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THE SHIFT LENGTH EXPERIMENT

What We Know About
8-, 10-, and 12-Hour Shifts
in Policing



POLICE
FOUNDATION



THE SHIFT LENGTH EXPERIMENT

What We Know About
8-, 10-, and 12-Hour Shifts
in Policing

By

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POLICE
FOUNDATION

Washington, DC

The Police Foundation is a national, nonpartisan, nonprofit organization dedicated to supporting innovation and improvement in policing. Established in 1970, the foundation has conducted seminal research in police behavior, policy, and procedure, and works to transfer to local agencies the best new information about practices for dealing effectively with a range of important police operational and administrative concerns. Motivating all of the foundation's efforts is the goal of efficient, humane policing that operates within the framework of democratic principles and the highest ideals of the nation.

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The Shift Length Experiment: What We Know About 8-, 10-, and 12-Hour Shifts in Policing is available at www.policefoundation.org/shiftexperiment/.



TABLE OF CONTENTS

Foreword	v
Acknowledgments	vii
Introduction	1
Key Findings from the Experiment	5
The Experiment	7
Method	8
Agencies	8
Sampling Procedures	8
Participation	8
Research Design and Methods	9
Multicenter Trial	9
Random Assignment	9
Outcomes and Data Collection Methods	9
Measures	11
<i>Laboratory simulations</i>	11
<i>Police department data</i>	11
<i>Self-report instruments</i>	12
Data Analysis	14
<i>Analytical approach</i>	14
<i>Effect size</i>	14
Results	15
Significant Findings	15
Quality of Work Life (QWL)	15
Sleep Amount	15
Sleepiness/Fatigue (subjective)	16
Alertness	17
Overtime Worked	17

Nonsignificant Findings	17
Work Performance and Safety	17
Health and Stress	18
Quality of Personal Life	18
Sleep Quality, Fatigue (objective), and Sleep Disorders	18
Off-Duty Employment	18
Summary of Cross-Industry Research on Compressed Workweeks	19
Early Research	19
More Recent Findings	20
What We Know About Compressed Workweeks in Law Enforcement Compared to Other Industries	21
Problems with Past Studies	21
Summary of Findings by Outcomes	22
Performance	22
<i>Self-initiated activities and effort</i>	23
<i>Quality of service</i>	23
<i>Communication</i>	23
<i>Cognitive performance</i>	24
Safety	24
Health	25
Quality of Life	27
Fatigue, Sleep, and Alertness	29
Overtime and Off-Duty Employment	32
Other Outcomes	33
Conclusion	35
Appendices	39
A. Description of Measures	39
B. Past and Current Psychometric Properties of Measures	42
References	43
Authors	51
Illustrations	
Tables	
1. Actual Distribution of Participants Per Cell	9
2. List of Measures Within Each Construct	13
3. Results of GLM Analysis and Associated Effect Sizes	16
Figures	
1. Flow of Participants Through Each Stage of the Experiment	10



FOREWORD

Over the last decade, there have been increased calls for evidence-based practices in policing. Without the commitment of police leaders to participate in scientific research in their agencies, much of what we know about what works—and what does not—in policing would not have been possible. The responsibility to maintain order and public safety, the reactive environment in which the police must often function, and resource constraints pose real challenges to scientific inquiry in police agencies. Thus, the decision to participate in complex research is not an easy one, even for the most progressive police chief. Yet, it is precisely because of these constraints that the advancement of science in policing is essential.

This experimental field study of the effects of compressed workweeks (fewer than five days) in policing required significant commitment and cooperation from police leaders and rank-and-file officers in the two study sites, Detroit (MI) and Arlington (TX). Few experimental studies in policing have required random assignment of officers to conditions that could have as significant an impact on their lives as that of the hours and days they work. These agencies—their leaders, officers, and police associations—worked diligently to ensure that this study could be successfully implemented. We acknowledge and applaud the important contribution they have made in advancing the evidence base in policing research.

When I led the Newark (NJ) Police Department from 1974 to 1985, the critical challenge facing police executives was to do more with less. Fiscal stringency cut a wide swath through the Newark Police Department, as it did many other major American police departments. In Newark and elsewhere, there were severe cutbacks in personnel, either through attrition or outright layoffs. There were reductions in resources ranging from patrol cars to computer facilities, and constant caution to hold down costs in all possible ways. Despite those challenges, we agreed to participate in two pioneering Police Foundation experiments—foot patrol and fear reduction—because we recognized that opening the department to outside examination and experimentation in which police theory and practice would be subjected to the rigors of scientific analysis would produce the best evidence available as to how well they work.

Nevertheless, at that time I could not have imagined allowing officers to work fewer days, even if the total hours were the same. Many personnel practices in

policing have been defined by tradition, and certainly the five-day, forty-hour workweek is one of the most established practices. Until now, police leaders have had little scientific evidence upon which to base their policies for work hours. Although there has been much conjecture over the last few decades about the pros and cons of 8-, 10-, and 12-hour shifts, few if any rigorous studies have been carried out in policing. While research from other industries has shed some light on the effects of compressed workweeks, much of that evidence has not been definitive nor has it been effectively transferred to the field of policing. This report reflects not only the experimental research we conducted but also a synthesis of other evidence accumulated over time.

In 1970, Paul A. Samuelson, a leading economist at MIT and former advisor to President Kennedy, asserted that “progress comes from technical invention . . . But there are also momentous *social inventions* . . . The 4-day workweek was precisely such a social invention.”¹ Samuelson’s characterization of the four-day workweek as a momentous social invention may have seemed premature in a scientific sense, but he nevertheless foreshadowed some of our study’s findings: benefits of four, 10-hour shifts included officers’ greater satisfaction with schedules, increased sleep, and substantial reductions in overtime hours. These same benefits, however, were not had by those on 12-hour shifts, and indeed we found reason for caution in implementing 12-hour shifts. The four-day workweek is certainly a viable option for police agencies, as there are noted advantages over 8-hour shifts. Nevertheless, no significant performance or health-related concerns were evident for any of the shifts we examined (8-, 10-, and 12-hour).

The findings from our study may have potential for municipalities struggling with massive budget cutbacks. Overtime costs, which are funded primarily through municipal general funds, have come under particular scrutiny in the last few years as agencies look for ways to reduce spending. As in the 1970s and 1980s, America’s police agencies are facing severe fiscal challenges, while there are no similar reductions in citizens’ demands for police services. The effects of cutbacks and the increasing need for police services have forced police executives to seek more cost efficient and productive ways of accomplishing the police mission.

A key to realizing this mission is to capitalize on the fruits of reliable research. The products of such research are important not only to suggest ways that police departments can be more productive, but also to educate the public on the possibilities and limitations of police service within existing constraints. It is our hope that the results of the shift length experiment will inform that process and aid law enforcement leaders in the implementation of policies and programs that improve agency performance as well as the safety, health, wellness, and performance of officers.

Hubert Williams
President
Police Foundation

¹ Poor, Riva. (1970, 7). *4 days, 40 hours: Reporting a Revolution in Work and Leisure*. Cambridge, MA: Bursk and Poor Publishing.



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As in any large-scale project, we owe a debt of gratitude to many people who helped in developing and implementing this experiment. Most importantly, we thank the Arlington (TX) and Detroit (MI) Police Departments whose participation in this study allowed us to learn about the impacts of various shift schedules, which will be of benefit to law enforcement executives, officers, and scholars.

We are grateful to Detroit Police Chief (retired) Ella Bully-Cummings and Arlington Police Chief Theron Bowman, PhD, for their commitment to advancing the field of policing through agency participation in research. The shift work study was one of the most complex and difficult field studies to run because it required officers to participate in simulations at all times of day and night (and at the end of their shifts), and considerable resources (such as office space, personnel, etc.). Without forward thinking, dedicated leaders such as Chief Bowman and Chief Bully-Cummings, much of the important research in policing would not be possible. Similarly, we thank the Detroit Police Officers Association and the Arlington Police Association, whose support allowed us to gain participation of willing officers.

We gratefully acknowledge a number of individuals in both police departments—key leaders and support staff—who dedicated time and effort to ensuring the success of the study. In Detroit, we thank the following individuals: Deputy Chief (ret.) Gail Wilson-Turner; Assistant Chief (ret.) Gary Christian; Commander (ret.) John Autrey, who served as project site coordinator; Chief Ralph Godbee (formerly assistant chief); Marty Bandemer, president of the Detroit Police Officers Association; and police personnel at the Casino Gaming Unit, who shared their office space with us. In Arlington, we greatly appreciate the efforts of Suzan Cogswell, operations analyst/official department officer liaison coordinator; Assistant Chief James Hawthorne; Lieutenant Osbaldo Flores; Sergeant LaTasha Watson, PhD; Corporal Keith Scullen; Beth Troy, assistant to the police chief; Sharon Jones, office coordinator, South Arlington Police Service Center; and the officers and supervisors at South Station who shared their office space with us.

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support and participated in our exercise simulations on-site in Detroit. Maggie Heisler, former senior social science analyst and our initial grant monitor, demonstrated enthusiasm and involvement in key project design issues as did her successor, Akiva Liberman, PhD, who helped iron out design issues important to the scientific merits of the study. We especially thank Thomas Feucht, PhD, executive senior science advisor, who worked with us in improving upon the proposed study design and promoted this effort.

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Finally, in order to capture various performance outcomes, we sought out a variety of simulation exercises and chose those that seemed most relevant and useful for our purposes. As such, we wish to acknowledge those individuals and organizations whose products and services were used in this study. We appreciate the cooperation of IES Interactive Training in Ann Arbor, Michigan. Dean Krutty, IES President, provided us with the MILO® shooting simulator for use in the Detroit Police Department, as well as support from staff members Jason LaMons and Mike Hogan who facilitated set up, training, and use of MILO® Range scenarios. We thank Ed Hotchkiss of PMI, Inc. in Maryland for assistance and training on the use of the Fitness-for-Duty Impairment Screener (FIT®). We thank Steve Somers from the B-PAD® Group, Inc. for assistance and training on the use and scoring of the B-PAD®. Scantron® Corporation did the layout and printing of our police survey, and we thank Esther Byrd and Julie Willmes for their assistance with the development of our Scantron® survey booklet, and Bunny Clarke for providing training on the scanning system.



INTRODUCTION

Ever since the earliest police forces were established, the schedules and hours that police officers work have been an issue of concern to officers and chiefs. Driving these concerns have been issues of safety, health, performance, quality of life, fatigue, and efficiency. Traditionally, police departments have relied on a five-day, eight-hour scheduling framework with three standard shifts (day, evening, midnight) in each twenty-four-hour period. However, since at least as early as the 1970s, law enforcement agencies have adopted alternate schedule configurations. Compressed workweek schedules (CWWs), in which the workweek is shortened and the length of the day is extended, have indeed been popularized in the last several decades in many industries, including policing.

The traditional five-day, forty-hour workweek did not become the U.S. standard until approximately seventy years ago. Labor unions strongly opposed long work hours that were common in the late eighteenth century but often to no avail. By the turn of the century, however, a number of industries had begun to implement eight-hour workdays (Dankert, Mann, and Northrup 1965). Following the Great Depression and subsequent legislation associated with the New Deal (the Walsh-Healy Public Contracts Act of 1935 and the Fair Labor Standards Act of 1938), more changes became possible such that private firms began to implement traditional five-day, forty-hour workweeks. Around that same time, a few corporations even began experimenting with a four ten-hour day schedule. By the 1970s, CWWs had gained in popularity, and the Federal Employees' Flexible and Compressed Work Schedules Act was enacted into law in 1978. During the 1970s and 1980s, tremendous attention was paid to CWWs.

Almost thirty years ago, in a National Institute of Justice-funded study of work scheduling, researchers surveyed 160 agencies regarding their practices and reported that almost 25 percent of departments had implemented 9-, 10-, 11- and even 12-hour schedules for one or more shifts (Stenzel and Buren 1983). Because no national data have been reported since that time, the Police Foundation conducted surveys with a random sample of law enforcement agencies in 2005 and 2009. The results of our national surveys seem to suggest that there is a great variation in

shift schedules employed in U.S. law enforcement, but there have been little available data on the advantages and disadvantages associated with these shifts.¹

Over the years, there has been considerable research to examine the impacts of CWWs and long working hours across industries, particularly in 24/7 and high-risk operations (e.g., hospitals, production and power plants, utilities, and transportation). Yet, Axelsson (2005, 17) noted that while management and employees believe the advantages of longer work days outweigh the disadvantages, “it could, perhaps, also be argued that the drawbacks of extended work shifts are largely unknown or ignored by these groups.”

While research on CWWs in policing is quite limited, there has been considerable conjecture about the benefits and drawbacks of CWWs and long work hours among law enforcement personnel. Not surprisingly, law enforcement personnel frequently claim that CWWs offer far more advantages than disadvantages. Among the many benefits espoused are the ability to increase coverage during peak hours of activity, improve officer job satisfaction and morale, increase performance, reduce response time, reduce crime, reduce costs for officers and agencies (e.g., commuting, overtime, and sick leave), limit fatigue, improve teamwork, allow for increased in-service training during periods of overlap, increase days off for personal pursuits/family activities, and reduce accidents and complaints against officers (see, e.g., Brown 1974; Cunningham 1982; Durrett 1983; Fournet 1983; Jacques 2010; Strunk 1978; Sundermeier 2008; Vega and Gilbert 1997; Vila, Kenney, Morrison, and Reuland 2000). Many of these purported benefits, however, are far from firmly established in the research literature. Due to a belief that such schedules may improve efficiency, many law enforcement executives have considered or implemented CWWs (Oliver 2005; Sundermeier 2008; Vega and Gilbert 1997).

Nevertheless, Cunningham (1990) noted some managers in Canadian law enforcement agencies were concerned about potential disadvantages associated with CWWs in terms of reduced opportunity for communication with staff, citizen complaints, potential costs, lack of investigative continuity, and lessened identification with the police profession due to time away from the job. In addition, Melekian (1999) noted potential drawbacks associated with CWWs, such as increased fatigue, reduced communication across shifts, lessened ability to deal with neighborhood problems, and, most importantly, disengagement from the job and reduced ability or time to establish and maintain relationships with the community, thereby detracting from community policing and job involvement.

In the absence of empirical evidence, agencies as well as police unions/associations have occasionally conducted their own research, albeit often without the benefit of rigorous scientific methods. As such, when agencies make decisions about scheduling, they often do so without sufficient scientifically acquired knowledge. Researchers have routinely noted the many unknown potential impacts of CWWs (e.g., deCarufel and Schaan 1990), and scientists and practitioners have called for additional research on CWWs and optimal shift lengths in law enforcement (e.g., Melekian 1999; Vila 2006).

Moreover, scientists have cautioned about the use of extended and long work hours in positions where public health and safety could be threatened (Armstrong-Stassen 1998; Knauth 2007; Macdonald and Bendak 2000; Rosa 1995; Scott and Kittaning 2001). Due to widespread knowledge of the impact of fatigue on safety, policies and requirements have been modified in many federally regulated industries. Indeed, according to Vila and colleagues, the well-known impact of fatigue on safety has led the federal government to regulate the work hours of private, for-profit workers—train engineers, truck drivers, commercial pilots, and nuclear power plant operators—but surprisingly not the police, “the government’s most public, sensitive, and routinely controversial service provider”

¹ A report on the two surveys, entitled *Trends in Shift Length: Results of a Random National Survey of Police Agencies* (Amendola et al.), is available at www.policefoundation.org/shiftexperiment/.

(Vila, Morrison, and Kenney 2002, 7). Yet, while law enforcement is fraught with considerable risks to officers and the public, examination of the impacts of CWWs in policing has been less frequent and often less rigorous than that conducted in other industries. Furthermore, much of the research across industries, including policing, has been limited by the research designs employed, the methodologies used, and/or measurement problems, often leading to contradictory or inconclusive findings.

In an effort to comprehensively address the many potential effects of CWWs in policing in a systematic way, the Police Foundation conducted an experiment in which officers were randomly assigned to shifts (8-, 10-, and 12-hour). We examined the independent effects of shift length, taking into consideration the time of day worked and the variations associated with specific agencies. Because past studies have tended to focus on a limited number of potentially important managerial and individual considerations, we examined a broad array of outcomes important to the officers themselves and the organizations, including officer stress, sleep, fatigue, health, and quality of life, off-duty employment and overtime, and a variety of performance and safety measures.

In this report, we begin by presenting the key findings of our experiment and then describe the methodology, the comprehensive array of measures employed, and the results of the analyses conducted in the experiment. Subsequently, we examine cross-industry research on compressed workweeks, including that from policing and its connection to our findings.



KEY FINDINGS FROM THE EXPERIMENT

Ten-hour shifts have advantages over 8-hour shifts.

Ten-hour shifts appear to offer some advantages over 8-hour shifts, both individually and organizationally, with no noted disadvantages. For example those officers working 10-hour shifts got significantly more sleep per night (over half an hour) than those on 8-hour shifts and had a significantly higher quality of work life. Also, those on 10-hour shifts worked the least amount of overtime of the three groups, potentially resulting in cost savings.

The benefits of 10-hour shifts do not extend to 12-hour shifts.

Although it may be expected that some advantages associated with 10-hour shifts would inure to those on 12-hour shifts, we did not find that in this study. For example, while those on 10-hour shifts got significantly more sleep than those on 8-hour shifts, the same was not true for those on 12-hour shifts.² Also, those on 10-hour shifts had a higher reported quality of work life than those on 8-hour shifts, but those on 12-hour shifts did not. While those on 12-hour shifts worked a lesser amount of overtime than those on 8-hour shifts, they still worked more than those on 10-hour shifts.

Twelve-hour shifts may pose safety risks to officers and the public.

While shift length did not impact safety (e.g., driving, reaction time), those assigned to 12-hour shifts had significantly lower average levels of alertness at work and were more sleepy than those on 8-hour shifts, something that was not true for those on 10-hour shifts. Because sleep scientists assert that people underestimate their fatigue levels (e.g., Rosekind and Schwartz 1988), the latter two findings should be concerning.

²Although the mean level of sleep for those on 12-hour shifts was higher than for those on 8-hour shifts, these differences did not reach statistical significance.

Eight-hour shifts may be more costly than organizations realize.

Officers assigned to 8-hour shifts worked significantly more overtime than did those on 10- or 12-hour shifts. In our study, those officers assigned to 8-hour shifts worked more than five times as much overtime per two-week period (5.75 hours) as those on 10-hour shifts (0.97 hours), and more than three times as much as those on 12-hour shifts (1.89 hours).

Shift length did not have a significant impact on any of our measures of performance, safety, work-family conflict, or health.

- Our performance and safety measures (interpersonal interactions, shooting skills, risky driving behaviors, reaction time, fatigue, and self-initiated departmental activity) were not impacted by shift length.
- The groups did not differ with regard to work-family conflict.
- During the six-month period in which officers were assigned to the experimental conditions, we did not detect differences across groups in terms of sick leave taken, stress experienced, increased cardiovascular problems, or gastrointestinal problems.³

³It is widely understood that cardiovascular problems develop over a number of years, so our lack of a shorter-term finding does not rule out the possibility that CWWs over many years could be associated with decreased cardiovascular health.



THE EXPERIMENT

We conducted a multisite randomized experiment designed to assess the impact of compressed workweek schedules (CWWs) on various outcomes in policing using multiple methods and both objective and self-report measures. Past findings related to extended shifts and CWWs in other industries and especially in policing have been somewhat mixed, in large part due to limitations of many studies in terms of research designs, methodological concerns, and measurement problems. It was the aim of this research on the impact of CWWs in policing to conduct a randomized experiment that would overcome some of the limitations of past research and more broadly address a variety of outcomes within the context of one study. As such, we examined a number of outcomes of interest, including officer performance, safety, health, quality of life, fatigue, sleep, and extra-duty employment, in order to examine the potential advantages and disadvantages associated with various shift schedules.

The experiment was conducted in two police departments (Detroit, Michigan, and Arlington, Texas) during the period of January 2007 through June 2009. After obtaining volunteers, we randomly assigned officers to one of three conditions: (a) five consecutive 8-hour days, (b) four consecutive 10-hour days, and (c) three consecutive 12-hour days.⁴ The agencies agreed to maintain the conditions (shift length, time of day, and district) throughout the course of the six-month period of the study. We employed a randomized block design, a research design that allowed us to take into account variability within the sites (Detroit and Arlington) and during different shifts (day, evening, and midnight), as well as possible interactions between shift length and those factors (see Weisburd and Taxman 2000).

⁴In order to ensure all officers worked eighty hours in each two-week period, officers assigned to 12-hour shifts worked three consecutive 12-hour shifts in week one, and three consecutive 12-hour shifts followed by a single 8-hour shift in week two, a configuration which is common among agencies operating on 12-hour shifts.

Method

Agencies

At the time of the study, both sites were operating on standard eight-hour duty tours with five consecutive days of work. Both Arlington and Detroit were large enough to ensure minimal impact on regular police operations and to provide a sufficient number of cases for our study. As of 2007, the Detroit Police Department had 3,049 sworn officers and the Arlington Police Department had 580.⁵ Although the proportion of sworn female officers employed in Detroit (27 percent) was higher than that of Arlington (18 percent), the proportion of officers who participated in the study was comparable across sites. Whereas Detroit had a higher proportion of Black officers (66 percent), Arlington had just 15 percent. There was also a higher proportion of single officers in Detroit (51.6 percent) than in Arlington (36.7 percent). Over 75 percent of participating officers from both sites had less than ten years on the job.

Sampling Procedures

Officers were recruited for the study on a voluntary basis as is required by federal regulation and consistent with institutional review board mandates. In order to be eligible for the study, the following two criteria were established for officers: (1) must be in the patrol operations division (assigned to respond to calls for service); and (2) must not be working foot patrol or on light/restricted duty (to ensure all participants were performing the same general duties). Officers were informed that if they volunteered for the study, they were agreeing to be assigned to any one of three shifts (8-, 10-, or 12-hour). Officers were also provided with monetary incentives associated with their participation.⁶

Our power analysis suggested a sample of 300 officers would be more than sufficient to ensure a high level of power for the study, and we obtained 326 volunteers. These officers were randomly assigned to one of three conditions: 8-hour shift ($n = 109$), 10-hour shift ($n = 109$), or 12-hour shift ($n = 108$). Our actual sample size was 128⁷ for Detroit and 147 for Arlington, resulting in a total of 275 participants in the study at Time 1. Due to attrition between Time 1 and Time 2, the sample size for Detroit decreased to 88 participants, while in Arlington it went down to 138, resulting in a total sample of 226, still sufficient to detect medium effect sizes but insufficient to detect smaller effects. The final distribution of participants per cell based on this design is shown in Table 1. Because evening shifts are typically most heavily staffed, our study also reflected a higher number of evening shift workers and fewer day shift participants.

Participation

In Figure 1, we present the flow of participants through the experiment from randomization through the outcome measures.

Attrition. There was both voluntary and involuntary attrition in this study. Voluntary attrition occurred when officers chose to drop out of the study either following assignment to their shift or at some other stage of the study. Involuntary attrition occurred when officers were discontinued from the treatment or excluded from the analysis for any of the following reasons: (a) the officer resigned or retired from

⁵These data came from the *2007 Law Enforcement Management and Administrative Statistics*, Bureau of Justice Statistics, U.S. Department of Justice. (Reaves, personal communication, September 29, 2010).

⁶Officers were provided with \$50 payments for completing a survey instrument in both Time 1 and Time 2. In addition, officers who completed sleep diaries and alertness logs were eligible for a number of \$1,000 randomly drawn prizes.

⁷179 were randomly assigned, and 51 did not follow through with the treatment.

Table 1. Actual Distribution of Participants Per Cell

		Detroit, Michigan (n = 88)				Arlington, Texas (n = 138)			
Length ↓	Schedule →	Day	Evening	Midnight	Total	Day	Evening	Midnight	Total
8-Hour Shift		7	8	7	22	8	24	13	45
10-Hour Shift		13	10	10	33	14	19	15	48
12-Hour Shift		8	16	9	33	9	21	15	45
Total		28	34	26	88	31	64	43	138

the agency; (b) the officer became disabled or ill; (c) the officer was not able to complete outcome measures because of a duty-related reason (at court, on departmental leave, at a hot call, could not be rescheduled); or (d) because the department either promoted the officer, transferred the officer to a non-patrol assignment, or changed their shift schedule (day, evening, or midnight). By definition, involuntary attrition is due to reasons that are uncorrelated with the treatment. For both the pre- and posttest, voluntary attrition was less than 12 percent, where involuntary attrition rates were under 8 percent.

Research Design and Methods

Multicenter Trial

While we had two sites for our research, we implemented one tightly controlled experiment in order to pool data across sites. This approach is a special type of replication study in which the sites are not replications per se, but rather part of the overall design (see, e.g., Fleiss 1982; Weisburd and Taxman 2000). In order for such multicenter trials to be valid, researchers must maintain consistency in research protocols, something we were able to control by using the same researchers across sites and employing standardized protocols for treatment and measurement, something not often possible in medical research. Since we knew some of the outcomes may be influenced by the time of day worked (day, evening, or midnight shift) or the agency in which officers worked, we employed a randomized block design that allowed us to control for these factors and thereby prevent a potential experimental confound.

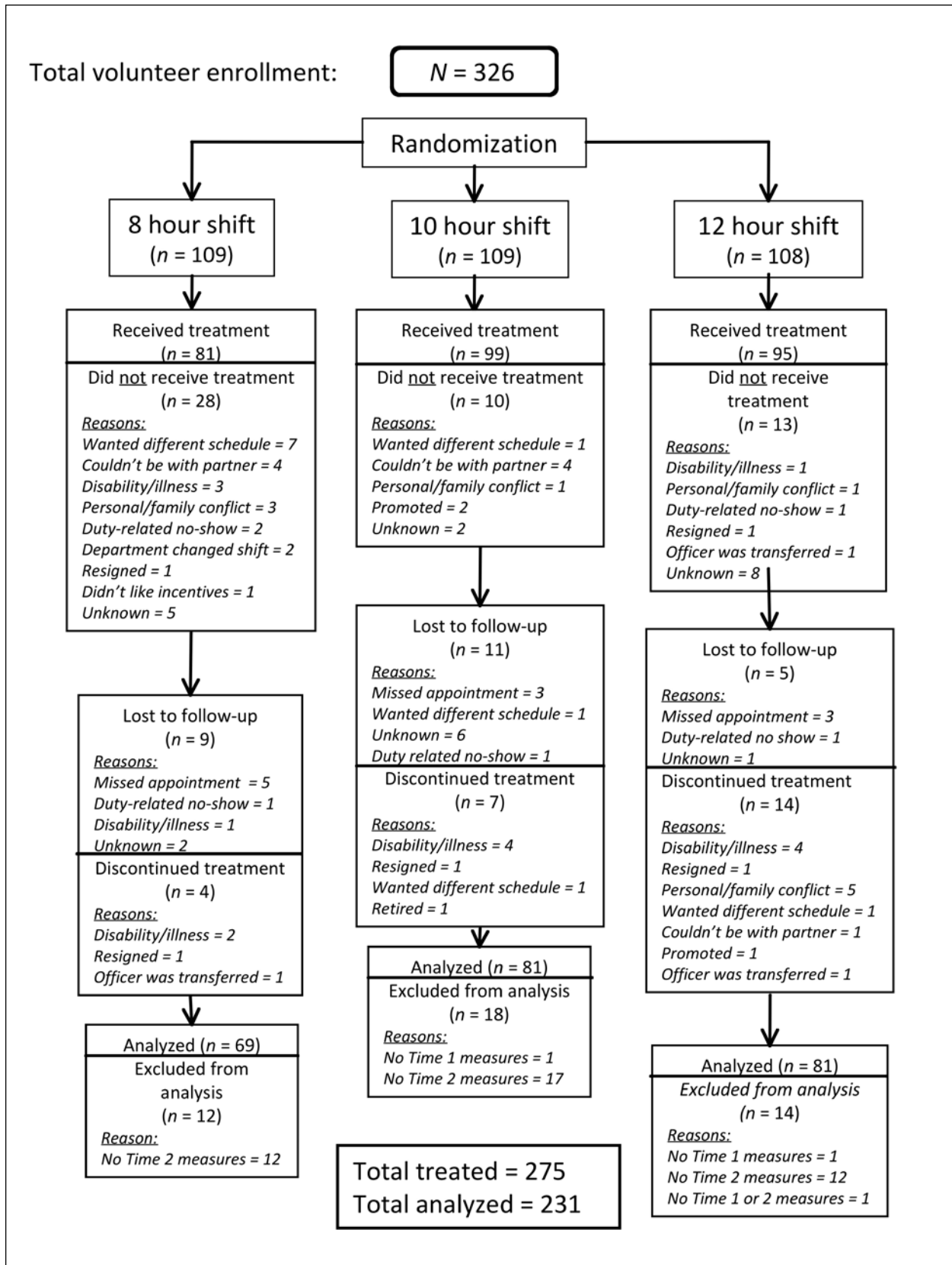
Random Assignment

In each study site, we conducted separate randomization procedures within each experimental block (agency and time of shift). Also, in order to minimize disruptions to departmental operations, we distributed the participants equally across patrol districts by randomly assigning within each district, so as not to overburden any particular district by selecting a greater number of officers from any particular district. We assigned a computer-generated, random number sequence to make the assignments.

Outcomes and Data Collection Methods

The purpose of this study was to examine a variety of outcomes. As such, we used a systematic process to identify broad categories of outcome measures (constructs) including (a) work performance and safety, (b) health and stress, (c) quality of life, (d) sleep, fatigue, and alertness, and (e) extra-duty

Figure 1. Flow of Participants Through Each Stage of the Experiment



employment (overtime and off-duty employment). In order to assess these constructs, we used a variety of data collection methods including (a) performance simulations and other objective measures we conducted in laboratory settings in the police agencies, (b) daily statistics from both police departments, and (c) surveys and other self-report instruments we administered. We collected data at two points in time: before treatment implementation (the pretest) and at the end of the six-month study period (the posttest).⁸

Measures

The selection of measures to employ in this study was based on a number of factors including past demonstrated reliability and/or validity, fidelity, ease of administration, and, to a lesser extent, cost. Past research has relied on limited, self- or supervisory reports of performance, or infrequently occurring outcomes (e.g., accidents, shootings).⁹ In order to overcome this problem so that we could compare all officers on a variety of outcomes, we used a performance simulation approach to obtaining data. This approach mimics that of the assessment center, a practical exercise method used to assess performance in order to make hiring and promotional decisions across a wide variety of industries, including law enforcement (see, e.g., Coulton and Feild 1995; Hughes 2006; Krause, Kersting, Heggstad, and Thornton 2006; Thornton and Gibbons 2009). This method allowed us to administer the same performance measures under the same conditions across all participating officers.

Laboratory simulations. Simulation exercises were completed for the pre- and posttest periods. Participants were required to complete five simulations during the last two to three hours of their work shifts to allow researchers to examine outcomes at a point at which fatigue was more likely to have occurred. To ensure all participants could be scheduled to complete the simulations during the last two to three hours of their shifts, data collection in the sites took from two to four weeks in Time 1 and about two weeks in Time 2. The five simulations, all of which are widely used, include the:

1. **Fitness-for-Duty Impairment Screener (FIT®):** a pupil-response test that detects fatigue via a measure of saccadic velocity (the speed of eye tracking).
2. **Behavioral Personnel Assessment Device (B-PAD®):** a video-based screening tool that captures officers' responses to scenarios to assess interpersonal behaviors.
3. **STISIM Drive®:** a PC-based, high-fidelity, fully interactive driving simulator for evaluating safety by capturing driving mistakes such as accidents, etc.
4. **Psychomotor Vigilance Test (PVT):** a PC-based stimulus-response method for assessing fatigue via reaction time, lapses (failure to respond), and false starts (responses when no stimulus was present).
5. **MILO/Range 3000®:** a shooting simulator used primarily for training purposes to assess shooting performance in realistic interactive situations using a laser-sighted weapon and video.

Police department data. While our primary focus was on laboratory simulations for the assessment of performance, we also gathered departmental data of self-initiated officer activity and sick leave for equal time periods.

⁸ Because it took approximately two weeks to administer the performance simulations in each agency (we were able to run ten to twelve officers through the exercises per day), the post measure was done as early as 5½ months after the treatment but no longer than six months after.

⁹ The low base rates for infrequently occurring events/critical incidents limit the ability to detect group differences.

Self-report instruments. In addition to the five simulations, each participant was asked to complete a series of surveys and other instruments, including:

- A short survey completed on the day of the simulations, inclusive of hours worked and time slept in the previous twenty-four hours, caffeine ingested, etc., as well as measures of health and sleep disorders (in Time 2 only).¹⁰
- A sleep diary and alertness log that were completed for a two-week period prior to the laboratory simulations.
- A 456-item survey, entitled *Law Enforcement Officer Survey of Work Attitudes, Personal Characteristics, Health, Safety, and Quality of Life*. This survey was administered using a Scantron® booklet made up of many previously validated and/or used measures of quality of life, stress, job satisfaction, and sleepiness, among others.

Due to the number of outcomes being assessed in this study, we not only categorized outcome measures/constructs but in some cases created composite indices made up of a variety of measures designed to capture the same construct, something that also allowed for an increase in statistical power.¹¹ In order to combine measures tapping into the same basic construct (e.g., stress), we transformed scores on individual instruments into standardized scores. This allowed us to convert measures with different response scales (scales of 1-5 or 1-7, etc.) into standard deviation units, where the mean value is 0 and the standard deviation is 1, and then add their values together to create one composite score.

In order to increase reliability and limit systematic variability of both outcomes relying on rated performance (interpersonal performance using the B-PAD® and shooting performance using the MILO/Range 3000®), rating training was provided for two separate individuals for the two exercises, and those individuals rated both Time 1 and Time 2 performance across all participants so as to maintain rating consistency.

We assessed the reliability of instruments/scales via Cronbach's alpha, a coefficient of reliability for internal consistency that indicates how well items within a scale measure a single latent construct. Scales with alpha levels of .70 and above are generally considered strong and alpha levels between .60 and .70 are, in most cases, considered acceptable (Ary, Jacobs, and Razavieh 1985; Cascio 1991). The majority of our outcome measures demonstrated internal consistency, with Cronbach's alpha coefficients over .75 for the latent constructs we used as outcome variables.¹² Table 2 presents a list of measures used to assess each construct. Detailed descriptions of the measures and sample items, where relevant, are provided in Appendix A, and past psychometric properties of the measures are provided in Appendix B, as are the scales' reliability coefficients obtained in this study.¹³

¹⁰ Health and sleep disorder items were obtained only in Time 2 because the identification of such issues at an earlier stage in the experiment would have imposed ethical responsibilities for disclosure of any identified conditions to the participants. If disclosure occurred, any treatment sought by participants would have created a confound. Instead, we identified symptoms associated with sleep disorders in Time 2 and then informed the participants via letter of our findings indicating that they should seek further assessment or diagnosis by trained medical personnel.

¹¹ By reducing the number of individual analyses to conduct, statistical power is not further diluted.

¹² While we recognize that the Cronbach's alpha levels for the shooting performance and driving simulator were low (.43 and .58, respectively), we felt that the items used in each measure were an accurate reflection of the dependent variable of interest in the study. The low alphas on the two scales may be attributed to the sample's homogeneity and the results may be justified for use in the analyses (see Bernardi 1994).

¹³ For more details on the measures, refer to the full technical report of this study, entitled *The Impact of Shift Length in Policing on Performance, Health, Quality of Life, Sleep, Fatigue, and Extra-Duty Employment* (Amendola et al. 2011), available at www.policefoundation.org/docs/library.html and www.ncjrs.gov.

Table 2. List of Measures Within Each Construct

CONSTRUCTS & INSTRUMENTS	Measuring	Author(s) of Measure, Year
Work Performance & Safety		
• Interpersonal Behavior	Performance	Composite of existing measures
—8 B-PAD® vignettes		The B-PAD Group, Inc., 1994, 1999, 2010
—Lost temper frequency		Czeisler et al. 2005
• Driving (STISIM®)	Safety	Rosenthal et al. 1995, Systems Technology, Inc.
• Shooting (MIL0/Range3000®)	Performance	IES Interactive Training
• Self-Initiated Activities	Performance	Composite of department data
—Arrests, citations/summonses, reports, and stops		
Health & Stress		
• Cardiovascular, Gastrointestinal Health	Health	Barton et al. 1995 (Costa subscale)
• Stress	Stress	Composite of existing measures
—Police Stress Questionnaire		McCreary and Thompson 2004
—Work Environment Inventory		Lieberman et al. 2002
—Police Daily Hassles Scale		Hart, Wearing, and Headey 1994
• Sick Leave	Health	Department data
Quality of Life		
• Quality of Work Life (QWL)	QWL	Composite of existing measures
—Job Satisfaction (MSQ)		Weiss, Dawis, England, and Lofquist 1967
—Schedule Satisfaction		Tucker, Smith, Macdonald, and Folkard 1998
—Organization Commitment		Allen and Meyer 1990
—Job Involvement Scale		Kanungo 1982
• Quality of Personal Life (QPL)	QPL	Composite of existing measures
—Work-Family Conflict I		Carlson, Kacmar, and Williams 2000
—Work-Family Conflict II		Netemeyer, Boles, and McMurrian 1996
Sleep & Fatigue		
• Sleep Amount, Quality (Sleep Diary)	Sleep Amount	Heitmann 2006 (unpublished)
• Sleepiness Composite (subjective fatigue)	Sleepiness	Composite of existing measures
—Sleep Assessment		Czeisler et al. 2005; Heitmann 2006 (unpub.)
—Epworth Sleepiness Scale		Johns 1991, 1992
• Alertness (Alertness Log) ^a	Alertness	Heitmann 2006 (Karolinska scale)
• Fatigue (objective, physiological)	Fatigue	Composite of existing measures
—Saccadic Velocity (FIT®)		PMI, Inc.
—Psychomotor Vigilance Test		Dinges and Powell 1985; Thorne et al. 2005
• Sleep Disorders	Sleep Disorders	Composite of existing measures
—Berlin Sleep Apnea (<i>adapted</i>)		Netzer et al. 1999
—Insomnia		Heitmann 2006
—Sleep Disorders		Czeisler et al. 2005
Extra-Duty (sleep diary)		
• Off-Duty Employment and Overtime ^b	Total Hours	

^aThe average daily alertness level on days worked was computed based on the fourteen-day period.¹⁴

^bOvertime was calculated as the amount of departmental hours worked in excess of eighty hours per two-week period.¹⁵

¹⁴While it is likely that alertness levels may decrease as the shift goes on, we were interested in the overall alertness across groups for the entire shift. Additional analysis may reveal differences towards the end of the shift.

¹⁵In instances when the hours did not total eighty hours due to the officer being on vacation, sick, or absent, overtime was assumed to equal zero for that particular officer's data.

It is important to note that since many of the outcome measures were derived from self-report items that assessed officers' attitudes and behavior, we examined whether the officers were presenting themselves in a more favorable light by including a measure of "social desirability bias." That measure consisted of a 33-item scale developed by Crowne and Marlowe (1960) to identify and potentially eliminate any cases where an officer may be responding untruthfully. In our sample, the scores ranged from 4.0 to 29.0 with a mean of 19.1 and a standard deviation of 5.0. All of the participating officers fell within the selected criteria (being 2.0 or less standard deviations from the mean) and, as a result, none of the participants' data needed to be excluded from our study. This is not surprising considering our sample consisted of police officers whose jobs are in jeopardy if they are dishonest.

Data Analysis

The results presented in this study are based primarily on comparisons of means for the three treatment conditions (8-, 10-, and 12-hour shift lengths) and statistical tests to indicate the probability of obtaining a difference between the three groups. Our alpha level for rejection of the null hypothesis was set at $p < .05$. Since there were virtually no rigorous past experimental designs testing the impact of shift length, our hypotheses were nondirectional and, as such, we employed two-tailed tests. Missing data were excluded from the analysis on a case-by-case basis, so our n for any of our statistical tests includes all of the valid cases in the dataset.

Analytical approach. Our analytic approach was an analysis of covariance (ANCOVA), where the pretest measures served as the covariate so as to control for any initial differences. This analysis was conducted using General Linear Model (GLM) analyses and the outcome scores were adjusted based on the pretest measures. Our independent variables, then, were the primary study variable, shift length (8-, 10-, or 12-hour), and our blocking variables—time of day of the shift (day, evening, midnight), and the agency itself—as well as any interactions between the shift length and the latter two variables.¹⁶

Effect size. Throughout the discussion of the results of this study, we present Cohen's f (Cohen 1988) effect size index to measure the magnitude of the differences.¹⁷ We relied on Cohen's criteria for interpreting the magnitude of the effects as small ($f = .10$), medium ($f = .25$), and large ($f = .40$), despite the fact that Lipsey has argued that effect size values of .10 and larger "could easily be of practical significance" (2000, 109). However, we do interpret all effects of .10 as meaningful as suggested by Lipsey.

¹⁶ If the block by treatment interactions did not achieve statistical significance at the .05 level, we excluded them from the analyses; see Fleiss (1982) who actually suggests an even more conservative alpha level of $p < .01$.

¹⁷ Cohen's effect size f index formula is the square root of the Eta squared (η^2) divided by 1 minus η^2 (Cohen 1988, 280–288). η^2 is calculated as the ratio of the effect variance (SS_{effect}) to the total variance (SS_{total})— $\eta^2 = SS_{\text{effect}} / SS_{\text{total}}$. The value for the SS_{total} in the formula includes the SS for each of the effects and the error term, but does not include the SS for the intercept in the GLM models. Note the η^2 column in one version of SPSS provided only partial η^2 output. As such, η^2 was manually calculated.



RESULTS

As previously mentioned, the specific objectives of this study were to examine the extent to which shift schedules impact measures of performance and safety, health, quality of life, sleep, fatigue, and extra-duty employment among law enforcement officers. A thorough examination of the key findings is reported in the sections below. Table 3 presents the results, with significant effects listed in bold.

Significant Findings

Quality of Work Life (QWL)

There was a significant effect of shift length when considering quality of work life, $F(2,197) = 3.94, p = .021$, which represents a small to medium effect ($f = .16$). The pairwise comparison of the adjusted group means revealed the QWL for those on 10-hour shifts was significantly higher than for those on 8-hour shifts (10-hour mean = 0.93; 8-hour mean = -1.29) but not for those on 12-hour shifts (mean = 0.03).¹⁸ For QWL, there was also a significant interaction between shift length and site, $F(2,197) = 4.76, p = .010$. Although not statistically significant in Detroit, the main effect of shift length in Arlington was $F(2,125) = 8.49, p = .000$, which translates to an effect size of $f = .31$ (medium). The 10-hour group reported a significantly higher quality of work life (mean = 3.08) as compared to those in the 8-hour (mean = $-0.63, p = .001$) and 12-hour (mean = $-0.13, p = .004$) groups. In Detroit, the 8-hour group also had the lowest mean, although not statistically different from the other groups.

Sleep Amount

The analysis of the average hours of sleep showed a significant effect among groups with respect to length of shift, $F(2,147) = 3.23, p = .043$, after controlling for the effect of the average number of hours sleep in the pretest, representing a small to medium effect ($f = .19$). A pairwise comparison test of the adjusted group means revealed the average hours of sleep for officers in the 10-hour shift were significantly

¹⁸ Means are based on z-scores.

Table 3. Results of GLM Analysis and Associated Effect Sizes

OUTCOME MEASURE	<i>F</i> (<i>df</i>) ^a	<i>P</i>	Effect size: Cohen's <i>f</i>
Performance and Safety			
Interpersonal Communication	1.73 (2,214)	.180	.12
Driving	.264 (2,214)	.768	.04
Shooting	.481 (2,111)	.619	.08
Self-initiated Activity	1.22 (2,252)	.298	.07
Health and Stress^b			
Cardiovascular Health	.007 (2,222)	.993	.01
Gastrointestinal Problems	.809 (2,202)	.447	.08
Work Stress	.319 (2,197)	.727	.03
Sick Leave	.16 (2,271)	.854	.03
Quality of Life			
Quality of Personal Life	.303 (2,192)	.739	.04
Quality of Work Life Composite	3.94 (2,197)	.021	.16
Shift Length * Site	4.76 (2,197)	.010	.19
Sleep, Fatigue, Alertness			
Average Sleep Amount	3.23 (2,147)	.043	.19
Average Sleep Quality	.865 (2,147)	.423	.09
Sleepiness (subjective fatigue)	5.75 (2,222)	.004	.20
Alertness	4.42 (2,132)	.014	.21
Shift Length * Site	6.01 (2,132)	.003	.30
Fatigue (FIT [®]) (objective)	.098 (2,201)	.906	.02
Fatigue (PVT) (objective)	1.49 (2,214)	.228	.11
Sleep Disorders ^c	.208 (2,224)	.812	.04
Extra-Duty Employment			
Off-Duty Employment	.241 (2,146)	.786	.05
Overtime	15.42 (2,145)	.000	.42
Shift Length * Site	5.86 (2,145)	.004	.24

^aThe *F* was calculated taking into account the pretest measure, site of study, and time of day.

^bGastrointestinal and cardiovascular problems were not measured during the pretest.

^cSleep disorders were not assessed during the pretest.

greater (mean = 7.86) than the average hours of sleep among officers on the 8-hour shift (mean = 7.27, $p = .036$), but not the 12-hour group (mean = 7.63, $p = ns$).

Sleepiness/Fatigue (subjective)

To assess sleepiness, we included items from the Harvard Study of Work Hours (Czeisler et al. 2005) and our sleep consultant, as well as the entire Epworth Sleepiness Scale. There was a significant effect of shift length on the sleepiness composite, $F(2,222) = 5.75$, $p = .004$. Testing the magnitude of the sleepiness construct resulted in a small to medium effect ($f = .20$) for shift length. A pairwise comparison test of

the adjusted group means revealed the average level of sleepiness for officers in the 12-hour shift (0.771) was significantly higher than for those on the 8-hour shift (mean = -0.721, $p = .003$).

Alertness

There was a significant effect for alertness based on shift length, $F(2,132) = 4.42, p = .014$, representing a small to medium effect size ($f = .21$). A pairwise comparison test of the adjusted group means revealed the average level of alertness for officers in the 12-hour shift was significantly lower (mean = 6.11) than the average alertness levels among officers on the 8-hour (mean = 6.74, $p = .012$), but not the 10-hour shift (mean = 6.31, $p = ns$).

There was also a significant treatment by site interaction for level of alertness, $F(2,132) = 6.01, p = .003$. In Arlington, the main effect of shift length was $F(2,91) = 8.47, p = .000$, which translates to an effect size of $f = .29$ (medium). Those working 12-hour shifts were significantly less alert (mean = 6.10) than those on the 10-hour shift (mean = 6.74, $p = .000$) and the 8-hour group (mean = 6.53, $p = .037$). While the 8-hour officers in Detroit appeared more alert than those on either compressed schedule, those differences were not statistically significant.

Overtime Worked

When considering the amount of overtime hours taken by officers, there was a significant difference across groups for shift length $F(2,145) = 15.42, p = .000$, which represents a large effect ($f = .42$). A pairwise comparison of the group means adjusted for the effect of the pretest overtime hours revealed the average amount of overtime among officers in the 8-hour shift (5.75 hours) was significantly higher than the average hours for officers in the 10-hour (mean = 0.97 hours, $p = .000$) and 12-hour (mean = 1.89 hours, $p = .000$).

There was, however, a significant interaction effect for shift length by study site when considering amount of overtime, $F(2,145) = 5.86, p = .004$. While the analysis revealed officers on 8-hour shifts in both sites worked the most amount of overtime, those in Detroit worked considerably more (mean = 8.76)¹⁹ than those in Arlington (mean = 2.74 hours). In Detroit, the main effect of shift length was $F(2,44) = 7.39, p = .002$, which translates to an effect size of $f = .53$ (large). The 8-hour group had significantly more overtime (mean = 9.01 hours) than both the 10-hour group (mean = 1.49, $p = .002$) and 12-hour group (mean = 3.02, $p = .013$), indicating either type of compressed schedule in Detroit results in less overtime than for 8-hour shifts. In Arlington, the main effect of shift length was $F(2,104) = 3.03, p = .053$,²⁰ which translates to an effect size of $f = .25$ (medium). Similar to Detroit, the findings in Arlington were all in the same direction, although the paired comparisons did not reach statistical significance.²¹

Nonsignificant Findings

Work Performance and Safety

We did not identify any differences across shift length groups for any of our performance and safety measures (shooting performance, driving safety, self-initiated activity on the job, or interpersonal

¹⁹ Adjusted for pretest overtime hours.

²⁰ Just reaching statistical significance.

²¹ The 8-hour group also had the most overtime (mean = 2.54 hours) as compared to those on 10-hour shifts who had the least (mean = 0.75, $p = .064$, approaching significance), and the 12-hour shift fell in between (mean = 1.04 hours, $p = ns$).

behavior in simulated encounters with suspects or the general public). However, it is important to note that for composites in which the measures were not internally consistent (shooting and driving performance), it is not known whether shift length may have an effect on specific items within each composite measure.²²

Health and Stress

Shift length did not have an impact on cardiovascular health or gastrointestinal problems, our composite stress measure, or the amount of sick leave taken. It should be pointed out that cardiovascular health is influenced by a number of factors and problems tend to build over time. Because our study only looked at changes over a six-month period, we cannot rule out the possibility that longer-term effects may occur. However, there is reason to believe the use of sick leave, gastrointestinal upsets, and subjective experiences of stress would be manifest in the shorter term (six months), based on the short-term nature of these measures and prior research on health and stress.

Quality of Personal Life

Due to the comprehensive nature of this study, we had to limit the number of outcome variables we examined. As such, while many studies have examined various aspects of personal life such as leisure time, in our study we chose to focus on the more job-relevant concern of the impact of shift schedules (shift length, number of days worked) on family via measures of work-family conflict. No statistically significant differences were identified on work-family conflict based on the shift length.

Sleep Quality, Fatigue (objective), and Sleep Disorders

While we did identify meaningful differences in the amount of sleep obtained based on the shift length (those on 10-hour shifts got significantly more sleep than those on 8-hour shifts), there were no observed differences in the reported quality of sleep, inconsistent with some prior findings. Additionally, the length of the shift did not differentiate those with reported sleep disorders or those for whom there was an indicator of potential sleep apnea. Although we noted important concerns with regard to sleepiness and lack of alertness for those on 12-hour shifts, there were no differences between shift length groups for physiological (objective) measures of fatigue (saccadic velocity of pupil using the FIT™ and reaction time using the PVT).

Off-Duty Employment

Finally, while we found a very meaningful difference across shift lengths with regard to the amount of overtime worked, it is perhaps surprising we did not find a significant difference based on off-duty employment. While those on 10-hour shifts had a lower number of hours of off-duty work, that finding was not statistically significant.

²² Composite measures were used to assess broader constructs (e.g., driving safety) in order to maximize power. The fact that the driving and shooting composites demonstrated low internal consistency may indicate that the items comprising each composite are independent. The analysis of each item independently would have reduced power significantly. Consequently, it is possible that certain types of risky driving behaviors (lane deviations versus speeding) may be independently impacted by shift length, whereas as a group they were not.



SUMMARY OF CROSS-INDUSTRY RESEARCH ON COMPRESSED WORKWEEKS

Early Research

During the 1970s, there was increased interest in CWWs across industries (including law enforcement), but much of what was known about them reflected anecdotal information, opinions, or data derived from indirect (Calvasina and Boxx 1975) or subjective measures. Some examples include highly subjective measures such as using chiefs' observations of family relations (Durrett 1983), or family spending associated with CWWs (Gavney, Calderwood, and Knowles 1979; Goodale and Aagaard 1975).

In 1981, however, Ronen and Primps (1981) reviewed the 1970s literature on CWWs across industries and found fourteen studies in which various impacts of CWWs were examined. In reviewing this early work, they found employee reactions and attitudes toward CWWs were mostly favorable (e.g., Goodale and Aagaard 1975; Nord and Costigan 1973; Northrup, Wilson, and Rose 1979; Poor and Steele 1970). Most workers on compressed schedules had higher job satisfaction (e.g., Hodge and Tellier 1975; Ivancevich 1974), reported more leisure time, and believed the compressed schedule had benefited their marriage and/or social life (Goodale and Aagaard 1975). However, fatigue was reportedly higher for those on compressed schedules as well (e.g., Hodge and Tellier 1975; Maklan 1977; Poor and Steele 1970; Volle, Brisson, Pérusse, Tanaka, and Doyon 1979).

When examining performance, however, Ronen and Primps (1981) reported mixed results. Benefits noted included improvements in supervisory ratings of performance (e.g., Foster, Latack, and Reindl 1979; Ivancevich 1974), reductions in absenteeism (e.g., Foster et al. 1979; Goodale and Aagaard 1975; Nord and Costigan 1973), and a 10 percent reduction in overtime for those on 10-hour shifts (Goodale and Aagaard 1975). Others, however, reported disadvantages associated with CWWs in terms of supervisory perceptions of productivity, quality, service to others, and work coordination (Goodale and Aagaard 1975).

In 1990, Moores conducted a meta-analysis of the effects of CWWs and found that for the two studies done in the 1980s, there was a moderate effect on absenteeism, and for the three in the 1970s, there was a small effect, whereas CWWs were associated with decreased absenteeism. For the six studies of productivity conducted with blue-collar workers, the mean effect was just 0.10. When considering job satisfaction, however, Moores (1990) found a large effect (1.16) across five studies, tempered by an increase in fatigue with a mean effect of -0.35. Using a more rudimentary counting approach, Moores (1990) reported that in all studies of satisfaction ($n = 37$) and productivity ($n = 42$) there were increases associated with CWWs and decreases in absenteeism ($n = 34$), turnover ($n = 20$), and overtime ($n = 4$).

More Recent Findings

While there were many limitations of early research, a more recent review of the impacts of CWWs relied on fifteen rigorous studies (Josten, Ng-A-Tham, and Thierry 2003). In that review, researchers noted positive effects were more frequently reported in studies prior to and including 1982, whereas later studies tended to find more negative effects associated with CWWs. Across earlier studies, employees' perceptions were more favorable than supervisors regarding CWWs (Cohen and Gadon 1978; Ronen and Primps 1981), as were those of younger workers.

Since the earlier research of the 1970s and 1980s, a growing body of research has accumulated on compressed schedules mainly due to concerns over safety or other important considerations in a variety of industries. Harrington (1994), for example, noted the increased amount of studies on CWWs in the early 1990s. Indeed, over the last couple of decades, research has been conducted across a variety of domains including, but not limited to, medicine (see, e.g., Burke 2003; Fitzpatrick, While, and Roberts 1999; McGettrick and O'Neill 2006); manufacturing and mining (see, e.g., Duchon, Smith, Keran, and Koehler 1994, 1997; Northrup 1991); utilities and power plants (see, e.g., Mitchell and Williamson 2000; Rosa 1992, 1993); and transportation, including trucking (see Aamodt 2010; Hamelin 1987), railroads (Härmä, Sallinen, Ranta, Mutanen, and Müller 2002; Sallinen et al. 2005), and aviation (Schroder, Rosa, and Witt 1998).

Overall, when considering compressed schedules, the findings have suggested: (a) employees generally and overwhelmingly favor them (e.g., Armstrong-Stassen 1998; Axelsson 2005; Bendak 2003; Dowd, Oakley, French, Fischer, and Storm 1994; Duchon et al. 1997; Duchon, Keran, and Smith 1994; Dunham, Pierce, and Castañeda 1987; Facer and Wadsworth 2010; Lowden, Kecklund, Axelsson, and Akerstedt 1998; Pierce and Dunham 1992; Rosa and Colligan 1992); (b) compressed schedules are associated with improvements in home and personal life including increased leisure, personal, and family time or greater satisfaction (e.g., Armstrong-Stassen 1998; Knauth 2007; Lowden et al. 1998; McGettrick and O'Neill 2006; Mitchell and Williamson 2000; Facer and Wadsworth 2010), as well as reduced work-family conflict (Facer and Wadsworth 2008, 2010); (c) longer days tend to be associated with greater fatigue (e.g., Armstrong-Stassen 1998; Bendak 2003; Knauth 2007); and (d) those on CWWs often get more or better sleep than those on traditional, 8-hour schedules (e.g., Duchon et al. 1997; Mitchell and Williamson 2000).²³ While these findings were mostly derived from self-reported data, they tended to be consistent regardless of the research designs employed or the scientific rigor of those studies.

²³ However, Axelsson (2005) noted that sleep duration is impacted by shift type, start and end times of shift, and recovery time between shifts.



WHAT WE KNOW ABOUT COMPRESSED WORKWEEKS IN LAW ENFORCEMENT COMPARED TO OTHER INDUSTRIES

Problems with Past Studies

Consistent with research in other occupations, scientists conducting studies on compressed schedules in law enforcement often have relied on less than optimal research designs and sample sizes, and employed insufficient or subjective outcome measures mainly due to field or practical limitations. The use of observational or cross-sectional research, instead of controlled, randomized studies, has limited the interpretation of past findings.

Indeed, much of the research in policing suffers from a variety of limitations, including the methodologies implemented, small sample size, and measurement problems. For instance, surveys and case studies have often resulted in low response rates or had a very limited number of cases (e.g., Vega and Gilbert 1997, obtained a response rate well under 50 percent). While some have used quasi-experimental designs, even those have had experimental confounds or other problems. For example, Cunningham's (1982) study in Saanich, Canada, had an intermingling of shift length and shift rotation. Similarly, Walker and Eisenberg (1995) confounded a changeover to a 12-hour work schedule with a simultaneous change to fixed shifts from a prior rotating shift configuration. Pierce and Dunham's (1992) study also had a flaw in that two shift lengths had very different types of schedules (i.e., seven consecutive 8-hour shifts compared to four consecutive 12-hour shifts).

In a study of three Canadian police forces, deCarufel and Schaan (1990) compared 9-hour shifts to 12-hour shifts. However, they also employed two different types of 12-hour schedules, both with day-to-night rotation. And while Peacock, Glube, Miller, and Clune (1983) used a number of highly objective measures (e.g., physiological), they did not employ a randomized design. Finally, the Ottawa shift system (Totterdell and Smith 1992) in Canada involved a comparison of 8- and 10-hour shifts, but the 10-hour shifts were employed during days and afternoons,

whereas the 8-hour shifts were implemented only for night shifts. Additionally, this schedule required that 8-hour night shifts run continuously for seven days followed by a six-day rest period, and 10-hour shifts consisted of just three or four shifts followed by two days off.

Also consistent with research on compressed schedules in other professions, some have noted improvements in performance and productivity when considering self-reported or supervisory ratings of performance (e.g., Walker and Eisenberg 1995; Weisburd and Buerger 1986). However, when considering the impact of CWWs on objective performance, there have been substantially less data produced. In light of design flaws or other limitations of past studies, it is no surprise that findings related to performance are far from conclusive.

Summary of Findings by Outcomes

In examining various types of outcomes in policing and across other industries, some interesting patterns have emerged. Throughout this section, we report on the findings from past studies in policing and other industries and whether the current research is consistent with or contradicts past findings.

Performance

In assessing the impacts of CWWs on performance, there are a number of important considerations. First, a distinction must be made related to subjective versus objective measures of performance, in part due to the inherent biases of subjective measures. Also, the research suggests that the time at which measures are taken is an important factor in considering the impacts of compressed schedules (beginning versus end of workday or workweek). There is also considerable variation based on the type of performance being measured. Furthermore, in a number of studies, honeymoon effects (effects that occur after implementation of a new shift but then disappear over time) have been reported. And it is important to examine the methodologies and research designs employed when considering the effects that have been reported. As such, we report on these issues and deficiencies in interpreting past research.

Firstly, in a meta-analysis of compressed schedules across disciplines, researchers examined twenty-five effect sizes across twelve sub-studies (six of which were coded as high on scientific rigor) and found that for the four studies examining productivity there was no effect, although there was a positive effect for subjective ratings of performance by supervisors (Baltes, Briggs, Huff, Wright, and Neuman 1999). Researchers who conducted a more recent systematic review concluded performance deteriorates for those working long hours, especially for very long shifts and when 12-hour shifts are combined with more than forty hours of work per week (Caruso, Hitchcock, Dick, Russo, and Schmit 2004). On the other hand, when considering subjective self-reports, some researchers (see, e.g., Facer and Wadsworth 2008, 2010) have reported that those on CWWs have increased productivity. Bommer, Johnson, Rich, Podsakoff, and MacKenzie (1995) asserted that objective and subjective performance measures are only modestly related and therefore should not be used interchangeably. Subjective, self-report data appear to reflect biases, not the least of which is preference for compressed workweeks.

Secondly, there is an added complexity when examining the impact of CWWs on performance, namely the point at which performance is measured and the day of the shift. For example, worsened performance has often been present at the end of the shift (Mitchell and Williamson 2000), the last day of the 12-hour shift (e.g., Duchon et al. 1994), or both (Rosa and Colligan 1988). Conversely, while Ugrovics and Wright (1990) also found those on 12-hour shifts experienced greater fatigue at the end of the shift, they reported it being worst on the first day of the workweek. In two studies, start times of 6:00 a.m. for those on 12-hour shifts were associated with greater health complaints, most likely due to circadian cycle dips between 4:00 and 6:00 a.m. (see, e.g., Caruso et al. 2004). As a result

of the consistency in findings related to performance and fatigue impairments at the end of a shift, we captured all of our laboratory-based measures at the end of the shifts to maximize the potential for detecting shift length differences.

Thirdly, when there have been reported improvements associated with CWWs across industries, honeymoon effects may also have been present. For example, early researchers who conducted a long-term study found that benefits observed during the initial period of the CWWs were no longer present after some time had passed (e.g., Ivancevich and Lyon 1977). In addition, Cunningham (1982) reported an increase in police work for Canadian officers working 12-hour shifts, but in the second year it decreased slightly.

Self-initiated activities and effort. The findings related to self-initiated activities and effort across and within industries have been somewhat inconsistent. For example, while Cunningham (1981, 1982) noted an initial increase in police performance in Saanich, the study in Vancouver showed a slight decrease in self-initiated activities after the 10-hour shifts began. In other industries, some have found that CWWs led to decreased work effort (Duchon et al. 1997) even when the schedule length increment is very small (Josten et al. 2003).²⁴ Reid, Robinson, and Todd (1993) reported a 7 percent drop in direct nursing activities for those working 12-hour compressed schedules. In addition, Jeanmonod and colleagues (2008) noted that more experienced nurses saw fewer patients when working 12-hour shifts than 9-hour shifts. Similarly, researchers examining emergency room physicians found those working 8- or 9-hour shifts had greater productivity (number of patients seen per hour) compared to those on 12-hour shifts (Hart and Krall 2007). On the other hand, McClay (2008) did not find decreases in productivity of medical residents on 10- or 12-hour shifts. Despite the contradictory findings across industries, we found no significant differences related to self-initiated activities of law enforcement officers in our experimental study.

Quality of service. Again, when considering quality of service, the findings have been contradictory. For example, Sundermeier (2008) found both pros and cons of CWWs in policing; quality of service was not negatively affected by the implementation of 12-hour shifts, although there was a slight increase in citizens' below-average ratings of officer performance. Baltes et al. (1999) concluded that for compressed schedules, regardless of experimental rigor or time since intervention, attitudinal measures were more greatly affected than behavioral outcomes, and supervisory ratings of performance, but not actual performance, were higher for those on compressed schedules. For example, nurses working 12-hour shifts reported they had provided better patient care (McGettrick and O'Neill 2006) or experienced greater continuity of care with their patients (Campolo, Pugh, Thompson, and Wallace 1998; Richardson, Dabner, and Curtis 2003) as compared to their prior 8-hour schedule. Because these findings were based on self-reports, it is likely the participants' preference for compressed schedules had a biasing effect. While some report no impact on patient care among nurses (Stone et al. 2006), others have found negative outcomes associated with CWWs. For example, there are many reports of reductions in quality of care by nurses (Bernreuter and Sullivan 1995; Eaton and Gottselig 1980; Fitzpatrick et al. 1999; Todd, Reid, and Robinson 1989).

In our study, we did not assess quality of service as it has been quite difficult to define in policing. While we did capture departmental complaints, the number of officers with complaints was too small to detect any differences across groups.

Communication. Studies related to the impact of CWWs on communication have also been inconsistent. While early studies by Cunningham (1981, 1982) suggested improved contacts with

²⁴Josten et al. (2003) noted decreased work effort when the time increment in shift length was just one hour longer.

the community associated with CWWs, Cunningham later (1989) found that police managers felt they were more likely to see their officers more regularly when they were assigned to 8-hour shifts as compared to 12-hour shifts. Furthermore, Cunningham (1990) argued longer hours could influence officer interactions with the public. Recently, DiMambro (2008) reported that a number of agencies that had adopted 12-hour shifts indicated a deleterious effect upon communication among officers or between officers and their supervisors. This appears to be consistent with much earlier research by Brown (1974), who reported that almost half of the agencies he surveyed that had adopted 12-hour shifts reported greater difficulty with cross-shift communication. Because these findings are based on subjective reports, they should be interpreted with increased scrutiny.

Research from other industries has also been mixed. For example, McGettrick and O'Neill (2006) reported poorer communication among medical staff when working CWWs, whereas others have shown improvements in internal communication (Johnson and Sharit 2001). On the other hand, Facer and Wadsworth (2008, 2010) noted those on CWWs had an improved ability to interact with citizens, but these findings too were based on subjective data.

In our randomized experiment, we examined interpersonal interactions with community members in a less subjective, laboratory-based exercise and found no differences based on shift length groupings.²⁵ However, we did not examine internal communication associated with CWWs.

Cognitive performance. Findings related to cognitive performance across industries have been mixed as well. There is some evidence that CWWs are associated with lower cognitive performance (e.g., grammatical reasoning, reaction time, motor abilities) when comparing workers on 12-hour shifts to those on 8-hour shifts (e.g., Duchon et al. 1994; Rosa and Bonnet 1993; Rosa and Colligan 1992). In a longitudinal study of control room operators at a continuous processing plant, workers on 12-hour shifts displayed poorer performance on a series of cognitive, perceptual, and motor skills tests as compared to those on 8-hour shifts (Breugh 1983). These studies suggest detrimental impacts of 12-hour shifts.

On the other hand, others have not found differences across shift lengths when examining critical thinking skills (e.g., Washburn 1991; Bernreuter and Sullivan 1995), or cognitive functioning among nurses (e.g., Campolo et al. 1998; Fields and Loveridge 1988). When considering the differences between 8- versus 10-hour shifts among air traffic control specialists on cognitive tasks such as reaction time or digit addition, researchers also did not find any significant differences (Schroeder et al. 1998). In our examination of reaction time using the Psychomotor Vigilance Test in our sample of police officers, we also did not detect any cognitive differences across shift length groups.

Safety

While the research on safety in policing has focused on fatigue rather than shift length (see, e.g., Vila 2000), research across industries has suggested increased accidents, incidents, or accident risk associated with longer shifts. However, some of that research has tended to focus on particularly long shifts. For example, Caruso et al. (2004) conducted a systematic review and concluded that injuries increased for those working long hours, especially for very long shifts and when 12-hour shifts are combined with more than forty hours of work per week. Additionally, in a study of truck drivers, Hamelin (1987) found that accident risk was quite high after driving for more than eleven hours. Furthermore, in a review of duty-period extensions for the Federal Aviation Administration (FAA), the Battelle Memorial Institute (1998) indicated shifts at or above twelve hours are associated with

²⁵ Our measure of interpersonal behavior was an expert rating using the B-PAD. While ratings are typically considered subjective, this measure was much more objective because the rater received extensive training by the B-PAD Group, the rater did not know the participants, and we relied on one rater across all participants to minimize rating errors.

a higher risk of error. As such, there have been considerable concerns about safety for those working twelve hours or more per shift.

Additionally, some have suggested that any increases in shift length pose additional risk and not just for the longest shifts. For instance, Folkard and Tucker (2003) reported there was an association between increased work hours and greater industrial accidents and injuries such that accident risk in the twelfth hour of work was more than double that of the first eight hours. Similarly, Folkard and Lombardi (2004) reported that, compared to 8-hour shifts, 10-hour shifts resulted in a 13 percent increased risk for accidents and injuries, and that rate jumped to 27.5 percent for 12-hour shifts. In fact, due to safety considerations associated with any increase in daily hours above eight, the National Research Council Panel on Human Factors in Air Traffic Control Automation recommended the FAA discourage CWWs because they may be associated with “degraded performance” (Wickens, Mavor, and McGee 1997).

Similar to findings related to performance, however, when considering subjectively measured safety, at least one study revealed a positive safety finding related to compressed 12-hour shifts. Specifically, Northrup (1991) noted that managers in a mini steel plant reported fewer accidents in general for 12-hour compressed shifts. However, it is important to note this finding was not true in the melt shop, a specific division in steel manufacturing. Furthermore, when relying on self-reports of nurses, Burke (2003) found an increase in errors as well as injuries to patients (e.g., received more complaints from patients’ families, administered incorrect medication or dosage, etc.) when work hours were increased. Other findings have also been mixed. For example, Laundry and Lees (1991) found reductions in minor injuries (cuts, scrapes, and bruises) after introduction of 12-hour shifts, yet higher rates of off-duty injuries, including those requiring medical care.

In our examination of driving safety, we did not detect any significant differences across shift length groups. However, it is important to note we measured a number of driving behaviors collectively rather than looking at each distinct driving behavior (e.g., lane deviations or accidents). And, again, while we found alertness decreased and sleepiness increased for those on 12-hour shifts, we did not detect any direct linkage to performance or safety using our measures. Nevertheless, in view of the prior findings across industries and the findings related to sleepiness and alertness found in our study, we would still caution authorities to carefully consider shifts of 12-hours or longer in relation to high-risk activities.

Health

One of the greatest areas of concern regarding CWWs is how they may affect the health of workers. Well over a decade ago, the results of a meta-analysis of the impact of work hours and health outcomes demonstrated a small ($r = .13$) but significant relationship between increasing hours of work and psychological and physiological health symptoms (Sparks, Cooper, Fried, and Shirom 1997). Yet in a recent systematic review, van der Hulst (2003, 183) noted “there is evidence of a link between long work hours and ill health, but there is a serious shortage of well-controlled studies that can confirm and strengthen the evidence.”

Nevertheless, researchers have identified greater health problems (Sparks et al. 1997), including mental health (Spurgeon 2003), when total weekly hours worked exceeded forty-eight. In addition, researchers conducting a recent systematic review of fifty-one studies and one meta-analysis concluded there have been increased health complaints for those working very long shifts and when 12-hour shifts are combined with more than forty hours of work per week (Caruso et al. 2004).

In a study of 410 truck drivers, Andrusaitis, Oliveira, and Filho (2006) found that increased number of hours worked was associated with lower-back pain and this difference was apparent with just a one-hour increase in work hours from a median of 9.0 to 10.0. In nursing, some have found that those working more than eight hours per day were significantly more likely to report having a number

of health-related problems, including musculoskeletal problems such as pain, numbness, tingling, aching, stiffness, and burning in the neck, shoulders, and back (Lipscomb, Trinkoff, Geiger-Brown, and Brady 2002); emotional exhaustion and other psychosomatic symptoms such as headaches, poor appetite, lower-back pain, faintness or dizziness (Burke 2003); and greater anxiety before and after shifts (Ruegg 1987).²⁶

Others, however, have reported neutral or more positive results associated with compressed schedules. A number of researchers have not found significant differences between 8- and 12-hour shifts for general health outcomes (e.g., Cunningham 1989) or psychological or gastrointestinal health (Tucker, Smith, Macdonald, and Folkard 1998), although the latter found that those on 12-hour shifts had fewer symptoms of cardiovascular disease and improved eating habits. Also, in their systematic review, Petticrew et al. (2007) reported improvements in mental health associated with CWWs. Further, self-reported physical health of nurses revealed no significant group differences based on shift length (Campolo et al. 1998), and Stone et al. (2006) reported nurses on 12-hour shifts were less emotionally exhausted than those working 8-hour shifts. Similarly, Eaton and Gottselig (1980) found a significant decrease in subjective symptoms such as cardiovascular complaints and general health complaints, as well as reduced anger-frustration and anxiety-fear states for those on 12-hour compressed schedules in nursing. But it is important to note that Josten et al. (2003) reported positive effects were more frequently reported in studies prior to and including 1982, whereas later studies tended to find more negative effects associated with CWWs, perhaps explaining this latter finding.

The inconsistencies across studies are likely also due to differences in scientific rigor and other methodological considerations. For example, in the most recent systematic review of forty studies addressing the impact of CWWs on health, researchers found just five prospective cohort studies using control groups, and reported that the results of these provide inconclusive evidence on the health effects of CWWs (Petticrew, Bambra, Whitehead, Sowden, and Akers 2007). While Bambra, Whitehead, Sowden, Akers, and Petticrew (2008, 764) concluded CWWs may improve work-life balance “with a low risk of adverse health or organizational effects,” they noted that better designed studies are needed.

There has been limited high-quality research on health outcomes associated with CWWs in law enforcement. While Davey, Obst, and Sheehan (2001) found long work hours led to increased levels of stress among law enforcement officers ($r = .28, p < .001$), there have been virtually no studies connecting CWWs to stress or outcomes of stress, other than limited physiological data collected by Peacock et al. (1983). When considering psychological well-being associated with CWWs, Totterdell and Smith (1992) did identify a significant improvement; however, 10-hour schedules were only implemented in the day and afternoon shifts in that system (called the Ottawa system). Reduced absenteeism, particularly related to sick leave, has been examined in some studies and is often touted as a benefit of CWWs in law enforcement. In fact, an early study in policing showed decreased sick leave associated with CWWs (Crowder 1982) with an effect size of .29. While Cunningham (1981, 1982) reported a reduction in absenteeism associated with CWWs in two Canadian agencies, these studies also had some limitations.

Additionally, honeymoon effects and other problems have been present in some studies of CWWs and health across industries. For example, in an eight-year longitudinal study of health outcomes after a change from an 8- to 12-hour shift in a manufacturing setting, Johnson and Sharit (2001) reported initial positive impacts upon digestive problems (such as heartburn, acid stomach, or diarrhea) and psychological issues (such as feelings of depression or irritability, nervousness, or difficulty concentrating) in the first year; however, these effects did not persist in the eight-year follow-up. Notably, Weisburd and Buerger (1986) reported that after implementing a compressed schedule in a

²⁶Ruegg's (1987) study was based on a change from 8-hour to 12-hour shifts among coronary care nurses.

law enforcement agency,²⁷ the chief indicated that while sick leave initially (first six months) dropped, it later increased.

It is also important to note that for many studies where health benefits have been noted for the longer shifts, the findings are tempered by a number of undermining factors. For example, while Mitchell and Williamson (2000) found workers on 8-hour shifts reported more health complaints than those on 12-hour shifts, they also had a higher proportion of smokers in the 8-hour group. And, when studying 775 workers over two ten-year periods, Lees and Laundry (1989) found stress-related health issues declined significantly once workers switched to a 12-hour shift. However, they cautioned that these findings may have been the result of increased leisure time and specific to a manufacturing environment.

In their systematic review, Petticrew et al. (2007) asserted that in many of the forty studies there were methodological limitations such as small sample sizes, inadequate control groups, and the need for more objective measures. In sum, it appears many of the mixed findings across industries may be the result of methodological variation, small sample sizes, or other measurement problems.

In our experiment, we examined health using measures of stress, cardiovascular and gastrointestinal symptoms, and sick leave. Although our measure of stress was a composite index using three separately validated, police-specific measures, we observed no significant differences based on shift length. When considering both cardiovascular and gastrointestinal symptoms as measured in studies of compressed schedules in other industries, we also found no statistically significant differences across 8-, 10-, or 12-hour shifts. It is important to note, however, cardiovascular symptoms typically develop over many years, so the fact that no differences were found over the six-month period of the study should be interpreted accordingly. Our final health measure, sick leave, did not vary as a function of shift length in our study.

Quality of Life

Research on quality of life has generally included examinations of social and family life as well as work life. The findings, however, have been mixed. Although a number of researchers examining quality of life in policing have indicated there is overwhelming support for CWWs (e.g., Barter Trenholm 1997; Cunningham 1981; Peacock et al. 1983; Pierce and Dunham 1992), findings related to quality of life have not always been consistent. In Pierce and Dunham's (1992) study, they reported significant improvement in leisure time and life satisfaction among officers on CWWs. They also reported a significant decrease in work schedule interference with personal activities; however, as noted above, these findings are likely confounded by the agency's prior schedule of seven consecutive 8-hour days. While deCarufel and Schaan (1990) noted that officers on CWWs were overwhelmingly better able to achieve separation between work and non-work activities, in our examination of work-family conflict we did not find significant differences across 8-, 10-, and 12-hour shifts.

Research on the impact of CWWs on quality of work life in policing has also been inconclusive. While Pierce and Dunham (1992) reported a significant improvement in overall job satisfaction and deCarufel and Schaan (1990) noted higher general job satisfaction associated with CWWs, those same researchers did not find general attitudes of officers related to organizational commitment, job involvement, and intrinsic motivation to be significantly impacted by CWWs. However, Cunningham (1981) found that those officers working 10-hour schedules as compared to 8-hour schedules were more satisfied with their new shift schedule, and Sundermeier (2008) found officers who switched to a 12-hour shift had more favorable perceptions of the shift and exhibited high morale and job

²⁷Four, 10.75-hour days followed by four days off.

satisfaction. In that study, however, only thirty-seven officers participated in the 12-hour shift. Again, limitations of these studies must be considered in interpreting these results.

Similarly, in our study, findings related to quality of life were mixed. There was no impact of shift length on work-family conflict; however, we did find an improvement in quality of work life. When taken collectively, we did identify a higher quality of work life for those on 10-hour shifts but not for those on 12-hour shifts.²⁸

Clearly, a number of studies on the impact of CWWs on personal life across industries have demonstrated improvements for those working 12-hour schedules as compared to 8-hour schedules (e.g., Johnson and Sharit 2001). For example, researchers have reported that those on 12-hour shifts had more time for family, social life, and domestic duties (Knauth 2007). Nursing research has also shown improved family and social life (e.g., Campolo et al. 1998; Dwyer, Jamieson, Moxham, Austen, and Smith 2007).

However, research on shift length has not always demonstrated improvements in quality of life for compressed workweeks. For example, nurses on 12-hour shifts in one study reported unfavorable perceptions concerning the benefits of their new shift, including less time to socialize with family and friends, inability to maintain a routine exercise schedule, and guilt from feeling the need to have time away from their patients (Wintle, Patrin, Crutchfield, Allgeier, and Gaston-Johansson 1995). Similarly, Todd, Robinson, and Reid (1993) examined nurses on compressed schedules who also reported negative impacts on social and domestic arrangements. And, in a study of pilots in the U.K., Bennett (2003) found that those working longer shifts reported a reduction in social activities. At the same time, age appears to be a factor in favorable perceptions about CWWs; Goodale and Aagaard (1975) found older workers were the most negative about CWWs.

In examining issues of work-life balance or work-family conflict, again findings have been mixed. Facer and Wadsworth (2008) reported municipal workers on a four-day, 10-hour schedule (4/10s) experienced lower levels of work-family conflict than those working all other shifts. Whereas the authors of a recent systematic review reported that the introduction of CWWs may "improve the work-life balance of [workers] . . ." (Petticrew et al. 2007, 2), others have not obtained significant findings (e.g., Grosswald 2004; Loudoun 2008).

Similarly, Todd, Robinson, and Reid (1993) examined nurses on compressed schedules who also reported decreased job satisfaction. Yet in other nursing studies examining 12-hour compressed schedules, the findings suggest either no differences (e.g., Bernreuter and Sullivan 1995) or greater job satisfaction (e.g., Stone et al. 2006; Ugrovics and Wright 1990). In other industries, the findings also are inconclusive. Nevertheless, based on a review of nursing studies from 1970 to 1993, Bernreuter and Sullivan (1995, 195) indicated nurses' satisfaction was not improved with 12-hour shifts, but "in fact, job satisfaction may be higher on 8- and 10-hour shifts."

Research has demonstrated that workers often prefer compressed workweek schedules and are more satisfied with their schedules (e.g., Dowd et al. 1994; Stone et al. 2006; Facer and Wadsworth 2010). Nevertheless, in other studies researchers have found the opposite, even when just a slight increase in shift length had been implemented. For example, in a review by Josten et al. (2003), researchers reported those on 9-hour shifts were less satisfied than those on 8-hour shifts. Although they noted there were studies in which ratings of those on 12-hour shifts were favorable, they expressed caution about the use of extended shifts since many of the studies they reviewed contained methodological flaws.

²⁸Our composite measure of quality of work life consisted of four items: job satisfaction, schedule satisfaction, organizational commitment, and job involvement.

Fatigue, Sleep, and Alertness

Among the most studied factors associated with CWWs are fatigue and sleep patterns, yet the findings in this area are also wide-ranging and somewhat inconclusive. When examining cognitive performance in a laboratory setting, researchers found that those with seventeen hours of sustained wakefulness performed at the same level as those with blood alcohol counts of 0.05 percent (the legal limit in many countries) and after twenty-four hours that number jumped to around 0.10 percent (Dawson and Reid 1997). The fact that performing while fatigued can be equated to performing while intoxicated suggests the importance of quality research to determine factors contributing to fatigue and its impact on safety and performance. In fact, Williamson and Feyer (2000) found that sleep-deprived participants performed 50 percent worse in cognitive functioning than those who were intoxicated. This is further reinforced by data showing increased fatigue is associated with an increased occurrence of work-related, near-miss injuries (Lilley, Feyer, Kirk, and Gander 2002) and decreased ability to perform mental and physical tasks (Alberta Human Resources and Employment 2004).

In policing, Vila et al. (2000) expressed concerns that fatigue could increase irritability, fearfulness, and lead officers to make bad decisions, lose their tempers, or even engage in misconduct. In addition, research has shown fatigue can have potential negative effects on worker performance, safety, and health (Vila 2006). According to Vila (2000), this is certainly true for law enforcement officers and may be even more so given the unique nature of their jobs.

Vega and Gilbert (1997) noted that fatigue and its relation to the compressed workweek is one of the most often cited concerns given by police administrators when considering alternative schedules for their officers. In a study of Canadian police officers on 9-hour and 12-hour shifts in three agencies, researchers found self-reported fatigue was more of a problem on the 12-hour shifts (deCarufel and Schaan 1990). In our experiment, officers on 12-hour shifts also reported being more sleepy and less alert at work.

However, according to deCarufel and Schaan (1990), although officers admitted fatigue was a concern, it was not a serious enough concern to make them want to return to an 8-hour shift schedule. Furthermore, Sundermeier (2008) found that while fatigue was reportedly a factor for CWWs in a Midwestern law enforcement agency, it did not translate to reductions in performance, something our study also confirms. In our study, officers on 12-hour shifts were significantly more likely to report being sleepy and less alert on the job, yet our objective measures of fatigue (reaction time and saccadic velocity) appeared unaffected. Nevertheless, based on a previous assertion by Rosekind and Schwartz (1988), it is very possible that self-report fatigue measures such as sleepiness and alertness at work were underreported.

When considering physiological, psychological, and subjective measures of alertness, researchers in one study found there were no negative effects of switching to a 12-hour system when compared to the 8-hour system (Peacock et al. 1983). While Vila et al. (2002) reported officers working CWWs were somewhat less fatigued, they noted the result was not conclusive due to the number of participants. And although Pierce and Dunham (1992) found stress and fatigue experienced by officers did significantly decrease after the switch to a 12-hour shift, others have not identified significant differences comparing 8- to 12-hour shifts (Smith, Hammond, Macdonald, and Folkard 1998). Again, the subjective underreporting of fatigue and potential bias associated with officer preferences for particular schedules may obviate these findings.

Sleep patterns and associated problems have often been cited as major concerns related to shift work. For example, Cochrane (2001) noted sleep problems related to shift work may increase law enforcement agency liability. In research conducted almost thirty years ago, 53 percent of officers surveyed reported sleeping an average of 6.5 hours or less (Peacock et al. 1983). More recently, Vila (2000) found officers averaged 6.6 hours of sleep per twenty-four-hour period. Also, Neylan and

colleagues (2002) reported police officers got less average total sleep (using subjective measures of sleep) than peer-nominated controls. However, in our study the average number of sleep hours was 7.56, inconsistent with these earlier findings. This could be due to changes in officers' sleep patterns over the past ten years or because prior researchers did not capture all sleep periods in a twenty-four-hour period as we did.²⁹

Nevertheless, when considering sleep patterns associated with CWWs, there have been some mixed findings. In one study, police officers reported sleeping more hours when working 12-hour shifts (6.5 hours) as compared to 8-hour shifts (6.2 hours) (Pilcher and Huffcutt 1996). Totterdell and Smith (1992) also reported that the implementation of 10-hour compressed schedules led to increased sleep when comparing the officers to those in a control agency, but the night shift workers remained on 8-hour schedules, confusing these findings.³⁰ In our experimental study, we found those on 10-hour shifts got significantly more sleep than those on 8-hour shifts (about 3.5 hours more per week), but the same was not true for those on 12-hour shifts.

In one of the most comprehensive studies of law enforcement fatigue, Vila et al. (2002) found that 41 percent of respondents across four police agencies had such poor sleep quality that clinicians would recommend they seek medical attention, and their sleep quality was twice as poor as the general public. Neylan and colleagues (2002) also found sleep quality for police officers was significantly lower than that of peer-nominated controls. The average sleep quality among officers in our study was 3.61 on a scale from 1.0 (very poor) to 5.0 (very good).

Indeed, many studies across fields have demonstrated that shift work can adversely affect the sleep quality of workers (Bendak 2003; Scott and Kittaning 2001; Garbarino et al. 2002). While the average sleep quality in our study was not compared to that of the general public, sleep quality differences across shift length groups were not statistically significant.

Numerous studies have demonstrated greater levels of fatigue associated with CWWs and some show related increases in risk. Specifically, in an experimental study with train drivers and railway traffic controllers, Härmä et al. (2002) found that a three-hour increase in shift length for the participants resulted in a 51 percent increase in the risk for severe sleepiness, and Sallinen et al. (2005) noted that for each additional hour at work the odds for severe sleepiness increased by 9 percent. Furthermore, it appears safety considerations exist even when the increment of time is much smaller. For example, Cruz, Rocco, and Hackworth (2000) studied air traffic controllers and found that those working 9-hour shifts as opposed to 8-hour shifts were significantly more likely to doze off at work (83 percent versus 60 percent, $\chi^2 = 11.64, p < .01$). Similarly, even a slight increase in shift length has been shown to be related to increased fatigue among nurses when comparing those on 8- and 9-hour shifts (Josten et al. 2003). While there have been mixed findings in the area of sleep associated with CWWs, Duchon et al. (1997) found that those working 12-hour shifts as compared to 8-hour shifts had increased levels of sleep and better sleep quality.

Twelve-hour shifts seem particularly concerning; indeed, many studies have linked 12-hour schedules to increased fatigue, especially when compared to 8-hour schedules (e.g., Bendak 2003; Garbarino et al. 2002; Macdonald and Bendak 2000; Rosa and Colligan 1992; Smith, Folkard, Tucker, and Macdonald 1998; White and Beswick 2003). Indeed, Harrington (1994, 702) asserted "most reviews contend that the 12-hour shift leads to increased fatigue and the potential (at least) for lower productivity and poorer safety records." Similarly, in a report to the FAA, researchers noted that workers on 12-hour shifts across a number of industries were considerably more fatigued than those

²⁹In our study, we asked officers to report all sleep periods in a twenty-four-hour period (inclusive of naps).

³⁰Ottawa shift system (those on 10-hour shifts worked days as compared to those on 8-hour shifts who worked nights).

on traditional 8- or 10-hour shifts (Battelle Memorial Institute 1998). Akerstedt (1997, 109) reported on findings of a review and concluded “taken together, the results to some extent support the common sense notion of fatigue/sleepiness being a function of the time worked,” noting it may be more pronounced if the days off are used for a secondary job.

Nevertheless, some researchers have not found significant differences in fatigue based on shift length (Fields and Loveridge 1988; Tucker et al. 1996; Washburn 1991). In fact, in a recent systematic review of forty studies on the effects of a CWW on various factors, researchers concluded that CWWs did not seem to have an unfavorable effect on fatigue (Petticrew et al. 2007). However, even the authors note that the lack of negative findings could be related to the popularity of CWWs among workers, which may have created a biasing effect. And it is important to reemphasize the finding that individuals underestimate their level of fatigue (Rosekind and Schwartz 1988). Clearly, worker preferences for CWWs also may temper self-report measures of fatigue; if they believe it will result in a return to or continuing with a more traditional 8-hour schedule, they are more likely to report feeling less fatigued on CWWs. Furthermore, Axelsson (2005, 17) has also underscored other methodological concerns that may have led to contradictory or inaccurate findings. These include small sample sizes, “peculiar” designs, and problems with participation.

Longer shifts have also been associated with decreased alertness and increased errors. For example, Rosa and Bonnet (1993) found declines in alertness when moving from an 8- to a 12-hour shift, consistent with findings by others (Daniel and Potasova 1989; Hamelin 1987; Volle et al. 1979). Furthermore, Rogers³¹ noted “. . . the effects of fatigue can include: difficulty in concentrating, slowed response times, poor decision making and reduced alertness” (Cramer 2007, 1).

Even though fatigue has implications for safety, it does not always translate to field performance. Indeed, even in many cases when researchers are able to demonstrate increased fatigue and/or reduced alertness associated with longer shifts, they are often unable to find any direct or indirect linkages to various performance measures (e.g., Lilley et al. 2002; Mills, Arnold, and Wood 1983).

Ultimately, these findings taken as a whole have led several scientists to conclude that just because employees are willing to work CWW schedules or are more satisfied with such shifts does not mean their work performance, fatigue, or well-being will be unaffected by longer workdays (Macdonald and Bendak 2000; Szczurak, Kaminska, and Szpak 2007). The assertion made by Rosa, Colligan, and Lewis (1989, 31) over twenty years ago, that “workers seem willing to tolerate greater fatigue and sleep loss for the social/personal gain” but it could be at a cost, still seems to be accurate today.

Despite the extensive scientific research suggesting negative impacts of CWWs on fatigue and alertness, there appears to be ongoing anecdotal information lending to more confusion in the field. For example, Circadian, a leading sleep and safety research firm, recently published a report on the advantages and disadvantages of 12-hour shifts, and indicated numerous advantages of 12-hour shifts from both a management and shift worker perspective: increased productivity, reduced errors, higher project completion rates, and more “dedicated” employees on the management side, longer and better quality breaks, twice as many weekends off, improved family and social life, improved morale, more home study time, increased utilization of personal time, little effect on overtime opportunities, and elimination of evening shifts on the worker side (Moore-Ede, Davis, and Sirois 2007, 4). Yet, while also noting disadvantages, they did not cite any specific studies to support these claims. In any event, they aptly concluded “the assessment of the merits of 12- vs. 8-hour shift schedules is a complex issue that does not have a simple answer. Clearly, there are compelling advantages for 12-hour schedules such as more time off and more weekend days off, but these are balanced by the longer working days and the

³¹ Dr. Naomi Rogers is a sleep expert from the Sleep and Circadian Research Group at the Woolcock Institute of Medical Research.

questions of mental and physical fatigue” (12). They also contended that 12-hour shifts have “proven to be safe and productive” (12), which seems to be an overstatement based on the scientific evidence to date. Additionally, while they indicated that 12-hour shifts seem to be “agreeable to most shift workers” (12), other scientists have suggested that mere preference is not a sound basis upon which to adopt 12-hour shifts (Macdonald and Bendak 2000; Szczurak et al. 2007) without due consideration of the safety and performance issues. Similarly, even though Smith, Folkard et al. (1998) suggested there may be advantages to 12-hour shifts in terms of lower stress, better physical and psychological well-being, improved durations of off-duty sleep, and improved family relations, they noted there are still concerns over fatigue and safety.

It is important to note that some have found increased safety concerns toward the end of a compressed schedule. For example, Smith, Folkard et al. (1998, 218) asserted “fatigue and decreased alertness toward the end of a 12-hour shift can be a real concern and should be borne in mind when such systems are implemented.” More specifically, Mitchell and Williamson (2000) found that among power plant workers more errors were made at the end of 12-hour shifts. Ugrovics and Wright (1990) found those on CWWs reported greater fatigue at the end of the shift, especially on the first day of the workweek, whereas Rosa and Colligan (1988) found work-related errors increased as the workweek progressed and as the 12-hour day progressed (later in the shift). These findings have led researchers in recent years to caution practitioners about compressed schedules in situations where public safety could be threatened (Armstrong-Stassen 1998; Knauth 2007; Macdonald and Bendak 2000; Rosa 1995; Scott and Kittaning 2001). Certainly, policing is one of these public safety domains in which critical incident exposure and risk for potentially devastating consequences are higher than for many other occupations.

Overtime and Off-Duty Employment

For the many employees who have compressed workweek schedules, the choice to pick up a second job for extra income becomes very appealing; indeed, Waters and Ussery (2007) noted that agency implementation of CWWs may encourage officers to seek second jobs as opposed to using the time off for rest and recuperation. After all, one of the argued benefits of a CWW is that on their days off employees will have extra time for rest and recovery from longer than average workdays. Typically, extra work hours and commute time are not factored into the analysis of CWW scheduling in terms of the potential impacts on health, safety, performance, quality of life, fatigue, or sleep. Nevertheless, there is a dearth of research regarding the role and impact of CWWs on off-duty work, overtime, commuting, and other activity patterns.

In one study, Cunningham (1981) found officers assigned to 10-hour shifts had greater court-related overtime compared to those on 8-hour shifts but much less overtime associated with regular workdays (which was reduced by more than half). Bayley and Worden (1998) argued there is considerable variation in overtime across agencies and individuals but almost no publicly available data. With regard to off-duty employment, Vila (2006) asserted that few police departments restrict or monitor off-duty jobs. However, when considering compressing officers’ schedules, agency leaders should be concerned about the additional time officers may accumulate in a twenty-four-hour period either commuting to and from work (e.g., Nielsen 2007), working overtime, or working off-duty, as any of these alone or in combination can often be excessive. Nevertheless, Sundermeier (2008) noted that the implementation of the 12-hour shift did not result in any negative fiscal impacts; for instance, the amount of overtime paid to complete reports decreased by 51 percent over the prior 8-hour schedule. Indeed, an early study in policing showed decreases in overtime associated with CWWs (*Four-day week* 1971) with an effect size of .22. In our experiment, we examined the amount of overtime reported

for those on 8-, 10-, and 12-hour shifts. Surprisingly, we found those officers working 8-hour shifts averaged five times the amount of overtime than those on 10-hour shifts, and three times that of those working 12-hour shifts. However, the differences across shift lengths for off-duty employment were not statistically significant. Our results are consistent with findings in other industries. For example, some have noted decreases in paid overtime for those on CWWs (Facer and Wadsworth 2010), which is consistent with an earlier finding by Foster et al. (1979) who found a 33 percent reduction in overtime for those on CWWs.

Other Outcomes

Some researchers have identified other organizational outcomes associated with compressed schedules, such as reduced commuting costs (e.g., Price 1981). For example, State of Utah employees surveyed by Facer and Wadsworth (2010) also reported reduced commuting costs for those on 4/10 schedules, a logical finding given fewer days at work and one that is consistent with assertions made by many who promote such schedules. Sundo and Fujii (2005) reported commute times may be further reduced on CWWs due to non-peak hour commutes. Facer and Wadsworth (2010) also noted that when the State of Utah examined energy consumption associated with a 4/10 compressed schedule, they noted over a 10 percent decrease in energy use or an overall statewide reduction of \$502,000. Others have reported that CWWs result in decreased leave and absenteeism (Facer and Wadsworth 2010; Foster et al. 1979). Hung (2006) suggests a potential cost savings with CWWs, but it appears to be based on minimizing staff levels. Although this is not based on 24/7 operations and is hypothetical rather than actual, the author has previously documented savings in commuting costs (Hung 1996).



CONCLUSION

While there has been considerably more research on the impact of CWWs using subjective measures (supervisory ratings, self appraisals) and that research is more likely to demonstrate performance improvements, objective measures show either no effect or in some cases negative impacts of CWWs. Most notably in the medical field, CWWs have sometimes been associated with reductions in quality of care, customer service, and other work activities.

In this experiment, we did not rely on supervisory ratings of performance due to past evidence of limitations associated with them. While we did examine self-initiated activities such as stops, arrests, and the like, shift length did not have a significant impact on nor did our study reveal any significant group differences in performance or productivity for CWWs. However, we did not examine quality of service provided to the community, something that should be assessed in future research. While we did not find any significant performance differences across shifts, this study does suggest reason for concern when implementing shifts of 12-hours or longer. It is for this reason that agencies should consider the types of activities officers engage in toward the end of these longer shifts.

Overall, past research suggests that internal organizational communication may be negatively impacted by compressed schedules. However, when considering contacts with the public, the majority of past research on interpersonal communication indicates no detrimental impacts of compressed schedules. Indeed, in our laboratory-based experiment there were no group differences in performance across a range of video vignettes involving encounters with the public. However, because we did not examine internal communication across or within shifts, it is important that future research focus on this consideration. In addition, agencies are advised to create within- and cross-shift mechanisms for coordination and communication, particularly when officers have more than three days off consecutively.

While our objective measures of fatigue did not reveal shift length differences, self-reported sleepiness and fatigue were greater for those officers on 12-hour shifts. Due to prior researchers' assertions regarding underreporting of fatigue, any indication of fatigue via subjective reports of officers should be taken seriously, as it may indeed represent an underestimate. The willingness of officers to report fatigue

may also be somewhat repressed by the police culture, which promotes toughness. As such, agencies should focus on wellness policies that emphasize adequate sleep and rest, and overall reduction of stress, as it has been associated with increased fatigue.

Although some past research suggests potential for reductions in absenteeism associated with CWWs, we did not find lower levels of sick-time usage associated with those on CWWs. In terms of other measures of health, such as cardiovascular health, gastrointestinal upsets, and overall stress levels, our study did not indicate any significant differences across shift lengths. It is important to note that cardiovascular disease is the result of a variety of causes and develops over a long period of time. It is for this reason that we recommend future longitudinal research on the impact of shift schedules on cardiovascular health. At the same time, our indicators of ill health, such as sick leave and stress, do not appear impacted by shift length and therefore should not be a reason for concern. However, shift length was associated with feelings of sleepiness and lowered alertness, which can be detrimental to health in the long run. While those on 12-hour shifts did not perform differently on our measure of reaction time or have worse driving behaviors, they certainly reported being less alert, which could ultimately lead to reduced reaction time. Based on our limited research, however, 12-hour shifts do not appear to impact officer safety and performance provided there is adequate rest time between shifts and hours are contained to twelve inclusive of overtime and off-duty work.

Quality of work life (measured as a composite of organizational commitment, job and schedule satisfaction, and job involvement) appears to be greatest for those working 10-hour shifts and worst for those working 8-hour shifts. Given the limitations of organizations to provide additional benefits and pay to officers, agencies should consider the implementation of CWWs as at least a short-term benefit to officers. It is not clear whether or not the advantages of these shifts will be seen as a long-term benefit, but they may improve officer attitudes about their work. Past studies, however, have often shown such benefits to be short term in nature, as honeymoon effects that may not result in positive feelings beyond the first six to twelve months.

While many past studies have suggested improvements in personal life (increased leisure, family time, general satisfaction), we examined personal life improvements strictly in terms of work-family conflict, as it appeared most relevant. We did not find any significant differences based on shift length for work-family conflict, so it appears that officers are able to reduce or adjust to any potential conflicts by knowing their schedule in advance. It is recommended that agencies continue to consider impacts of family issues on work life, something that was outside the scope of this study.

Consistent with early work by Goodale and Aagard (1975), we did identify a reduction in overtime for those working CWWs. This could result in significant cost savings to agencies implementing CWWs. However, we did not investigate the costs of implementation of a CWW, and anecdotal evidence suggests some additional costs associated with the relief factor for 10-hour shifts and the fact that a twenty-four-hour day is not divisible by 10-hour shifts. Given the limited funding available in law enforcement agencies because of the recent economic downturn, it is important that agencies consider the costs of personnel in making determinations about efficiency. Because personnel costs typically account for 80 to 90 percent of law enforcement budgets, police leaders should consider ways to reduce excessive overtime costs, as these can be quite extensive given that most agencies pay out at the rate of 1.5 times normal pay. The fact that this study revealed reductions in overtime for those on CWWs offers some promise in terms of more efficient management. Nevertheless, we cannot rule out the possibility that the two agencies and their supervisors arbitrarily restricted overtime for those officers participating in the study, though they were instructed to treat them the same as all other personnel with regard to departmental operations.

This study was the first comprehensive randomized experiment conducted on CWWs in law enforcement. Prior research across industries has been hampered by lack of experimental controls,

and yet our findings were consistent with some past research. Overall, this study has revealed that there can be benefits associated with CWWs, particularly the 4/40 configuration (10-hour shifts). While those benefits do not inure to those on 12-hour shifts, our findings do not raise significant concerns associated with the implementation of 12-hour shifts. However, given the findings across industries and our findings regarding alertness and sleepiness, agencies considering or currently using 12-hour (or longer) shifts should carefully monitor officers' total work hours including off-duty and overtime work, ensure there is sufficient recovery time between shifts, routinely query officers regarding their perceived levels of fatigue (at various times throughout the shift), and make adjustments to activities accordingly. It should also be emphasized that simply implementing an 8- or 10-hour shift is not sufficient for reducing fatigue, improving quality of life, or reducing risks to safety, health, and performance. Many agencies continue to employ double shifts in certain circumstances, rely on rapidly rotating shifts (something that has long shown to be detrimental on many levels), or routinely hold over certain personnel for more than four hours in a typical day. Such activities should be avoided and agencies should instead begin to focus on officer wellness, safety, and health by providing various programs and implementing and enforcing policies designed to protect the safety and health of officers and their families, as well as that of the general public.



Appendices

Appendix A: Description of Measures

The STISIM® Drive (Rosenthal, Parseghian, Allen, and Stein 1995) was used to assess driving performance. The STISIM® is a computerized program designed to simulate various driving conditions and environments that require attention and response to different stimuli such as stop signs, pedestrians walking out onto the street, bicyclists, etc. The STISIM® provides outcome measures that include number of tickets, accidents, lane deviations, divided attention, and more. For this study, we measured the following driving behaviors/outcomes: (a) number of off-road accidents, (b) number of collisions, (c) number of pedestrians hit, (d) number of speed exceedances, (e) number of traffic light tickets, and (f) number of illegal turns.

The MILO®/Range 3000® shooting simulator was used to assess shooting performance. Three measures of shooting performance were obtained from this simulation: (a) command presence, (b) accuracy, and (c) judgment as previously described.

The Behavioral Personnel Assessment Device (B-PAD®) (Rand 1987) is a video-based simulation that assesses interpersonal skills and judgment by examining how an officer would respond to a series of different situations. The B-PAD® allows us to measure officers' task orientation (ability to assess the situation), interpersonal skills, and overall effectiveness.

The Police Stress Questionnaire (PSQ) is an instrument used to assess job stressors specific to a police officer (McCreary and Thompson 2004). The scale consists of items related to organizational stressors (e.g., "[Please indicate how much stress has been caused over the past six months as a result of] excessive administrative duties.") and operational stressors (e.g., "[Please indicate how much stress has been caused over the past six months as a result of] occupation-related health issues.").

The Police Daily Hassles Scale (PDH) (Hart, Wearing, and Headey 1994) was adapted from the original Daily Hassles and Uplifts Scale (Kanner, Coyne, Schaefer, and Lazarus 1981) to assess ongoing stressors specific to law enforcement. Two categories of daily hassles were used in our survey: organizational hassles (e.g., "not receiving recognition for a job well done") and operational (e.g., "departmental handling of complaints").

The Work Environment Inventory (WEI) is a 68-item questionnaire that assesses exposure to routine occupational stressors, excluding duty-related critical incidents such as being attacked (Lieberman et al. 2002). Examples include, “My supervisors and I respect and trust each other” and “I do not let my neighbors know what I do for a living.”

We used **Costa’s subscale of Gastrointestinal Index (GI) and Cardiovascular Index (CI) from the Standard Shiftwork Index** (Barton 1995). Each index is comprised of eight items, consisting of a 4-point Likert scale ranging from “almost never” to “almost always”. GI questions include items such as, “How often do you complain of digestive difficulties?” and “How often do you feel /nauseous?” CI questions include items such as, “How often do you suffer from heart palpitations?” and “How often do you suffer from shortness of breath when climbing the stairs normally?”

The Minnesota Satisfaction Questionnaire (MSQ) (Weiss et al. 1967) measures job satisfaction using a variety of scales, including achievement, independence, social status, recognition, supervision, and working conditions. The reliability and validity of this instrument has been well documented over time.

The Organizational Commitment Questionnaire (OCQ) (Allen and Meyer 1990) aims to address the degree to which employees feel committed to their organization across three categories of commitment: (a) affective commitment (an individual’s identification with, attachment to, and involvement in a particular organization); (b) continuance commitment (the costs that an employee associates with leaving the organization); and (c) normative commitment (an employee’s feeling of obligation to remain with the organization). The OCQ is a 24-item questionnaire.

The Job Involvement (JI) Scale assesses an individual’s perspective of the importance of his or her job (Kanungo 1982). This scale examines one’s psychological identification with a particular job and the extent to which it meets his or her needs. Established reliability and validity of the JI Scale has been demonstrated (see, e.g., Kanungo 1982). Each scale score was transformed to a z-score in order to combine measures into a single composite score of quality of work life.

Work-Family Conflict I (Carlson et al. 2000) assesses the impact of an individual’s job on his/her family life. The scale provides for the assessment of time-based conflict (when time devoted to one role makes it difficult to participate in another role); strain-based conflict (when strain experienced in one role intrudes into and interferes with participation in another role); and behavior-based conflict (when specific behaviors required in one role are incompatible with behavioral expectations in another role).

Work-Family Conflict II (Netemeyer, Boles, and McMarrian 1996) reflects the impact of work on family life. Although this scale does not include various dimensions of work-family conflict as does the Carlson et al. (2000) scale, it does provide an additional measure of commonly agreed on aspects of work-family conflict.

The Epworth Sleepiness Scale is an 8-item measure of fatigue and sleepiness that asks participants to indicate the degree to which they would doze during various activities. The Epworth Sleepiness Scale has been positively associated with self-reported problems of sleepiness (Chervin and Aldrich 1999). Past reliabilities of the Epworth Sleepiness Scale demonstrate test-retest reliabilities of .82 (Johns 1992) and .86 (ICC¹ Knutson, Rathouz, Yan, Liu, and Lauderdale 2006), as well as Cronbach’s alphas of .73 and .88 (Johns 1992).

¹ Based on an intraclass correlation coefficient (Knutson et al. 2006).

The Fitness-for-Duty Impairment Screener (FIT) requires participants to track a series of lights that move from the left to right in the eye's periphery, after which a series of centered lights flash to measure pupil dilation. Four measures are derived from the FIT: (a) saccadic velocity, (b) constriction latency, (c) pupil diameter, and (d) amplitude. Recent research has shown saccadic velocity to be the most sensitive measure of fatigue and it was most relevant to our analyses. Saccadic velocity has been shown to be sensitive to sleep deprivation (e.g., Roland et al. 2005; Russo et al. 2003) and significantly correlates to other measures of sleepiness such as the sleep latency test and Stanford Sleepiness Scale (Rowland et al. 2005). Additional scientific validation has been performed by several organizations (see Addiction Research Center of NIH/Johns Hopkins, Walter Reed Army Institute of Research, Vermont Alcohol Research Center, and Institute for Circadian Physiology).

The Psychomotor Vigilance Test (PVT) is an assessment of reaction time (Dinges and Powell 1985). We used the hand-held version developed at Walter Reed (Thorne et al. 2005). Performance data from the PVT resulted in the following variables: (1) mean reaction time; (2) frequency of lapses (number of times the subject fails to respond to the signal); (3) duration of lapse domain (shifts in lapse duration calculated from the reciprocal of the 10 percent slowest RTs); (4) optimum response times (the average of the 10 percent fastest RTs per trial); and (5) false response frequency (responses that were initiated when no stimulus was present).

Appendix B: Past and Current Psychometric Properties of Measures¹

Shaded rows are dependent variables ($n = 16$). **n/a** = not applicable because it is (a) part of a composite we created, (b) a composite we created, or (c) a construct without measures. **u/a** = unavailable (no past coefficients identified)

CONSTRUCTS ($n = 7$) Instrument/Measure	Total Items	Reliability (past)	Validity (past)	Reliability α obtained	Author(s) of Measure, Year
WORK PERFORMANCE	n/a	n/a	n/a	n/a	n/a
Interpersonal Behavior	n/a	n/a	n/a	.79	<i>Composite of existing measures</i>
-8 B-PAD [®] vignettes	n/a	.84 to .94 ^a	.72 ^b	n/a	B-PAD Group 1994, 1999, 2010
-Lost temper frequency	1	u/a	u/a	n/a	Czeisler et al. 2005
Driving-STISIM Drive [®]	n/a	.82	u/a	.58 ^c	Systems Technology, Inc.
Shooting-MILO/Range 3000 [®]	n/a	u/a	u/a	.43 ^c	IES Interactive Training
Self-initiated Activities	n/a	n/a	n/a	.78	<i>Composite of officer activities</i>
HEALTH	n/a	n/a	n/a	n/a	n/a
Cardiovascular Health	8	u/a	u/a	.81	Barton et al. 1995 (Costa subscale)
Gastrointestinal Health	8	u/a	u/a	.80	Barton et al. 1995 (Costa subscale)
STRESS	194	n/a	n/a	.92	<i>Composite of existing measures</i>
-Police Stress Questionnaire	40	.92 to .93	u/a	n/a	McCreary and Thompson 2004
-Work Environment Inventory	68	.92 to .97	u/a	n/a	Lieberman et al. 2002
-Police Daily Hassles Scale	86	.72 to .94	.60	n/a	Hart, Wearing, and Headey 1994
QUALITY-WORK LIFE	65	n/a	n/a	.88	<i>Composite of existing measures</i>
-Job Satisfaction (MSQ)	20	.59 to .97	.47 to .70	n/a	Weiss et al. 1967
-Schedule Satisfaction	4	u/a	u/a	n/a	Tucker et al. 1998
-Organizational Commitment	24	.75 to .87	.21 to .77	n/a	Allen and Meyer 1990
-Job Involvement Scale	16	.62 to .89	-.12 to .80	n/a	Kanungo 1982
QUALITY-PERSONAL LIFE	14	n/a	n/a	.85	<i>Composite of existing measures</i>
-Work-Family Conflict I	9	.78 to .87	-.24, -.39	n/a	Carlson et al. 2000
-Work-Family Conflict II	5	.82 to .90	.83 to .89	n/a	Netemeyer et al. 1996
SLEEP & FATIGUE	n/a	n/a	n/a	n/a	n/a
Sleepiness Composite	12	n/a	n/a	.82	<i>Composite of existing measures</i>
-Sleep Assessment	54	u/a	u/a	n/a	Czeisler et al. 2005; Heitmann 2006
-Epworth Sleepiness Scale	8	.73 to .88	u/a	n/a	Johns 1991, 1992
Alertness (Alertness Log)	n/a	n/a	n/a	n/a	Used Karolinska Rating Scale
Fatigue	n/a	n/a	n/a	n/a	n/a
Saccadic Velocity (FIT [®])	n/a	u/a	-.97, -.99	.82	PMI, Inc.
Psychomotor Vigilance Test	n/a	u/a	u/a	.77	Dinges and Powell 1985
Sleep Disorders Composite	14	n/a	n/a	.80	<i>Composite of existing measures</i>
Berlin Sleep Apnea (<i>adapted</i>)	7	.63 to .92	u/a	n/a	Netzer et al. 1999
Insomnia	1	u/a	u/a	n/a	Heitmann 2006 ^d
Sleep Disorders	6	u/a	u/a	n/a	Czeisler et al. 2005
EXTRA-DUTY (sleep diary)	n/a	n/a	n/a	n/a	Composite includes commute time
Overtime	n/a	n/a	n/a	n/a	# of hours in excess of 80 per 2 weeks
Off-Duty	n/a	n/a	n/a	n/a	# of hours per 2 weeks

^aDoerner and Nowell 1999.

^bRand 1987.

^cOur reliability estimates provide evidence that various aspects of driving and shooting are unique.

^dPersonal communication, April 23, 2006.

¹For more information about past reliability and validity, see the full technical report of this experiment, *The Impact of Shift Length in Policing on Performance, Health, Quality of Life, Sleep, Fatigue, and Extra-Duty Employment: Final Report* (Amendola, et al. 2011), at www.policefoundation.org/docs/library.html or www.ncjrs.gov.



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