. Because of this there is little data comparing gender differences between male and female shift workers working side by side. This is a crucial topic because as women continue to play an increasing role in the workforce, especially in historically male occupations, a one size fits all approach may not be appropriate. As we strive to promote equality and equity in the workplace, we need to consider gender differences that may arise in shift work. Recent research has shown an increase in Health-Related Productivity Loss in female shift workers when compared to their male counterparts (Cho, Lee & Kang, 2020).

Cho, Lee & Kang (2020) also examined the relationship between shift work and health related productivity loss due to sick absence or productivity loss in a cohort of Korean workers. This study compared non-shift workers to shift workers as well as different types of shift work including fixed evenings, fixed nights, rotating shift, 24-hour shifts and split shifts. This study found significant productivity losses in shift workers compared to non-shift workers (2.5%, $p<.05$). The largest productivity loss was found in the night shift at 7.7% productivity loss. This study measured productivity loss related to absenteeism (missing work), as well as presenteeism (productivity loss while at work). Most of the productivity loss was attributable to absenteeism and this was more prevalent

among female shift workers. Interestingly, there was not found to be significant productivity loss due to absenteeism in the rotating shift cohort which is what my research focused on. However, shift rotations can take many different forms from shift lengths of 8, 10, or 12-hours, direction of shift either clockwise or counterclockwise and the amount of time at each shift before rotation. A rotation could mean a biweekly rotation, a monthly rotation, a semiannual rotation, or a quick rotation. In other words, due to the variability of rotating shift schedules, the particulars of each schedule must be clearly defined. At the very least this research shows that the relationship between shift work and sick absence warrants further investigation.

Current research is exploring whether work-family conflict (WFC) may or may not affect the relationship between shift work and sick absence. The idea is that if shift work makes balancing work and family more difficult, it would result in more sick absence. Norwegian researchers Jacobsen and Fjeldbraaten (2017) investigated this relationship in a sample of 1864 Norwegian hospital workers working shift schedules. Norway has generous social and sick time benefits when compared to other parts of the world. What they found was very interesting. Although there was no direct correlation between increased sick absence and shift work, through self-report questionnaires they discovered that shift work increases work-family conflict and decreases perceived health. What they also found was that the worse the perceived health of the worker, the more sick absence. There was an indirect effect of shift work on sick absence through perceived health.

Ropponen et al. (2019) assessed the relationship between shift work and sickness absence in a group of Finnish hospital employees by using objective payroll data. This

research targeted short terms sick absences which was defined as 1-3 consecutive days of missed work. The data analyzed was collected from payroll records between 2008 and 2015 and compared a sample of day workers (n=6225) to a sample of rotating shift workers (n=12,156). Strengths of the study were the large sample size and objective data which were not subject to the type of selection bias of self-reports. They found that the more consecutive night shifts an employee worked consecutively, the higher their rate of short-term sick absence. This was especially true for employees who worked greater than four consecutive night shifts. Another interesting finding was that short-term sick absence increased in employees who worked longer than 48 weekly working hours. This supports the wealth of research that longer weekly working hours contribute to missed work. As Jacobsen and Fjeldbraaten previously stated, this may contribute to work family conflict or a myriad of other reasons other than actual illness for utilizing sick time.

Another factor that was associated with increased sick absence were quick returns which were defined as less than 11 hours between consecutive working shifts. This quick return (also called short shift interval) has been shown to have a strong dose dependent relationship within the manufacturing industry as well. Previous research has found a significant reduction in sleep for workers who return to work quickly, forcing them to instead utilize sick time. This has also been shown to be true in retail and manufacturing (Rahman et al., 2020). This may be exacerbated by commuting times which cut down on potential sleep time. For employees with five or more quick returns to work in a 28-day period increased sick absence was also found. Future research should explore any interaction effect between these factors as well as any cumulative effect of multiple

conditions on employees. For example, what would be the significance of workers who had all three of these conditions? Would there be a multiplicative effect of missed work?

It is well documented that sick absence increases across the night shift, however this may be even more prevalent for populations of workers who are not in good physical health and thereby are less suited to cope with the rigors of the night shift and utilize sick time to recover. This relationship was uncovered in a study of 464 police officers in the Buffalo, NY police dept from 2004-2009. Not only was there an increase in sick time among cops working the night shift, but this relationship was significantly increased when body mass index (BMI) was factored in. For officers with normal BMI, sick absence did not differ significantly across day or night shift. However, for officers with a BMI greater than 25, the likelihood of sick absence on the night shift was significantly higher than for those working the day shift (Fekedulegn et al., 2013). This supports the premise that there may be an increased prevalence of sick time for shift workers who are in poor health. In a 2013 study of sick absence and work stress in Italian police officers, Magnavita and Garbarino found that low levels of support, reward and perceived control were associated with increased levels of sickness absence, while higher levels of effort and job demand were associated with increased total days lost (Magnavita & Garbarino, 2013).

Shift Work and Accidents

Not surprisingly excessive sleepiness during working hours creates safety concerns. Accidents like the Exxon Valdez oil spill in 1989 and the Chernobyl and Three Mile Island nuclear plant meltdowns were found likely to be fatigue related due to insufficient sleep and extended work hours (Akerstedt & Wright, 2009). Fatigue may

have also played a role in faulty decision making which contributed to the space shuttle Challenger disaster (Villa, Morrison, & Kenny, 2002). Momentary lapses in attention in industrial or transportation settings can have dire consequences. This also includes pilots and anyone who drives for a living.

The National Transportation Safety Board has found that 30-40% of all US truck accident are fatigue related and have by far the greatest likelihood of occurring at night (Akerstedt & Wright, 2009). In fact, hitting "rumble strips" while driving has been shown to only increase attention for 1-2 minutes before returning to original levels.

Approximately 30% of all fatal traffic and airline accidents are believed to be fatigue related (NTSB, 1999). For accidents at sea this number is believed to be around 20%. Altogether, work related accidents are believed to cost more than $40 billion in the US by some estimates (Akerstedt &Wright, 2009). In fact, conservative estimates put the cost of sleep deprivation and fatigue at over $ 100 billion annually or $10,000 per year per shift worker (National Sleep Foundation, 1999).

Workers on night and rotating shifts are more likely to be involved in work related accidents and to use more sick time than workers on either fixed day or night shifts (Bambra et al., 2008). This morbidity is not limited to the work setting. In samples of workers with already existing symptoms (insomnia/sleepiness, ulcers, cardiac issues) the addition of night or rotating shift work demonstrates a multiplicative effect in days of work missed when compared to day shift workers suffering from the same symptoms (Drake et al., 2004). Rajaratnam et al. (2011) similarly found that of the 4957 police participants, 26.1% reported falling asleep while driving at least once a month. This is a staggering statistic when considering how much driving police officers are required to do

both on and off duty. The Philadelphia Police Shift Rescheduling Program was a study conducted by Charles Czeisler examining different schedules in the Philadelphia Police Dept. A six-day 8-hour counterclockwise schedule that rotated every 8 days was compared with a 4-day 8.5 hour clockwise rotating schedule that rotated every 3 weeks. In addition to improvements in sleep quality, alertness, health and safety, on the job motor vehicle accidents declined 40 % in the 4-day 8.5-hour rotation when compared with data from the previous two years.

Workplace accidents and the productivity lost due to these accidents are costly expenses for industries to incur. It makes sense that reduction in time and production lost due to workplace accidents is worth exploring. There is evidence that workplace accidents can be reduced by adjusting the shift schedule. In an evaluation of sleep and performance at a Canadian underground mining operation, Hossain et al. (2004) compared a group of 500 miners who changed from a backward rotating 8-hour shift schedule to a forward rotating 10-hour shift schedule.

One finding was that the miners were very resistant to the new schedule at first, but a year later they preferred it compared to the original schedule. One of the interesting findings was in work hours lost due to accidental injuries at the mine site. In the year before the schedule change, there were 4400 hours lost due to workplace accidents and injury. In the year following the schedule change that number dropped significantly to 2206 hours (Hossain et. al., 2004). There could be numerous reasons for this drop however at the very least it warrants further exploration. A reduction in work related injuries could result in reduction in sick time as well.

Health Consequences of Shift Work

Humans have evolved to be alert and awake during daytime hours, and to sleep at night. One reason is that at night our body temperature decreases to aid in the onset of our sleep cycle. Our body also increases production of melatonin and other chemicals that aid with sleep (Wright, Bogdan, & Wyatt, 2012). At night we also produce very low levels of certain hormones such as cortisol, which the body produces during stressful or life-threatening situations and during daytime hours. Studies have shown that working through the night increases our body temperature and elevates the production of cortisol both of which are associated with daytime function and alertness.

There are numerous documented health consequences to shift work. The prevalence of gastrointestinal issues is one of the most consistent findings when studying disorders related to night and rotating shift work, especially when reporting peptic ulcers. Studies have shown that working night and rotating shifts increases the secretion of gastrin and pepsinogen which aid in digestion. Elevated levels of these can lead to increases in these ulcers (Drake et al., 2004). Further research should examine if the chemical composition of coffee and energy drinks which are presumably consumed more on night and rotating shifts also contribute to these gastrointestinal issues.

There is also substantial research to suggest a correlation between shift work and cardiovascular disease. Although Drake et al. (2004) were not able to link heart disease to excessive sleepiness or insomnia, there was a significant relationship between cardiac disease and night and rotating shift work even after controlling for BMI, high blood pressure, smoking status, diabetes and alcohol intake. In a recent study, 10 days of partial sleep deprivation resulted in an elevation of C-reactive protein which is an inflammatory

marker for cardiovascular disease (Drake et al., 2004). The cortisol awakening response (CAR) is characterized by a 40-75% increase in salivary cortisol levels which are highest approximately 30 minutes after awakening (Wirth et al., 2011). Shift schedules can disrupt these biological functions. This interferes with our body's natural urge to increase melatonin and decrease temperature in preparation for sleep (Touitou et al., 1990). Thereby we are fighting our body's natural urge to rest at night which is one of the reasons why workers on night shift often feel more malaise and lower levels of alertness and diminished cognitive function, commonly known as "brain fog." (Bambra et al., 2008).

Recent research supports that the worst circadian timing of a shift is when it is fully positioned at a time when we are biologically programmed to experience sleep (Postnova, Postnov, Seneviratne, & Robinson, 2014). When we deviate from this there are often physiological and psychological consequences that follow. These include but are not limited to health problems including sleeps disturbances, fatigue, digestive issues, depression, weight gain, cardiovascular disease and higher incidence of some cancers including colon cancer in men and breast cancer in women (Bambra et al., 2008). In fact, some studies have put the risk of developing cardiovascular disease as much as 40% higher in those working night or rotating shifts (Barger et al., 2012).

Social Consequences

There are also social consequences to working irregular shift schedules. Some of these include negative work/family spillover, including lower spousal satisfaction. Childcare can be negatively affected by shiftwork. The fatigue associated with night and rotating shift work is especially prevalent when a night shift is followed by parental

responsibilities during the day. This is especially prevalent with young children under the age of six (Grosswalde, 2003). Night and rotating shift workers are also more likely miss family and social functions, and to see their friends less often leading to a decreased life satisfaction in these areas. The negative social consequences associated with insomnia and excessive sleepiness were increased when night and rotating shift work were introduced. (Drake et al., 2004).

History of the New Jersey State Police

The New Jersey State Police was established 100 years ago in 1921 making 2021 the centennial year. The organization was originally established to provide law enforcement to the rural areas of the state. After the State Police Bill was passed in March of 1921 a class of 118 out of 600 applicants reported to Sea Girt, NJ for training. This is where the current State Police Academy is today. The New Jersey State Police Academy consists of 24-26 weeks of intense physical training in which the recruits live at the academy Monday-Friday. The academy is well known for its high physical standard as well as the challenging physical environment. Because the academy is located on the shoreline, workouts are conducted many times on the sand with long runs through the sand and surf. The wind off the shoreline can be intense. Winter classes are often below freezing and summer classes experience temperatures exceeding 90-100 degrees. If a recruit is lucky enough to start at the right time, they may even get to experience both extremes.

On Dec. 1, 1921, 81 troopers took the oath of office and, as legend would have it set out to their various patrols on Dec. 5, 1921 in a blinding snowstorm to their assignments across the state. The highest-ranking officer in the New Jersey State Police is

the Superintendent who holds the rank of Colonel. The current Colonel is Patrick Callahan. The first Colonel of the New Jersey State Police was H. Norman Schwarzkopf, badge #1. He was chosen for this post because he was a Major General in the US Army and a West Point Graduate. This is part of the reason that the New Jersey State Police is known for its para-military structure and military bearing. Interestingly the son of Norman Schwarzkopf of the same name was the commanding officer of The United States Armed Forces in the first Gulf War.

The current core functions of the New Jersey State Police involving patrol and enforcement of State Highways and Interstate Highways in the state. They also patrol the toll roads such as the Garden State Parkway and the New Jersey Turnpike. Aside from traffic enforcement, accident investigation and responding to calls for service, the New Jersey State Police also provide general policing for areas in the state that do not have municipal police departments. Today there are approximately 2400 sworn members of the New Jersey State Police with over 1000 civilian employees as well. Over 1000 troopers work in specialized units in various areas such as Crime Scene Investigations, Aviation and other administrative positions. However, every trooper starts out at a patrol station, a post that is affectionately known as, "the road." Some troopers choose to stay at patrol station while others branch out to various assignments over time. The factor that connects them is that they all started out at the same assignment. For the purposes of this research we focused on the troopers who are assigned to uniformed patrol, "on the road." Over the course of time troopers have worked a variety of shift schedules. When the organization was first created, troopers lived at the station/barracks that they were assigned to. They ate, slept and answered calls for service after which time they only

returned home when they were relieved of duty by the incoming shift. In fact, in the early days if a trooper wanted to get married, he had to get permission from the Colonel, otherwise he could lose his job.

The current organization of the NJ State Police consists of the office of the Superintendent, as well as four branches: The Administration Branch, the Homeland Security Branch, the Investigation Branch and the Operations Branch. Each Branch is further divided into Sections. The patrol responsibilities fall under the Operations Branch in the Field Operation Section. This is where all of the state's 21 patrol stations are located. These 21 Road Stations are separated into Troops. There are four Troops: A, B, C, and D. Troop A is responsible for patrolling the southern part of the stated, Troop B is responsible for the northern part of the state and Troop C is responsible for the central part of the state. Troop D is responsible for the Toll Roadways which include the New Jersey Turnpike and the Garden State Parkway (www.njsp.org).

For the purposes of this research we will focus our attention on Troop B which patrols the northern part of NJ. Troop B has eight stations: Totowa, Somerville, Perryville, Netcong, Hope, Sussex, Washington and the Meadowlands Sports Complex. Each station is comprised of four patrol squads as well as an Assistant Station Commander and a Station Commander. Each station also has a detective bureau, comprised of troopers who undergo specialized training to receive their detective designation. Each patrol squad is led by a Squad Supervisor and a Patrol Supervisor and an assortment of 8 to 12 troopers on patrol. The troopers work 12-hour patrol shifts 7a-7p or 6a-6p and are comprised of both male and female troopers. The squads rotate from day shift to night shift every two weeks on what is commonly referred to as the "Pittman"

schedule. The work week technically starts on Saturday. A given squad will work the same shift Monday, Tuesday, and Friday the first week followed by Saturday, Sunday, Wednesday and Thursday the following week. At this point the Squad will be off until Monday when they switch to days and nights respectively. Considerations of the topic of shift work scheduling has been ongoing for some time. Although all stations currently adhere to a 12-hour biweekly rotation, it hasn't always been that way. Some stations have experimented with different schedules over the years. One of these Stations is Washington Station located in rural Warren County, NJ. As opposed to a biweekly rotation, Washington Station worked a monthly day/night rotation still on a 12-hour shift.

With the growing emphasis on shift work disorder and police conduct, it is worth examining if there is a difference with regard to outcomes relating to these two schedules. For several years, Washington Station worked the monthly day/night rotating twelve-hour shift schedule. In 2017, Washington Station changed to a biweekly day/night rotation. This scheduling change provided the opportunity to compare outcomes from these two schedules and see if there were any significant differences between them that could provide a benefit one way or the other.

Study Aims, Hypotheses and Rationale for Choice of Outcome Variables

This research explored the relationship between rotating shift schedules and certain aspects of police work. Specifically, for police officers working a rotating 12-hour shift schedule, it was hypothesized that less frequent day/night rotation have advantages over more frequent day/night rotations. Specifically, I compared a 12-hour workday that rotated from day shift to night shift biweekly, to one which only rotated from day to night once a month.

We examined these two competing shift schedules to see if there were significant differences in areas such as productivity, off duty incidents, injury rates and sick time. Productivity was measured by traffic stops as these are proactive activities as opposed to calls for service such as traffic accidents that are more reactive. Injury rates were assessed to see if rates of injury during biweekly rotations were significantly different from those during monthly rotations. Citizen complaints were assessed to see if there was any association between the rates of these complaints and either schedule, the logic being that a biweekly rotation could potentially make troopers more irritable and shorter tempered with the general public resulting in more citizen complaints.

The reasoning behind this research is that police switching from day shift to night shift once a month may have more favorable outcomes than those switching from day shift to night shift biweekly. All incidents are collected and logged in a secure database that will make locating the data relatively straightforward.

It was predicted that the schedule with monthly rotations would be associated with better productivity, fewer sick days and fewer negative consequence than biweekly rotations. There was already a basis for this comparison. All New Jersey State Police Stations work 12 -hour shifts. One New Jersey State Police Station, Washington Station, has worked both a biweekly and a monthly day/night rotation in recent years. Washington Station switched from a monthly rotation to a biweekly rotation in January 2017. Prior to 2017, a monthly rotation was used for several years. Note, due to the Covid-19 crisis any data from March 2020 onward would likely be confounded by events related to the pandemic so the study relies on data from the period between 2014 and 2019 only. By comparing data from 2014-2016 that ran on a monthly rotation to data from 2017-2019

that ran on a biweekly rotation from day shift to night shift, the hypothesis that longer periods on each shift would be beneficial was tested.

Because sick time is unlimited in the New Jersey State Police, this is a continuous variable. Based on current research, the hypothesis was that troopers on a monthly rotation would utilize less sick time than those on a biweekly rotation. When a trooper calls out sick, often another one must be called in to fill his shift at an overtime rate so the number of unscheduled overtime hours will also be compared between the two schedules. Current research supports the hypothesis that better adjustment reduces the rate of injury of shift workers (Violanti et al., 2013). Studies of nurses have shown that those working night shifts have a significantly higher rate of injury than their day worker counterparts (Thompson et al., 2016). A monthly rotation could result in a lower rate of injury. This could be measured by data gathered by the New Jersey State Police Compliance Unit and Medical Unit on job related injuries that they track. This would result in fewer work-related injuries during 2014-2016, when the monthly rotation was utilized, than 2017-2019 when the biweekly day/night rotation was utilized. In sum, a monthly day/night rotation should be more beneficial to shift workers than a two- weekday/night rotation.

Productivity in this case was measured by traffic stops. Because traffic stops generally are initiated by the individual trooper this would measure if troopers working a monthly or biweekly day/night rotation are making significantly more or fewer traffic stops. Because traffic stops occur at a reasonably high number, there would be enough stops to conduct an analysis. Traffic stops are also one of the most frequently conducted and readily recorded activities conducted by troopers on patrol. To provide an idea of scope, in the most recent annual report New Jersey State Troopers conducted 299,596

traffic stops in the six months between January 1, 2016 and June 30, 2016. Of these 79,306 (27%) were conducted by Troop B, which patrols the northern third of the state. The most common offenses for conducting traffic stops were speeding, careless driving, unsafe lane change and operating a handheld device (cell phone). Of these 299,596 traffic stops, only 4% (12,148) resulted in post-stop activity such as an arrest or a car search. The rest resulted in traffic enforcement. This enforcement included 114,629 traffic summonses (38%), 130,909 warnings (44%), and 54,058 no enforcement (18%). Specifically, during this time period Washington Station conducted 5,487 traffic stops.

Troop car accidents were chosen to analyze job safety. Because troop car accidents can result in injury to both troopers and the motoring public as well as damage to equipment resulting in shortages of patrol cars and increased costs, this research examined if there was a relationship between the number of troop car accidents and a monthly day/night rotation compared to a biweekly day/night rotation.

Misconduct allegations were chosen because they reflect the relationship between troopers and the general public. They also reflect performance and procedural errors that occur in real time situations on patrol. Research has shown that stress and fatigue can affect not only job performance but also irritability and temperament when dealing with the general public. Police that are fatigued are more likely to be short tempered and irritable, which could result in an increase in citizen complaints. Stress and fatigue can also increase the likelihood of procedural errors that relate to the number of negative performance infractions. Because both of these issues relate to public safety it is worth examining if working a monthly day/night rotation or a biweekly day/night rotation is associated with the number of performance notices and citizen complaints that are

generated. The most recent data show that the number of annual misconduct allegations for the New Jersey State Police were 720 in 2014, 727 in 2015, 680 in 2016, 762 in 2017 and 707 in 2018. The New Jersey State Police take misconduct allegations very seriously and dedicates a great deal of resources to investigating these allegations.

Chapter II

Method

Because archival data was utilized for this research, the sample was limited to troopers who worked at Washington Station in the given time frame.

Setting

Washington Station is located in Northwest New Jersey in Washington Twp., Warren County. Washington Station is designated Troop B. Troop B serves the northern geographical portion of NJ, covering approximately 2807 square miles and serving a population of approximately 5 million people and ten counties.

Troop B is responsible for providing full police coverage to 29 municipalities and part time police coverage to six municipalities. Troop B patrols 218 miles of the five Interstate Highways that traverse North Jersey. These include Interstate 78, 80, 287, 280, and 95 (www.njsp.org). There are eight stations total in Troop B. These stations include Netcong Station, Somerville Station, Totowa Station, Sussex Station, Hope Station, Perryville Station, the Meadowlands Sports Complex and Washington Station. The nature of the archival data limited sample size but provided the opportunity for a within subjects analysis. Troopers in administrative roles were not included because they do not work the shift schedules being investigated. Detectives assigned to Washington Station were also not considered for the same reason.

There were 126 troopers who worked at New Jersey State Police Washington Station between 2014 and 2019. Of the original 126, thirty troopers worked both the monthly rotating day/night shift schedule, and the bi-weekly rotating day/night shift schedule. Shifts were twelve hours long and commenced at 6:00am for the day shift and 6:00pm for the night shift. The format for the monthly rotation was as follows, D, D, Off, Off, D, D, D, Off, Off, D, D, Off, Off, Off, D, D, Off, Off, D, D, D, Off, Off, D, D, Off, Off, Off. This cycle would then be repeated for the night shift. The schedule for the bi-weekly day/night shift rotation was N,N, Off, Off, N, N, N, Off, Off, N, N, Off, Off, Off. The cycle would then repeat with day shift. Troopers worked a total of 14 days and 160 hours per month not including overtime. Vacation and personal time were not factored into this analysis as they could not be obtained. Gender and descriptive information were not available for this cohort for confidentiality reasons. Table 1 shows the Monthly Shift Rotation. Table 2 Illustrates the Bi-Weekly Shift Rotation.

Table 1: Monthly Day/Night Rotation 12-hour shift

Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Day Shift	Day Shift	OFF	OFF	Day Shift	Day Shift	Day Shift
OFF	OFF	Day Shift	Day Shift	OFF	OFF	OFF
Day Shift	Day Shift	OFF	OFF	Day Shift	Day Shift	Day Shift
OFF	OFF	Day Shift	Day Shift	OFF	OFF	OFF

Source: Washington Station New Jersey State Police 2014-2016.

Table 2: Bi-Weekly Day/Night Rotation 12-hour shift

Mon	Tues	Weds	Thurs	Fri	Sat	Sun
Day Shift	Day Shift	OFF	OFF	Day Shift	Day Shift	Day Shift
OFF	OFF	Day Shift	Day Shift	OFF	OFF	OFF
Night Shift	Night Shift	OFF	OFF	Night Shift	Night Shift	Night Shift
OFF	OFF	Night Shift	Night Shift	OFF	OFF	OFF

Source: Washington Station, New Jersey State Police 2017-2019.

In 2016 there were a total of 45 troopers assigned to Washington Station. This was broken down into a Station Commander, an Assistant Station Commander and four patrol squads. Patrol squads are made up of a Squad Supervisor, a Patrol Supervisor and assorted troopers with varying levels of experience. These troopers are responsible for responding to calls for service and proactive policing. Each squad works a 12-hour shift that begins at 6:00 am and ends at 6:00 pm at which time they are relieved by another squad which covers the station area from 6:00pm to 6:00 am. Assigned troopers reside in varying locations in relation to Washington Station. Of the 45 assigned troopers, only 3 were female. This is not unusual as the makeup of the New Jersey State Police is overwhelmingly male.

In 2017 there were a total of 47 troopers assigned to Washington Station. Again, this was comprised of a Station Commander, an Assistant Station Commander and four patrol squads. Each Squad was composed of a Squad Supervisor, a patrol supervisor and eight to ten troopers on routine patrol. Of the 47 troopers assigned to Washington Station in 2017, only two were female. The shifts were again 12 hours long and began at 6:00am and ended at 6:00pm when the night shift would arrive and patrol from 6:00pm to 6:00

am. The shifts between the two calendar years were identical in length and start/end time with the only difference being that in 2016 troopers alternated between day and night shift every month, while in 2017 troopers alternated between day shift and night shift biweekly.

Participants

Sick Time: Within Subjects Samples

The original sample for sick time analysis included 30 troopers who worked both the monthly day/night rotation in 2016 and the biweekly day/night rotation in 2017. All troopers were assigned to patrol duty at Washington Station in both 2016 and 2017 calendar years. Sick time in the organization is captured and logged in hours not days. Because sick time is unlimited in the New Jersey State Police it can be relied on as a continuous variable. It cannot run out, minimizing concern that troopers will be motivated to arbitrarily use all of their allotted sick time in order to avoid losing it at the end of each calendar year.

Archival Data was analyzed for the 30 troopers consisting of 28 males and 2 females. Twelve troopers were removed from the study sample for either long term injury/disability or family leave. This left 18 troopers left for within subjects analysis. Because family leave and long-term injury are recorded in the sick time database, and account for unusually large amounts of sick time, their inclusion would potentially skew the results which is why they were removed.

Annual sick time data was collected for the 18 troopers who worked both schedules. They were labeled case 1 through 18. Data for the sample was de-identified to preserve anonymity. Data was recorded in total hours for both calendar years.

Traffic Stops: Within Subjects Sample

The sample used for the within subjects traffic stop analysis consisted of 16 troopers who worked both the monthly day/night rotation and the biweekly day/night rotation between the years of 2014-2019. The schedule change was made on January 1, 2017 therefore traffic stops for 2014-2016 were used to analyze the monthly rotation. Traffic stops from 2017-2019 were used to analyze the biweekly day/night rotation. Stop data was collected by the New Jersey State Police MAPPS/Special Projects Unit and was likewise de-identified.

Troopers were only included who worked at least a full calendar year at each of the schedules. Troopers who did not work a full calendar year at either of the schedules were excluded. For any trooper who worked only one year at each schedule, total stops for each of those years was used for analysis. For any trooper who worked more than one full calendar year at one or both schedules, the average traffic stops per year for each of the schedules were used for analysis. For example, if a trooper worked two full years at one schedule and only one full year at the other schedule, total yearly traffic stops for the two years for the former were averaged whereas for the latter a single year's stops were used.

Traffic Stops: Between Groups Sample

In addition to the within subjects analysis of traffic stops for troopers who worked both the monthly and biweekly rotating shift schedules, a between groups analysis was also conducted for traffic stops. This analysis was comprised of troopers who worked either the monthly day/night shift rotation between the calendar years of 2014-2016, or the biweekly day/night shift rotation between the calendar years of 2017-2019. No individual trooper was in both groups. This sample consisted of 58 troopers total, 21 of whom worked the monthly shift rotation and 37 of whom worked the biweekly shift rotation. Troopers who did not work at least a full calendar year at one of the schedules were excluded. Troopers who were on extended administrative leave were likewise excluded.

For any trooper who only worked one year at each schedule total stops for each of those years was used for analysis. For example, if a trooper worked two full years at one schedule and only one full year at the other schedule, total traffic stops for the two years were averaged and that number was used for analysis. This sample size was also limited since it utilized archival data.

Procedure

Sick time data was collected and stored by the New Jersey State Police Compliance Unit. This unit is comprised of a mix of enlisted and civilian personnel who are responsible for collecting and maintaining the database. A formal request was made through official channels for this data with the understanding that identifiable information would be protected. This request was ultimately approved by the Superintendent Office of the New Jersey State Police. This request took several weeks to be approved and

ultimately had to be revised and resubmitted for clarification. I received this data via encrypted email and the data was stored on an encrypted, firewall and password protected laptop computer.

The process for collecting traffic stop data was similar to that of sick time but data were housed in a different location. The same request used to request sick time was used to request traffic stop data. The traffic stop data was collected and housed by the MAPPS/Special Projects Unit. This study was conducted using aggregate archival data housed by the New Jersey State Police Compliance Unit and the New Jersey State Police MAPPS/Special Projects Unit. The study was approved by the Harvard University Committee for Use of Human Subjects.

Outcome Measures

Primary Outcome Measures

Sickness Absence: There are several reasons why sick-absence was selected as an outcome measure for this research. One reason is that it is accurately and reliably housed and recorded for long periods of time, thus it can be compared for within subjects analysis. It is also recorded in hours which is more accurate and more useful for statistical analyses than being recorded in days. Most troopers do utilize sick time which makes it a valuable measurement in that there will be recorded data for most members. Sick time has been shown to be a reliable indicator of overall health and well-being. A worker who utilizes less sick time can reasonably be assumed to be healthier than those who utilize more. Sick time has been shown to correlate not only with physical but with mental health (Shiri et.al., 2021) There is a cost factor associated with sick time, it requires addition resources to cover call outs resulting in increased overtime. As a measure of

future health, sick time can be used for early identification of negative health trends both on an individual and organizational basis. There is also a safety aspect to sick time. Sick time resulting in staffing shortages can put responding officers at risk due to decreased back up.

Traffic Stops: There are several reasons why traffic stops were selected as an outcome measure for this investigation. In searching for a measure of productivity it was important to select an outcome that is widely used and that is self-initiated. Traffic stops satisfy both criteria. Every trooper is expected to conduct proactive traffic enforcement and traffic stops are frequently conducted by patrol troopers. Traffic stops are recorded and archived making between groups comparison more robust. Due to heavy traffic conditions, there is no shortage of cars on the roadway so troopers can make traffic stops throughout the shift. Most traffic stops take between 10 and 15 minutes. Productivity in this case was measured by the number of traffic stops. Traffic stops have been widely used as a reliable measure of productivity in policing because they are normally self-initiated and high enough in number to analyze effectively (Amendola et al., 2011).

Secondary Outcome Variables

There were three secondary outcome variables for which data were obtained. These three variables were cumulative annual sick hours for Washington Station (2014-2019), annual Troop Car Accidents for Washington Station (2014-2019), and annual citizen complaints for (2014-2019) at Washington Station.

Statistical Analysis

Data analysis was conducted separately for each study aim. Exploratory findings were recorded for the following study aims. The following analyses were two- tailed and $p<.05$ was used as the critical level of significance.

Aim 1: Sick Time Within Subjects

To determine the differences, if any, between a monthly day/night rotation and a biweekly day/night rotation regarding sick time usage within individual subjects, the following tests were conducted. First, the Shapiro Wilk Test was used to determine normality. Due to non-normality of sick time data, the Wilcoxon Sign Rank Test was used as a non-parametric test of significance. However, a paired t-test was also conducted to determine the effect size of the difference in sick absence between the two schedules using G Power Version 3 to calculate Cohen's d (Faul, Erdfelder, Lang, & Buchner, 2007).

Aim 2: Traffic Stops Within Subjects

To determine the difference, if any, between a monthly day/night rotation and a biweekly day/night rotation with regard to productivity measured within individual subjects, the following tests were conducted. First the Shapiro Wilk Test determined that traffic stops were normally distributed, therefore a paired t-test was conducted on yearly traffic stops. To determine effect size, Cohen's d was calculated using G Power.

Aim 3: Traffic Stops Between Groups

The Shapiro Wilk Test determined that these data were normally distributed. Therefore an unpaired t-test was conducted to determine the difference, if any, in productivity measured by annual traffic stops between two independent samples of troopers who worked either a monthly day/night shift rotation between the years of 2014-2017, or a biweekly day/night shift rotation between the years of 2017-2019. To determine the effect size of the group difference, G Power was used to calculate Cohen's d.

Chapter III

Results

Annual Sick Absence for Monthly vs. Biweekly Day/Night Rotation 12-hour Shift Schedule

Figure 1 provides information on the within subjects sample of troopers for annual sick absence for both monthly and biweekly day/night shift rotations (n=18). Average annual sick hours in 2016 on the monthly day/night rotation was 16.56 (95%CI, 5.12, 27.99). Average annual sick hours in 2017 on the biweekly rotation was 26.78 (95% CI, 15.39, 38.17). A Shapiro-Wilk test of normality revealed a non-normal distribution of sick time among troopers during the monthly day/night shift rotation in 2016 ($p<.000$). However, the distribution of sick hours among these same troopers working the biweekly day/night shift rotation did not reveal a significant result ($p=.132$).

Table 3: Sick Time Within Subjects Descriptive Statistics

N		Mean	Std. Deviation	Minimum	Maximum
SICKHOURS 2016	18	16.5556	22.99673	.00	72.00
SICKHOURS 2017	18	26.7778	22.90789	.00	72.00

Note: Descriptive statistics regarding sick time for the within subjects sample of troopers who worked both the monthly day/night shift rotation in 2016 and the biweekly day/night shift rotation in 2017.

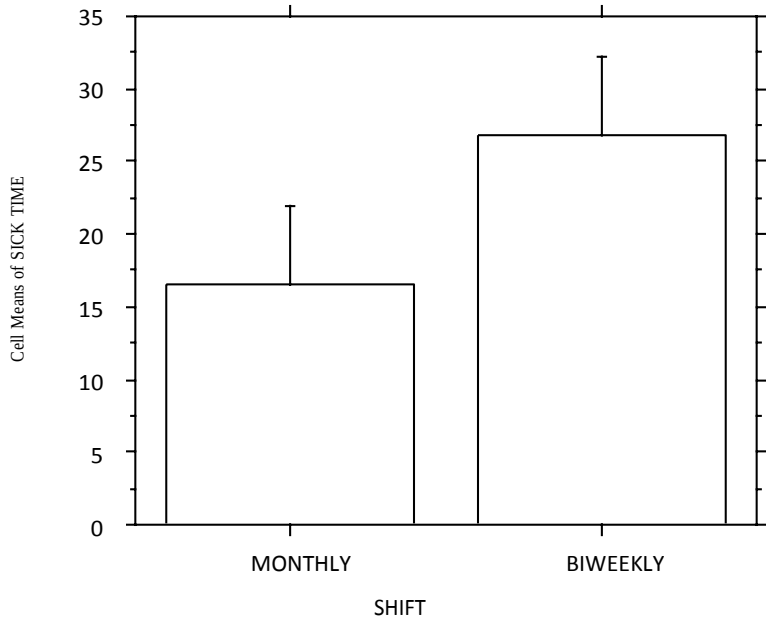

Figure 1: Sick Time

Within-subjects analysis of sick time in troopers who worked both the monthly shift rotation in 2016 and the biweekly shift rotation in 2017. Standard error of the mean shown.

Table 4: Tests of Normality Sick Time Within Subjects

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SICKHOURS 2016	.320	18	.000	.762	18	.000
SICKHOURS 2017	.185	18	.105	.920	18	.132

Note: Tests of normality for sick time data from the within subjects sample of troopers who worked both the monthly day/night shift rotation in 2016 and the bi-weekly day/night shift rotation in 2017. The Kolmogorov Smirnov and Shapiro Wilk statistic for the monthly day/night shift rotation was significant indicating non-normality, while the bi-weekly day night shift rotation did not violate normality.

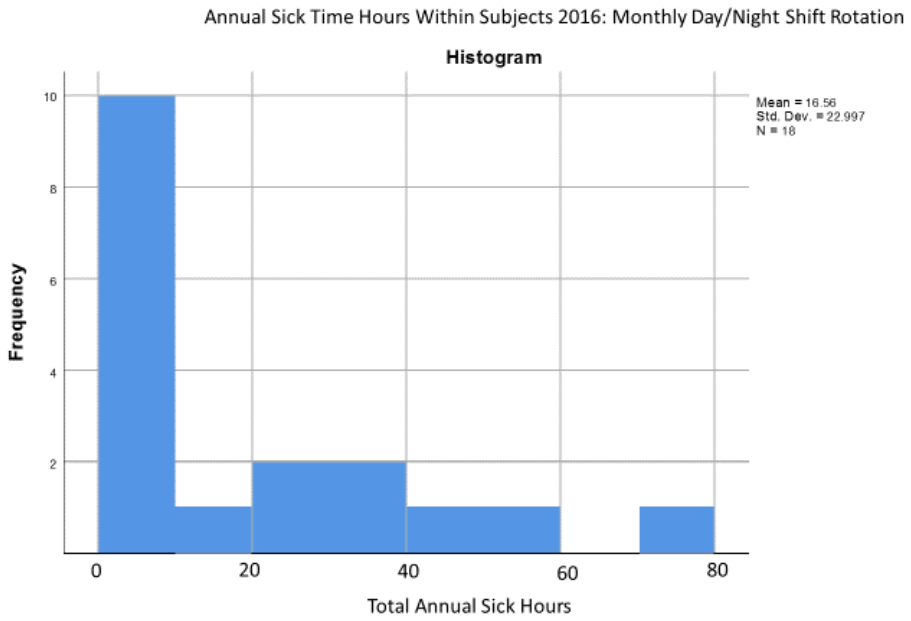

Figure 2: Sick Time Monthly Rotation

Annual sick time usage during the monthly shift rotation in 2016. Note non-normal positively skewed distribution.

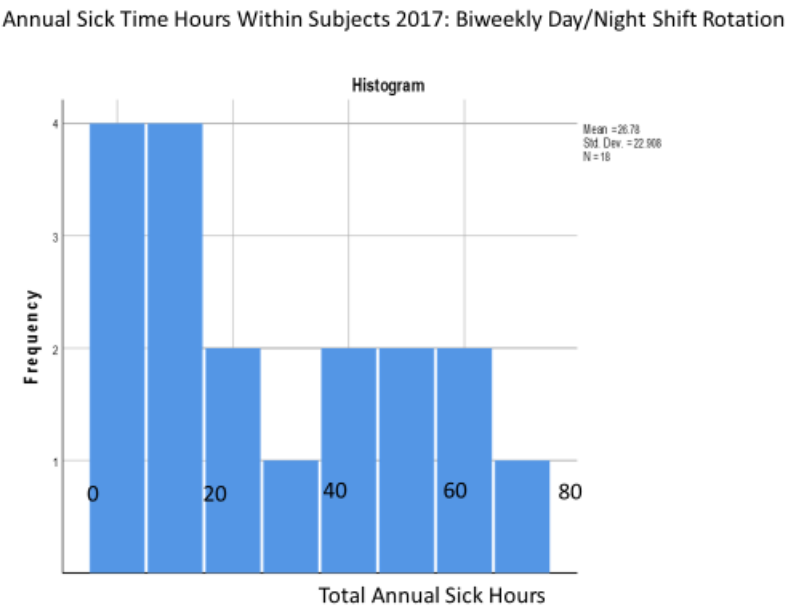

Figure 3: Sick Time Biweekly Rotation

Distributions of annual sick time usage during the biweekly day/night shift rotation. Note non-normal positively skewed distribution.

Because the Shapiro-Wilk Test indicated a non-normal distribution of annual sick time data, the Wilcoxon Sign Rank Test, a non-parametric test, was used to test for significance. The result of this analysis was not significant (Z=-1.635, p=.102) confirming that, although average sick time taken during the biweekly rotation was higher in the biweekly than the monthly rotation, the difference was not statistically significant. Although not normally distributed, a paired sample t-test also revealed that, although sick hours did not differ significantly between shift types (p=.204), there was an almost medium effect size for shift type on annual sick hours (d=.445).

Table 5: Results of the Wilcoxon Signed Rank Test for Sick Time

			Mean Rank	Sum of Ranks
SICKHOURS:2017 – SICKHOURS:2016	Negative Ranks	4a	6.63	26.50
	Positive Ranks	10b	7.85	78.50
	Ties	4c		
	Total	18		

Z	-1.635b
Asymp. Sig. (2-tailed)	.102

Note: Within subjects sample of troopers who worked both monthly day/night shift rotation in 2016 and the biweekly day/night shift rotation in 2017. This test was conducted secondarily because the 2016 sick time data violated the Shapiro Wilk Test for normality.

Table 6: Sick Hours Data Set

	2016 Sick Hours Total	2017 Sick Hours Total
Trooper 1	24	32
Trooper 2	0	0
Trooper 3	0	12
Trooper 4	72	0
Trooper 5	0	48
Trooper 6	36	60
Trooper 7	32	24
Trooper 8	0	12
Trooper 9	44	36
Trooper 10	0	56
Trooper 11	0	0
Trooper 12	0	72
Trooper 13	0	10
Trooper 14	0	0
Trooper 15	0	36
Trooper 16	58	24
Trooper 17	20	48
Trooper 18	12	12

Note: Sick time data for the within subjects sample of troopers who worked the monthly day/night shift rotation in 2016 and the biweekly day/night shift rotation in 2017.

Annual Traffic Stops for Monthly vs. Biweekly Day/Night Rotation 12-hour Shift Schedule

Figure 4 provides information on average annual traffic stops for the within subjects sample of troopers who worked both the monthly day/night shift rotation and the biweekly day/night shift rotation (n=16). Average annual traffic stops for troopers working the monthly day/night shift rotation was 318.13 (95% CI, 241.62, 394.63). Average annual traffic stops for troopers working the biweekly day/night shift rotation was 260.17 (95% CI, 182.99, 337.35). It should be noted that a Shapiro-Wilk Test did reveal significant non-normality for traffic stops on the monthly day/night shift rotation (p=.047). This may be due in part to the limited sample size. However, the Shapiro Wilk Test did not reveal significant non-normality for troopers working the biweekly day/night shift rotation (p=.657). Therefore, both parametric (paired t-test) and non-parametric (Wilcoxon Signed Rank) tests were performed. A paired sample t-test revealed that troopers who worked the monthly day/night shift rotation made significantly more traffic stops than those working the biweekly day/night shift rotation (p=.003). There was a small to medium effect size between shift type and traffic stops (d=.401).

Table 7: Wilcoxon Signed Rank Test for Traffic Stops

TotalStopsbiweekly - TotalStopsmonth	Negative Ranks	14a	8.86	124.00
	Positive Ranks	2b	6.00	12.00
	Ties	0c		
	Total	16		

Z	-2.896[b]
Asymp. Sig. (2-tailed)	.004

Note: Within subjects sample of troopers who worked both monthly day/night shift rotation in 2016 and the biweekly day/night shift rotation in 2017. This test was conducted as a supplement because the 2016 traffic stop data violated the Shapiro Wilk Test for normality.

	Count	Mean	Std. Dev.	Std. Error
MONTHLY	16	318.125	143.571	35.893
BIWEEKLY	16	260.169	144.845	36.211

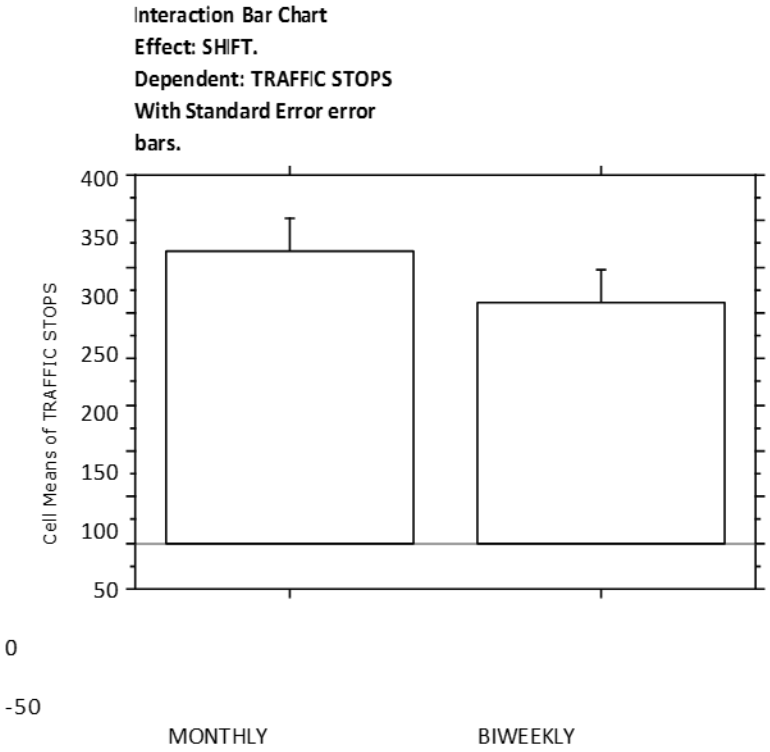

Figure 4: Traffic Stops Within Subjects Paired t-test

Paired t-test for the within subjects analysis of troopers who worked both the monthly shift rotation in 2016 and the biweekly shift rotation in 2017.

Table 8: Traffic Stops Within Subjects ANOVA

Subject	15	591708.685	39447.246				
SHIFT.	1	26871.415	26871.415	12.525	.0030	.0030	.0030
SHIFT. * Subject	15	32182.380	2145.492				

Dependent: TRAFFIC STOPS

Note: ANOVA table for the within subjects analysis of troopers who worked both the monthly and biweekly shift rotation.

Table 9: Traffic Stops Within Subjects Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TotalStopsmonth	.187	16	.137	.885	16	.047
TotalStopsbiweekly	.114	16	.200*	.960	16	.657

Note: Test of normality for the within subjects sample of troopers who worked both the monthly and biweekly shift rotation.

Table 10: Traffic Stops Within Subjects Descriptive Statistics

N		Mean	Std. Deviation	Minimum	Maximum
TotalStopsmonth	16	318.1250	143.57145	10.00	558.00
TotalStopsbiweekly	16	260.1688	144.84466	3.00	582.00

Note: Descriptive statistics for the within subjects analysis of troopers who worked both the monthly and biweekly shift rotation.

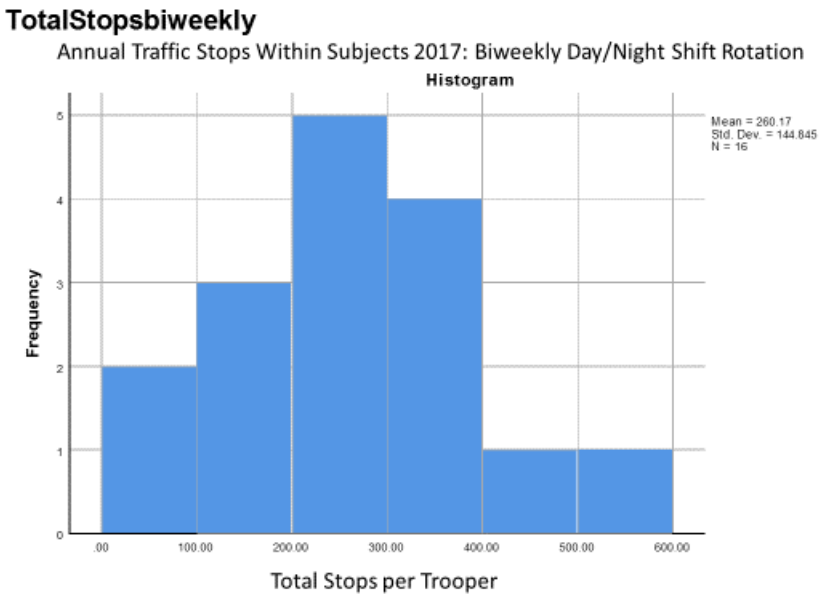

Figure 5: Traffic Stops Within Subjects Biweekly Rotation

Distribution of annual traffic stops during the biweekly shift rotation. Note non-normal distribution for biweekly shift rotation.

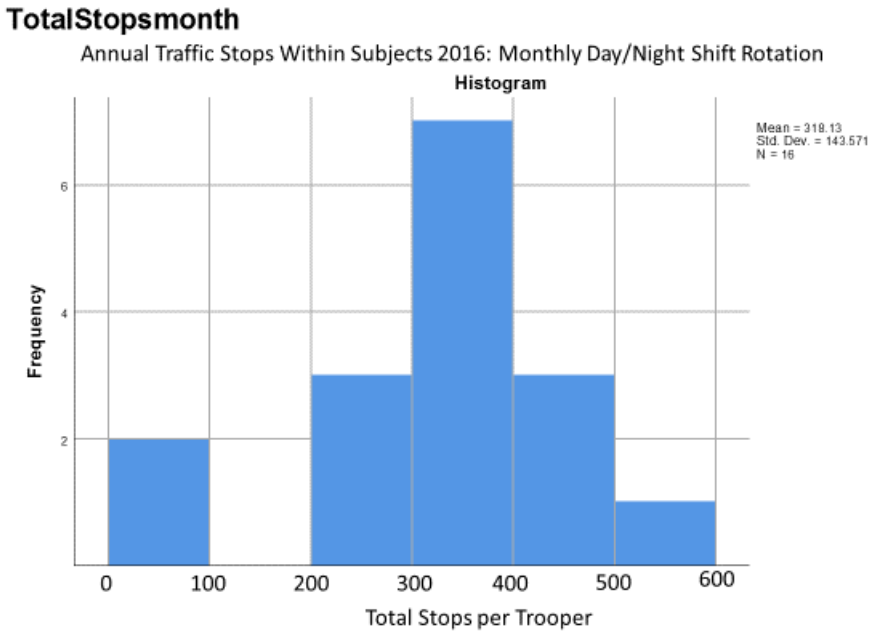

Figure 6: Traffic Stops Within Subjects Monthly Rotation

Distribution of annual traffic stops during the monthly shift rotation. Note monthly shift rotation is normally distributed.

Table 11: Total Avg Annual Traffic Stops

	Monthly Rotation Avg Annual Traffic Stops	Biweekly Rotation Avg Annual Traffic Stops
Trooper 1	216.3	148.5
Trooper 2	339.0	199.0
Trooper 3	263.3	276.3
Trooper 4	388.0	180.0
Trooper 5	271.3	213.0
Trooper 6	558.0	582.0
Trooper 7	342.0	332.6
Trooper 8	355.0	313.3
Trooper 9	12.5	7.5
Trooper 10	436.0	348.5
Trooper 11	379.0	363.0
Trooper 12	10.0	3.0
Trooper 13	422.0	415.0
Trooper 14	420.0	282.0
Trooper 15	359.6	299.0
Trooper 16	318.0	200.0

Note: Traffic stop data for the within subjects sample of troopers who worked the monthly day/night shift rotation in 2016 and the biweekly day/night shift rotation in 2017.

Traffic Stops Between Groups

The independent variable was shift schedule with monthly rotation coded as 0 and biweekly rotation coded as 1. The dependent variable was total annual traffic stops. Table 11 and 12 list the between groups data for analysis. Figure 7 shows total annual traffic stops for two independent samples of troopers who either worked the monthly or biweekly day/night shift rotation. An independent sample t-test was conducted using SPSS. Version 24.

For the 21 troopers who worked only the monthly rotation between 2014-2016 average annuals traffic stops per trooper was 365.98. For the 37 troopers who worked the biweekly rotation between 2017-2019, average annual traffic stops were 284.79. (95% CI: 286.01, 342.27). Shapiro Wilk Test for normality was not significant (p=.365) therefore the data was normally distributed. An independent sample t-test revealed a value of t=2.79 between both groups (p=.004). This demonstrated that troopers who worked the monthly rotation conducted significantly more annual traffic stops than those on the biweekly rotation.

	Count	Mean	Std. Dev.	Std. Error
Monthly	21	365.976	118.877	25.941
Biweekly	37	284.719	88.369	14.528

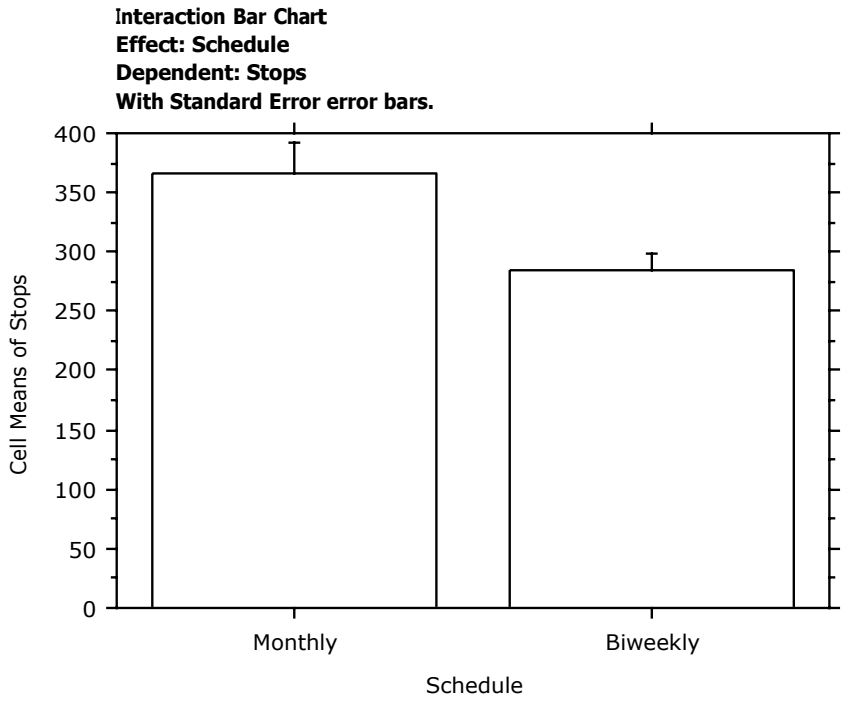

Figure 7: Traffic Stops Between Groups Paired t-test

Descriptive and visual representation of between groups analysis of independent t-test for traffic stops. Note troopers who worked a monthly day/night rotation made significantly more traffic stops on average than those who worked a biweekly day/night rotation.

Table 12: ANOVA Test Between Groups Traffic Stops

Schedule	1	88454.004	88454.004	8.786	.0045
Residual	56	563762.895	10067.195		

Note: ANOVA test for between group sample of troopers who worked either the monthly shift rotation or the biweekly shift rotation.

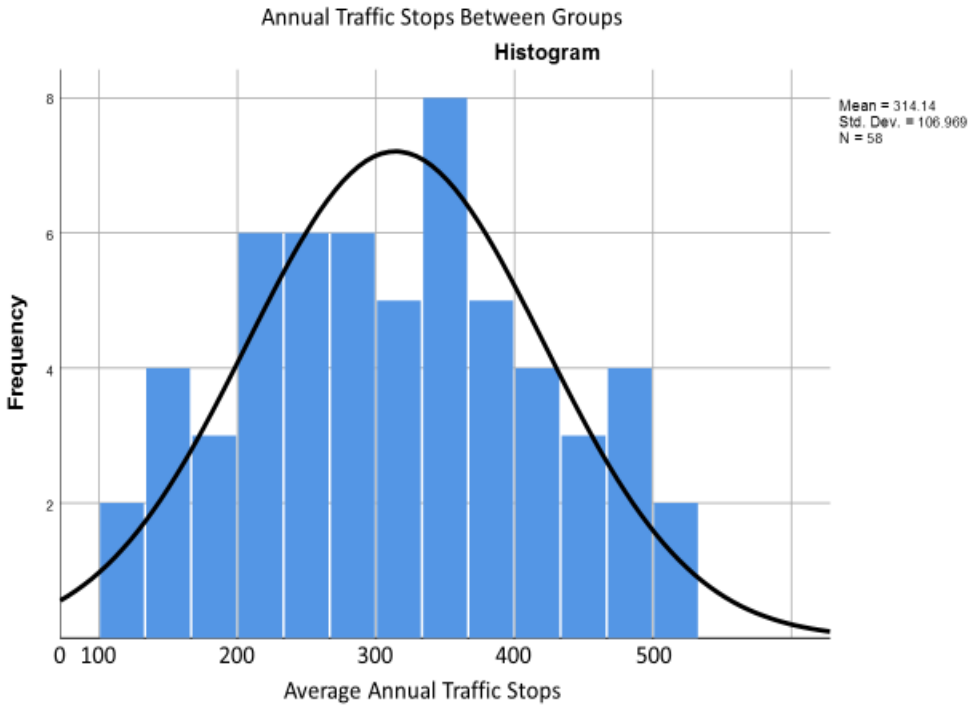

Figure 8: Distribution of Annual Traffic Stops Between Groups

Distributions of annual traffic stops between troopers who worked the monthly shift rotation and troopers who worked the biweekly shift rotation.

Table 13: Traffic Stops Unpaired t-test

Independent Samples Test

		t-test for Equality of Means			
		Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence ... Lower
STOPS	Equal variances assumed	.004	81.25727	27.41307	26.34229
	Equal variances not assumed	.010	81.25727	29.73205	20.74762

Note: Results of the unpaired t-test for troopers who worked either the monthly or biweekly shift schedule. Note troopers who worked the monthly shift rotation made significantly more traffic stops than troopers who worked the biweekly shift rotation.

Table 14: Traffic Stops Monthly Rotation

Trooper 1 220	Trooper 2 365	Trooper 3 287	Trooper 4 499	Trooper 5 491	Trooper 6 333	Trooper 7 353
Trooper 8 138	Trooper 9 387	Trooper 10 354.5	Trooper 11 408	Trooper 12 426	Trooper 13 479	Trooper 14 362
Trooper 15 521	Trooper 16 527	Trooper 17 379	Trooper 18 350	Trooper 19 199	Trooper 20 482	Trooper 21 125

Note: Traffic stop data for the between groups sample of troopers who worked the monthly day/night shift rotation between 2014-2016.

Table 15: Traffic Stops Biweekly Rotation

Tpr.22 310.3	Tpr.23 181	Tpr.24 205	Tpr.25 339.3	Tpr.26 379	Tpr.27 348	Tpr.28 265	Tpr.29 152	Tpr.30 137	Tpr.31 444
Tpr.32 351	Tpr.33 234	Tpr.34 272	Tpr.35 312	Tpr.36 197	Tpr.37 302	Tpr.38 436	Tpr.39 227	Tpr.40 405	Tpr.41 393
Tpr.42 250	Tpr.43 263	Tpr.44 282	Tpr.45 284	Tpr.46 293	Tpr.47 209	Tpr.48 125	Tpr.49 151	Tpr.50 240	Tpr.51 330
Tpr.52 387	Tpr.53 255	Tpr.54 299	Tpr.55 202	Tpr.56 400	Tpr.57 233	Tpr.58 442			

Note: Traffic stop data for the between groups sample of troopers who worked the biweekly day/night shift rotation between 2017-2019.

Other Secondary Data was Collected from the New Jersey State Police

Cumulative Sick Time Hours: Cumulative sick time for the entire station was collected for each of the calendar year: 2014-2019. Although this data does not parse out administrative assignments, long term injury or family leave, it does paint a basic picture of annual sick time usage. Annual total sick time for each calendar year 2014-2016 was 2920 hours, 2142 hours, and 2794 hours respectively. Since these three year were under the monthly day/night rotating shift schedule they collectively average 2618 sick hours per year for each of the three years. Annual total sick time for the three calendar years 2017, 2018 and 2019 were 2744 hours 2520 hours and 3096 hours respectively. This is an average of 2786 hours per year on the biweekly day/night shift rotation. Average annual

sick time was lower for the monthly day/night shift rotation than for the biweekly day/night shift rotation.

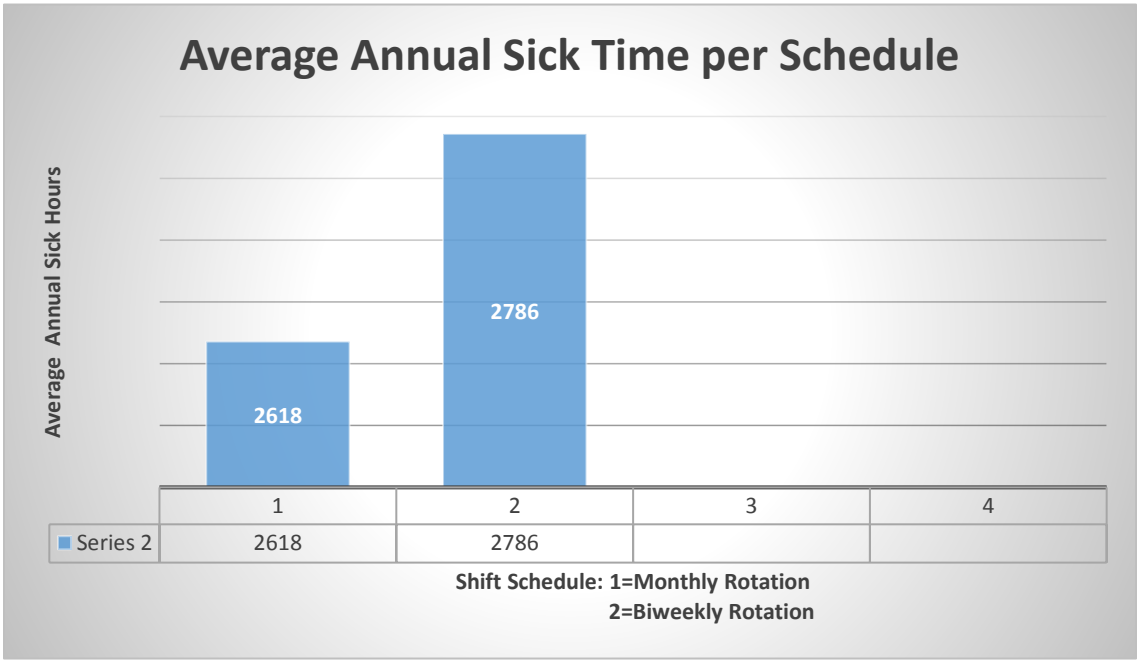

Figure 9: Total sick time hours by schedule 2014-2019

Column 1 represents the monthly rotation and column 2 represents the biweekly rotation.

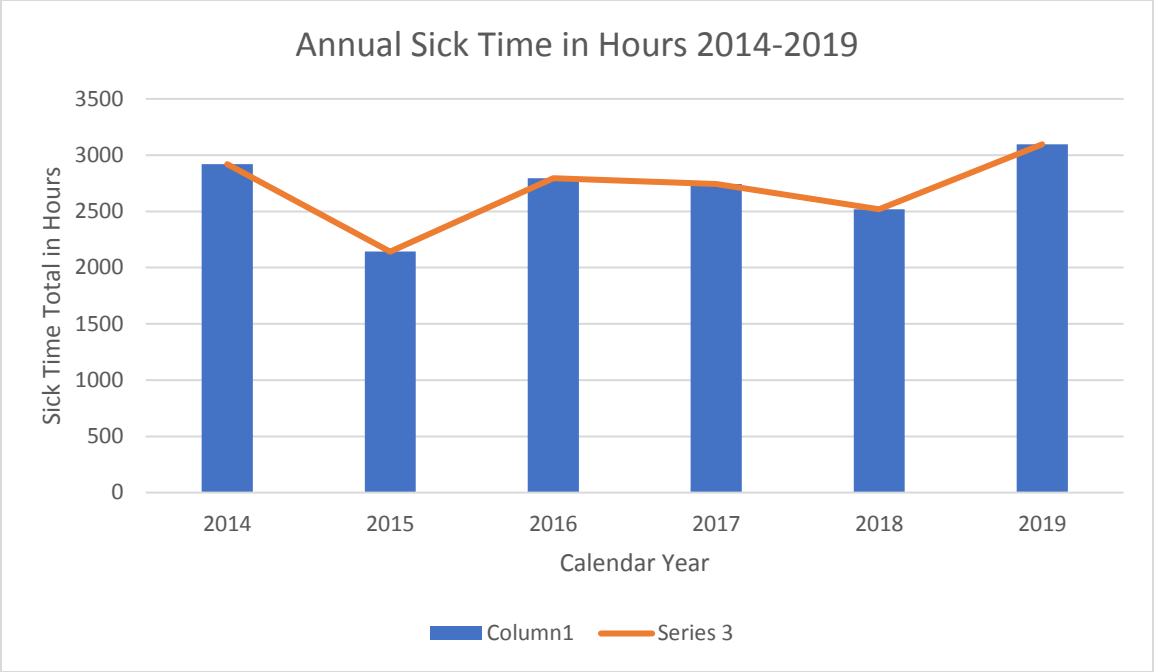

Figure 10: Total annual Sick Time hours for calendar years 2014-2019

Yearly sick time totals for Washington Station.

Troop Car Accidents: Figure 10 represents the number of troop car accidents that occurred at Washington Station between calendar years 2014-2019. A troop car accident is a motor vehicle accident which involves an assigned marked or unmarked State Police vehicle. There has been a concerted effort to reduce the number of troop car accidents which result in potential injury to troopers and the general public and reduce the fleet of troop car available for patrol. The number of troop car accidents at Washington Station from calendar years 2014-2019 was as follows: 2014= 6 Troop Car Accidents, 2015=13 Troop Car Accidents, 2016=10 Troop Car Accidents, 2017=8 Troop Car Accidents, 2018=10 Troop Car Accidents, 2019=5 Troop Car Accidents. It should be noted that in 2018 the New Jersey Station Police installed speed triggers in all marked troop cars.

These triggers are set to activate the camera when a troop car reaches a speed of 90 mph or greater. Total troop car accidents on the monthly day/night shift schedule were 29. Total troop car accidents for the biweekly day/night rotating shift schedule were 23. Although there were fewer troop car accidents on the biweekly rotating shift schedule, there is no way to know if shift schedule had any effect on this. This difference could be due in part to the institution of speed triggers.

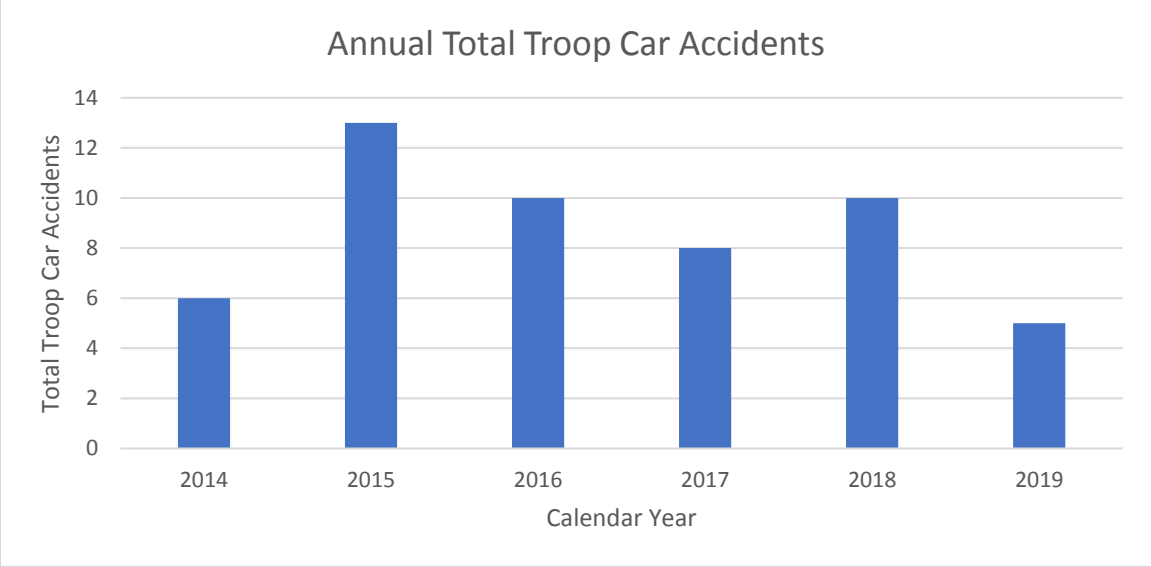

Figure 11: Annual Troop Car Accidents

Total annual troop car accidents by year 2014-2019.

Citizen Complaints: Complaints are generated from interactions between law enforcement and the general public. People who think that they have been mistreated by the New Jersey State Police can make a formal complaint that will be logged, recorded and investigated depending on the severity of the allegation. Complaints can range from attitude/demeanor to driving complaints and unwarranted traffic stops as well as

numerous other categories. The Office of Professional Standards (OPS) logs and houses these complaints. For calendar years 2014-2019 the number of complaints generated for Washington Station was as follows: 2014= 4 complaints, 2015=8 complaints, 2016=9 complaints, 2017=15 complaints, 2018=6 complaints, 2019=10 complaints. Total complaints for the monthly day/night shift rotation were 21. Total complaints for the biweekly day/night shift rotation were 31. This illustrates that more complaints were generated on the biweekly rotation than on the monthly rotation however there are many societal factors and trends that could have influenced this finding.

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Chapter IV

Discussion

This analysis demonstrated that for a within subjects sample of troopers working out of Washington Station, troopers working a monthly day/night shift rotation utilized less average annual sick time than troopers working a biweekly day/night shift rotation. Although sick time did not differ significantly between the two schedules, there was a medium effect size of shift schedule on annual sick time. A within subjects analysis of troopers working a monthly day/night shift rotation showed significantly more traffic stops on average than troopers working a biweekly day/night shift rotation. There was a medium effect size between shift type and average annual traffic stops.

A between groups analysis of the monthly and biweekly day/night shift rotation also demonstrated that troopers who rotated from day shift to night shift every month made significantly more traffic stops than an independent sample of troopers who rotated from day shift to night shift biweekly. Washington Station recorded less total sick time on the monthly rotation than the biweekly rotation. For the secondary variables, fewer troop car accidents occurred on the biweekly rotation than the monthly rotation. Fewer total citizen complaints were generated on the monthly rotation than the biweekly rotation.

The purpose of this analysis was to gain a further understanding of the effect of different shift schedules on certain outcomes in policing. To do this we compared a within subjects sample of New Jersey State Troopers who each worked two different shift

schedules over the course of several years. These shift schedules did not differ in length, but instead differed in the frequency of rotation between day and night shift. This study is unique because most shift work research today across all occupations including policing, has compared different shift lengths. Very few have targeted the frequency of rotation. This study also provided the unique opportunity to analyze a within subjects sample from within the organization. Most research to date has studied cross-sectional, or between groups analysis. Rarely has there been an opportunity to study the same group over time across different schedules. The station that was analyzed was Washington Station located in rural Warren County, NJ. This was the only station that had worked two different shift schedules in recent years. The troopers analyzed were all on patrol duty during the time periods for the analysis. Troopers in administrative roles who did not work one of the shifts were excluded.

The reasoning behind the study was that rotating between day and night shifts disrupts the normal circadian rhythm which can impact sleep quality. This impact on sleep quality has been shown to affect reaction time, cognitive function, physiological health and mental health among numerous other indicators. To demonstrate this outcome variables were chosen that demonstrated the effects of these different schedules. These variables were chosen for both validity and availability of the data. One of the outcome variables chosen was sick time measured in hours per year. The years chosen were consecutive, 2016 and 2017. These were chosen because 2016 ran on a monthly day/night shift rotation, while 2017 ran on a biweekly day/night shift rotation.

We wanted to see if sick time differed between schedules and if there was any advantage to either schedule as far as sick time taken. Clearly less sick time is better,

because it not only suggests healthier troopers, but reduces administrative problems and safety concerns of trying to staff a station with sick callouts. Moreover, it reduces the overtime costs of having to call in members on their off days which accumulates overtime for the station. A station with less sick call outs generally runs more smoothly. Sick time is unlimited so there was little concern that troopers would call out in order to use all their sick time before the year ran out. Although we were unable to obtain between groups data for sick time between the two shift schedules, this data would prove useful to further explore the use of sick time between the two competing schedules and would be advantageous in that it could pull from a larger sample. It would be interesting to see in the future what the result of such analysis would be and if it would further support the hypothesis that the monthly shift rotation results in less sickness absence than the biweekly rotation.

The other outcome variable chosen was traffic stops. This variable was chosen because it is one of the most plentiful, consistent activities which patrol troopers perform on a regular basis. For this reason, the number of traffic stops was plentiful enough to perform an effective statistical analysis. The reasoning behind this was to assess if there was any difference in productivity between the two schedules. It was hypothesized that one of the benefits of overall health and well-being would be that troopers who worked a schedule with fewer rotations between day and night shift would be more productive which would result in more traffic stops on a monthly day/night rotation than on a biweekly day/night rotation. If troopers are making more traffic stops, this is generally beneficial because there is a correlation between increased traffic enforcement and reduced motor vehicle accidents. We were also able to obtain between groups and within

subjects data for traffic stops that allowed for two separate analyses of traffic stops between the two competing shift schedules and allowed us to compare how analysis of two independent samples compared to a paired sample for traffic stops.

The results of this analysis were that troopers who rotated between day and night shift monthly used less sick time than they did when they were on a schedule that rotated from day shift to night shift biweekly. This result, although not significant, did have a medium effect size. The analysis of traffic stops revealed that the troopers conducted significantly more traffic stops when they rotated from day shift to night shift monthly than when they worked a schedule that rotated from day shift to night shift biweekly. This was true both for the within subjects analysis and the between groups analysis. There was also found to be a medium effect size between traffic stops when comparing the two competing schedules.

There were additional aggregate descriptive data collected. Although the same type of analysis could not be performed, these data do provide further insight into the shift schedules that were analyzed. One of these datasets compared troop car accidents. Troop car accidents are exactly what they sound like, accidents involving troop cars and troopers while on patrol. Although relatively infrequent due to the high training and performance standards of the New Jersey State Police, and the oversight and emphasis on traffic safety, troop car accidents will always happen. It is in the nature of driving long periods of time under duress, at elevated speeds, at night and in bad weather to name a few factors. Troop car accidents are especially problematic because they reduce the number of vehicles available for patrol, can result in injuries to troopers and the general public, can be financially costly, and reduce the availability of troopers to respond to

other calls for service. There were fewer total troop car accidents during the years when the biweekly shift rotation was used than the years when the monthly shift rotation was used. Unfortunately, data were not available to further analyze these findings. One reason might be that in 2018 the New Jersey State Police instituted speed triggers in their vehicles which would activate the cameras in troop cars when speeds in excess of 90 mph were reached. This reduced the incentive for troopers to drive at elevated speeds unless responding to expedited calls for service and likely reduced the number of troop car accidents division wide.

Another set of data that was obtained were complaints from the general public. These data are important because they directly reflect interactions between troopers and the general public. When a member of the general public feels that they have been mistreated by a trooper they can make a complaint to the Office of Professional Standards which then investigates the complaint. Clearly, fewer complaints are better because they demonstrate a positive relationship between troopers and the general public. Fewer complaints also reduce the backlog of complaints which must be reviewed by the state thereby expending time and resources. This is not to say that frivolous or malicious complaints are not made against troopers. They are and the New Jersey State Police has a reputation of having some of the highest ethical law enforcement standards anywhere in the US. These complaints are investigated and often found to be either unfounded or unsubstantiated. For these reasons generally speaking the fewer complaints, the better. There were fewer total complaints during the time period when Washington Station was rotating from day to night shift every month than when the rotation occurred biweekly.

This is strictly observational as there is no way to determine if this had anything to do with the frequency of the shift rotation, however it is an observation worth noting.

General Discussion

Shift work is a prevalent and necessary part of society and the world economy today. Shift work permeates many different areas of our lives from manufacturing and commerce to customer service security, production and emergency services to name a few. There is an ever-increasing body of research on shift work. However, with shift work being a relatively new phenomenon there is still much to be learned. If there are schedules that optimize performance and safety as well as productivity and overall workplace satisfaction these need to be explored. There is an increasing movement today for a balance between work and family life. In years past people would often work to provide for their family without regard for whether they enjoyed their occupations. That dynamic is shifting and with more two income working households there is more opportunity for exploring what occupations make us happy.

There are many factors which go into shift work. Shift length has received the most attention with 8, 10, and 12-hour shifts being the most common basis for comparison. The jury is still out for which shift length is optimal. Research has suggested that 8-hour shifts result in better health. Research has also shown that compressed work weeks such as 12-hour shifts provide more time off to spend with friends and family and lower commuting costs. There is also research to suggest that there is no significant difference in any of these areas between shift length.

Another area which has received a great deal of attention is day vs. night shift. It is widely held that day shifts are optimal because they line up better with our circadian

rhythm, our internal clock that works off the light cycle to control most of our bodily functions. Night shift work is widely held to be problematic in that it disrupts this natural rhythm and can lead to negative outcomes such as cognitive impairment or "brain fog" during working hours which affects safety and productivity. Night shift work is also well documented to negatively affect work/life satisfaction and mental health because it makes normal social interactions more difficult. It is well documented that safety and productivity are reduced at night (Folkard & Tucker, 2003). When the rest of the world is awake, night workers are often sleeping. Pressure to resume daytime wakefulness can often lead to circadian confusion in these workers. Many occupations rotate from day to night shift over given period. Here lies the crux of this research. There is relatively little research on effects of the frequency of these rotations and if there are any benefits to fewer rotations between day and night shifts.

Emergency services are one of the most common occupations which involves shift work. The need for 24-hour coverage for medical services, and other emergency services such as Police/Fire/EMS necessitates it. We should consider ourselves lucky to have access to these services around the clock. Policing has come to the forefront in recent years. The relationship between the police and the general public is crucial for society to function properly. Negative interactions between the police and the general public have been the focus of a great deal of media attention in recent years. Justified allegations and incidents of police misconduct and brutality have commanded a great deal of attention as they should. The advent of cell phone cameras and body worn cameras and a 24-hour news cycle have brought attention to this crucial issue.

We need only look to the summer of 2020 when the murder of George Floyd sparked a firestorm of protests notwithstanding the Covid-19 pandemic which was occurring at the same time. These protests while mostly peaceful and resulted in injury and property damage to both law enforcement and the general public. It must be noted that the overwhelming majority of contacts between police and the general public conclude without incident. The FBI estimates that of the 20 million police interactions with the public every year, less than 10,000 result in a negative conclusion. That said, it is crucial that we look for ways to improve policing not just with oversight but with systemic practices. One of the most prevalent of these is shift schedule. Most police departments must operate this way to ensure 24-hour coverage for the communities they serve.

Although police can and should be held to a higher standard, it is important to remember that police officers are human. They react to stress and stimuli just like every other human. They make mistakes. Police work is not easy. We don't call the police when everything is going well. Police officers see trauma on regular basis. This exposure takes its toll both physically and mentally. Police officers have some of the highest rates of divorce, domestic violence and suicide in the US. Police officers also have some of the shortest life expectancies of any occupation. The average life of a police officer is 59. This is well below the average life expectancy in the US and more than half of all police officers do not live more than five years after retirement. If we can find ways to optimize shift schedule to benefit the physical and mental health of police officers, we may in some small way reduce the incidence of negative interactions between police and the public and reduce some of these more negative outcomes.

Strengths and Limitation

There are numerous limitations to this research. One of the limitations is that because we analyzed archival data our sample was limited to the data that was available. Because of this the sample size was very small. Our sample was only 16 troopers for the within subjects sick time analysis and 18 troopers for the within subjects traffic stop analysis. These were troopers who worked both schedules in consecutive years. In addition, we were only able to utilize two consecutive years. Branching out further into other years could increase our sample size and thereby increase the power of analysis. There is the possibility that effects of schedule change may not be fully realized from one year to the next and may take several years.

Another limitation is that we only utilized one station because it was the only station that worked both shift schedules. This station may have specific nuances that do not generalize to other stations. Washington Station is more of a rural general policing station and is not comparatively call heavy. This differs from other station that are primarily traffic and highway enforcement of which there are many. These stations do a different type of policing and that could result in differences in the data. This research also compared a very specific population in law enforcement. This may not generalize to other occupations that utilize shift work.

Another limitation is that although certain factors were excluded such as long-term injury and family leave, there are other factors that could affect our analysis. One of them is overtime. Because supplemental overtime is generally voluntary, we did not assess overtime usage. Comparing a trooper who works little or no overtime to one that works almost every day could impact productivity and sick time as well. There are almost

certainly other factors that we have not accounted for that could affect the data we collected. This is true of all research and is why future research should focus on larger sample sizes. Future research should include between groups analysis of police officers who only worked one of the schedules. This would be useful to provide a larger sample and a more powerful analysis.

One of the most important limitations is the lack of demographic information in the sample. Factors such as age, race, gender, marital status and others were unavailable for confidentiality reasons. These factors have been shown to be useful in prior research and would have been helpful to provide a broader understanding of what factors shift work affects. Research has shown there are age and gender differences in shift schedules and that these can affect outcomes such as productivity sick time and work satisfaction. Comparing gender differences is difficult because there are very few females in law enforcement. Law enforcement is as heavily male as nursing is female.

This study does have some strengths as well and directions for future research. One of the strengths is the within subjects analysis. Although the sample size was small the within subjects comparison does address some of the error that is created by individual differences in between groups analysis. Although within subjects analysis is difficult because it takes time, we were able to use existing archival data to conduct this analysis. One of the drawbacks of within subjects analysis is the time it takes to analyze the same group twice. People can drop out of the study for several reasons or funding can be dropped. We did not have to deal with those real-world problems. Using archival data, we were able to do a between groups analysis and within subjects analysis regarding traffic stops and productivity. This only strengthens the conclusion that was reached.

There is a concern in laboratory research whether results obtained in laboratory studies will translate to real world circumstances. There have been numerous laboratory findings that do not translate to the real world. In this research we used real world data that was not intended for this analysis. It was collected in real time outside of a traditional laboratory setting. Any influence that a traditional laboratory-based analysis could have had on the behavior of troopers was minimized. There is value in analyzing this real-world data even though we are limited to what we have access to. Using this data was also efficient. It allowed us to look at existing data that was already collected. How often is data recorded and never analyzed? This proved to be a cost-effective way to conduct analysis by using what we already had access to.

Another strength of this research and a direction for future study is what was being analyzed. Most research on shift work has focused on shift length and comparing day shift to night shift. This research instead looked at the frequency of rotation from day shift to night shift in two very specific shift schedules. Future research should continue to assess the frequency of these rotations as a factor in many of the outcomes associated with shift work. As luck would have it, the hypotheses that were proposed were supported by the data analysis. Although this was not a true experiment, and we cannot derive a causal relationship between shift schedule and sick absence or productivity, the data analysis does support the claims that there may be advantages to less frequent rotation in shift scheduled. Perhaps in the future more traditional experiments can be conducted to further explore the impact of shift work in policing.

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