ABSTRACT

TREIBER, LINDA ANN. **Workplace Organization, Labor Process Control and Occupational Health** (Under the direction of Dr. Michael Schulman.)

The purpose of this research is to understand the complex relationships between working conditions and occupational health. The research draws from labor process theory that generally views worker control over the labor process as essential to non-alienated labor and from epidemiologic models of host, agent/exposure, and environment. Using General Social Survey 2002 cross sectional data, I investigate the effects of standard epidemiologic factors and worker labor process control factors in multivariate models to predict the dependent variables of workplace injury, persistent pain, exhaustion, and general health status. I suggest that labor process autonomy, social cohesion and skill utilization generally have positive and protective effects on worker occupational health status net of socio-demographic, job status, exposures, and environments. The addition of labor process factors to the epidemiologic triad improves the model specification of persistent pain, exhaustion and general health status; however, the specification of workplace injury models was not improved. Analyses indicate that labor process control is protective for workers who do not perform heavy lifting, but such control may exacerbate workplace injury for those who do perform heavy lifting. Of particular interest is the significant protective effect of perceived safety climate in all models, which may reflect normative consent. The study concludes that the sociological addition of labor process factors to the epidemiologic model needs to be further modified to include issues of labor process consent and organizational commitment.

WORKPLACE ORGANIZATION, LABOR PROCESS CONTROL AND

OCCUPATIONAL HEALTH

By

LINDA ANN TREIBER

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APPROVED BY:

Maxine Thompson	Donald Tomaskovic-Devey
Michael Schulman Chair of Advisory Committee	Catherine Zimmer

BIOGRAPHY

Linda A. Treiber was born in 1957 in Sandusky, Ohio to John and Ellen Treiber. Her childhood and teen years were spent in rural Ohio. She received a Bachelor of Arts degree in Sociology from Miami University in 1979. She earned a Bachelor of Science degree in Nursing from Ashland University in 1989. She attended graduate school at The Ohio State University where she received a Master of Science degree in Community Heath Nursing in 1997. Her areas of doctoral specialization at North Carolina State University include work, organizations, and industry, social inequality, and the sociology of health and illness. Linda received her Doctor of Philosophy degree in 2005 and plans to pursue a career in academia.

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TABLE OF CONTENTS

	Page
LIST OF FIGURES	vi
LIST OF TABLES	vii
1. INTRODUCTION	1
1.1 Prologue	1
1.2 Theoretical Framework	1
1.3 Project Description	3
1.4 Research Questions	4
1.5 Outline of Subsequent Chapters	4
2. THE HEALTH AND SAFETY OF WORKERS	6
2.1 Research Literatures	6
2.2 Trends and Patterns of Occupational Health	6
2.3 Applied Studies of Occupational Health	7
2.4 Critical Approaches to Occupational Health	8
2.5 The Social Distribution of Occupational Health Outcomes	11
3. EPIDEMIOLOGY, LABOR PROCESSES, AND WORKER HEALTH	20
3.1 Occupational Health and the Epidemiologic Model	20
3.2 Dimensions of Labor Process Control	22
3.3 Essential Components and Paradoxes of Labor Process Control	26
4. DATA AND METHODS	32
4.1 Data for the Project	32
4.2 Operationalization and Analysis of Key Variables	33
4.3 Modeling of Relationships and Analysis Plan	50
4.4 Sets of Hypotheses	53
5. UNIVARIATE AND BIVARIATE ANALYSES	56
5.1 Description of Dependent Variables	56
5.2 Description of Independent Variables	59

5.3 Bivariate Regressions 65
5.4 Bivariate Correlations 72

6. MULTIVARIATE ANALYSES 74

6.1 Results of Multivariate Regression Models Predicting Workplace Injury 75
6.2 Workplace Injury: Summary and Discussion 88
6.3 Results of Multivariate Regression Models Predicting Persistent Pain 91
6.4 Persistent Pain: Summary and Discussion 96
6.5 Results of Multivariate Regression Models Predicting Exhaustion 99
6.6 Exhaustion: Summary and Discussion 105
6.7 Results of Multivariate Regression Models Predicting Health Status 108
6.8 Health Status: Summary and Discussion 118

7. DISCUSSION AND CONCLUSIONS 121

7.1 Hypotheses Concerning Autonomy 123
7.2 Hypotheses Concerning Social Cohesion 130
7.3 Hypotheses Concerning Skill Utilization 137
7.4 Revisiting Occupational Harm: Discussion 143
7.5 Recommendations and Policy Issues 152

REFERENCES 159

APPENDIX A 170

APPENDIX B 171

APPENDIX C 173

LIST OF FIGURES

		Page
Figure 4.1	Analysis Plan	52
Figure 6.1	Interaction of Autonomy and Heavy Lifting on Injury	84
Figure 6.2	Interaction Effects of Cohesion and Heavy Lifting on Injury	86
Figure 6.3	Interaction Effects of Skill Utilization and Heavy Lifting on Injury	87
Figure 6.4	Non-Linear Effects of Skill on Self-Reported Health Status	117

LIST OF TABLES

		Page
Table 3.1	Ideal Types of Labor Process Control and Adverse Health Outcomes	25
Table 3.2	Unintended Consequences of High versus Low Labor Process Control	31
Table 4.1	Summary of Dependent Variables	36
Table 4.2	Summary of Socio-Demographic Variables	38
Table 4.3	Summary of Job Status Variables	41
Table 4.4	Summary of Labor Process Variables	42
Table 4.5	Summary of Exposure Variables	47
Table 4.6	Summary of Environment Variables	50
Table 5.1	Description of Dependent and Independent Variables	64
Table 5.2	Bivariate Regressions: Unstandardized Estimates (SE)	71
Table 6.1	Negative Binomial Regressions: Unstandardized Estimates (SE) of Workplace Injury on Selected Predictor Variables	80
Table 6.2	Negative Binomial Regressions: Unstandardized Estimate (SE) of Workplace Injury on Heavy Lifting and Labor Process Interactions	83
Table 6.3	Logistic Regressions: Parameter Estimates [Odds Ratio] (SE) of Persistent Pain on Selected Predictor Variables	95
Table 6.4	OLS Regressions: Unstandardized Estimate (SE) of Exhaustion on Selected Predictor Variables	104
Table 6.5	OLS Regressions: Unstandardized Estimates (SE) of Health Status on Selected Predictor Variables	113
Table 6.6	Tests for Non-Linear Effects of Labor Process Factors Predicting Health Status: Unstandardized Estimates (SE).	115
Table 6.7	Inflection Point: Effects of Skill Utilization on Health Status	116
Table 7.1	List of Research Hypotheses	122

Table 7.2	Summary of Hypotheses Concerning Labor Process Autonomy	129
Table 7.3	Summary of Hypotheses Concerning Social Cohesion	136
Table 7.4	Summary of Hypotheses Concerning Skill Utilization	142

CHAPTER 1

INTRODUCTION

1.1 Prologue

The purpose of this dissertation is to investigate the relationship between workplace organization, epidemiologic and labor process factors, and self-reported health outcomes. Sociologists have argued that the ability to negotiate control over workplace conditions is essential in decreasing worker alienation and exploitation (Braverman 1974; Burawoy 1979; Hodson 2001; Kohn and Schooler 1973; Marx 1971; Seeman 1959). Less attention has been directed toward examining physical health outcomes as products of workplace organization and control. My research tests hypotheses about worker labor process control and the positive and negative effects it has on self-reported occupational health outcomes: injury, pain, exhaustion, and general health status.

1.2 Theoretical Framework

Drawing from literatures on the labor process and workplace organization, (Braverman 1974; Burawoy 1979; Clawson 1980; Edwards 1979; Simpson 1985), I argue that self-reported health outcomes vary as a function of worker labor process control, with the expectation that workers with high levels of labor process control (i.e., autonomy, skill, and control over the social relations at work) will be less likely to experience harmful occupational health outcomes such as injury, pain, and exhaustion and will be less likely to describe their general health status as "poor" than will workers with low levels of labor process control. I extend the general theoretical model in the sociological literature concerning the alienating effects of workplace organization where the focus is on a proleterianized industrial workforce to include paradoxes of labor process control and consent for a variety of workers. While this model assumes that workers with low levels of labor process control will be vulnerable to adverse occupational health outcomes, it also considers the ways in which other workers such as skilled craft workers, professionals, and managers (i.e., workers with high labor process control) experience adverse occupational health outcomes. Workers with high levels of labor process control have both the power and freedom to manage exposures, that is, they have the ability to moderate time spent engaging in potentially harmful tasks or to avoid or reject hazardous working conditions altogether. However, workers with high degrees of labor process control paradoxically have freedom to consent to long hours, to production dangers, and to disregard safety mandates. Therefore, worker control over essential labor processes may also result in unintended consequences: workers' social and individual agency, including the ability to generate normative consent, may lead to adverse health outcomes. The dissertation analysis investigates and models these complex paradoxical relationships.

In developing the theoretical framework, I employ core sociological concepts as well as epidemiological ones. I draw from a model of workplace organization that suggests a framework of overlapping contexts, with a specific focus on the interaction between individual status indicators (or so-called "human factors") and the context of work, including work characteristics (e.g., production related task exposures) and working environment (e.g., safety climate) (Haddon 1980; Kinicki, McKee and Wade 1996; National Institute for Occupational Safety and Health 2002; see also Runyan 1998). I extend epidemiological models though the inclusion of sociological tenets of the labor process and by attending to the ways in which these factors are linked to occupational and general health outcomes.

1.3 Project Description

To investigate key hypotheses, I employ secondary survey data. I examine differential patterns of occupational health outcomes (workplace injury, persistent pain, and exhaustion) and general health status using the General Social Survey (GSS) 2002, a large national cross sectional data set. The GSS 2002 contains a module on Quality of Working Life, which includes survey items pertaining to workers' perceptions of workplace organization, including labor process control. I employ descriptive and inferential statistical techniques, including negative binomial, logistic and OLS regression to test research questions. These data also permit exploratory investigation of the paradoxical nature of worker labor process control and self reported health outcomes in terms of both intended and unintended consequences.

The design of this study fits well with the research priority area of workplace organization and health and safety of workers under the National Occupational Research Agenda (NORA), a framework designed by National Institute for Occupational Safety and Health (United States, Department of Health and Human Services, NIOSH 2002). The findings are useful for health promotion and industrial safety researchers for developing safer workplaces. This dissertation also brings a sociological perspective to mainstream approaches to worker health and safety. The findings add to the sociological knowledge of labor process coercion and consent, thus broadening the models of worker exploitation to include adverse occupational and general health outcomes.

1. 4 Research Questions

In this study, I investigate worker occupational health and general health outcomes using the following questions to guide the research:

1. How do worker labor process control characteristics (autonomy, social cohesion, and skill utilization) relate to worker self-reported health outcomes in terms of workplace injury, persistent pain and exhaustion? How do labor process control factors relate to general health status?
2. What is the nature of the relationship between worker labor process control and adverse occupational health outcomes? Will there be a point where increased worker labor process control is actually harmful to health? How is this determined?
3. Do labor process control factors operate differently for workers with different status characteristics (e.g., men versus women, whites versus non-whites) in terms of injury, pain, exhaustion, and general health status?

1.5 Outline of Subsequent Chapters

In the next chapter, I examine the social and epidemiologic factors that influence occupational and general health outcomes, emphasizing those aspects which are part of the workplace organization. Chapter Three examines the epidemiologic and labor process approaches to occupational health, and introduces the core labor process concepts. Chapter Four details the operationalization and analysis strategies for the dissertation. A discussion of the data for the project is included as are operational definitions for all variables used. Chapter Five includes the univariate and bivariate analyses for all variables. Chapter Six details the multivariate analyses for the dependent variables of workplace injury, persistent pain, exhaustion and health status, including an examination of possible interaction effects for selected key variables. Chapter Seven includes a discussion of the research hypotheses, implications of the research, and avenues for further investigation.

CHAPTER 2

THE HEALTH AND SAFETY OF WORKERS

2.1 Research Literatures

The literature exploring the relationships between work and occupational health comes from a wide variety of academic disciplines including public health, health promotion, epidemiology, ergonomic engineering, psychology, economics, and sociology. Research in these literatures can be broken down into one of three main foci: those concerned with describing the trends and patterns of occupational health, those with an applied focus-that of keeping the working environments (and workers themselves) safe while maintaining production, and critical approaches which examine the broader social organization of work and how the labor process structure of industries and jobs impacts health.

2.2 Trends and Patterns of Occupational Health

The bulk of the existing data on adverse occupational health outcomes, such as deaths, injuries and illnesses, comes from official government sources (e.g. Bureau of Labor Statistics, CDC; NIOSH). Such large-scale studies and research reports are useful for determining differential patterns of adverse occupational health outcomes, particularly demographic and sectoral trends in work-related mortality and morbidity (e.g., Castillo, Landen and Layne 1994; Derstine 1996; Loomis, Bena and Bailer 2003; Personick 1990; Toscano 1997; Toscano Windau and Knestaut 1998). These large-scale studies tend to be concerned primarily with actual injury or illness events and general trends by industry and/or occupation.   Such studies address adverse mental health outcomes (e.g., burnout, exhaustion and distress) less frequently. While an excellent source of descriptive data, this type of research often does not examine the relations of power in the workplace (e.g., in terms of class, gender and race); nor does it address issues of labor process control.

Descriptive epidemiological studies focusing on high risk categories of workers (e.g., minorities and youth in dangerous industries) are valuable resources for understanding patterns of differential exposure and occupational health with a specific focus, for example, nursing (Rogers 1996) and youth workers (Evensen, Schulman, Runyan, Zakocs, and Dunn 2000). While often focusing on exposures and selected risk factors, many descriptive studies lack an analysis of labor process variables and how workers with varying levels of autonomy negotiate both production and safety (for exceptions see Evensen et al. 2000; Mayhew and Quinlan 2002).

2.3 Applied Studies of Occupational Health

The bulk of applied research comes from evaluation of health and safety promotion program effectiveness. In health and safety promotion paradigms, adverse occupational health outcomes are viewed as largely preventable when behavioral interventions are targeted at different points in time (see Haddon 1980). Applied approaches with an individualist focus tend to target health and safety interventions at the worker level. Through worker training and education programs, worker health and safety programs are designed to decrease worker mistakes in judgment (Christoffel and Gallagher 1999). The more psychologically oriented approaches focus on the underlying reasons for risk-taking behaviors, for example, by addressing youth workers' emotional immaturity and feelings of invulnerability and the effects of personal coping resources (Bohle and Quinlan 2000). Engineering approaches tend to focus on redesigning the tools and work environment, often using scientific management techniques to improve workplace safety (Bohle and Quinlan 2000).

Although applied safety research greatly adds to our knowledge of occupational health, it suffers from a number of limitations. First, applied approaches often have a rationalist behaviorist bias, grounded in the assumption that once workers have complete knowledge, they will make safe and rational choices. Such approaches fail to appreciate that workers are parts of social groups embedded in a workplace culture. For example, despite safety education, workers take risks to avoid production stoppages and to keep co-workers on the line happy; often taking risks is both normative and altruistic (Nichols 1997). Because of the focus on changing individual behaviors, applied approaches run the risk of victim blaming (Becker 1993; see also Ryan 1971). This is particularly salient after industrial accidents where organizations shift the focus away from production related dangers to emphasize worker fault or "human error" (Perrow 1984). The focus on human error can lead to continued monitoring and surveillance of workers (e.g., Taylorist scientific management), as ways to improve worker safety (Hall 1993; Nichols 1997).

2.4 Critical Approaches to Occupational Health

Critical structural approaches argue that adverse occupational health outcomes are a result of the quantity and quality of jobs within the structure of labor markets: workers are forced to take dangerous jobs because of scarcity in the opportunity structure. Unlike the classical economists, who trust that market forces will monetarily reward dangerous or unpleasant jobs (Adam Smith (1966[1776]) critical approaches highlight differences in the balance of power in terms of the labor process (Tilly and Tilly 1998; Wooding and

Levenstein1999). Economic approaches assume that individual workers may avoid dangerous or hazardous working conditions by "voting with their feet", as evidenced by high turnover rates in hazardous, dirty jobs (Griffth 1993). Market forces seem to reward dangerous work in skilled craft-based occupations with above average wages (Applebaum 1999), which supports theories of compensating differentials.

However, while explaining some injury trends, the classic economic approach also has a rationalist bias, incorrectly assumes that workers and employers are equal partners in economic exchange. Because of a lack of collective power, workers are frequently unable to self-terminate such employment because they have few other labor market options (Griffth 1993; Rosner and Markowitz 1987; Wallace 1987). More often, however, the highest risks are borne by unskilled or temporary laborers, whose earnings are low (Mayhew and Quinlan 2002; Quinlan 1999). Some of the most dangerous and dirty jobs such as agricultural labor, poultry and seafood processing are seasonal in nature, dominated by racial and ethnic minority workers (Griffith 1993). Low-paid health care workers such as nurses' aides are especially vulnerable to injuries related to repetitive motion, assaults and strain–jobs where women and minorities women are over-represented (Toscano Windau and Knestaut 1998).

Significant structural research documents the negative effects of capital restructuring, sectoral shifts and downsizing on worker health and safety (Greenlund and. Elling 1995; Quinlan, Mayhew and Bohle 2001; Richardson and Loomis 1997). Interdisciplinary studies in the realm of political economy of worker health and safety also critically investigate regulatory environment issues such as the enforcement and passage of protective workplace legislation, relative strengths and weaknesses of governmental agencies (particularly OSHA) and organized labor's struggle for achieving and maintaining workplace safety in the face of capital resistance (Bayer 1988; Berman 1987; Gray and Sholtz 1991; Wooding and Levenstein 1999).

The sociological literature centers on several core themes concerning the harmful effects of work in modern industrial society. One central concern is the study of workers' efforts to maintain autonomy and relative labor process control under hegemonic conditions (e.g., Blauner 1964; Braverman 1974; Burawoy 1979; Clawson 1980; Edwards 1979; Juravich 1985; for a review, see Simpson 1985). However, the nature of the relationship of worker labor process control to occupational and general health outcomes has received less attention. Although few sociological studies deal explicitly with labor process control and occupational health, notable exceptions exist.

Case studies of workers in firms provide information about the relationship between the labor process and adverse occupational health outcomes (e.g., Dwyer 1991; Nichols 1997). Using a case study model, Dwyer (1991) examines the relationship between "industrial accidents" (roughly translated to include injuries) as a function of differential power in terms of a three-level typology: rewards, command, and organizational levels. Dwyer hypothesizes that the greater the relative importance of a given level in the management of workers' relationships to the dangers of their jobs, the greater the production of accidents produced at the level (Dwyer 1991:150). Contained within the "rewards" level are financial incentives, such as piecework, contract work, fee-for service, bonus payments, and profit sharing, including wages paid under the table (Dwyer 1991:99). For example, Dwyer hypothesized that when the level of incentives (or rewards) is emphasized, safety will suffer. From his interviews with workers, Dwyer found that incentive-based rewards were linked to increases in accidents, as workers perceived that the use of safety precautions would slow the pace of work, thus leading to a reduction in financial bonuses.

Issues of the normalization of dangerous production processes have been documented in case studies of workers in high-risk fields including construction (e.g., Applebaum 1981,1999; Cherry 1974; Riemer 1977) coal mining (Wallace 1987), and other high-risk industries (Berman 1978; Perrow 1984). Nichols (1997) documents consent to management's agenda as a theme in his interviews of injured manufacturing workers. Here, occupational injury results from worker attempts to correct faulty production processes and to keep products from being damaged (Nichols 1997:45-46).

The ways in which workers perceive the safety climate are also related to occupational health outcomes. Zohar (1980) describes the concept of safety climate as reflective of workers' perceptions of managerial commitment to an organizational climate where safety is a high priority. Building on Zohar's research, Gillen, Baltz, Gassel, Kirsch, and Vaccaro (2002) found that perceived safety climate was positively correlated with injury severity for injured construction workers. That is, *even when workers had been injured,* they tended to view the safety climate at their worksites favorably (Gillen et al. 2002: 45). This may suggest the existence of normative acceptance of the existing environment, regardless of the actual hazards.

2.5 The Social Distribution of Occupational Health Outcomes

Despite governmental mandates and workplace regulations, adverse occupational health outcomes remain significant social problems (see Tesh 1988; also Wooding and Levenstein 1999). An assessment by the National Safety Council estimates the cost to US society of on- the- job injuries *alone* in 1996 (i.e., excluding fatalities) at $121 billion dollars- a sum that includes lost wages, lost productivity, health care expenses, and other costs (National Safety Council 1999). Although rates of occupational deaths and illnesses are generally declining in the United States, the rate of decline has not been uniform across occupational and industry groups (Loomis, Bena and Bailer 2003; United States, Department of Health and Human Services NIOSH, 2004).

According to US Department of Labor, there were 5,915 occupational deaths in the year 2000 in the United States (United States, Bureau of Labor Statistics 2001a). On each day of that year, an average of 16 workers lost their lives. During the years 1980-1997, 103,945 civilian workers in the US died as a result of their occupations, also at an average rate of 16 work-related deaths per day (United States, Department of Health and Human Services, CDC 2000). Other types of adverse occupational health outcomes, such as injuries, illnesses and distress are also common. In 2000, a total of 5.7 million work-related injuries and illnesses were reported in the U.S. private industry sector alone- at a rate of 6.1 cases per 100 fulltime equivalent workers [FTE] (United States, Bureau of Labor Statistics 2001b). Of the 5.7 million injuries and illness reported in 2000, about 2.8 million required recuperation from work, restricted duties at work, or both (United States, Bureau of Labor Statistics. 2001b: 3). The leading types of injuries or illnesses involving days away from work are sprains and strains, most often involving the back (US Bureau of Labor Statistics 2001c). Repetitive motion injuries are also prevalent; carpal tunnel syndrome and tendonitis have consistently appeared in the top 10 injuries and illnesses resulting in lost work time (United States, Bureau of Labor Statistics 2001c). Stress and anxiety as a result of one’s occupation result in lost work productivity and increased health care expenditures (United States, Department of Health and Human Services, NIOSH 1999). Changes in workplace organization, such as increasing workloads, long hours, hectic routines, conflicting job roles, and unpleasant or dangerous job tasks, contribute to increased occupational injuries as well as to stress and burnout (United States, Department of Health and Human Services, NIOSH 1999).

Although the problem of adverse occupational health outcomes is widespread, official statistics often under-estimate its extent (Berman 1978; Wooding and Levenstein 1999). Workers may fail to report work-related injuries and illnesses because they fear employer retribution, particularly in labor markets that provide temporary or uncertain employment (Aronsson 1999; Dwyer 1991). Workers are less likely to report types of occupational health outcomes that develop over time: conditions caused by repetitive physical and mental stresses and toxic exposures are often difficult to directly link to employers and are more likely to be disputed (Wooding and Levenstein 1999). Many adverse occupational health outcomes such as emotional distress, exhaustion, fear of violence, and verbal abuse, fall under the radar of official statistics. In addition, most data sources do not capture the "near misses" (i.e., injuries that almost happened) or accounts of dangerous situations.

Industry and Job Differentials

Although reporting mechanisms are imperfect, consistent patterns of occupational health do exist, often reflecting differential hazard exposures. In terms of adverse occupational health outcomes, all industries are not created equal: mining, construction, transportation, and agriculture, forestry and fishing consistently rank in the top ten most dangerous industrial sectors in terms of fatality rates (United States, Bureau of Labor

Statistics 2001a). In *Healthy People 2010,* these industries are targeted by the Centers for Disease Control and Prevention as key industries in need of priority intervention for fatality and injury reduction (United States, Department of Health and Human Services 2000). For example, for the years 1980-1997, 19% percent of all job related deaths occurred in the construction industry, at a rate of 15 deaths per 100,000 workers; over 3 times higher than the average work rate (United States, Department of Health and Human Services, CDC 2001). In 2002, construction continued to record the highest number of fatal injuries of any major industry; although the rate had declined 9% from the series high in 2001 (United States, Bureau of Labor Statistics 2003).

Although relatively low in mortality rates, service industries are "high impact" in terms of injuries and illnesses: that is, they are industries defined as having large numbers of workplace injuries and illnesses, not necessarily the highest incidence rates (i.e., number of new injuries in a time period/divided by number of exposed workers in that same period) (Personick 1990:30; Toscano 1997). For example, industries that employ large numbers of workers such as health care services (e.g., hospitals and nursing care facilities) are considered "high impact" industries, because of the large volume of injuries produced (e.g., back injuries and assaults). The health services sector has occupational injury rates similar to meat processing, manufacturing and trucking (United States, Bureau of Labor Statistics 2001). The CDC targets health services as a priority industry in need of reduction of work-related injuries resulting in medical treatment, lost time from work, or restricted activity (United States, Department of Health and Human Services, CDC 2000).

Within industries, certain types of jobs are more dangerous than others. Truck drivers are fatally injured at high rates, largely because the time spent driving increases the risk of vehicular death (Jackson and Loomis 2002). Tasks, such as lifting heavy objects and repetitive hand movements, also predispose workers for injury. For construction laborers, exposure to a wide variety of potentially dangerous work duties contributes to risk of injury and death (Jackson and Loomis 2002). Construction laborers often work at heights and operate power equipment, such as saws, drills, or heavy machinery, often with little occupational experience or training, which likely contributes to the occupation's consistent rank as one of the most dangerous (Burkhart et al. 1993; Chen and Fosbroke 1998; Jackson and Loomis 2002; Ore and Stout 1997). In the health services industry, nursing aides are at high risk for occupational illnesses such as HIV or AIDS and injury because frequent lifting and positioning of patients- some of who are confused and combative (Personick 1990; Polgar 2000; Rogers 1996).

Sometimes the work environment is dangerous. Unhealthy workplace conditions (e.g., textile fibers, coal dust, benzene, asbestos, lead and noise) can lead to occupational injury, illness, and stress for manufacturing and extractive sector workers (Bayer 1988; Berman 1978; United States, Department of Health and Human Services, CDC 2004; Wallace 1987). The construction work environment includes a diversity of projects going on simultaneously under frequently changing topographical conditions, often under time constraints, thus complicating efforts to make construction work safe (Ringen, Seegal and Englund 1995).

Work can be dangerous because of the high potential for threatening interactions with others (Ritzer and Walczak 1986). For example, police and guards frequently deal with abuse and violence (Barker 1999) and are often the victims of violent assault. Being threatened by a passenger, a client or customer will elicit a stress response, which involves the release of catecholamine, a stress induced “flight or fight” response (Messing 1998). Exposure to stressors may result in health problems (e.g., high blood pressure) due to constant tension, or lowered resistance to infection due to altered immune responses (Messing 1998: 113-114).

Workplace violence, including homicide, is perennially among the top three causes of workplace fatalities, particularly for taxi drivers, police and sales workers; such violence is increasing in other types of work where workers deal with the public (United States, Bureau of Labor Statistics 2003).

Generally speaking, those who *do* the work (i.e., not those who tell others what to do) get injured, develop occupational injuries, or die on the job (Littler and Salaman 1984, italics added). Executives and white collar managers have traditionally low job-related physical injury rates, because of relatively minimal hazard exposure. However, the categorical dichotomization between workers and owners of capital is overly simple and does not necessarily capture the complex nature of the contemporary stratification system. In advanced industrial nations, a middle stratum, composed of autonomous professionals and small business owners, exists with varying degrees of labor process control and commitment and varying adverse health outcomes (Wooding and Levenstein 1999:57; Wright 1997).

Occupational burnout and elevated stress levels are problematic for executives, physicians, and other professionals (Hoff, Whitcomb and Nelson 2002; Jackall 1989). Semi-professional, interactive service and care workers who deal with client verbal abuse also experience burnout and stress. This growing problem is often related to inadequate staffing patterns, work overload, and emotional demands associated with caring for others (Aiken et al. 2002; Cancian and Oliker 2000; Messing 1998; Rogers 1996).

Gender and Race Differentials

In terms of status characteristics, gender is consistently associated with patterns of occupational health. Of all workers fatally injured on the job in 2000, 92% were male (United States, Bureau of Labor Statistics 2001a). Standard government data sources (e.g., Bureau of Labor Statistics) and epidemiologic measures show that occupational injuries and deaths are more frequent in men (Toscano Windau and Knestaut 1998). This pattern has remained fairly regular over time (United States, Bureau of Labor Statistics 2003; Toscano Windau and Knestaut 1998). During 1980-1997, males comprised 93% of all workplace fatalities, at rates approximately 11 times greater than females (United States, Department of Health and Human Services, CDC 2001). Dissimilar risks for adverse occupational health outcomes occur largely because men and women tend to work in different jobs and settings with differential risks and rewards (Reskin and Roos 1990; Tomaskovic-Devey 1993). Therefore, gender differences in the division of labor are part of the reason for differential exposure patterns; some of the most dangerous industries and jobs (e.g., mining, construction and truck driving) are dominated by men (Jackson and Loomis 2002; Toscano Windau and Knestaut 1998; Wootten 1997). Because males are fatally injured on the job at rates higher than females, legislation has tended to regulate the types of work dominated by men, with less attention paid to female-dominated types of work (Messing 1998). This has led to a common misperception that women's work is "safe". However, certain types of occupational health hazards are common in "female" jobs (Klitzman, Silverstein, Punnett and Mock 1990; Messing 1998). Although occupational *fatality* rates for women are low, female workers incur more occupational injuries from repetitive motion, assaults and inhalation of hazardous substances (such as anesthetic gases) than males (Klitzman et al. 1990; Toscano, Windau and Knetaut 1998:18).

Critics contend that hidden hazards and stressors common in women's jobs (e.g., verbal abuse, emotion work) required in many jobs dominated by women are under-reported and are generally unregulated (Hochschild 1983; Messing 1998). Legislation designed to protect workers from the physical and emotional stressors common to women workers is non-existent. According to Karen Messing (1998):

> Occupational health science and intervention have not often been about women…There are standards for how much weight a stevedore can lift and how often, but none for how many shirts a woman can sew on a shift. There is a threshold limit value for exposure to asbestos for miners, but no limit to the number of insults a receptionist may hear per hour without a break (P. xiv)

In terms of emotional harm, sociologists find that psychological distress is more common in women than in men (Kessler and McRae 1981; Mirowsky and Ross 1995). In terms of general health, men of all ages have higher rates of mortality, but women tend to have higher rates of non-fatal illness (Waldron 1976). Women are more likely than men to describe their general health as "fair" or "poor" (United States, Department of Health and Human Services, CDC 2003:208).

As is the case with overall health, race is a salient factor in differential occupational health outcomes (Aday 1994; Williams and Collins 1995). According to the US Centers for Disease Control and Prevention, in the years 1980-1997, 85% of the civilian workers who died on the job were white-however, African Americans had a higher fatality rate (5.5 per 100,000 workers versus 5.0 for whites (2001). Some of the most dangerous jobs have been traditionally allocated to African American and Hispanic workers, contributing to elevated rates of adverse occupational health outcomes for these minority groups relative to majority whites (Baron 1983; Davis, Rowland, Walker and Taylor 1995; Michaels 1983; Robinson 1989). In labor markets unequally segmented by race, minority workers find few opportunities and take risky and dirty types of jobs (Tomaskovic-Devey 1993). For example, studies of health care workers have shown that African Americans are disproportionally represented in jobs that have the highest rates of injuries (Arnold 1996). Even when job titles are ostensibly the same, minority workers may experience unequal distribution of risk within jobs, and overt discrimination (Feagin and Imani 1994).

CHAPTER THREE

EPIDEMIOLOGY, LABOR PROCESSES, AND WORKER HEALTH

3.1 Occupational Health and the Epidemiologic Model

The negotiation and distribution of power in the workplace significantly affects the health and safety of workers; thus, occupational health outcomes and health status are linked to labor processes, the conditions of work, and industrial environments (Blauner 1964; Wooding and Levenstein 1999). Within the field of public health, epidemiology is both descriptive in its documentation of distribution of illness patterns in a population and analytic in the predictive values of risk (Christoffel and Gallagher 1999). As noted in the previous section, clear epidemiological patterns of occupational health exist: by labor market sector, by job and industry, and by worker status characteristics, such as gender and race.

The epidemiological triangle (or triad) allows for the investigation of injury and illness as an interaction between three main areas: host, agent, and environment (Mausner and Kramer 1985). *Host* factors include the characteristics present in individuals that may influence individual susceptibility to illness, such as age, race, or sex. *Environmental* factors are elements of the host's surroundings which may deter or aid in the development of an illness or injury; thus, environmental factors affect opportunities for exposure (US Department of Health and Human Services, CDC, 2004). The third part of the epidemiologic triad is the *agent,* which is essential for an illness or injury to occur. For example, agents may include microorganisms, chemical substances, forms of radiation, and, in the case of injury, physical force (US Department of Health and Human Services, CDC, 2004).

The Haddon Matrix improves upon the standard epidemiological triangle by shifting to a multiple causation model (Haddon 1980; Christoffel and Gallagher 1999). The matrix models injury as a product of events in four main foci: host or "human factors", agent or vehicle, physical and socio-cultural environments (Haddon 1980). Thus, this model of injury is applicable to workers in a workplace setting.

While very useful in describing and analyzing occupational health, the standard epidemiologic triad and the Haddon Matrix do not explore the dimensions of power in the workplace. The addition of labor process control theories to standard epidemiologic models fills this lacuna. Occupational health is influenced by the ways in which negotiations and distributions of labor process power are influenced by (and interact with) worker status characteristics, exposures and environments.

Studies of the interaction between working conditions and health date back to Karl Marx. In his writings, Marx (1964, 1971) ties the concept of alienated labor to physical health outcomes by detailing the disastrous health effects of overwork on workers (e.g. untimely death and physical exhaustion). With the advent of medical sociology, sociologists of work tended to focus on alienation as a psycho-social state, leaving the physical status relatively unexamined (see Suchman 1963). This dissertation seeks to re-integrate physical health into the sociology of work and alienated labor literatures.

Drawing from the works of Weber and Marx, I argue that the type of bureaucratic rationality that characterizes capitalist production is problematic for worker safety and health. By breaking work down into its component parts, scientific managers gained control over many essential labor processes; as a result, workers lost discretion in terms of decision-making processes (e.g., tools used and innovative techniques), leading to work that is routine, mundane, and alienating (Clawson 1980; Braverman 1974). Managerial labor process control is strengthened and augmented by the deskilling of work and the drive for bureaucratic rational efficiency. As managerial labor process control increases (from a combination of bureaucracy and scientific management techniques), craft customs and traditions are replaced by formal work rules in multiple layers of formal hierarchy (Clawson 1980: Edwards 1979). By designing safety equipment that removes worker discretion (e.g., in terms of the ability to make unsafe choices), ergonomic engineers may unintentionally align with managers in terms of labor process control (Bohle and Quinlan 2000).

A Marxist view of safety technology emphasizes the ways in which workplace innovations serve the interests of capital, even as they ostensibly claim to protect the workers (Elling 1989; Hall 1993; Wooding and Levenstein 1999). Ergonomics and other types of safety interventions grew out of the scientific management tradition, with the underlying assumption that there is one best way to do things, often resulting in job design characterized by increased routinization and decreased complexity (Bohle and Quinlan 2000; Braverman 1974). Within organizations, mandated health and safety directives, while seemingly designed to protect workers, may also reinforce managerial labor process control through limiting worker discretion and skill (Elling 1989; Hall 1993; Wooding and Levenstein 1999).

3.2 Dimensions of Labor Process Control

Several dimensions of the labor process are especially salient for worker control over the conditions of work: (1) the ability to work autonomously; (2) the ability to exercise skill on the job (the opposite of routine, repetition or scripted interactions, often common in rationalized types of work), and (3) the ability to control social relations of work (and to share in workgroup cohesion) (Braverman 1974; Burawoy 1979; Hodson 2001; Kohn and Schooler 1973; Marx 1971; Seeman 1959). These attributes of workplace organization in terms of labor process control are not distributed equally. Issues of labor process control are particularly salient for workers who may have been excluded from the "best jobs" such as women and minority workers. Thus, workers with low levels of labor process control working under hazardous conditions will be most likely to experience adverse health outcomes.

Industrial models of the labor process focus on a largely proletarianized workforce. Models where professional workers gain control over essential work processes through skill and autonomy have received less attention in the labor process literature (Smith and Thompson 1999*).* The categorical dichotomization between "workers" and "owners" does not automatically capture the multifaceted nature of work under capitalism, where middle class independent professionals and small business owners exist under varying degrees of labor process control (Kohn 1976; Wooding and Levenstein 1999:57; Wright 1997).

While operating under the assumption that proletarianized workers with low levels of labor process control will be most susceptible to adverse occupational health, I also consider the ways in which workers with high levels of labor process control such as managers and professionals paradoxically consent to various types of hazardous conditions, including long hours of work, extended responsibilities and unsafe work practices. Therefore, in this analysis, I include workers who manage others (as well as those who do not) because of the wide variation in the managerial role; here I am most interested in variations in self reported labor process control and its relationship to health.

Critics of labor process models note that both Braverman and Burawoy fail to develop the significant role that both race and gender play in shaping workplace organization (Smith 1994; Vallas 2001; Wardell 1999). Gender norms act as selection criteria on both the supply and demand sides of the labor market equations. Workers self-select into occupations because of internalized gender norms, while employers choose workers that fit stereotypical gender and race images or they choose workers they perceive to be "like" themselves (Collins 1997; England and Browne 1992; Kirschenman and Neckerman 2000). Given the persistence of occupational segregation by gender and race, there may exist patterns of labor process control that are raced or gendered. For example, like occupations, labor processes within occupations can be gendered female or male, which can be problematic for workers of the opposite gender in gender segregated work. Men are often teased if they enter female dominated fields such as nursing assistant work (Diamond 1984) where occupational norms include caring and nurturing as traditionally feminine types of emotional labor (Cancian and Oliker 2000). Women in traditionally male occupations like construction work are subject to derision and ridicule (Eisenberg 1998) while women attorneys find they must adopt a tough adversarial style in order to survive (Pierce 1995). Differences by gender and race in terms of how the dangerousness of tasks are interpreted likely exist.

In this project, I extend the labor process model to investigate the ways in which worker status characteristics may interact with various levels of labor process control in terms of occupational and general health. Thus, I anticipate that labor processes may operate differently for men and women and for whites and minority workers, which may explain (in part) differential occupational health outcomes. Because exposures and worker labor process control can vary within jobs, this project will allow me to investigate the relative importance of: 1) status characteristics such as race and gender; 2) job characteristics; 3) labor process factors; 4) exposures; and 5) environments in relation to work-related and general health outcomes. Table 1 lists the ideal types of work in terms of labor process control and occupational health outcomes.

Table 3.1: Ideal Types of Labor Process Control and Adverse Health Outcomes

	Adverse Occupational Health Outcomes	
Labor Process Control Level	**Low Risk**	**High Risk**
High Autonomous Socially Cohesive Skilled	"Professional work" More male than female, more white than minority	"Skilled trade/construction" Traditionally male-some historical minority barriers to entry
Low Non-Autonomous Impersonal/non-cohesive Deskilled	"Pink collar work" * Traditionally female, many minorities	"Scientific management-assembly line" (Gender and racially segregated by industry)

*According to the arguments made in the text discussion, when workers have little control, the risk of adverse mental and physical health outcomes is high. Thus, the pink-collar designation reflects a normative designation and does not fully account for the "hidden" types of injuries common in many women's jobs, including those that are related to emotional labor.

The consequences of worker labor process control in terms of autonomy, skill, and social cohesion are predicted here to be beneficial; that is, workers with high levels of labor process control should experience fewer adverse occupational health outcomes associated with work, such as injury, pain and exhaustion, net of the influence of occupational exposures. This relationship is not strictly linear. The balance of power can shift over time and context, thus worker versus managerial labor process control is frequently contradictory and multi-directional (Wardell 1999). These shifts in power in terms of labor process control may have unintended consequences for the occupational health of workers.

3.3 Essential Components and Paradoxes of Labor Process Control

Labor Process Autonomy

Worker autonomy is defined as the ability to control the terms, content and pace of work (Simpson 1985). High levels of worker autonomy are associated with lower levels of somatic symptoms and psychological distress (Kohn 1976; Kohn and Schooler 1973; Spector 1986). Adherent to an industrial model of labor process theory (e.g., Blauner, Burawoy, Braverman), this framework assumes that workers have little autonomy under conditions of high managerial control (see Table 1). Close supervision and rigid hierarchical authority allow such workers little freedom when job duties are rigidly defined and the pace of work is controlled by managerial dictate (Blauner 1964). In tightly controlled workplaces, workers with low autonomy are not easily able to remove themselves from workplace hazards.

However, it should be noted that workers with little skill or autonomy find ways to shape the work they do despite the fact that they often labor under high levels of managerial control (Juravich 1985). Workers may find workplace rules or safety equipment mandates impossible to follow given available resources (Personick 1990). Paradoxically, when workers seek to regain autonomy, they may put themselves at elevated risk for adverse health outcomes. For example, workers may refuse to wear mandated protective equipment or disable safety control systems. Such bids for control are frequently implicated in occupational injuries and deaths (Hall 1993; Nichols 1997).

Additionally, skilled, autonomous workers, ostensibly in control of their labor, have the freedom to choose unsafe ways of working. While traditionally associated with high worker skill and discretion, many "craft ideal" types of work (such as construction) are frequently the most dangerous in terms of fatalities and injuries. Professional workers also may consent to conditions that predispose them to adverse occupational health outcomes, for example by choosing work schedules (e.g., long hours) that lead to adverse occupational health outcomes such as exhaustion.

Social Cohesion

Social cohesion is described by both Durkheim (suicide) and Marx as a protective hedge against coercive systems of managerial control. In firms where workgroup cohesion exists, workers are able to solidify shared goals; co-workers keep each other's safety in mind, and they share in knowledge of both safe and unsafe practices, danger and risk (Dwyer 1991). Positive social relationships at work can help workers overcome adverse effects of alienating work (Tausky 1992) and can buffer the relations between stressors and emotional exhaustion (House 1981). In otherwise alienating work environments, social cohesion is a potential source of social support, which may serve as a buffer to reduce occupational harm and distress levels (Cobb 1976; House, McMichael, Wells, Kaplan, and Landerman 1979; House 1981).

Supportive co-worker relationships help workers maintain a united front against managerial abuse and help workers maintain dignity (Hodson 2001:49). Co-workers are considered friends; they "watch each others' backs" and help one another out. At a formal level, union membership has traditionally been protective against adverse occupational health outcomes (Berman 1978; Freeman and Medoff 1984), particularly when employees band together for protection against hazardous conditions. Improved safety conditions as a result of worker participation and involvement in labor process design (Adler, Goldoflas and Levine 1997) and safety training design (Hilyer, Leviton, Overman and Mukherjee 2000) exemplify ways in which social cohesion may decrease adverse occupational health outcomes.

When workers have little control over the social relations at work, they are subject to the negative effects of bureaucratic impersonality (Blauner 1964). Instead of social cohesion, workers are competitors in an impersonal system, vying for rewards in a structure that often demands compliance (Doeringer and Piore 1971). Loss of the protective function of the informal workgroup may be an unexpected result of high turnover and increased absenteeism found in low paying jobs where workers never get the chance to form solid workgroups (Dwyer 1991:114). Instead of relying on friends and co-workers to watch their backs, workers depend on the managerial rules and regulations to provide equitable treatment and safe conditions.

The ability to control the social relations of work may also have unintended (i.e, adverse) consequences for occupational health. Cohesive social groups may be protective, (e.g., against managerial control) but they may also transmit occupational norms that encourage acceptance of production dangers (Hodson 2001). Work groups also transmit gendered work identities (Hodson 2001: p. 48) that may be related to occupational health (for examples from ethnographies in construction, see Applebaum 1999; Cherry 1974; Riemer 1977).

As a system of labor process control, bureaucracy has the ability to garner worker consent. Through systems of internal rewards, perceptions of fairness and equal treatment, workplace organization in a bureaucracy provides cohesion of a different sort: it brings workers and managers together under the umbrella of shared production goals (Doeringer and Piore 1971). Workers may consent to dangers because they perceive that management is doing all they can to make the workplace safe (i.e, providing a climate of safety) even in the presence of hazardous conditions (Nichols 1997). When promotions and bonuses are tied to the performance of safety compliance and accident reduction, instances of adverse occupational health outcomes may go unreported (Dwyer 1991). Formal social groups such as unions have been instrumental in gaining improved working conditions; yet, unions have been faulted for attending to issues of wages and benefits, while allowing control over labor processes to remain in the hands of management (Gordon 1996). Table 3.2 provides a brief summary of intended and unintended consequences of labor process control.

Skill Utilization

The ability to maintain skill in the face of capitalist labor process control is essential to decreasing alienation on the job, and as such, is potentially protective against adverse occupational health outcomes. Deskilled or rationalized labor lies in contrast to the ideal type of craft work, where tasks are variable or uncertain and less amenable to managerial and engineering control (Blauner 1964; Braverman 1974; Simpson 1985; Stinchcombe 1959). Examining the direct relationship between skill variety and health, Korunka, Weiss and Karetta (1993) found that monotonous jobs requiring little skill were associated with more physical complaints then were less monotonous types of work.

When work is under tight managerial control, work is often deskilled and repetitive. Systems of scientific management and ergonomic engineering are designed to maintain production while keeping injury at an appropriate level of risk (Wooding and Levenstein 1999). The ability to avoid injury is one of the skills learned as part of craft worker job socialization, often viewed as a source of pride (Hall 1993; Riemer 1977). Craft skills involved in injury avoidance are replaced by safety rules and procedures that must be followed by workers. Injuries can be blamed on workers who do not follow the rules, not management's negligence. Although the definition and measurement of skill is the subject of sociological debate (Attewell 1990; Form 1989; Spenner 1990; Steinberg 1990), it is still an important component of labor process control and as such, will be included here.

In summary, I argue that adverse occupational health outcomes will vary as a function of worker status characteristics. Gender, race and education play a part in the sorting of workers into jobs. However, within jobs, exposures and labor process control factors can vary: that is, within jobs, men and women and minorities and whites may report differing levels of labor process control and exposures, leading to differential health outcomes. Worker labor process control (autonomy, social cohesion, and skill utilization) is hypothesized to have largely beneficial effects on occupational health outcomes. That is, increases in worker control will be associated with lower negative health outcomes. However, because of the complex nature of workplace organization, the relationship will be curvilinear. Workers with high levels of control may consent to workplace hazards leading to adverse health outcomes. Additionally, these relationships may also differ because labor processes do not operate the same way for all workers. In the following section of this proposal, I outline the specific methods for the dissertation and offer research hypotheses.

Table 3.2. Unintended Consequences of High versus Low Labor Process Control

HIGH Worker Control	LOW Worker Control	Unintended Consequences
Autonomy		
Worker discretion high Worker sets pace Time discretion high Freedom to move freely in physical space Ability to avoid hazards	Close supervision Hierarchical authority Low worker discretion Pace controlled by managers, engineers Rigidly defined job duties Cannot remove self from hazards easily	Autonomous workers have the discretion to choose unsafe ways of working Supervisory approval of worker risk-taking to maintain production
Control over Social Relations: Social Cohesion		
Co-workers are considered friends Workers band together for protection against hazardous conditions Workers "watch each others backs" and can be relied upon to offer assistance Worker Labor solidarity	Impersonality Workers don't know one another Workers compete against one another Rules ostensibly provide for fair and equitable treatment Rewards tied to compliance	Cohesive social groups normalize risk taking Dangers may be perceived as normative Labor sides with management Bureaucracy may increase consent-workers believe that workplace is safe Workers under-report injuries and accidents to achieve rewards
Control over Skill: Variety and Utilization		
Emphasis on quality and pride in work Worker ideas and input valued Safety skills part of craft identity	Scientific management and ergonomics designed to maintain production while keeping injury at an "appropriate" level of risk Deskilled/ Repetitive Safety rules and procedures are emphasized Workers responsible for following all rules	Workers find creative ways to circumvent safety mandates and ergonomic controls Workers find rules impossible to follow given available workplace resources

CHAPTER 4

DATA AND METHODS

4.1 Data for the Project

Data for this analysis are from the General Social Survey (GSS) 2002, an ongoing program of social science research that began in 1972 (Davis, Smith and Marsden 2002). The National Data Program conducts GSS interview data collection for the Social Sciences at the National Opinion Research Center (NORC), University of Chicago. The GSS is a national probability sample of all non-institutionalized English-speaking persons 18 years of age or older, living in the United States (Davis, Smith and Marsden 2002). Data from the interviews were processed per NORC standard procedures that include cleaning data and checking for agreement with coding specifications for inconsistent or illegitimate codes (Davis, Smith and Marsden 2002). New to the GSS for 2002 is a question module on the Quality of Working Life, where respondents are asked a series of questions about working conditions in their “main job” and health. Question responses from the GSS module provide the bulk of the data for this project.

For 2002, the original number of completed interviews in the GSS was 2,765. In the Quality of Working Life Module, those who did not work were not asked questions (i.e., deemed not-applicable) about the quality of their jobs (n=969). Because this project is concerned with the effects of workplace organization on health, I restrict analyses to those respondents who indicated that they were currently working full or part time (n=1744) or who indicated that they had jobs but were “not at work (i.e., last week) because of temporary illness, vacation or strike” (n=52).

The GSS has relatively little missing data; in most cases, there were none. However, the large number of variables (23) used in this analysis increases the likelihood of non-response on some items. Only respondents providing meaningful answers to all relevant questions were included in the dissertation. For all variables, reported “no answer” or “don’t know” responses to key questions were deleted. An exception to response deletion was made for the variables “age” and “hours worked”, where mean substitution was used for the small number of “no answer” responses.[1] The number of deleted responses averaged around two percent for each variable.

Comparisons for age, gender, race and education between the sample with the deletions and the sample where the deletions were included, yielded non-significant differences, lending credence to the claim that non-response and missing data were random. With the deletion of respondents who did not work (n=969) from the original GSS sample and the deletion of key items with “don’t know” or “no answer” responses (n=189), the total sample size equals 1607.

4.2 Operationalization and Analysis of Key Variables

Dependent Variables

As listed in Table 4.1, the main dependent variables in this project are: 1) injury; 2) persistent pain (arm pain and/or back pain); 3) exhaustion; and 4) self-reported health status. As described earlier in the dissertation, these are key indicators of both occupational and general health. I discuss the univariate statistics for all variables in detail in the next chapter.

[1] For age, the mean value of 41 was substituted in five responses; for hours worked, the mean value of 42 was substituted for fifteen responses.

Workplace injury. Self-reported occupational injury is used as a measure of adverse occupational health. GSS respondents were asked, "In the past 12 months, how many times have you been injured on the job?" Response categories range from 0 (none) to 7 (7 or more). In a random sample, instances of self-reported occupational injury are somewhat rare events. Examination of distribution and frequency statistics suggests that relatively few workers have experienced injury and that the distribution of this variable is non-normal. OLS regression may be used in the presence of severe skewness of the dependent variable in this manner, however, a better choice for skewed distributions is a distribution more tailored to the distribution of responses, such as the Poisson or negative binomial (Allison 1999). Because of this, I tested regressions in using both Poisson and negative binomial regression for the analysis of the models using workplace injury as a dependent variable.

Persistent pain. Somatic complaints such as back pain and pain in upper extremities are often associated with job-related back injuries and repetitive motion injuries. GSS respondents were asked "In the past 12 months have you had back pain every day for a week or more?" and "In the past 12 months have you had pain in the hands, wrists, arms, or shoulders every day for a week or more?" Respondents were not asked if these problems were directly associated with work. However, in the GSS 2002 Quality of Working Life Module, the conceptual association with these types of somatic complaints and workplace injuries is strong given where they fall in the questionnaire itself.[2] I combine affirmative responses to each pain measure so that respondents reporting "yes" to either arm pain, back pain (or both) are categorized as having persistent pain. I analyze the likelihood of persistent pain using logistic regression.

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[2] The question immediately preceding the pain items is: "How often during the past month have you felt used up at the end of the day? The question immediately following the pain items is "In the past 12 months, how many times have you been injured on the job?"

Exhaustion. The GSS question, "How often during the past month have you felt used up at the end of the day?" is used as a measure of worker exhaustion. Response categories are a five-point Likert scale with the categories "very often", "often", "sometimes", "rarely" and "never". I reverse code this variable so that "very often" is equal to the highest level (i.e., 5) and that the "never" category is the lowest (i.e., 1). Achen (1991, c.f. Garson 2005) states that there must be at least a 5-point Likert scale for use in OLS regression, which is the case here. In addition, analyses of 5-point Likert scales with OLS techniques are common in the medical sociology literature. Therefore, OLS regression is used for this dependent variable.

Health status. General health status is measured using self-reported health, a standard variable in many health studies (i.e., 1981 National Center for Health Statistics) that has been shown to have good reliability and validity in its ability to capture health conditions (Ware 1986). While self-rated general health status does not focus on a specific dimension of health, research has shown it to be a good predictor of patient-initiated physician visits, both in terms of general medical and mental health visits (Ware 1986: 217).

GSS respondents were asked, "Would you say that in general, your health is…Excellent, Very Good, Good, Fair or Poor?" For this analysis, the five-point Likert scale responses were reverse coded (e.g., excellent health=5; poor health=1). Although an ordinal level of measurement, OLS regression is often used in models using self-reported health as the dependent variable. Other studies of self-reported health use dichotomous categories and logistic regression (e.g., good/ excellent versus fair/poor) or ordinal logistic regression for ordered categories (Ware 1986). However, for ease of interpretation, I use OLS regression to analyze this set of models.

Table 4.1. Summary of Dependent Variables

Concept **Operationalization**	**Description**
Injury "In the past 12 months, how many times have you been injured on the job?	Response categories range from 0 (none) to 7 (7 or more). Analysis: Poisson and Negative Binomial Regressions
Persistent Pain Combination of "yes" responses to the following questions: "In the past 12 months have you had back pain every day for a week or more?" (Yes/No) "In the past 12 months have you had pain in the hands, wrists, arms, or shoulders every day for a week or more?" (Yes/No)	Dichotomous outcomes 1=persistent pain 0=no pain Analysis: Logistic Regression
Exhaustion "How often during the past month have you felt used up at the end of the day?"	Response categories are a five-point Likert scale. Ordinal response categories reverse coded. 5= "very often"; 4="often"; 3="sometimes"; 2= "rarely"; 1= "never" Analysis: OLS Regression
Health Status "Would you say that in general, your health is Excellent, Very Good, Good, Fair or Poor?"	Response categories are a five-point Likert scale. Ordinal response categories reverse coded. 5= "excellent"; 4= "very good"; 3= "good"; 2= "fair"; 1= "poor" Analysis: OLS Regression

Independent Variables

The descriptions of the independent variables are classified in terms of socio-demographic characteristics, job status controls, labor process factors, exposures, and environments. In the next section, I explain each set of variables in accordance with the analysis model, presented in Figure 4.1.

Socio-demographic Status Characteristics

The socio-demographic characteristics, age, gender, race and education (see Table 4.2) are individual level status factors. In addition to being important sociological measures, socio-demographic factors traditionally represent the "host" portion of the epidemiological triad.

Age. One's age is an important factor in determining occupational and general health; as such, it is important as a measure of individual socio-demographic status. Respondent's date of birth is recoded into actual age at time of interview in GSS dataset. Age is a continuous dependent variable in the analyses.

Gender. As described in the literature review, occupational and general health patterns differ for men and women. In the GSS, interviewers coded respondents as "Male" or "Female". For the analyses, I use a categorical dummy variable (1=male and 0=female).

Race. New to the 2002 GSS is the ability of respondents to self-identify membership in more than one racial category. Respondents were asked: "What is your race? Indicate one or more races that you consider yourself to be." Here, respondent's first mentioned race is used as the main racial identifier. I created a "white/non-white" dichotomy where 1-white and 0=non-white. Because of small numbers of minorities, a third category, "Other Race" was not used. Although the GSS also includes a question that asks about Hispanic origin, this ethnicity identifier was not used.

Education. Educational level is often used as a measure of human capital and socioeconomic status when considering health (Cubbin and Smith 2002)[3]. The GSS includes

[3] As an alternative to education, one may use respondent socioeconomic index (SEI), which is based on procedures developed by Otis Dudley Duncan in the late 1940's (Davis, Smith and Marsden 2003). As stated in Appendix G of the GSS codebook (2003: 1508), Duncan originally regressed prestige scores for 45 occupational titles on education and income to produce weights that would predict prestige. This algorithm was

a slightly different measure of education that includes degrees earned as meaningful categories. Here respondents were asked to name the highest degree in school that they had obtained (e.g., less than high school, high school, associate's degree/junior college, bachelor's degree and graduate degree). I further collapsed these categories by combining the associate's degree/junior college and Bachelor's degree categories, so that education is a four category dummy variable (see Table 4.2)[4]

Table 4.2. Summary of Socio-Demographic Variables

Concept/ Operationalization	Description
Age in years	Date of birth recoded into actual age in GSS dataset. Continuous level measurement.
Gender Interviewer coded.	Dichotomous dummy variable. 1=Male 0= Female
Race "What is your race? Indicate one or more races that you consider yourself to be." Respondent's first mentioned race is used.	Dichotomous dummy variable. 1=White 0=Non-white
Education "What is the highest grade in school you have completed?"	Four categories used: Less than high school High school Associates/Bachelor's degree Graduate degree

then used to calculate SEI scores for all occupational categories in the 1950 census classification. The current GSS uses scores based on the 1980 US census codes.

[4] The GSS also offers education measured as a continuous variable-self reported highest year in school, with response categories ranging from "no formal schooling" (GSS coded as 0) to "8 years of college" (GSS coded as 20). This was not used for primary analyses.

Job Status Variables

In addition to standard socio-demographic variables, measures of job status provide additional information about the potential susceptibility of an individual (or host) to adverse occupational health outcomes**.** Whether or not one has health insurance, is self-employed, is a manager, and tenure at current job are status factors that influence occupational health. These measures are used as job status indicators and augment the host portion of the epidemiologic triad. Table 4.3 describes these variables.

Health insurance status. Access to health care is an important factor in predicting general health (Aday 1994). GSS respondents were asked, "Do you have any health insurance, including Medicare or Medicaid?" To control for health insurance status, a dichotomous dummy variable (1=yes; 0=no) for presence of health insurance is used.

Worker/self-employed. Because the self-employed are ostensibly in control of their work, I use self employment as a job status measure. GSS respondents were asked: "Are you self-employed or do you work for someone else?" A dichotomous dummy variable is used where "work for someone else"=0 and "self employed"=1.

Manages others. Managers, by definition, direct or control the work of others. As such, this measure is used as a characteristic of job status. In the 2002 GSS**,** respondents were asked to name their occupation.[5] Responses were then placed into categories using the US Census 1980 Occupational categories. Those respondents falling into the category of Executive, Administrative and Managerial occupations (per the 1980 census categories) are

[5] The GSS also asked the following question: "In your (SPOUSE'S) job, (do you/does he/she) supervise anyone who is directly responsible to (you/him/her)?" This question was not included in the Quality of Working Life topical module. Because of high numbers (1,441) of non-applicable cases (i.e., respondents not working, not married, spouse not working) this item was not used.

designated as “managers” (versus non-managers). A dichotomous variable is used where 1=manager and 0=non-manager.

Tenure. Initially, I planned to control for job tenure by restricting the analyses to workers who had worked at the same firm for more than one year. This resulted in a large number of case deletions. As an alternative, I chose to include all full or part time workers in the sample and use “years on the job” as a job status control measure. “Years on the job” is used as a measure of job tenure. Respondents were asked, “How long have you worked in your present job for your current employer?” Responses were entered in whole years. Respondents with job tenure of less than one year were coded as zero. Preliminary examination of this variable showed it to be non-normal in its distribution. Based on the distribution of cases, I constructed a three category dummy variable, described in Table 4.3.

Table 4.3. Summary of Job Status Variables

Concept/ Operationalization	Description
Insurance status "Do you have any health insurance, including Medicare or Medicaid?"	Dichotomous dummy variable. 1=Health insurance 0=No health insurance
Self-employed "Are you self employed or do you work for someone else?"	Dichotomous dummy variable. 1=Self-employed 0=Work for someone else
Manages others Respondents were asked to name their occupation. These responses were then placed into categories using the US Census 1980 occupational categories	Dichotomous dummy variable. Manager=1 (Executive, Administrative and Managerial) Non-manager=0
Tenure "How long have you worked in your present job for your current employer?" (reported in whole years only)	Three category dummy variable: Less than 1 year to 3 years 4 to 9 years 10 or more years

Labor Process Variables

A central argument of this project is that control over one's labor is an important determinant of occupational health. As stated earlier, the classic epidemiologic triad does not address this aspect of workplace organization. Three central aspects of labor process control are conceptualized: autonomy, social cohesion, and skill utilization. Table 4.4 provides a description of the variables used to operationalize these concepts.

Table 4.4. Summary of Labor Process Variables

Concept Operationalization	Description
Autonomy "I have a lot of say about what happens on my job" "I am given a lot of freedom to decide how to do my own work" "How often are you allowed to change your starting and quitting times on a daily basis?" "How often do you participate with others in helping set the way things are done?"	Summated index of reverse coded ordinal items. Response categories for first two items in the index are a four- point Likert scale: 4="strongly agree"; 3="agree"; 2="disagree"; 1="strongly disagree". Response categories for third and fourth index items are also four-point Likert scales, reverse coded: 4="often"; 3="sometimes"; 2="rarely"; 1= "never". Cronbach's alpha = 0.635
Social Cohesion "The people I work with can be relied on when I need help." "The people I work with take a personal interest in me"	Summated index of reverse coded ordinal items. Response categories for both items in the index are a four-point Likert scale: 4="very true"; 3="somewhat true"; 2= "not too true"; 1= "not at all true" Index transformed into four categories: Low cohesion Adequate cohesion Good cohesion Excellent cohesion Cronbach's alpha = 0. 399
Skill "My job lets me use my skills and abilities" "I have an opportunity to develop my own special abilities" "My job requires that I keep learning new things" "I get to do a number of different things on my job"	Summated index of reverse coded ordinal items. Response categories for all items in the index are a four- point Likert scale: 4="strongly agree"; 3="agree"; 2="disagree"; 1="strongly disagree". Cronbach's alpha = 0. 703

Autonomy. A key component of alienated labor is the loss of labor process control leading to decreased worker autonomy (Blauner 1964; Braverman 1974). As noted in Chapter 3, labor process autonomy may have both intended and unintended effects on occupational health outcomes. To assess worker autonomy, I created an index using four related measures where GSS respondents were asked to respond to a list of statements that "might or might not describe your main job". The index includes the following statements: "I have a lot of say about what happens on my job"; "I am given a lot of freedom to decide how to do my own work." I assigned reverse ordered numerical values to the Likert four response categories: "strongly agree", "agree", "disagree", and "strongly disagree" (e.g., 4=strongly agree, 3=agree, 2=disagree or 1=strongly disagree). Because freedom to change one's work schedule and control over production processes are also associated with autonomy (Hodson and Sullivan 2002; Karasek 1979), I included the following items as part of the concept of autonomy: "How often do you participate with others in helping set the way things are done?" and "How often are you allowed to change your starting and quitting times on a daily basis?" The response categories for these items are also four-point Likert scales: "often", "sometimes", "rarely" or "never." The scores were reverse coded so that the negative responses received lower numerical scores (e.g., often=4; never=1). I constructed a simple additive index using a summated response score of the three reverse ordered items so that autonomy could range from a possible score of 3 (indicating low autonomy) to a score of 12 (indicating high autonomy). Reliability of this index is good as indicated by a Cronbach's alpha of 0.635 for the index.

Social cohesion. Essential to labor process control is the freedom to control the social relations of work (Blauner 1964; Hodson 2001). I conceptualize the ability to control the social relations of work as essential to non-alienated labor, where social cohesion exists, workers are free to form positive relationships with co-workers (Blauner 1964).

Social cohesion is operationalized as a composite measure of two items asked of GSS respondents: “The people I work with can be relied on when I need help” and “The people I work with take a personal interest in me”. Response categories (“very true”, “somewhat true”, “not too true”, or “not at all true”) were reverse coded and summated so that the scores could range from 2 (meaning very low social cohesion), to a high social cohesion score of 8. Cronbach’s alpha for the social cohesion measure equals 0.399, which is lower than the other composite indices in the models. It should be noted, however, that Cronbach’s alpha is influenced by small numbers of items and that only two items comprise the measure.

Initial examination of the distribution of the cohesion index indicated that the responses tended to cluster at the high end of the index, that is most of the respondents tended to agree with the social cohesion items. Based on modal categories of the distribution, I created a four category dummy variable reflective of levels of cohesion, described in Table 4.4.

Another measure of the ability to control the social relations of work is the ability to organize collectively. Some GSS respondents were asked the following question: “Do you (or your spouse) belong to a labor union? (Who?)”, with the following response categories: “Yes, respondent belongs; Yes, spouse belongs; Yes, both belong; No, neither belong”. The question was not part of the Quality of Working Life module. Because of large numbers of missing data (i.e., respondents not working, not married, spouse not working), this item was not used.

Skill utilization. Another important aspect of labor process control is the ability to use one's skills (Simpson 1985). Non-routine types of work often require a variety of skills and abilities. I operationalized skill utilization as a composite measure of the following four items: "My job requires that I keep learning new things," "I get to do a number of different things on my job," "My job lets me use my skills and abilities," and "I have an opportunity to develop my own special abilities." I constructed a summated score for skill utilization by assigning reverse ordered numerical values to the response choices (e.g.**,** 4=strongly agree, 3=agree, 2=disagree or 1=strongly disagree), so that skill could range from a low score of 4 (indicating low skill utilization) to a high score of 16 (indicating high skill utilization). General face validity and reliability of these items are good. The Cronbach's alpha for the skill utilization index equals 0. 703.

Exposure Agent Variables

Exposures to agents such as chemical substances, radiation, and physical force are factors thought to be essential elements in the production of adverse occupational health outcomes (US Department of Health and Human Services, CDC, 2004). To approximate exposures, I use the following measures: 1) job time exposure in terms of weekly hours worked; 2) specific job task exposures including repetitive hand movements, 3) lifting, and 4) pace of work. Table 4.5 provides a brief description of these variables.

Task exposures: repetitive hand movements and lifting. Two measures of task exposure that are generally associated with risk of injury are lifting and repetitive motion. In 2002, GSS respondents were asked to answer "yes" or "no" to the following questions: 1) "Does your job require you to do repeated lifting, pushing, pulling or bending?" and 2) "Does your job regularly require you to perform repetitive or forceful hand movements or involve awkward postures?"   Each task exposure measure is used as a dichotomous dummy variable in the regression models.

Weekly hours worked. Another measure of exposure is *duration:* that is, as hours worked increase, so do potential exposures. Although this analysis is restricted to respondents who indicated that they work full or part time, their hours may vary. Number of hours worked weekly (as named by the respondent) is used as an independent variable. In the GSS, respondents who indicated that they worked full or part time were asked, "How many hours did you work last week, at all jobs?" The answers were coded numerically. For respondents who indicated that they have a job, but were not at work in the week prior to the survey, the question was modified to determine the "number of hours" they "usually work a week" (i.e., instead of last week).   Responses from these two items were used to create the hours worked variable.

Pace.   Working fast has been shown to be a factor in occupational injury, which may be exacerbated by repetitive tasks or heavy lifting (Wooding and Levenstein 1999). In the Quality of Working Life Module, 2002 GSS respondents were asked to comment on a list of statements that described their "main job." To indicate pace of work, I used the four-point Likert scale responses ("strongly agree," "agree," "disagree," or "strongly disagree") to the statement, "My job requires that I work very fast." The response categories are reverse coded here (i.e., strongly agree=4 and strongly disagree=1) to reflect pace magnitude.

Table 4.5. Summary of Exposure Variables

Concept Operationalization	Description
Hours Worked Full or part time workers were asked, "How many hours did you work last week, at all jobs?" Respondents who have a job but were not at work last week were asked to name the "number of hours" they "usually work a week".	Number of hours worked in a week
Repetitive Hand Movements "Does your job regularly require you to perform repetitive or forceful hand movements or involve awkward postures?" (Yes/No)	Dichotomous dummy variable. 1=Repetitive hand movements 0=No repetitive hand movements
Lifting "Does your job require you to do repeated lifting, pushing, pulling or bending?" (Yes/No)	Dichotomous dummy variable. 1=Lifting 0=No lifting
Pace "My job requires that I work very fast"	Ordinal response categories reverse coded. 4= "strongly agree"; 3="agree"; 2="disagree"; "1=strongly disagree".

Environment Variables

In the traditional epidemiologic triad, the environment is where the host and the agent are brought together so that disease (or injury) can occur (US Department of Health and Human Services, CDC, 2004). The environment affects the opportunity for exposure; for example, geology, climate, insects, or sanitation can be environmental factors (US Department of Health and Human Services, CDC, 2004). I use perceived safety climate and high/ low risk (in terms of industrial injury ranking) as environmental measures.

Perceived safety climate. I use the concept of perceived safety climate as a measure of organizational environment related to attitudinal norms (see Zohar 1980). Perceived organizational commitment to safety may reduce adverse occupational health exposures. Alternatively, worker perception of managerial benevolence in the environment may reflect worker labor process consent, which may increase exposure to adverse conditions. The perceived safety climate index includes several items summed into a single numerical score. To construct this measure, I use four questions: 1) “The safety of workers is a high priority with management where I work”; 2) “There are no significant compromises or shortcuts taken when worker safety is at stake”; 3) “Where I work, employees and management work together to ensure the safest possible working conditions”; and 4) “The safety and health conditions where I work are good”. All responses are the four-category Likert items of “strongly agree”, “agree”, “disagree” or “strongly disagree”. The logic of the measure is that higher scores indicate a more favorable safety climate. Therefore, I reverse-coded all safety climate items (e.g., strongly agree=4) and combined them into an additive index. The resultant perceived safety climate index could range from a minimum score of 4 (indicating minimal safety) to a maximum score of 16 (indicating a high degree of safety). General face validity of these items is good. The safety climate items are highly correlated with one another. The Cronbach’s alpha coefficient for the entire safety climate index equals 0.892.

Industrial injury ranking. Because some industries are more dangerous than others, a contextual measure of industrial sector risk is included to improve the exposure model specification[6]. Although mortality rates are good indicators of the dangerousness of an

[6] *Healthy People 2010,* a publication by the United States Department of Health and Human Services (and CDC) lists health objectives in the area of occupational health and safety. All industries are included in objective 20.1, which is to “reduce deaths from work related injuries”; the high mortality industries of mining, construction, transportation and agriculture, forestry, and fishing were targeted by the Centers for Disease Control and Prevention as key industries in need of priority intervention for fatality and injury reduction (United States, Bureau of Labor Statistics 2001a; United States, Department of Health and Human Services 2000). To tap into the issues of high mortality in industry, a dichotomous measure of highest risk industry versus other industrial sectors was created using information from the respondent’s industry in terms of 1980 Standard Industrial Codes (need manual reference). Using the National Census of Fatal Occupational Injuries in 2002, a ranking of industry by rates was created (Appendix A). Because of the large difference between the highest mortality industries and low mortality industries, a dichotomous measure was constructed. Initially this measure was used in all models. Subsequent analyses used injury rates (i.e., instead of mortality rates) to characterize industry risk, as outlined in Table 4.6.

industry, they only tell part of the story. Because workplace injuries occur much more frequently than occupational deaths, occupational injury rates by industry provide a somewhat different picture of workplace hazards. Using the Survey of Occupational Injuries and Illnesses, 2002 (United States, Bureau of Labor Statistics, 2004), I ranked industries by injury rates per 100 employees. The 2004 injury and illness data are organized by 1987 Standard Industrial Classification occupational classification codes. Because the 2002 GSS uses 1980 Standard Industrial codes to classify respondent industry, it was necessary to approximate the categories in the 1980 industry codes. The injury rates per 100 employees in the major Standard Industrial Classifications (1980 system) are listed in Appendix A. I group these into high injury, moderate injury and low injury industries, creating two dummy variables, as outlined in Table 4.5. “Moderate injury” is the omitted category in the subsequent regression analyses.

Table 4.6. Summary of Environment Variables

Concept Operationalization	Description
Perceived Safety Climate "The safety of workers is a high priority with management where I work." "There are no significant compromises or shortcuts taken when worker safety is at stake." "Where I work, employees and management work together to ensure the safest possible working conditions." "The safety and health conditions where I work are good."	Summated index of reverse coded ordinal items. Response categories for each item in the index are a four- point Likert scale: 4="strongly agree"; 3="agree"; 2="disagree"; 1="strongly disagree". Cronbach's alpha = 0. 892.
Industrial Injury Ranking Standard Industrial Classification Codes 1987 Matched to 1980 Standard Industrial Classification Codes. Industries rank ordered by rates per 100 employees. Rates are listed in Appendix A.	Industry injury rank order Dummy variables: Highest Risk (Manufacturing, Construction, Agriculture, Transportation) Moderate Risk (Mining, Wholesale/Retail, Services)-reference category Low Risk (Finance, Public Administration)

4. 3 Modeling of Relationships and Analysis Plan

Using the GSS 2002 data, I argue that workers' loss of control over the labor process contributes to adverse occupational health outcomes as operationalized by four dependent variables: 1) workplace injury; 2) persistent pain; 3) exhaustion; and 4) health status. After assessing univariate and bivariate statistics for all variables, I investigate multivariate relationships through a series of nested and non-nested regression models.

For each of the dependent variables, I apply the same research protocol. As depicted in Figure 4.1, I first analyze the relationships between socio-demographic status variables of age, race, gender, and education and each of the four dependent variables. This first set of models investigates differential gaps in adverse health outcomes by age, race, gender and education. Next, I add job status characteristics-self-employment status, and health insurance status, managerial status and job tenure variables to the models. These variables are introduced as job status control factors. The third set of models examines the effects of labor process factors (i.e., autonomy, skill, and social cohesion) on occupational health, net of the effects of socio-demographic and job status characteristics. The labor process models tests the hypothesis that some or all the effects of individual and job level factors are due to differences in worker labor process control.

The fourth set of additive models tests the effects of exposure factors on occupational health net of socio-demographic and job status controls. I evaluate the relationship between work exposures in terms of repetitive motion and lifting, hours worked, and pace of work on occupational and general health. By adding the exposure variables to the socio-demographic and job status models, I establish the effects of exposure, net of the effects of socio-demographics and job status control variables, on occupational health.

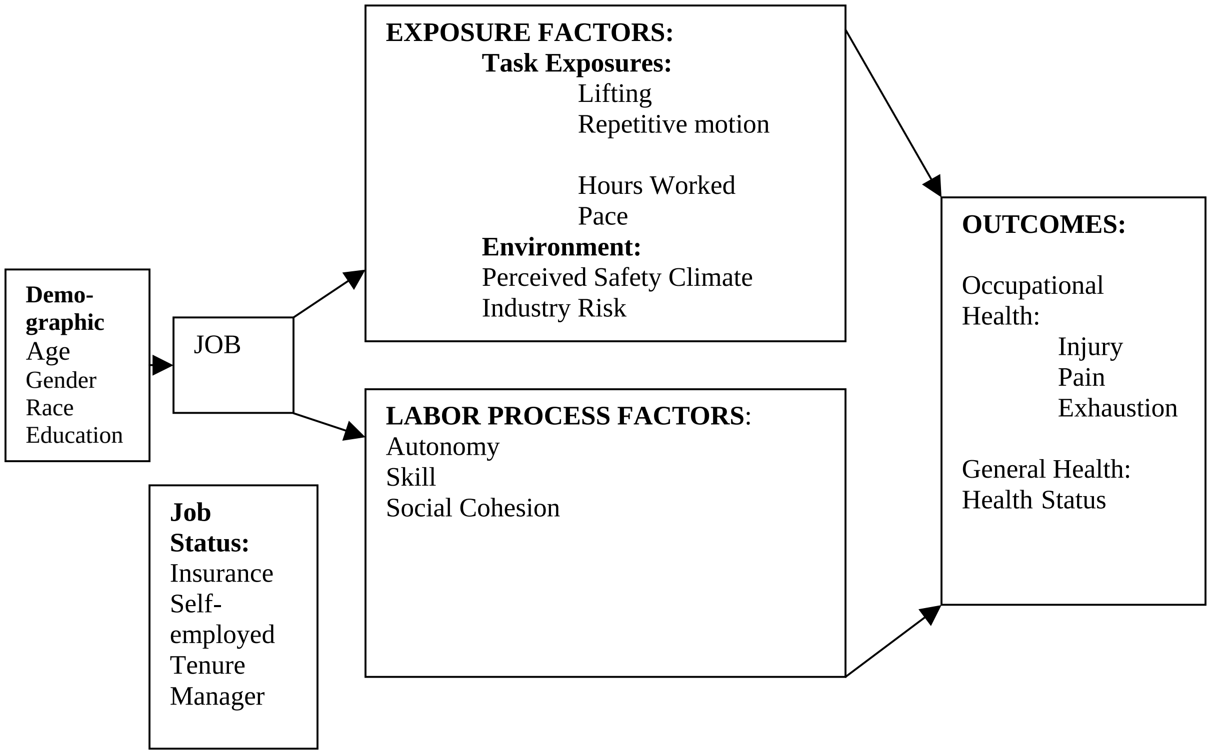

Figure 4.1: Analysis Plan

The fifth set of additive models looks at the impact of environment. To evaluate the effects of environmental factors, I add industrial injury rank and perceived safety climate to the exposure model. The fifth set of models approximate the epidemiologic triad components of host, agent/exposure, and environment.

I then construct a full model that includes labor process, exposures, and environmental factors, as well as socio-demographic and job status control variables. The full model allows for an investigation of the possible protective effects of worker labor process control on health controlling for epidemiologic factors. This basic sequence of nested and non-nested models is repeated for each of the four dependent variables: workplace injury, persistent pain, exhaustion, and health status. I test for non-linear effects by squaring each labor process measure and adding it as an independent variable to the main effects model. Finally, I create product interaction terms for labor process factors and key socio-demographic variables and task exposures and test for their effects.

4.4 Sets of Hypotheses

The literature review suggests several hypotheses regarding worker labor process control and health outcomes, which I list in this section. The hypotheses are grouped to reflect the three main research questions posed in Chapter 1. The first set are concerned with the general relationships between labor processes and health; the second set concern the nature and possibility of non-linear effects, and the third set address possible socio-demographic and labor process interactions.

The first research question is: "How do worker labor process control characteristics (autonomy, social cohesion, skill) relate to worker self-reported health outcomes in terms of injury, pain and exhaustion? How do labor process control factors relate to general health status?" To provide answers, I offer the following hypotheses:

> ***Hypothesis 1****: There are negative relationships between the indicators of worker labor process autonomy and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.*

> ***Hypothesis 1A****: There are positive relationships between the indicators of worker labor process autonomy and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis*

> ***Hypothesis 2****: There are negative relationships between the indicators of worker labor process control in terms of social cohesion and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.*

Hypothesis 2A: *There are positive relationships between the indicators of worker labor process control in terms of social cohesion and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis.*

Hypothesis 3*: There are negative relationships between the indicators of worker labor process skill utilization and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.*

Hypothesis 3A*: There are positive relationships between the indicators of worker labor process skill utilization and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis*

The second research question asked: "What is the nature of the relationship between worker labor process control and adverse occupational health outcomes? Will there be a point where increased worker labor process control is actually harmful to health? What factors influence this?" I test for non-linear effects by squaring each labor process measure and adding it as an independent variable to the full model. In addition to the above hypotheses, I offer Hypothesis 4 where I test for non-linear relationships by adding squared terms for autonomy, social cohesion and skill to regression models:

Hypothesis 4*: There are non-linear relationships between the indicators of worker labor process control (worker autonomy, social cohesion, skill utilization) and the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status net of the effects of the other variables in the model.*

Of interest are the ways in which labor process factors may contribute to unanticipated consequences for worker health as well as the ways in which labor processes may operate differently for men and women, whites and non-whites. The third research question asks, "Do labor process control factors operate differently for workers with different status characteristics (e.g., men versus women, whites versus non-whites) in terms of injury, pain, exhaustion, and general health status?" Put somewhat differently, do the data suggest that gender and/or race and labor process factors interact in terms of their effect on adverse and general health outcomes? That is, does adding the interaction terms improve our prediction of worker health? To test these ideas, I create product interaction terms for key socio-demographic variables and test for their effects. Hypothesis 5 is generated as a response to research question #3.

> ***Hypothesis 5****: The level of worker labor process control (worker autonomy, social cohesion, skill utilization) in the workplace has different effects on the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status for whites versus non-whites and for males versus females.*

The final hypothesis draws on both the first and second research questions. Labor process characteristics are related to worker self-reported outcomes in unexpected ways, so that increased worker control may be harmful to health. Here, I seek to investigate whether or not exposure factors influence this relationship in their ability to moderate the effects of labor process control.

> ***Hypothesis 6****: The level of worker labor process control(worker autonomy, social cohesion, skill utilization) in the workplace has different effects on the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status for those who perform the task exposures of repetitive hand movements and heavy lifting as compared to those who do not.*

In this section, I outlined a study that seeks to add to our knowledge of labor process and health, both in terms of adverse occupational health outcomes such as injury, pain and exhaustion, as well as general health status. A description of GSS data, operational definitions and measurement for all variables were outlined, as was the analysis plan for each dependent variable. This section concludes with a set of testable research hypotheses. In the next chapter, I present the results of the analyses outlined here.

CHAPTER 5

UNIVARIATE AND BIVARIATE ANALYSES

The analyses in this chapter are presented in three main parts. First, the descriptive statistics for all main variables are presented. Second, the bivariate regression analyses are examined. Finally, the bivariate correlation matrix is analyzed, setting the background for regression analyses. The next chapter will include the multivariate regression models for each dependent variable.

This section presents descriptive statistics for all variables presented in the previous chapter. I begin with a discussion of the dependent variables: self-reported workplace injury, persistent pain, exhaustion, and health status, followed by a description of all independent variables used (Table 5.1).

5.1 Description of Dependent Variables

Workplace Injury

In the 2002 GSS Quality of Working Life Module, respondents were asked to name the number of times they had been "injured on the job in the past 12 months". Respondents were not asked about the *severity* of the injuries, however, so information about whether or not the injury involved time off work or a visit to a health care provider is not available.

In response to the GSS question, 176 of working adults (10.95%) reported instances of workplace injuries (see Table 5.1). The mean number of injuries was less than one (0.2); the mode and the median were both zero. The standard deviation equals 0.8 and the range equals 7.0. This variable is positively skewed (5.702) with a high kurtosis of 37.623.

Use of the negative binomial versus Poisson regression model. As reported in the descriptive statistics section, the variable for number of times injured at work is highly skewed; most of the responses fall into the "no injury" category. This seems reasonable in a cross-sectional sample of respondents where workplace injury should be a rare event. OLS regression can be used in the presence of severe skewness of the dependent variable in this manner. However, a better choice is a distribution tailored to the distribution of responses. Because the number of workplace injuries variable is a non-negative count variable that is positively skewed, it is well suited to either the Poisson or negative binomial distributions.

The most common problem with Poisson regression is the tendency toward over-dispersion because of the lack of a random disturbance term that allows for omitted explanatory variables (Allison 1999a:223). The negative binomial is a generalization of the Poisson model that adds a disturbance term to account for the over-dispersion (Allison 1999a:226). Because the injury measure is constructed as a count variable, regressions were tested using both Poisson and negative binomial models. The likelihood ratio test statistic indicated that the estimate for the negative binomial model was significantly different from zero[7]. Therefore, in subsequent sections, I report the negative binomial model results for both the bivariate and multivariate analysis of the injury measure.

Persistent Pain

The GSS 2002 Quality of Working Life Module contains two questions assessing pain, from which I created a pain scale as a measure of persistent pain: "In the past 12 months have you had back pain every day for a week or more?" and "In the past 12 months have you had pain in the hands, wrists, arms, or shoulders every day for a week or more?" I

[7] Likelihood Ratio was computed as the difference between the log likelihoods of the main effects negative binomial model and Poisson regression models, multiplied by -2. LR=332.44, degrees of freedom=1.

assigned zero values to negative responses for each question category (i.e., whether the respondent experienced persistent back pain and whether the respondent experienced persistent hand, wrist, arm, or shoulder pain).[8] The resultant three-category pain scale was then dichotomized into “persistent pain” or “no pain” categories. Persistent pain was present in 40.57% of the respondents. Logistic regression is used to analyze this dichotomous outcome.

Exhaustion

Exhaustion is measured by a five-point ordinal Likert scale, reverse coded so that lower scores indicate lower levels of exhaustion. As stated earlier, respondents were asked how often during the past month had they felt “used up” at the end of the day. Of the respondents, 6.29 percent said “never”; 17.24 percent said “rarely”; 34.04 percent said “sometimes”; 23.65 percent said “often”; and 18.59 percent said “very often”.

In this analysis, I use the exhaustion scale as a continuous measure, although it is not a ratio level variable. The use of OLS for analysis preserves the five-category ordinal scale, and allows for easier interpretation than would five-category ordinal regression. The mean exhaustion score is 3.31, which tells us that on average, respondents were somewhat exhausted at the end of the day. The standard deviation is 1.146 and the range equals 4.0. The skewness equals -0.1359 and the kurtosis equals -0.7426.

Self-Reported Health Status

Self-reported health status is measured using a five point Likert scale, reverse coded so that low numbers represent lower health status. Of the 1607 respondents in the analysis, 1.56 percent described their health as “poor”; 10.45 percent described their health as “fair”;

[8] The results indicated that 59.43% have neither type of pain, 24.58% have one type of pain, and 15.99% have both types of pain.

29 percent described their health as “good”; 31.30 percent described their health as “very good”; and 27.69 percent described their health as “excellent”.

In this analysis, I use self-reported health status as a continuous measure. Although it is not a ratio level variable, use of OLS for analysis preserves the five- category ordinal dependent variable, and allows for easier interpretation than would five-category ordinal regression. Use of five-point Likert scales in OLS regression is common in the health status literature (see Ware 1986). As described in Table 5.1, the mean health score is 3.73, indicating that the mean health rating of respondents is good. The standard deviation is 1.026 and the range equals 4.0. The variable is slightly negatively skewed (-0.3715) and the kurtosis is also negative (-0.6646).

5.2 Description of Independent Variables

Socio-Demographic Measures

The respondents are split nearly evenly by gender (48.91% male and 51.09% female). Age ranges from 18 years to 86 years (range=68 years) with a mean age of 41 years and a standard deviation of 12.69. The skew for age is 0.362 and the kurtosis is negative (-0.5167).

As stated previously, I operationalized race as the respondent’s first mentioned race for the GSS question, “What is your race? Indicate one or more races that you consider yourself to be”. The majority of the respondents name “White” as their first mentioned race (78.9%). “Black or African American” is the first race named by 14.69% of the sample. “Hispanic” is the first mentioned race by approximately 3.0 % and “American Indian or Alaska Native” is the first named race by 1.06% of the sample. The remaining categories[9]

[9] Other race categories included: Asian Indian, Chinese, Filipino, Japanese, Korean, Vietnamese, Other Asian, Native Hawaiian, Guamanian or Chamorro, Samoan, Other Pacific Islander, and Some Other Race.

were less than one percent. Because of small numbers of non-white respondents, I created a dichotomous dummy variable by coding “white” and “non-white” categories, yielding a total of 21.1 % respondents in the “non-white” category.

The GSS 2002 includes two different education measures. Respondents were asked to name the highest year of school completed as well as the highest degree obtained[10]. However, the use of the continuous measure fails to capture meaningful categories of achievement, (e.g., high school diploma, bachelor’s degree, etc.). Therefore, I created a four category dummy variable using the GSS variable DEGREE with the following categories: less than high school (9.21%), high school diploma (54.32%), Associate/Bachelor’s degree (27.19%), and graduate degree (9.275). This variable is used in the regression models, although the continuous variable years of education was sometimes used as a comparison to assess threshold effects.

Job Status Characteristics

To measure managerial status, I created a dichotomous dummy from the GSS variable, OCC80. The category, “Managers” includes all persons whose 1980 census occupational category is listed as “Executive, Administrative and Managerial”. Using this criterion, 15.86% of the sampled respondents are considered managers.

To control for the effects of health insurance on health, I include a dichotomous dummy measure of insurance status. The majority (87.18 %) of respondents affirmed that they had “any health insurance, including Medicare or Medicaid”. This percent is based on a sample of employed respondents. A small percentage of the respondents are self-

[10] Years of education ranges from 0 to 20 years with a standard deviation of 2.73. The mean number of years of education is 13.8 with a standard deviation of 2.73. The skewness is somewhat negative at -0.254 and the kurtosis equals 1.89.

employed: 11.76% said that they worked for themselves versus 88.24% of the respondents who said that they worked for someone else.

As a measure of job tenure, GSS respondents were asked, "How long have you worked in your present job for your present employer?" The average worker indicates approximately seven years of experience in his or her present job (6.93 years). A wide range of job tenure exists, ranging from less than one year to 50 years on the job, with a standard deviation of 8.3. The skewness equals 1.745 and the kurtosis equals 3.146. Because of the wide variation, I created three categorical dummy variables to indicate job tenure: senior tenure, (10 or more years) 27.13%; mid-level tenure (4-9 years) 24.14%; and new hire (0-3 years) equals 48.72%.

Labor Process Control Variables

The index measuring worker autonomy has a range of 12: from a low score of 4 to a high of 16 with a standard deviation of 2.6. The mean for this variable equals 12.21, indicating that the average worker is somewhat autonomous on the job. The variable is negatively skewed (-.058) and has a kurtosis of -0.032.

The two-item index for social cohesion has a range of 6, with a low score of 2 (low cohesion) to the high score of 8 and a standard deviation of 1.3. The mean social cohesion score equals 6.69, indicating that the average worker in this sample has a relatively high degree of social cohesion at work. The variable is negatively skewed (-1.062) with a somewhat kurtotitc shape (1.17).

Because of the skewed distribution of the cohesion index, I created a four-category categorical variable reflective of the modal distribution. Low cohesion (less than or equal to

5) accounted for 15.3% of the sample. Adequate cohesion (score of 6) equals 24.6%. Good cohesion (score of 7) equals 25.6%, while excellent cohesion (score of 8) equals 34.5%.

The skill utilization index has a range of 12; the low score equals 4 to a high score of 16 with a standard deviation of 2.22.   The mean value is 13.01, indicating that the average worker generally agrees that he or she uses skills and abilities as part of the main job. The variable is negatively skewed at -0.715 and the kurtosis equals 0.567.

Exposures

The sample is split closely between those who stated that they performed repeated or heavy lifting as part of the job (46.24%) and those did not (53.76%). Slightly over half of the respondents indicated they performed forceful or repetitive hand motions at work (50.72%). Respondents report working an average of 41.86 hours per week. The range of 88 hours and the standard deviation of 14.36 indicate a large degree of variation. The skewness equals 0.229 and the kurtosis equals 1.34. A moderately fast pace of work is required of the sampled respondents. As stated previously, pace of work was measured by the 4 point Likert responses to the following question: **“**My job requires that I work very fast”, reverse coded, so that 4=strongly agree and 1=strongly disagree.   The mean score of 2.79 and the median of 3.0, indicate that workers generally agreed to the above statement. The range equals 3.0 and the standard deviation equals 0.819. Skewness equals -0.038 and kurtosis equals -0.788.

Environment

The perceived safety climate index ranges from 4 to 16, with a standard deviation of 2.41. The mean safety climate score is 13.1, indicating that respondents generally agree that there is attention to worker safety in their workplace. The skew is negative (-0.6495) and the kurtosis equals 0.483.   As outlined in the previous section, the injury risk variable was created by examining the injury rates by industry using Bureau of Labor Statistics rates for 2002 and subsequently categorizing respondents' reported industrial sectors as a high, moderate, or low risk industry based on industrial sector injury rates. A total of 470 (29.2%) respondents worked in the high-risk industries of Manufacturing, Construction, Agriculture and Transportation. The moderate risk categories of Wholesale/Retail Trade, Services, and Mining employed 941 workers (58.6%), and the low injury industries of Finance and Public Administration employed 193 (12%).

Table 5.1. Description of Dependent and Independent Variables (N=1607).

Variable	% of Total	Mean	Median	Standard Deviation	Range	Skewness	Kurtosis
Workplace Injury # times injured on job in past 12 months	0 injury= 89.05% 1 injury= 7.28 % 2 injuries=1.37 % 3 injuries=0.09% 4 injuries=0.19% 5 injuries=0.37% 6 injuries=0.37% 7 or more=0.44%	0.207	0.0	0.8	7.0	5.702	37.623
Persistent Pain	Persistent pain=40.57% No pain=59.43%						
Exhaustion 1=never 5=very often	Never=6.29% rarely=17.24% Sometimes=34.04% Often=23.65% Very often=18.59	3.31	3.0	1.146	4.0	-0.1359	-0.7426
Health Status 1=poor 5=excellent	Poor=1.56 % Fair=10.45% Good=29 % Very good=31.30% Excellent=27.69	3.73	4.0	1.026	4.0	-0.3715	-0.6646
Age		40.99	40.0	12.69	68	0.362	-0.5167
Gender	Male=48.91% Female=51.09%						
Race	White=78.9% Non-white=21.1%						
Degree Highest degree completed	Less than 12=9.21% High School=54.32% Associate/Bachelor's=27.19% Graduate School=9.27%						
Health Insurance	Insured=87.2% Non-insured=12.8%	0.872					
Self-employed	Self-employed=11.76% Work for others=88.24%	0.117					
Manager 1980 census	Manager=15.68% Non-mgr=84.32%						
Tenure Years at current main job	0-3 years=48.72% 4-9 years= 24.14% 10 + years= 27.13%	6.93	4.0	8.3	50.0	1.745	3.146
Autonomy Index		12.21	12.0	2.6	12.0	-0.58	-0.032
Social Cohesion Index	Low =15.3% Adequate=24.6% Good=25.6% Excellent=34.5%	6.69	7.0	1.3	6.0	-1.062	1.17
Skill Utilization		13.01	13.0	2.22	12.0	-0.715	0.567
Heavy Lifting	Heavy lifting =46.2% No heavy lifting =53.8%						
Repetitive Hand Movements	Repetitive hand movements=50.7% no movements= 49.28%	0.507					
Hours worked		41.86	40	14.36	88.0	0.229	1.34
Pace	"Job requires that I work very fast" 4=strongly agree 1=strongly disagree	2.8	3.0	0.819	3.0	-0.038	-0.788
Industrial Injury Risk	High Risk =29.25% Moderate Risk =58.6 % Low Risk =12%	0.292					
Safety Climate		13.1	13.0	2.41	12.0	-0.6495	0.483

5.3 Bivariate Regressions

In this section, I present the bivariate relationships between dependent and independent variables. The negative binomial distribution was used to assess the bivariate relationships between independent variables and number of times injured on the job. Logistic regression was used to assess the bivariate relationships between independent variables and persistent pain. OLS regression was used to assess the bivariate relationships between the independent variables and exhaustion and self-reported health status. Bivariate correlations are also presented and discussed as preliminary evaluation of the data.

Bivariate Regressions: Workplace Injury

In terms of socio-demographics, a negative relationship between age and number of occupational injuries exists. Gender, (or in this case, being male) is positively associated with injury. The relationship between race (white=1) and workplace injury is non-significant. Neither measure of education that I tested is significantly related to injury (i.e., years of education or highest degree achieved).

In terms of job characteristics and workplace injury**,** managerial status has a strong negative association with workplace injury. Having health insurance is also inversely related to injury. The other job status characteristics of self-employment status and job tenure (tested as continuous and categorical measures*)* are not significantly associated with workplace injury. Of the labor process factors, only autonomy is significantly inversely related to workplace injury. Social cohesion and skill utilization are non-significant.

At the bivariate level of analysis, exposure measures are generally good predictors of injury. The task exposures of repetitive hand movements and heavy lifting are strongly associated with workplace injuries (see Table 5.2). Pace of work borders on significance (p=<.099). Hours worked is also statistically significant here: as hours worked go up, so do predicted numbers of injuries.

Of the environmental variables, the safety climate index is significant and negatively associated with workplace injuries. However, neither of the of the industrial injury sector measures is significant in the bivariate regressions.

Bivariate Regressions: Persistent Pain

The bivariate relationships between age, race, gender and persistent pain are non-significant. The continuous measure, years of education, shows a statistically significant inverse relationship. When using degree achieved (i.e., instead of years of education) a different picture emerges. Turning to the categories of highest degree earned, there is a borderline significant relationship (p=.06) between having less than a high school diploma and the presence of persistent pain (compared to the baseline group of those with a high school diploma). Those with a graduate degree are significantly less likely to experience persistent pain compared to the baseline group. Having an associate's/bachelor's degree was a non-significant predictor of persistent pain.

In terms of job status characteristics**,** managerial status significantly predicts a reduction in the likelihood of persistent pain. Having insurance is marginally (p=.08) associated with lowered odds of pain. Self-employment is not significantly associated with persistent pain. Senior job tenure was associated with an increase in the likelihood of persistent pain, when compared to the baseline group of mid-range tenure (i.e., 4-9 years).

All of the worker labor process control factors (autonomy, social cohesion and skill utilization) predict a decrease in the odds of persistent pain at the bivariate level of analysis. As a categorical variable, low social cohesion is marginally associated with increased pain, while good and excellent cohesion are associated with pain reduction (when compared to the baseline, adequate cohesion).

In terms of exposures, repetitive hand movements and heavy lifting predict increases in the likelihood of persistent pain (see Table 5.2). The other exposure measures, pace of work and hours worked, do not have significant predictive effects in the bivariate logistic regression models. The safety climate index is significantly inversely associated with persistent pain. However, neither of the industrial injury measures is significant in the bivariate logistic regressions predicting persistent pain.

Bivariate Regressions: Exhaustion

In terms of socio-demographics, age and gender have statistically significant effects on exhaustion. Age has negative effects on exhaustion; as age increases, the degree of exhaustion decreases, generally meaning that younger workers find their jobs more exhausting[11]. Males report lower levels of exhaustion than females. When compared to non-whites, the model does not predict whites to have significantly different levels of exhaustion. Neither years of education nor degree are significantly associated with exhaustion.

None of the job status characteristics prove to be good predictors of exhaustion in the bivariate regression models. Insurance was not a significant factor in preventing exhaustion.

[11] There are a number of possible explanations. It could be because younger workers have lower quality jobs and their responses reflect that. It may also mean that older workers have become accustomed to working for a living and have found ways to make their work more bearable. Workers may also attrite out of exhausting or dangerous jobs.

Self-employment is not strongly associated with exhaustion, although the parameter estimate approaches significance.

At the bivariate level, the labor process factor of autonomy is statistically significant and inversely related to exhaustion. As an index, social cohesion is inversely related to exhaustion. When categorical measures are used, low cohesion is associated with an increase in exhaustion while excellent cohesion is predicted to decrease exhaustion. The category of good cohesion was not significant. Skill utilization was not significantly related to exhaustion.

All exposure variables, with the exception of hours worked, are good predictors of exhaustion. The task exposures of repetitive hand movements and heavy lifting strongly predict increased levels of exhaustion. Pace of work is positively associated with exhaustion ($p<.0001$) at the bivariate level.

The safety climate index is inversely associated with exhaustion, so that as the climate is perceived to be increasingly safe, exhaustion declines. Neither of the industrial injury measures is significant in the bivariate regressions.

Bivariate Regressions: Health Status.

Age, race, and gender had non-significant effects at the bivariate level. Of the socio-demographic variables, only education (tested as both a continuous measure and as highest degree earned) is a good predictor of health status. In terms of degree categories, having less than a high school diploma is associated with lower levels of health, while the reverse is true for college degree holders.

In terms of job status characteristics, self-employment is positively associated with health status. Having health insurance is also positively associated with health status.

Managerial status is not a good predictor of health at the bivariate level. Job tenure, as a continuous measure, is non-significant. However, when broken into categories, those with relatively low job tenure and those with senior tenure alike are predicted to report negative health status as compared to the baseline group, workers with 4-9 years on the job.

All labor process factors (i.e., autonomy, social cohesion, and skill utilization) are positively associated with self-reported health status, suggesting that as worker labor process control increases, so does general health (Table 5.2). Low cohesion is associated with lowered health status, as compared to the baseline group, those with adequate cohesion.

The exposure variables, with the exception of pace of work, are good predictors of health status at the bivariate level. The model predicts lowered health status for workers who report repetitive hand movements and heavy lifting on the job as compared to the baseline of workers who do not report these exposures. The continuous measure of number of hours worked in a week is a significant predictor of health status at the bivariate level.

In terms of environmental factors, the safety climate index is significant and positively associated with health status. Low industrial injury risk is a positive predictor of health, although high injury risk did not have the opposite effects when compared to the baseline of moderate injury risk.

Summary of Bivariate Regressions across Dependent Variables

In summary, there are a few measures that are good predictors for each of the four dependent variables, but most of the independent variables used are not this consistent. *Autonomy* is the only labor process factor that is a significant predictor of the dependent variables in all bivariate regressions. The task exposures of *repetitive hand movements* and *heavy lifting* and the environmental measure of *safety climate* are also significant independent variables for the four dependent variables.

Many independent variables are strong predictors of some health outcomes, but not others. For example, *age* is a good bivariate predictor of both injury and exhaustion, but not of pain or health status. *Gender* is significant in the injury and exhaustion models, but not when predicting pain or health. *Education* is strong in pain and general health, but not for injury or exhaustion. *Managerial status* predicts injury and persistent pain. *Insured* is helpful for predicting injury and health but not exhaustion or pain. *Cohesion* is a strong predictor for all dependent variables with the exception of injury. *Skill* is a significant predictor of pain and health only.

Other variables only have limited use in the models at this level. *Self-employment* is only significant for health status. *The industrial injury rank* variable is only significant in its prediction of health status. Two of the variables used in the bivariate regressions had no significant effects at the bivariate level for any of the four dependent variables. *Race* is not statistically significant at the bivariate level in any of the models. When *years on the job* was used in its continuous form it was not significant across all dependent variables. However, when broken down into tenure categories, newly hired and senior job tenure status were associated with negative health at the bivariate level. The relationships between all independent variables and each of the four dependent variables are examined more fully in subsequent regression models in the following sections.

Table 5.2 Bivariate Regressions: Unstandardized Estimates (SE) N=1607

	Workplace injury (negative binomial)	**Persistent pain** (logistic regression)	**Exhaustion** (OLS regression)	**Health status** (OLS regression)
Independent variable				
Age in years	-0.026 (0.0076)***	-0.00063 (0.004)	-0.0118 (0.0022)****	-0.0028 (0.002)
White	0.117 (0.233)	0.197 (0.126)	0.1067 (0.0701)	0.0668 (0.0628)
Male	0.427 (0.187)*	-0.030 (0.102)	-0.2117 (0.057)***	0.053 (0.0512)
Education (in years)	-0.041 (0.036)	-0.075 (0.019)****	-0.0034 (0.0105)	0.0632 (0.0092)****
Degree Less than hs	-0.012 (0.33)	0.334 (0.178) +	0.0714 (0.102)	-0.2474 (0.09)**
Associate/Bachelor's Degree	-0.235 (0.223)	-0.183 (0.120)	0.0065 (0.0672)	0.2716 (0.0593)****
Graduate Degree	-0.296 (0.343)	-0.661 (0.196)***	-0.0117 (0.1017)	0.3674 (0.0897)****
Self-employed	-0.034 (0.293)	0.156 (0.156)	-0.17025 (0.0887)+	0.1967 (0.0794)*
Manager	-1.695 (0.366)****	-0.305 (0.144)*	0.0932 (0.0786)	0.0929 (0.0704)
Insured	-0.52 (0.264)*	-0.26 (0.150)+	0.0821 (0.0855)	0.2151** (0.0764)
Years on the Job	-0.018 (0.012)	0.0072 (0.0061)	0.0022 (0.0035)	-0.0022 (0.0031)
New Hire (0-3 years)	0.209 (0.234)	0.158 (0.128)	0.1256 (0.0572)	-0.1596 (0.0636)*
Senior tenure 10 years or more	-0.103 (0.268)	0.289 (0.143)*	0.1256 (0.08)	-0.1722 (0.0715) *
Autonomy	-0.081 (0.035)*	-0.048 (0.02)*	-0.0381 (0.011)***	0.0764 (0.0097)****
Social Cohesion Index	-0.113 (0.072)	-0.213 (0.04)****	-0.1643 (0.0217)****	0.1122 (0.0195)****
Low Cohesion	0.0097 (0.296)	0.302 (0.163)+	0.354 (0.0916)***	-0.2675 (0.0824)**
Good Cohesion	-0.271 (0.263)	-0.377 (0.144)**	-0.132 (0.0795)	0.1858 (0.0715)**
Excellent Cohesion	-0.33 (0.246)	-0.433 (0.135)**	-0.2782 (0.0742)***	0.1702 (0.0668)**
Skill Utilization	-0.043 (0.042)	-0.073 (0.023)**	-0.000803 (0.0129)	0.0886 (0.0113)****
Repetitive Hand Movements	1.042 (0.189)****	0.909 (0.105)****	0.296 (0.0567)****	-0.2064 (0.051) ****
Lifting	1.549 (0.19)****	0.663 (0.103)****	0.2041 (0.0571)***	-0.251 (0.051) ****
Hours	0.0145 (0.0065)*	-0.0012 (0.0035)	0.0127 (0.002)	0.0054 (0.0018)**
Pace	0.181 (0.11) +	0.095 (0.062)	0.3157 (0.034)****	0.0236 (0.0313)
Safety climate	-0.169 (0.035)****	-0.087 (0.021)****	-0.0553 (0.0118)****	0.0597 (0.0105) ****
High Injury	0.326 (0.209)	0.091 (0.115)	-0.0549 (0.0647)	-0.0958 (0.0578)
Low injury	0.230 (0.293)	-0.0017 (0.161)	-0.1516 (.0905)	0.1912 (0.0809)*

Unstandardized coefficients. Standard error in parentheses. +p<.10 *p<.05; **p<.01; ***p<.001; ****p<.0001

5.4 Bivariate Correlations

Previous examination of bivariate regression has focused on the relationships of the independent variables to each of the dependent variables. Next, I examine the bivariate correlations between independent variables in the models, with an eye toward possible collinear effects.

Bivariate correlations of above .60 among independent variables are generally thought to be problematic, although it is possible for multi-colinearity to exist even when bivariate correlations are less strong (Allison 1999b:141). In the zero-order correlation matrix (Appendix B) no independent variables with correlations of .50 or greater were identified. I address all correlations between independent variables of .20 or greater, significant at the <.0001 level of significance. Issues related to potentially problematic correlations will be addressed in more detail in the discussion chapter.

Lifting is inversely correlated with education (r=-.30) as is repetitive hand movements and education(r=-.25). Each correlation is a reflection of manual labor aspect of low skill jobs. Lifting is also moderately correlated with repetitive hand movements (r=.44). For the purpose of the regression analyses, I keep lifting and repetitive hand movements as separate types of task exposures, keeping in mind that they tap into similar aspects of risk.

Males are more likely to work long hours than are females as evidenced by the .22 correlation between gender and hours worked. Males are also more likely to work in high injury industries (e.g., construction, agriculture, etc) than are females (r=.32).

There is a moderate correlation between years on the job and age (r=.46), which may or may not cause problems with multi-colinearity in subsequent regression analyses. Not surprisingly, autonomy is correlated with self-employment (*r*=.30) and managerial status (*r*=.20). Skill is correlated with education (*r*=.23). Although the various labor process components used in this analysis represent different aspects of labor process control, they are strongly correlated with one another. For example, autonomy and skill are moderately correlated (*r*=.48) as are cohesion and skill (*r*=.32) and autonomy and cohesion (*r*=.34). These variables are included in the multivariate regression analysis in the current form.

Safety climate is moderately correlated with (*r*=.37) autonomy, labor process and skill. This may be because the safe workplaces are also ones in which workers have labor process control, or perhaps there is a normative aspect to the safety climate questions (see Zohar 1980).

Summary

The bivariate results emphasize that it is important to have different dependent variables when assessing the relationships between workplace organization and health. The variables of workplace injury, persistent pain, and exhaustion measure different aspects of occupational health. Additionally, looking at general health is a valuable way to estimate how much the effects of one's working life can affect health status. Using only one dependent variable would mask possible relationships.

In addition to different dependent variables, I have identified specific indicators of the labor process as well. Workplace autonomy, social cohesion and skill utilization are all important, yet distinctly different aspects of worker labor process control. Multivariate analyses examine complex relationships net of their effects. In the next chapter I present the results of the multivariate models.

CHAPTER 6

MULTIVARIATE ANALYSES

In the previous chapter, I reported descriptive statistics and bivariate regressions. In this chapter, I report on the effects of the labor process variables in concert with other variables in the regression models. The series of additive models show the differential effects of socio-demographics, job status characteristics, labor processes, exposures, and environments on occupational and general health outcomes. This chapter is organized in four main sections, each with four subsections. For each dependent variable (i.e., workplace injury, persistent pain, exhaustion, and health status) I report the results of: 1) additive multivariate models; 2) models testing for non-linear effects using second order polynomials; 3) interaction effects for selected socio-demographic and task exposures with labor process variables; and 4) a discussion of the results. Evidence from the analyses in this section will be used to assess the research questions and hypotheses, which follow in the next chapter.

6.1 Results of Multivariate Regression Models Predicting Workplace Injury

The negative binomial distribution is used to estimate the workplace injury models. Because the dependent variable (number of workplace injuries in last 12 months) is logged, the interpretation of the coefficients is similar to logistic regression coefficients (Allison 1999a:221). For selected significant predictor variables, I report the percent change in the number of workplace injuries with a one unit increase in the independent variable using the formula: (100* (exp β)-1).

Model 1 includes the socio-demographic factors of age, race, gender and educational degree. Only age and the dummy variable for gender are significant predictors of workplace injuries (Table 6.1). As in the bivariate models, age is related to occupational injury. The effects of age retain statistical significant throughout the series of models. If we calculate the expected percent change in the number of workplace injuries with each one-year increase in age, we see that model predicts a 2.65 percent decrease in number of injuries.[12] The parameter estimate for gender of .4471 tells us that males have injury counts that are approximately 56 percent higher than females. As in the bivariate regressions, race (white=1) and levels of education are not significant predictors of workplace injuries.

The Job Status Model (Model 2) improves upon the Socio-Demographic Model by introducing variables for self-employment, insurance status, managerial status, and job tenure. Of the job status characteristics, only managerial status is a significant predictor of number of workplace injuries. Managerial status decreases the predicted log injury count by -1.699, net of the other variables in the model. Stated differently, managers have numbers of workplace injuries that are 81.7 percent lower on average than non-managers.

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[12] For example, 100(e (-0.0269)-1) = 0.9734 -1=-0.0265*100=-2.65.

In terms of socio-demographic covariates, the effects of age are diminished somewhat by the addition of job status characteristics, likely a reflection of the relationship between age and the quality of jobs. The effect of being male on workplace injuries is increased with the addition of job status characteristics to the model. The reasons for this are not clear as the individual correlations between male and the job status variables of self-employment, managerial status, insurance and job tenure are low and largely non-significant (Appendix B). In comparison to Model 1, the addition of job status variables improves our prediction of workplace injury counts. The likelihood ratio statistic[13] of 25.36 with 5 degrees of freedom is statistically significant (critical chi-square at .01=15.086). The addition of job status factors improves upon the standard socio-demographic model, largely through the strength of the managerial status variable.

Model 3 adds the labor process factors of autonomy, social cohesion, and skill utilization to the socio-demographic and job status variables in Model 2. At the multivariate level, none of the labor process factors are significant predictors of workplace injuries, although at the bivariate level, autonomy is significantly associated with a decline in the number of workplace injuries. This suggests that there may be some conceptual overlap between the managerial status variable and autonomy.[14] This also tells us that labor process autonomy has positive effects for injury reduction, although the optimum operationalization of the measure (i.e., autonomy and/or managerial status) still needs to be determined. The

[13] The Likelihood Ratio statistic is the difference between the log likelihoods of two nested models multiplied by negative two. Degrees of freedom are equal to the number of additional parameters in the more complex model.

[14] Autonomy and managerial status are positively correlated (r=.2). Although effect of autonomy on injury is significant at the bivariate level, when managerial status is added to the bivariate model,, the significance of autonomy drops to non-significance (p=.18), while managerial status is significant at <.0001,suggesting some overlap in the concepts. Further investigation reveals that when the Labor Process Model is run <u>without</u> the managerial status variable, the autonomy variable retains statistical significance. The statistical significance of the autonomy variable is lost with the addition of exposures, however.

Labor Process Model does not significantly improve our prediction of number of workplace injuries over the Job Status Model. The likelihood ratio statistic of 5.08 with 5 degrees of freedom was not statistically significant (critical chi-square at .10=9.236).

Model 4 adds epidemiologic exposures to Model 2. Heavy lifting is a statistically significant predictor of workplace injury, net of the effects of the other variables in the model. However, the parameter estimate for repetitive hand movements is not statistically significant. This is a surprising finding given the significant relationship between hand movements and number of workplace injuries at the bivariate level (Table 5.2). Although they are correlated, repetitive hand movements and heavy lifting measure distinctly different types of task exposures However, when used as independent variables predicting workplace injury, there maybe an overlap in job duties that involve the task exposures of heavy lifting and repetitive hand movements.[15] Hours worked is also a significant predictor variable in the Exposures Model. The model predicts that with each one-hour increase in hours worked, the number of injuries goes up by about 1.4 percent.

The parameter effects of age diminish somewhat with the addition of task exposures, but remain statistically significant. Gender (male=1) is a strong predictor of injuries in Models 1-3, but diminishes to non-significant levels with the addition of the exposure variables in Model 4. The Exposures Model is a statistically significant improvement over the Job Status Model (Model 2). The likelihood ratio statistic equals 60.7226 with 4 degrees of freedom (critical chi-square at .01 = 13.277).

[15] The correlation between heavy lifting and repetitive hand movements is .44. When the variable for heavy lifting is removed from the main effects model, the variable for repetitive hand movements becomes statistically significant, suggesting multi-co linearity between the heavy lifting and repetitive hand movement variables in terms of workplace injury. I ran a subsequent main effects regression model where I combined the repetitive hand movement and heavy lifting variables into a single measure (e.g., task exposure). The task exposure variable was statistically significant at <.0001. The other variables in the model remained largely unchanged.

Model 5 (Environment) adds the environmental factors of safety climate and dummy variables for high and low industrial sector injury risk. The safety climate parameter estimate of -0.2081 is statistically significant: the model predicts an 18.78 percent decrease in the number of injuries for each 1-point increase in the safety climate index. The industrial sector injury risk variables are not statistically significant. The model is a significant improvement over the Exposures Model (Model 4), as evidenced by the likelihood ratio statistic of 40.39 with 3 degrees of freedom (critical chi-square at .01 =11.341).

The Main Model, (Model 6) includes all variables, and differs from Model 5 by the introduction of labor process factors to the improved status and epidemiological model. The addition of the labor process variables erodes the strength of the safety climate parameter estimate to a lower (but still statistically significant) level. This suggests that there may be a relationship between the effects of the safety environment and labor processes on the dependent variable, workplace injury. I ran a series of models to interpret the relationships between the safety climate variable, the autonomy variable, and workplace injury. Recall that autonomy was statistically significant (p=.02) at the bivariate level, but was reduced to non-significant levels in the Labor Process and Main Effects Models. Adding the safety climate variable to a bivariate regression of injury on autonomy erodes the significance level of autonomy to p=.79, suggesting that safety climate, in terms of actual working conditions, explains the effects of autonomy on injury. Safety climate also measures normative acceptance of working conditions (Zohar 1980), suggesting that the belief in managerial efforts to keep workers safe may mediates autonomy's effects.

The predictor variables of managerial status and heavy lifting remain significant at p<.0001 levels. Repetitive hand movements border on statistical significance (p=.08) in the

Main Model. Looking across all models, we see that age remains a significant predictor of workplace injuries, although its effects are eroded somewhat. Race and levels of education are not significant predictors of workplace injuries in the any of the series of nested models.

The non-significant likelihood ratio of 5.59 with 5 degrees of freedom indicates that this model is a not a major improvement over Model 5. The inclusion of the labor process measures did not improve the predictive ability of the model, net of the effects of the other variables, lending credence to the argument that epidemiologic models are sufficient to predict workplace injuries.

Table 6.1. Negative Binomial Regressions: Unstandardized Estimate (SE) of Workplace Injury on Selected Predictor Variables (N=1607).

Parameter Variable	1 Socio-Demographic	2 Job Status	3 Labor Processes	4 Exposures	5 Environment	6 Main Model
Age	-0.027 (0.008) ***	-0.023 (0.008)**	-0.023 (0.008)**	-0.020 (0.009)*	-0.019 (0.008)*	-0.018 (0.008)*
White	0.148 (0.231)	0.138 (0.231)	0. 188 (0.232)	0.081 (0.223)	0.233 (0.224)	0.235 (0.224)
Male	0.447 (0.188)*	0.504 (0.189)**	0.495 (0.189)**	0.216 (0.188)	0.123 (0.199)	0.137 (0.199)
Less than HS Education	-0.0004 (0.327)	-0.118 (0.327)	-0.119 (0.331)	-0.3182 (0.309)	-0.391 (0.311)	-0.372 (0.311)
AD/BA Education	-0.105 (0.223)	-0.028 (0.227)	0.034 (0.229)	0.182 (0.226)	0.359 (0.225)	0.319 (0.227)
Graduate Degree	-0.0165 (0.345)	0.140 (0.351)	0.0975 (0.358)	0.536 (0.349)	0.677 (0.358)+	0.639 (0.367)+
Self-Employed		0.332 (0.177)	0.454 (0.316)	-0.0160 (0.299)	0.256 (0.300)	0.201 (0.307)
Insured		-0.305 (0.275)	-0.360 (0.277)	-0.116 (0.264)	-0.181 (0.263)	-0.217 (0.264)
Manager		-1.699 (0.376)****	-1.607 (0.380)****	-1.429 (0.380)***	-1.259 (0.378)***	-1.239 (0.381)**
Job Tenure 0-3 years		0.111 (0.237)	0.126 (0.238)	0.207 (0.231)	0.348 (0.234)	0.346 (0.235)
Job Tenure 10+ years		0.098 (0.277)	0.125 (0.278)	0.080 (0.269)	0.207 (0.271)	0.183 (0.272)
Autonomy			-0.065 (0.042)			0.012 (0.0416)
Low Social Cohesion			-0.085 (0.299)			-0.188 (0.289)
Good Social Cohesion			-0.255 (0.263)			-0.371 (0.252)
Excellent Cohesion			-0.332 (0.254)			0.077 (0.248)
Skill Utilization			0.027 (0.051)			0.045 (0.053)
Repetitive Hand				0.317 (0.221)	0.348 (0.219)	0.386 (0.220)+07
Heavy Lifting				1.325 (0.224)****	1.438 (0.229)****	1.487 (0.231)****
Working Fast				0.055 (0.108)	0.091 (0.109)	0.074 (0.112)
Hours Worked				0.0140 (0.0066)*	0.017 (0.0064)**	0.015 (0.0065)*
Perceived Safety Climate					-0.208 (0.036)****	-0.240 (0.041)****
High Risk Industry					0.342 (0.220)	0.351 (0.221)
Low Risk Industry					0.478 (0.299)	0.492 (0.303)
Intercept	-0.858	-0.783	-0.206	-2.772	-0.923	-1.086
Log likelihood	-588.7668	-576.0845	-573.5456	-545.7232	-525.5264	-522.7324
Likelihood Ratio Test	n/a	25.3646** 1 vs. 2	5.0778 ns 2 vs. 3	60.7226** 2 vs. 4	40.3936** 4 vs. 5	5.588 ns 5 vs. 6

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (Two-tailed test)**

Testing for Non-Linear Effects of Labor Processes on Workplace Injury

In Chapter 3, I suggested that the effects of worker labor process control on occupational and general health outcomes might be non-linear. In this section, I examine the possible non-linear effects of labor processes (autonomy, social cohesion, and skill utilization) by squaring each labor process term and adding it separately to the main effects model (Table 6.2). Each of the squared term models was compared to the Main Model using the Likelihood Ratio test statistic. The cohesion-squared model was compared to a main effects model that included the cohesion variable in continuous form.[16] The addition of the squared terms did not improve the specification of any of the models, lending credence to the assumption that the relationships are linear. Parameter estimates for the product interaction terms in interaction Models 1-3 and likelihood ratio significance tests appear in Appendix C, Table 1.

Interaction Effects of Socio-demographics and Labor Processes on Workplace Injury

In this section, I report the results of product interaction terms for the socio-demographic variables of race and gender and the labor process factors. Because the workplace injury trends differ by race and gender, labor process factors may operate differently for males versus females, and for non-whites versus whites. I created product interaction terms for the socio-demographic variables measuring race and gender and the labor process variables, and added them separately to the main effects model. Whenever possible, I tested for interaction effects for both the categorical and continuous forms of the variable. Significant interaction effects for race and the labor process factors of autonomy, social cohesion and skill were not found. Similarly, the addition of product interaction terms

[16] The main effects model with cohesion as a continuous variable has a log likelihood of -524.4772.

for gender and labor process factors to the main effects model did not significantly improve its specification. Results appear in Appendix C, Table 2.

Interaction Effects of Task Exposure and Labor Processes on Workplace Injury

Does the effect of worker labor process control on injury differ for workers who perform repetitive hand movements versus those who do not? Does the level of worker labor process control in the workplace have differing effects on injury for workers that perform heavy lifting versus those who do not? To answer these questions, I created product interaction terms to investigate whether autonomy, social cohesion, or skill in the workplace have different effects on workplace injury for workers who perform these task exposures versus those who do not. The product interaction terms for repetitive hand movements and the labor process factors of autonomy, social cohesion and skill were not significant. The full results appear in Appendix C, Table 3. However, the product interaction terms for heavy lifting and the labor process factors of autonomy, social cohesion and skill were significant (Table 6.2).[17]

[17] I also tested for interaction effects between the labor process factors and the task exposure variable that I created by combining the dummy variables for repetitive hand movements and heavy lifting. Statistically significant interaction effects were found for the models containing the product interaction terms for tasks*cohesion and tasks*skill. The product interaction of tasks* autonomy was significant at the .10 level only.

Table 6.2. Negative Binomial Regressions: Unstandardized Estimate (SE) of <u>Workplace Injury</u> on Heavy Lifting and Labor Process Interactions (N=1607).

Parameter Variable	Main Effects Model (Table 6.1)	Lifting*Autonomy	Lifting*Cohesion	Lifting*Skill
Age	-0.0175 (0.0084)*	-0.0189 (0.0085)*	-0.0184 (0.0084)*	-0.0186 (0.0084)*
White	0.235 (0.224)	0.196 (0.223)	0.281 (0.224)	0.185 (0.223)
Male	0.137 (0.199)	0.157 (0.200)	0.162 (0.200)	0.164 (0.200)
Less than HS	-0.372 (0.311)	-0.348 (0.310)	-0.374 (0.306)	-0.346 (0.308)
AD/BA Education	0.319 (0.227)	0.366 (0.229)	0.346 (0.226)	0.360 (0.227)
Graduate Degree	0.639 (0.367)+	0.747 (0.373)*	0.658 (0.370)	0.746 (0.374)
Self-Employed	0.201 (0.307)	0.168 (0.311)	0.182 (0.263)	0.171 (0.308)
Insured	-0.217 (0.264)	-0.221 (0.264)	-0.205 (0.263)	-0.236 (0.263)
Manager	-1.239 (0.381)**	-1.266 (0.388)**	-1.305 (0.384)***	-1.263 (0.385)**
Job Tenure 0-3 years	0.346 (0.235)	0.349 (0.235)	0.288 (0.232)	0.315 (0.235)
Job Tenure 10+ years	0.183 (0.272)	0.226 (0.273)	0.158 (0.270)	0.198 (0.272)
Autonomy	0.0124 (0.0416)	-0.105 (0.065)	0.017 (0.041)	0.018 (0.041)
Low Social Cohesion	-0.188 (0.289)	-0.234 (0.288)	-0.099 (0.458)	-0.217 (0.287)
Good Social Cohesion	-0.371 (0.252)	-0.339 (0.252)	-3.27 (1.05)	-0.371 (0.252)
Excellent Cohesion	0.077 (0.248)	0.105 (0.249)	-0.327 (0.379)	0.098 (0.248)
Skill Utilization	0.0447 (0.053)	0.050 (0.053)	0.060 (0.053)	-0.094 (0.079)
Repetitive Hand	0.386 (0.220)+07	0.328 (0.223)	0.393 (0.221)	0.323 (0.222)
Heavy Lifting	1.487 (0.231)****	-0.514 (0.869)	0.873 (0.360)	-1.093 (1.107)
Working Fast	0.0741 (0.112)	0.080 (0.112)	0.065 (0.111)	0.0740 (0.112)
Hours Worked	0.0149 (0.0065)*	0.015 (0.0065)	0.0148 (0.0065)*	0.0149 (0.0065)*
Safety Climate	-0.240 (0.041)****	-0.243 (0.041)	-0.232 (0.041)****	-0.243 (0.041)****
High Risk Industry	0.351 (0.221)	0.385 (0.222)	0.338 (0.219)	0.371 (0.221)
Low Risk Industry	0.492 (0.303)	0.513 (0.302)	0.455 (0.306)	0.467 (0.304)
Lift* Autonomy		0.171 (0.072)*		
Lift*Low Cohesion			-0.016 (0.561)	
Lift*Good Cohesion			3.479 (1.093)**	
Lift*Excel Cohesion			0.0624 (0.473)	
Lift*Skill				0.203 (0.086)*
Intercept	-1.086	0.311	-1.033	0.751
Log likelihood	-522.7324	-519.8830	-511.6732	-519.9234
Likelihood Ratio/DF	5.588	5.699 df=1 *	22.118** df=3	5.618* df=1

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (Two-tailed test)**

For the lifting and autonomy interaction model, the product interaction term for the autonomy index and the category of heavy lifting yields a significant chi-square of 5.699 at the .05 level (critical chi-square=3.84). We can use the model to estimate numbers of workplace injuries for selected values of heavy lifting (e.g., 0 or 1) and labor process autonomy.[18] The predicted values are plotted in Figure 6.1.

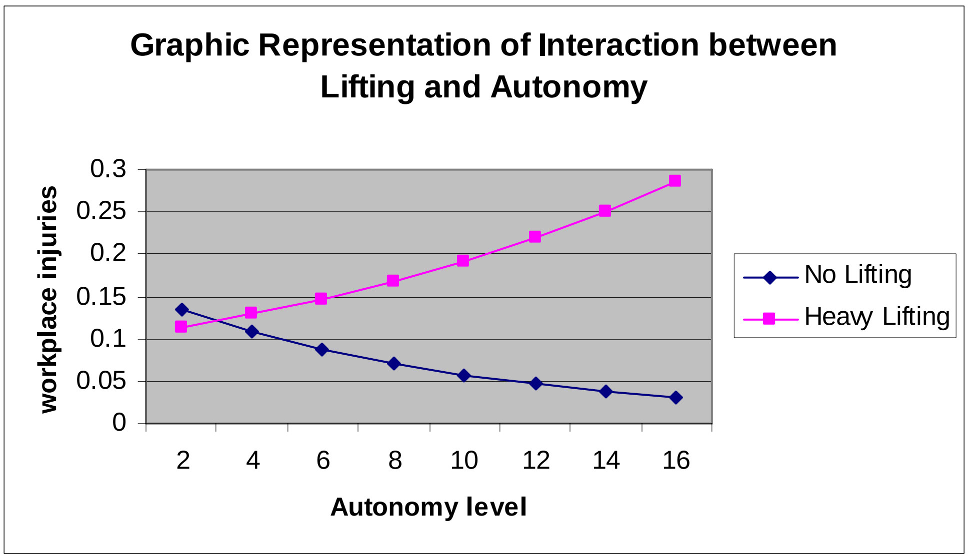

Figure 6.1. Interaction of Autonomy and Heavy Lifting on Injury

As illustrated in Figure 6.1, workplace autonomy reduces numbers of injuries under conditions where workers do not experience the task exposure variable of heavy lifting. The effects of workplace autonomy are different for workers who perform heavy lifting as part of their jobs. For workers who perform heavy lifting, as autonomy increases, numbers of injuries rise. For workers who do not perform heavy lifting, as autonomy increases, numbers of injuries decline. The slope for autonomy and heavy lifting is in the opposite direction,

[18] The model for predicting autonomy's effects on numbers of workplace injuries for workers who do not do heavy lifting =-1.7973 + (-0.1053* X) and the model for workers who do perform heavy lifting=-2.3114 + (0.0661* X) where X=level of autonomy.

lending credence to the idea that autonomy may have unintended effects on occupational health. It may be the case that autonomous workers may lift too much, for example, under workplace conditions where supervision is minimal and rules and regulations are limited. If workers are paid by the job (as many autonomous workers are) they may try to “make out” by doubling up on workloads (Burawoy 1979). Conversely, under conditions of low autonomy, strict work rules and regulations may keep workers safe.

The interaction may also reflect a possible unmeasured labor process consent mechanism, where workers with low autonomy refuse to take health risks such as lifting heavy loads, while workers who have high levels of consent “buy into” managerial production goals. Adding measures of organizational commitment to future models may help elaborate the mechanisms more fully.[19]

Interaction effects are also noted for the effects of social cohesion and heavy lifting on numbers of workplace injury. That is, social cohesion and heavy lifting have conditional effects on injury. The incremental chi-square of 22.118 is statistically significant at .01 level (critical chi-square=11.34). I use the model to estimate the number of workplace injuries for selected values of heavy lifting (e.g., 0 or 1) and the categories of low, adequate, good and excellent cohesion.

[19] Possible 2002 GSS items that could be used to reflect the concept of organizational commitment include: “My main satisfaction in life comes from work”; “At the place I work, I am treated with respect”; “I trust the management where I work” and “I am proud to be working for my employer”.

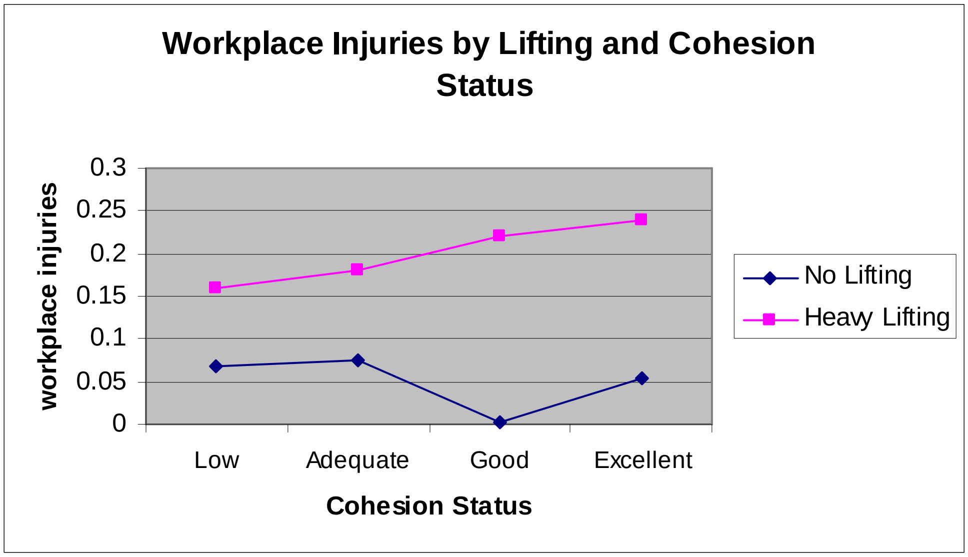

Figure 6.2. Interaction of Cohesion and Heavy Lifting on Injury

The conditional slopes in Figure 6.2 illustrate that those who have heavy lifting as part of the job have higher numbers of injuries as compared to those who do not. As indicated by the distance between the slopes, regardless of level of cohesion, workers who perform heavy lifting have more injuries. The top slope, depicting heavy lifting, reveals that the levels of injury increase slightly as levels of cohesion go up. Compared to the slope for workers who do not do heavy lifting, we see that the effects of cohesion are largely positive when there is no exposure to heavy lifting. Workers who report good cohesion levels at the workplace and who do not have heavy lifting exposure have the lowest predicted numbers of workplace injury. The unintended consequence of the social cohesion and heavy lifting interaction could be a reflection of group or occupational work norms, where taking risks (in this case lifting heavy loads) is part of the occupational culture.

Skill utilization and heavy lifting also interact in terms of workplace injury.

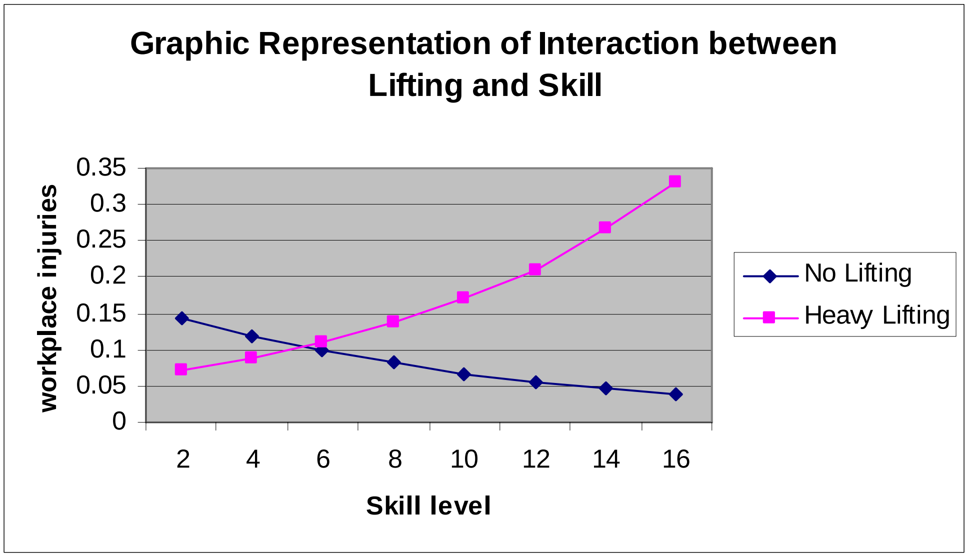

Figure 6.3. Interaction of Skill Utilization and Heavy Lifting on Injury

The lifting and skill utilization index interaction model yields a significant chi-square of 5.618 at the .05 level (critical chi-square=3.84). I use the model to estimate the number of workplace injuries for selected values of heavy lifting (e.g., 0 or 1) and skill utilization levels.[20] The predicted values are plotted in Figure 6.3.

In the interaction model graph, we notice that around skill level 6, there is a point where the slopes cross. This suggests that at lower levels of skill, workers who perform heavy lifting, as well as workers who do not, have injury outcomes that are virtually the same. However, as the divergent slopes illustrate, when workers do not perform heavy lifting, increased skill is associated with a decline in the number of workplace injuries. For workers who perform heavy lifting, increases in skill are associated with higher numbers of injuries. This suggests that there are unintended consequences associated with skilled labor in concert with task exposure. Having skill does not make one immune from the effects of

[20] The model for predicting the effect of skill utilization on numbers of workplace injuries for workers who do not perform heavy lifting = (-1.756 + (-0.094* X)) and the model for workers who do perform heavy lifting = (-2.8486+ (0.1088* X)) where X=level of skill utilization.

heavy lifting. For example, skilled laborers such as construction trade workers traditionally have high rates of occupational injury. Worker labor process consent may also be a factor. Skilled laborers may be invested in maintaining production goals, and as a result, put themselves at risk for injury by lifting heavy loads. Skilled workers may also have involvement in by-the-job or piece-rate systems of compensation, so that monetary recompense justifies their commitment to production goals. Future empirical research may benefit from the inclusion of a measure of organizational commitment in the regression models.

6.2 Workplace Injury: Summary and Discussion

Labor process control did not significantly affect the number of workplace injuries, contrary to expectation. Adding labor processes to the epidemiologic triad (as represented in the main effects model) did not improve the model specification. This supports the traditional epidemiologic paradigm as adequate in its ability to predict workplace injury. However, interactions with autonomy, social cohesion, and skill utilization and the task exposure, heavy lifting exist. This may reflect unintended consequences of labor process control under certain exposure conditions. Future research should examine these preliminary findings more closely.

The classic epidemiologic paradigm provides an important framework for understanding workplace injury, particularly in terms of exposures. Workplace injury occurs by doing the types of things that put the body at risk: for example, heavy lifting and long hours. Of interest as well are the effects of safety climate on injury. The findings indicate that in terms of injury, worker labor process control is not as important as high safety climate ratings. Simple elaboration models reveal that the safety climate variable has intervening effects on autonomy in terms of workplace injury. Recall that the safety climate index may have a normative bias.[21] An employee who agrees strongly with all the items in the index may also believe in the benevolence of the employer. In addition to measuring safety conditions, the safety climate measure may also reflect labor process consent. Does feeling that the employer cares about safety matter more than having control over the conditions of labor? Although preliminary results point in this direction, future research needs to examine this juxtaposition of control and consent. Inclusion of measures of organizational commitment in future empirical models can help to examine the role of labor process consent more fully.

Socio-demographic factors such as age, race, gender, and education are analogous to the "host" portion of the epidemiologic triad. Age clearly matters when it comes to workplace injury: younger workers are more often hurt on the job. There are a number of possible reasons for this. Recall that the effects of age are eroded in the job status model, where measures of job tenure are added. Younger workers have less work experience from which to draw upon. They may have not yet "learned the ropes," so to speak, in terms of injury avoidance. Younger workers are less likely to have good jobs. The effects of age decline further when exposures and environments are added to the model.

Gender is a statistically significant predictor of workplace injury. When controlling for exposures, the statistically significant effects of gender decline. This supports an epidemiological explanation: injury is about doing the kind of dangerous work that puts you

[21] The index consists of 4 questions: 1) "The safety of workers is a high priority with management where I work"; 2) "There are no significant compromises or shortcuts taken when worker safety is at stake." 3) "Where I work, employees and management work together to ensure the safest possible working conditions." And 4) "The safety and health conditions where I work are good."

in harm's way, which men are more likely to do. This may also reflect a bias in the way that workplace injury is defined. Recall that the operational definition: "In the past 12 months, how many times have you been injured on the job?" Because the recall time span (last 12 months) is long, unless the injury happened fairly recently, workers are more likely to recall major injury events, biasing the results toward more serious injuries. Consider however, the hidden hazards in the types of jobs held by women. Emotional distress from dealing with angry customers, for example, and verbal abuse are not going to be picked up by this question. Women may also not define less serious injuries as "on the job injury", when compared to catastrophic injuries such as traumatic amputation that can occur in heavy industry, agriculture or construction, fields dominated by men.

The significant difference in number of injuries for managers compared to non-managers invites further inquiry about managers and their duties. This confirms that those who tell others what to do are much less likely to experience workplace injury than those who actually do the work. Even when controlling for labor process control factors, exposures, and environments, the protective effects of managerial status on injury remain significant. This leads to the question: What is it about being a manager that contributes to injury avoidance?

The variable used in the analyses was created from US Census 1980 occupational codes (Executive, Administrative and Managerial) which designate managerial occupations. The dummy variable, "manager" denotes a professional manager, as opposed to a line foreman in an industrial plant or shift supervisor at a fast food restaurant. Would lower level managers fare the same way? At the bivariate level, autonomy was the only labor process factor that was statistically significant. However, in the Labor Process Model (Model 3), autonomy no longer has statistically significant effects. When the Labor Process Model is run without the managerial status variable, autonomy regains statistical significance suggesting some overlap in the concepts. As the variable stands, it is also a measure of social class. However, further research should investigate the duties of managers in a variety of levels and how this may relate to injury. The possible interaction effects of managerial status with labor process variables could also be addressed in future research.

6.3 Results of Multivariate Regression Models Predicting Persistent Pain

Logistic regression is used to estimate the persistent pain models. In the logistic regression model, the dependent variable is the predicted log odds of falling into one category or another. In this case, the dependent variable is the predicted log odds of persistent pain in the back, arms or shoulders “every day for a week in the past 12 months”. The parameter estimates listed in Table 6.3 are the effects of the log odds of falling in the “persistent pain” category. The parameter estimates represent the amount of change in the log odds; however, using the odds ratio to explain coefficients has better intuitive meaning (Allison 1999). Where appropriate, I interpret the coefficients by using the odds ratio, which is the antilog of the logistic regression coefficient.

In the Socio-Demographic Model (Model 1), the parameter estimate for race (white=1) is statistically significant net of the effects of gender, age and education, although race was non-significant in the bivariate regression (Table 5.2). This may indicate the interlocking nature of socio-demographic status: race only becomes important when other factors are controlled for in the model. The antilog of the logistic regression coefficient (or odds ratio) for white is 1.29. This tells us that whites are 29 percent more likely to experience pain than non-whites (the baseline group), net of the other variables in the model. The categorical variables for education, in terms of highest degree earned, are generally significant predictors of persistent pain. Those with less than a high school degree are 42 percent more likely (odds ratio 1.42) to experience pain than the baseline group, those with a high school degree. The positive effects of education are also evident: those with a graduate degree are 49.7 percent less likely to experience persistent pain compared to those with a high school degree (odds ratio=.503).

Turning to the job status variables, self-employment and insurance were not statistically significant. The logistic regression coefficient (i.e., effect on the log odds) for the dummy variable, manager, equals –0.2925 with an odds ratio of (e-.2925), which equals .746. Since the odds ratio is less than 1, and the regression coefficient, negative, the odds of managers experiencing persistent pain are less likely: the model predicts that managers are 25.4 percent less likely to experience pain than non-managers. The coefficient for job tenure of ten years or greater is 0.2969. Exponentiating this yields an odds ratio of 1.346, meaning that the odds of persistent pain for someone with 10 or more years of job tenure are 34.6 percent more likely than the baseline group (those with four to nine years of tenure) to experience persistent pain. The effects for race remain significant. The addition of the job status variables erodes some of the educational attainment effects on pain. The incremental chi-square of 9.79 indicates that the addition of the job status variables only marginally improves the specification of the model.[22]

Model 3 (Labor Process) adds the labor process factors to Model 2 (Job Status). Although the parameter estimates for labor process autonomy, cohesion, and skill utilization

[22] The incremental chi-square is the difference between the -2 log likelihoods of two nested models with degrees of freedom equal to the number of additional parameters in the more complex model.

are statistically significant at the bivariate levels, with the addition of socio-demographic and job status variables, autonomy and skill are no longer statistically significant. Of the social cohesion dummy variables, low cohesion is also non-significant. However, both good and excellent social cohesion decrease the predicted log odds of persistent pain. The parameter estimate for excellent social cohesion is –0.4753. Exponentiating this yields an odds ratio of 0.622. This means that the odds of persistent pain are about 60 percent less for those with excellent social cohesion than for someone at the level of adequate cohesion, the baseline group.

The addition of the labor process factors erodes some of the effects of education, managerial status, and job tenure on the log odds of persistent pain. The incremental chi-square of 30.416 (critical chi-square at .001=20.517) indicates that the addition of labor process factors in Model 3 is a significant improvement over the socio-demographic and job status variables in Model 2.

The Exposure Model (Model 4) adds epidemiological exposure factors to the socio-demographic and job status variables in Model 2. Moving to the individual task exposure variables, we find that the parameter estimate (0.7259) for repetitive hand movements is highly significant ($p<.0001$). The predicted log odds of pain for those who report repetitive hand movements are 2.067 times the odds for workers with non-repetitive hand movements as part of their jobs, net of the other factors in the model. Heavy lifting is also a significant predictor of pain. Those who do heavy lifting are 38 percent more likely to experience pain than those who do not. Hours worked and pace were not significant.

The addition of exposures slightly erodes the effects of race. The parameter estimate for graduate degree is significant in Models 1, 2, and 3 but then drops from significance with the addition of exposure factors to the model. This could be because there is a statistically significant negative correlation between education and task exposure variables, indicative of manual labor tasks in jobs that require less education. Adding exposures to Model 2 significantly improves its prediction of persistent pain. The incremental chi-square of 67.709 is significant at the .001 level.

Model 5 adds environmental exposures to the task exposures in Model 4.   The safety climate index is a significant predictor variable; however the dummy variables for high and low industrial injury risk were not. The odds ratio of 0.0809 tells us that for each one unit increase in the safety climate index, the likelihood of persistent pain drops by approximately 8 percent. The addition of the environmental exposures does little to change the significance of the task exposures, repetitive hand movements and heavy lifting. The addition of the environmental factors in Model 5 significantly improves our prediction of the odds of persistent pain (incremental chi-square=15.314; critical chi square 11.345 at .01).

The Main Model, (Model 6) includes all variables and differs from Model 5 by the inclusion of labor process factors. The Main Model is a significant improvement over Model 5 (incremental chi-square=16.511; critical chi-square=15.086 at .01). Autonomy did not remain significant in the in the main effects model (Model 6) where exposures and environments are included. The labor process factors of good social cohesion and excellent social cohesion retain statistical significance when compared to Model 3, although the protective effects of excellent cohesion are eroded somewhat by the addition of epidemiological exposures and environmental factors. The perceived safety climate index falls from .001 level of significance to .05 in the presence of labor process factors.

Table 6.3. Logistic Regressions: Parameter Estimates [Odds Ratio] (SE) of Persistent Pain on Selected Predictor Variables (N=1607)

Parameter variable	Model 1 Socio-Demographics	Model 2 Job Status	Model 3 Labor Process	Model 4 Exposures	Model 5 Environment	Model 6 Main Model
Age	0.0006 [1.0] (0.004)	-0.0013 [1.0] (0.005)	-0.000006 [1.0] (0.005)	0.00243 [1.0] (0.005)	0.00363 [1.0] (0.005)	0.00396 [1.0] (0.005)
White	0.255 [1.3] (0.13)*	0.259 [1.3] (0.13)*	0.304 [1.4] (0.13)*	0.243 1.3] (0.13)+.06	0.266 [1.3] (0.13)*	0.287 [1.3] (0.14)*
Male	-0.057 [.95] (0.10)	-0.064 [.94] (0.10)	-0.117 [.89] (0.11)	-0.126 [.88] (0.11)	-0.126 [.88] (0.12)	-0.168 [.85] (0.12)
Less than High School	0.35 [1.4] (0.18)*	0.305 [1.4] (0.18) +	0.301 [1.5] (0.18)	0.181 [1.2] (0.19)	0.181 [1.2] (0.19)	0.191 [1.2] (0.19)
AD/Bachelor's Degree	-0.203 [.82] (0.12)+	-0.16 [.85] (0.12)	-0.144 [.87] (0.13)	0.041 [1.0] (0.13)	0.043 [1.0] (0.13)	0.034 [1.0] (0.13)
Graduate Degree	-0.686 [.50] (0.198) ***	-0.666 [.51] (0.199)***	-0.614 [.54] (0.203)**	-0.34 [.71] (0.208)	-0.361 [.70] (0.212)+	-0.349 [.71] (0.215)
Self-Employed		0.147 [1.2] (0.16)	0.216 [1.2] (0.17)	0.08 [1.1] (0.17)	0.178 [1.2] (0.17)	0.153 [1.2] (0.18)
Insured		-0.16 [.85] (0.16)	-0.181 [.84] (0.16)	-0.094 [.91] (0.16)	-0.108 [.91] (0.16)	-0.119 [.89] (0.17)
Manager		-0.293 [.75] (0.15)*	-0.263 [.77] (0.15)+	-0.141 [.87] (0.15)	-0.095 [.91] (0.16)	-0.118 [.89] (0.16)
Job Tenure 0-3 years		0.122 [1.1] (0.13)	0.098 [1.1] (0.13)	0.184 [1.2] (0.14)	0.192 [1.2] (0.14)	0.174 [1.2] (0.14)
Job Tenure 10 or more years		0.297 [1.4] (0.15)*	0.28 [1.3] (0.15)+	0.294 [1.3] (0.15)+	0.278 [1.3] (0.15)+	0.277 [1.3] (0.15)+
Autonomy			-0.00002 [1.0] (0.024)			0.024 [1.0] (0.025)
Low Social Cohesion			0.241 [1.3] (0.168)			0.169 [1.2] (0.174)
Good Social Cohesion			-0.391 [.68] (0.15) **			-0.404 [.67] (0.15)**
Excellent Social Cohesion			-0.475 [.62] (0.14) ***			-0.367 [.69] (0.15) *
Skill			-0.019 [.98] (0.03)			-0.011 [.99] (0.03)
Repetitive Hand Movements				0.726 [2.1] (0.12)****	0.715 [2.0] (0.12)****	0.712 [2.0] (0.12)****
Heavy Lifting				0.322 [1.4] (0.12)**	0.337 [1.4] (0.12)**	0.314* [1.4] (0.12)
Pace/Working Fast				0.018 [1.0] (0.067)	0.015 [1.0] (0.067)	0.0092 [1.0] (0.069)
Hours Worked				0.0011 [1.0] (0.004)	0.0017 [.92] (0.004)	0.0016 [1.0] (0.003)
Safety Climate					-0.084 .92] (0.02)***	-0.037 [.94] (0.13)*
High Risk Industry					-0.032 [.97] (0.13)	-0.037 [.96] (0.13)
Low Risk Industry					0.129 [1.1] (0.17)	0.143 [1.2] (0.17)
Intercept	-0.491 *	-0.406	0.013	-1.324***	-0.327	-0.526
-2 Log likelihood	2146.445	2136.655	2106.239	2068.946	2053.632	2037.121
Incremental Chi-Square	n/a	9.79 + 1 vs. 2	30.416 *** 2 vs. 3	67.709*** 2 vs. 4	15.314** 4 vs. 5	16.511** 5 vs. 6

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (Two-tailed test)**

Testing for Non-Linear Effects of Labor Processes on Persistent Pain

As stated in Chapter 4, I created three squared terms to test for curvilinear effects for the labor process variables (i.e., autonomy, cohesion and skill). To test for interaction effects, the model with cohesion squared is compared to a main model where cohesion is left as a continuous index.[23] None of the squared terms are significant at the .05 level (Appendix C, Table 4).

Interaction Effects of Socio-demographics and Labor Processes on Persistent Pain

Next, I examine the interaction effects between socio-demographic variables and labor process control variables. None of the interaction effects are statistically significant at the .05 level (Appendix C; Table 5), although the interaction of the degree categorical variables and the categorical variables for levels of cohesion is significant at the .10 level.

Interaction Effects of Task Exposures and Labor Processes on Persistent Pain

No significant interaction effects between the task exposures of repetitive hand movements and the labor process factors of autonomy, social cohesion, and skill utilization were found. Similarly, there were no significant interactions for heavy lifting and the labor process factors Appendix C; Table 6).

6.4 Persistent Pain: Summary and Discussion

The central theoretical framework underlying this research is the importance of workplace organization for worker health outcomes. The ways in which work is organized, including how much control workers have over the conditions of labor, affect the heath and safety of workers. If we think about the epidemiologic triad as a standard way to think about

[23] The -2 Log Likelihood for the Main Model with the continuous cohesion variable =2039.469

adverse occupational health outcomes, the socio-demographic variables (Model 1) most closely represent the host or human factors portion of the triad. The addition of job status variables (Model 2) represents an improvement to the basic demographic model. Models 4 and 5 represent the other factors in the triad: exposing agents and environment.

The epidemiologic factors tell us a great deal about persistent pain. However, adding the labor process variables improves the model: our prediction of the odds of persistent pain is improved by the addition of labor process factors to the basic epidemiologic model (Model 6). In particular, this research shows that good or excellent social cohesion at work is beneficial for reducing persistent pain.

In terms of predicting the odds of persistent pain, the models tell us that the variable measuring repetitive hand movements is a statistically significant predictor of persistent pain (p=<.0001). Recall that this differs from the workplace injury model, where repetitive hand movements were only marginally significant, but heavy lifting was highly significant throughout the model series. When we think about the differences in the dependent variables measuring workplace injury and persistent pain, the differences in task exposure significance make sense. The definition of workplace injuries is more akin to the concept of "accidents": events that happen quickly, unexpectedly, resulting in bodily harm that is promptly recognizable. The long-term effects of workplace exposures such as repetitive hand movements are insidious and may not be immediately recognizable until persistent pain develops; persistent pain is chronic; workplace injuries are acute.

When it comes to predicting the odds of persistent pain, race matters, but the reasons why are not completely clear. In every model, white respondents are more likely than non-whites to report persistent pain. The effects of race were little changed when controlling for job status variables, labor process factors, exposures and environments. Race did not interact with any of the labor process factors or the task exposures in terms of predicting persistent pain. This finding deserves further investigation. There may be possible interaction effects with education or income, which were not examined here.

6.5 Results of Multivariate Regression Models Predicting Exhaustion

OLS regression was used to estimate the models predicting exhaustion. Socio-demographic variables provide an interesting picture of exhaustion. Age, race and gender are all significant predictors of exhaustion (Table 6.4). As in the bivariate regressions, age is inversely related to exhaustion, an effect that remains statistically significant throughout the additive model series. It may seem counter-intuitive that as age decreases, levels of exhaustion increase, yet there are several possible explanations. This finding could be a reflection of the quality of jobs that younger workers tend to hold. Or perhaps it is a reflection of how workers learn to pace themselves or that workers adopt normative acceptance toward work over time. Older workers may learn ways to avoid working too hard (Burawoy 1979), or perhaps they adapt to the idea that they must work for a living. It may also be the case that older workers attrite out of exhausting jobs when possible.

The positive parameter estimate of 0.173 indicates that white workers experience greater levels of exhaustion when compared to the baseline group, non-whites. As in the bivariate regression, the model predicts that males have lower average exhaustion scores than females. The effects of gender remain statistically significant throughout the series of models[24]. The parameter estimates for degree are non-significant at all levels, in comparison to the baseline group, those with a high school diploma as the highest degree earned. It appears that both educated and non-educated workers alike experience exhaustion. The adjusted R-Square of 0.0263 tells us that the socio-demographic factors explain about 3% of the variation in the dependent variable, exhaustion.

[24] *Note:* this is unlike the injury model where gender's effects diminish with the addition of the labor process factors.

Model 2 adds job status characteristics to the socio-demographic factors. With the exception of senior job tenure, none of the job status characteristics have statistically significant effects on exhaustion. Job tenure is not a significant predictor of exhaustion for those with three years or less on the job, when compared to the baseline group of those with job tenure of four to nine years. However, job tenure of ten or more years does significantly increase predicted levels of exhaustion[25]. Net of the effects of the other variables in the model, age, race and gender are still significant predictors of exhaustion. The addition of job status characteristics in Model 2 moderately improves specification. The incremental F of 4.96 is significant at the .01 level (critical F=3.78)[26].

Model 3 adds the labor process factors of autonomy, social cohesion and skill utilization to the socio-demographics and job status variables. Turning to the individual labor process effects, we see that workplace autonomy reduces worker exhaustion, net of the socio-demographics and job status variables. The model also shows that skill utilization has a statistically significant relationship with exhaustion; however, the slope direction is *positive*. This supports the proposition that labor process control may have unintended effects: net of the effects of socio-demographics and job status factors, skill utilization *increases* exhaustion.

The parameter estimates for low, good, and excellent social cohesion are statistically significant. This tells us, for example, workers in low cohesion work settings have average exhaustion scores .37 units *higher* than the baseline group (those with adequate cohesion),

[25] When years on the job was used as a continuous variable, the model predicted that net of the effects of the other variables in the model, that for each additional year of job tenure, one could expect a .013 unit increase in self-reported exhaustion. The difference in categorical dummies shows possible threshold effects for tenure.

[26] Incremental F= (adjusted R-square new model-adjusted R-square old model)/ (k1-k2)/(1-adjusted R-square new model)/ (N-k1). Where k1= number of parameters in the new model and k2=number of parameters in old model with (k1-k2) and (N-k1) degrees of freedom

while those with excellent cohesion have average exhaustion scores .29 units *lower* than the baseline group net of the effects of the other variables in the model. In summary, all labor process factors have statistically significant effects on worker exhaustion.

In Model 3, the significant parameter estimate for race is increased when we control for labor process factors: whites have average exhaustion scores .19 units higher than the baseline group, non-whites. There is little change in the parameter estimates for the other independent variables in the model with the addition of the labor process factors. The addition of labor process factors in Model 3 significantly improves specification. The adjusted R-square in Model 2 doubles in size to .0719 and the incremental F of 12.548 is significant at the .01 level.

The addition of workplace exposures (Model 4) to the socio-demographic and job status characteristics in Model 2 greatly improves its specification. The adjusted R-square rises to .1052 with a significant incremental F of 31.09 (critical F=3.32 at .01 level of significance). The model reveals that exposures are statistically significant predictors of exhaustion. Repetitive hand movements and lifting increase average exhaustion by .20 and .13 units respectively, net of the effects of the other variables. Increases in pace of work and the number of hours worked are also significant ($p<.001$) predictors of exhaustion. The addition of exposure measures decreases the significance of race, which might be a reflection of the quality of jobs done by non-whites.

The Environment Model (5) adds measures of the perceived safety climate and industrial injury risk to the Exposure Model (4). Of the environmental factors, safety climate is statistically significant at the ($p=<.0001$). The model shows that for each one-unit decrease in the safety climate index, we can expect an approximate .05 unit increase in exhaustion, net of the other factors in the model. The parameter estimate of -0.18207 shows that those in low risk industries have average exhaustion scores .18 units lower than the baseline group (workers in moderate risk industries). Although the low risk industry category is a significant independent variable, the category for high risk industry is non-significant.

The effects of race diminish with the addition of environmental risk factors in Model 5, although the effects of age and gender remain significant. Heavy lifting is no longer significant, however, pace and hours remain robust in their estimates. The effects of the task exposure variables (repetitive hand movements and heavy lifting) decrease with the addition of the environmental factors, giving evidence to the claim that safety environment may buffer specific task exposures. Model 5 is a significant improvement over Model 4. The adjusted R-square increases to 0.1177 and the incremental F is 7.49 (critical F at .01=3.78).

The Main Model (Model 6) includes all factors. Compared to Model 5, which does not include the labor process factors, the Main Model is a significant improvement over Model 5 (incremental F= 5.888; critical F at p .01=3.02). In terms of the effects of labor process control factors, autonomy is non-significant. Although the effects decrease slightly when controlling for exposure and environmental factors, social cohesion remains a significant predictor of self-reported exhaustion in the main model. In Model 6, (Table 6.4) we see that those with excellent social cohesion at work have average exhaustion scores approximately .20 units lower than the baseline group, those with adequate cohesion. Low social cohesion also has strong effects in the expected (opposite) direction, showing an average increase in exhaustion scores of .29 units, net of the other factors in the model. The addition of exposure and environmental factors erode the effects of skill utilization to non-significant levels.

Looking at the socio-demographics, the effects of respondent age on self-reported exhaustion remain strong throughout the additive series. The parameter estimate for race remains significant; indicating that whites have average exhaustion scores .15 units higher than the baseline group, non-whites. The model demonstrates that males have average exhaustion scores .31 units lower than females, while education remains non-significant. Those with ten or greater years of job tenure have average exhaustion scores .21 units higher than the baseline group, those with four to nine years of tenure. The job status characteristics, with the exception of job tenure, are non-significant.

Several exposure factors remain important predictors of exhaustion net of the addition of the labor process factors. Although heavy lifting is no longer a significant predictor of exhaustion, net of the effects of the other variables in the model, workers reporting repetitive hand movements as a regular part of the job have average exhaustion scores .18 units higher than those who do not. For each one-unit increase in working fast, we see a .21 unit increase in exhaustion. As anticipated, hours worked have significant effects on exhaustion: each one-hour increase in work increases exhaustion scores by .012 units.

In the full model, the effects of perceived safety climate on self-reported exhaustion are eroded somewhat by the addition of the labor process factors, but remain significant. The model predicts that for each one-unit decrease in the safety climate index, there is a .033 increase in exhaustion. Although there were no significant effects for high injury industry, those in low injury industrial setting are predicted to have average exhaustion scores .20 units lower than the baseline group, those working in moderate injury industries.

Table 6.4. OLS Regressions: Unstandardized Estimate (SE) of Exhaustion on Selected Predictor Variables (N=1607).

Parameter Variable	1 Socio-Demographic	2 Job Status	3 Labor Process	4 Exposures	5 Environment	6 Main
Age	-0.013 (0.002)****	-0.016 (0.003)****	-0.015 (0.003)****	-0.010 (0.003)****	-0.01 (0.003)****	-0.01 (0.002)****
White	0.173 (0.070)*	0.155 (0.070)*	0.193 (0.069)**	0.116 (0.068)+	0.126 (0.067)+	0.152 (0.07)*
Male	-0.224 (0.057)****	-0.219 (0.057)***	-0.247 (0.056)****	-0.302 (0.056) ****	-0.296 (0.059)****	-0.313 (0.059)****
Less than High School	0.095 (0.101)	0.120 (0.101)	0.122 (0.093)	0.084 (0.098)	0.074 (0.097)	0.077 (0.097)
Associate/Bachelor's Degree	0.003 (0.067)	-0.010 (0.067)	-0.006 (0.067)	0.045 (0.066)	0.049 (0.066)	0.048 (0.066)
Graduate Degree	0.044 (0.101)	0.031 (0.101)	0.034 (0.101)	0.083 (0.101)	0.059 (0.101)	0.067 (0.102)
Self-employed		-0.113 (0.09)	-0.061 (0.091)	-0.143 (0.087)	-0.093 (0.088)	-0.0813 (0.087)
Insured		0.116 (0.089)	0.086 (0.087)	0.13 (0.086)	0.138 (0.086)	0.117 (0.085)
Manager		0.117 (0.079)	0.138 (0.078)+	0.078 (0.078)	0.123 (0.078)	0.125 (0.078)
Job Tenure-0-3 years		-0.025 (0.072)	-0.041 (0.071)	0.041 (0.07)	0.037 (0.069)	0.0177 (0.069)
Tenure greater than 10 years		0.237 (0.081)**	0.221 (0.08)**	0.224 (0.078)**	0.217 (0.078)**	0.211 (0.077)**
Autonomy			-0.026 (0.013)*			-0.010 (0.013)
Low Social Cohesion			0.369 (0.092)****			0.286 (0.089)**
Good Social Cohesion			-0.156 (0.078)*			-0.147 (0.076)+
Excellent Cohesion			-0.286 (0.075)***			-0.199 (0.075)**
Skill Utilization			0.042 (0.015)**			0.018 (0.015)
Repetitive Hand Move.				0.204 (0.062)***	0.196 (0.061)**	0.180 (0.061)**
Heavy Lifting				0.128 (0.064)*	0.111 (0.064)+	0.100 (0.064)
Pace/Working Fast				0.237 (0.035) ****	0.234 (0.034) ****	0.214 (0.035) ****
Hours Worked				0.012 (0.002)****	0.013 (0.002)****	0.012 (0.002)****
Perceived Safety Climate					-0.053 (0.011)****	-0.033 (0.013)*
High Risk Industry					-0.037 (0.067)	-0.036 (0.066)
Low Risk Industry					-0.182 (0.088)*	-0.199 (0.087)*
Intercept	3.78971****	3.8010****	3.6137****	2.2535****	2.29226****	2.7133****
Adjusted R-Square	0.0263	0.0353	0.0719	0.1052	0.1177	0.1338
Incremental F	N/A	4.962** 1 vs. 2	12.548** 2 vs. 3	31.09 ** 2 vs. 4	7.49** 4 vs. 5	5.888** 5 vs. 6

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (Two-tailed test).**

Testing for Non-Linear Effects of Labor Processes on Exhaustion

As stated earlier, I created three squared terms to test for curvilinear effects for the labor process variables (i.e., autonomy, cohesion and skill). Cohesion is left in its continuous state (i.e., as an index) for the squared term and compared to a main effects model where cohesion is a continuous variable[27]. None of the squared terms are statistically significant (Appendix C; Table 7).

Interaction Effects of Socio-demographics and Labor Processes on Exhaustion

None of the product interaction terms for the socio-demographic variables (race and gender) and labor process factors was statistically significant. The addition of the product interaction terms did not improve the model specification of exhaustion. The individual parameter estimates, model adjusted R-squares and incremental F statistics appear in Appendix C, Table 8.

Interaction Effects of Task Exposures and Labor Processes on Exhaustion

None of the interaction terms for repetitive hand movements and the labor process factors were significant. The product interaction terms for heavy lifting and exhaustion were also non-significant. The individual parameter estimates, model adjusted R-squares and incremental F statistics appear in Appendix C, Table 9.

6.6 Exhaustion: Summary and Discussion

The addition of labor process factors to the basic epidemiologic triad improves the model's specificity of the dependent variable, exhaustion. The additive multivariate models examine the potential for autonomy to reduce exhaustion, net of the effects of socio-

[27] The adjusted R-square for cohesion squared model is *less* than the main effects model =.1347. Therefore, the incremental F was not computed.

demographic factors, job status variables, exposures, and environments. The labor process model (Model 3, Table 6.4) offers support for autonomy's protective effects: workers in control of their labor processes in an autonomous manner are less exhausted at the end of the day. However, in the subsequent regression models, autonomy's benefits are moderated by the effects of task exposures and environments. The parameter estimate for autonomy fades to statistical non-significance.

The benefit of social cohesion in decreasing worker exhaustion is an important finding that adds to our knowledge of how workplace organization affects worker occupational health outcomes. At the workplace, excellent cohesion (and to a lesser degree, good social cohesion) decrease worker exhaustion, net of the effects of socio-demographic factors, job status characteristics, exposures, and environments. As expected, low social cohesion at the workplace increases exhaustion.

An unanticipated finding is that skill utilization increases exhaustion, net of the effects of socio-demographics, job status, and the other labor process variables. However, with the addition of exposures and environments to the main effects model, skill utilization is no longer statistically significant. The loss of statistical significance in the face of exposures and environments might reflect the unintended consequences of occupational control (Simpson 1985), particularly the skilled craft worker or professional paradigm. Although essential to non-alienated labor, using skills and abilities on the job can be exhausting, particularly when working long hours or at a fast pace. Although not part of my original hypotheses, this finding suggests future research questions, particularly, possible interaction effects between skill and hours or pace, as well as skill and education.

When it comes to predicting exhaustion, how long and how fast you work are also important. Recall that this differs from the workplace injury and persistent pain models where pace of work was not significant. Working long hours was not a significant predictor of persistent pain; however, it was highly significant in terms of exhaustion. Multiple factors contribute differentially to adverse occupational health outcomes. This underscores the importance of looking at multiple measures of occupational health as distinctly different dependent variables.

As in the workplace injury and persistent pain models, high safety climate scores are protective against exhaustion, although the effects are eroded by the addition of labor process factors. As noted previously, the safety climate index also measures a normative consent and a belief that management cares about safety. This may stand in opposition to the idea that workers and management are involved in a struggle over the processes of production. Future research could examine the possible interaction effects of safety climate as a measure of consent and labor process control. I discuss this funding more fully in the next chapter.

Women are more exhausted than are men; whites, more so than non-whites. The increase in exhaustion for women may be a result of the increased emotional labor in the types of work that women tend to do, a factor that is not explicitly addressed in the regression models. Alternatively, it may mean that there is strong gender norm for males that would prohibit admitting being to "feeling used up" because it implies weakness or being taken advantage of by others.   Similarly, whether or not the difference in race is about the quality of jobs held or some other factor is not clear, although the effects of race are eroded somewhat in by the addition of exposures and environments (Models 4 and 5). It may be that whites feel freer than non-whites to affirm that work is exhausting for them, a reflection of "white privilege". Whether these gender and race differences reflect a somatic difference in exhaustion or just the willingness to report "feeling used up at the end of the day" is not possible to determine from the dataset. The point is that this is a real feeling for those answering the question and that those perceived differences exist. Future research is needed to examine these effects.

6.7 Results of Multivariate Regression Models Predicting Health Status

OLS regression was used to estimate the models predicting health status (Table 6.5). Looking across all models, we see that age is a significant predictor of health status, net of the effects of race, gender and highest degree achieved. This was not the case in the bivariate model, suggesting antecedent (race, gender) or intervening (degree) effects. As in the bivariate relationships, race and gender are not significant predictors of general health status in the models.

Education, in terms of highest degree attained, is a significant independent variable. Those with less than a high school diploma are predicted to have lowered health status, compared to the baseline of a high school diploma, net of the effects of age, race, and gender. Conversely, the model shows positive health status for those with collegiate degrees, both at the undergraduate and graduate levels. Looking across all models, one notes that some of the effects of education on health status gradually erode with the addition of other predictor variables to the models, but remain significant. The adjusted R-square of 0.0295 tells us that the socio-demographic variables alone explain about 3% of the variation in the dependent variable.

The addition of job status characteristics (Model 2) to the regression model improves the R-square to 0.0372. Self-employment status and health insurance are both statistically significant (positive) predictors of health status. The categorical variable, years on the job is statistically significant.[28] The model shows that those workers who have been on the job from zero to three years and those who have been on the job for ten or more years will have lower health status scores than the baseline group of mid-tenure workers (four to nine years), net of the other variables in the model. In the case of the novice worker, decreased health status might be a reflection of the stress associated with the learning curve of a new job. In the case of senior tenure, boredom might be a factor. Therefore, this finding may represent unmeasured heterogeneity in the model. The addition of job status characteristics is a moderate improvement in terms of statistical significance. The incremental F of 2.55 is significant at .05 level.

Model 3 adds the labor process concepts of autonomy, social cohesion, and skill utilization to the socioeconomic and job status model. Autonomy at work significantly improves health status net of the effects of socio-demographic characteristics and job status characteristics. For each one unit increase in the autonomy index, there is a .038 increase in health status. Social cohesion has differing effects depending on the cohesion level. At the lowest categorical level, social cohesion does not have a statistically significant effect on health (Table 6.5). However, both good cohesion and excellent cohesion have statistically significant effects (compared to the baseline of adequate cohesion) in the model. Skill utilization also has a positive relationship with general health status, net of the effects of

[28] When years on the job is used as a continuous variable in previous equations; it was non-significant in terms of its ability to predict health status.

socio-demographic and job characteristics. For each one unit increase in the skill utilization index, we can expect a .013 increase in health status.

Looking at the parameter estimates for the job status characteristics, we see that although self-employment has positive effects on general health in Model 2, its effects are eroded by the addition of labor process characteristics (Model 3), suggesting some overlap in the concepts[29]. The health insurance variable remains significant. The socio-demographic characteristics age and education also remain significant predictors of health status in Model 3. The negative effects of less than a high school education on health were not diminished net of the labor process factors. However, at the higher levels, educational effects were slightly eroded. The addition of the labor process variables significantly improves our ability to predict health status as evidenced by the calculated incremental F-statistic of 12.81 (critical F=3.02 at .01 significance level).

The Exposure Model (Model 4) adds epidemiological exposure factors to the socio-demographic and job status control variables in Model 2. In terms of task exposures, only heavy lifting has significant negative effects on overall health. With the addition of task exposures, the importance of education in terms of health remains significant when compared to Model 2. When controlling for task exposures, self-employment status improves health status. This makes sense given the fact that many times those who are self employed work in dangerous industries (e.g. agriculture, construction). Those new to the job and those who have been on the job for ten years or more have lowered health status as compared to those in the mid-tenure (baseline) group.

The Environmental Model (Model 5) adds the safety climate index and industrial injury ranking dummies to the Exposure Model. The most notable addition here is the

[29] The Pearson's correlation with autonomy= .26 ($p<.0001$)

statistically significant parameter estimate for perceived safety climate in terms of self-reported health status. The model predicts that for each one-unit increase in the safety climate index, there is a .054 increase in health status, net of the effects of the other variables in the model. Neither of the industrial injury categories is statistically significant. The addition of environmental factors to the exposure variables in Model 4 improves the model specification (calculated incremental F=9.41; critical F value at .01=3.78).

The Main Model (Model 6) includes all socio-demographic and job status characteristics, exposures, environmental aspects and labor process factors. When compared to Model 3, we see that the labor process factors are slightly eroded by the inclusion of the exposure and environmental measures. In particular, skill utilization is no longer significant at the .05 level. The incremental F of 6.72 (critical=3.02 at .01) shows that the inclusion of labor process factors to the model with exposures and environments (Model 5) significantly improves our prediction of self-reported health status.

Looking across the models, we can see that age is consistently associated with health status, with little variation across the models. Race and gender remain non-significant. The effects of education are somewhat diminished in the Main Model. Across Models 5 and 6, higher levels of the safety climate index are consistently associated with good health; however, the effects of the safety climate on worker health decrease when labor process factors are included. This may support the idea that labor processes can mediate perceived safety conditions. For example, worker labor process control may override the benefits of safety structures, especially if elements of the perceived safety climate include safety ergonomics or scientific management techniques. Previous research has shown workers sometimes resist safety interventions ostensible designed to protect them (Nichols 1997).

We must also consider the ways in which the perceived safety climate may be less a measure of environment in terms of actual working conditions and more a measure of a measure of attitudinal norms favoring a human relations model (see Zohar 1980). I discuss this further in the next chapter.

Table 6.5. OLS Regressions: Unstandardized Estimate (Standard Error) of Health Status on Selected Predictor Variables (N=1607).

Parameter Variable	1 Socio-Demographic	2 Job Status	3 Labor Processes	4 Exposures	5 Environment	6 Main Model
Age	-0.004 (0.002)**	-0.006 (0.002) **	-0.006 (-0.002) **	-0.006 * (-0.072)	-0.007 (0.002)**	-0.006 ** (-0.073)
White	0.037 (0.063)	0.024 (0.063)	-0.011 (0.062)	0.011 (0.004)	0.011 (0.022)	-0.014 (-0.062)
Male	0.062 (0.051)	0.057 (0.051)	0.06 (0.050)	0.08 (0.039)	0.078 (0.054)	0.074 (0.054)
Less than High School	-0.246 (0.09)**	-0.231 (0.090)*	-0.19 (0.09)*	0.193 (0.90)*	-0.183 (0.09)*	-0.157 (0.09)+
Associate/Bachelor's Degree	0.276 (0.06)****	0.243 (0.060)****	0.193 (0.06)**	0.19 (0.061)**	0.174 (0.061)**	0.147 (0.061)*
Graduate Degree	0.389 (0.091)****	0.373 (0.090)****	0.262 (0.090)**	0.279 (0.093)**	0.174 (0.061)**	0.204 (0.094)*
Self-Employed		0.232 (0.081)**	0.113 (0.081)	0.253 (0.081)**	0.20 (0.0806)*	0.133 (0.082)
Insured		0.166 (0.079)*	0.159 (0.078)*	0.138 (0.08)+	0.138 (0.079)+ .	0.140 (0.078)+
Manager		0.024 (0.071)	-0.049 (0.070)	-0.035 (0.072)	-0.077 (0.072)	-0.106 (0.072)
Job Tenure-0-3 Years		-0.138 (0.064)*	-0.11 (0.063)+	-0.137 (0.064)*	-0.143 (0.064)*	-0.117 (0.063)+.
Tenure-greater than 10 years		-0.144 (0.073)*	-0.127 (0.071)+	-0.148 (0.073)*	-0.137 (0.072)+	-0.129 (0.071)+
Autonomy			0.038 (0.012) ***			0.034 (0.012)**
Low Social Cohesion			-0.123 (0.082)			-0.129 (0.082)
Good Social Cohesion			0.167 (0.070)*			0.156 (0.07)*
Excellent Social Cohesion			0.131 (0.067) +			0.088 (0.069)
Skill Utilization			0.039 (0.013) **			0.025 (0.014)+
Repetitive Hand Move				-.0918 (0.057)	-0.078 (0.057)	-0.064 (0.056)
Heavy Lifting				--0.146 (0.059)*	-0.128 (0.059)*	-0.106 (0.059)+
Working Fast				0.020 (0.032)	0.022 (0.032)	0.02 (0.032)
Hours Worked				0.003 (0.002) +	0.003 (0.002)	0.002 (0.002)
Perceived Safety Climate					0.055 (0.011)****	0.025 (0.012)**
High Risk Industry					-0.076 (0.061)	-0.064 (0.06)
Low Risk Industry					0.132 (0.081)	0.133 (0.081)+
Intercept	3.7592****	3.7772 ****	2.7996****	3.75330****	3.0937****	2.7073****
Adjusted R-Square	0.0295	0.0372	0.0743	0.0447	0.0614	0.0809
Incremental F	N/A	2.55 * 1 vs. 2	12.81** 2 vs. 3	3.1217* 2 vs. 4	9.41** 4 vs. 5	6.721** 5 vs. 6

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (two-tailed test).**

Testing for Non-Linear Effects of Labor Processes on Health Status

Next, I examine the possible non-linear effects of the three labor process variables by squaring each term and adding each in turn to the Main Model. The cohesion squared model is compared to a main effects model that includes the continuous form of the cohesion index (Model 6A). There are no statistically significant effects for the squared autonomy and social cohesion terms. The results for these models appear in Appendix C, Table 10. Skill utilization is found to have curvilinear effects (Table 6.6). The parameter estimate for the squared skill term is significant with an incremental F of 3.97, which is significant at the .05 level (critical F=3.84).

Table 6.6. Tests for Non-linear Effects for Labor Process Factors Predicting Health Status Unstandardized Coefficients (SE). (N=1607)

Parameter Variable	**Main Effects Model (From Table 6.5)**	**Skill*Skill**
Age	-0.0063 ** (-0.0727)	-0.0061 (0.0023)**
White	-0.0139 (-0.0618)	-0.012 (0.0617)
Male	0.0742 (0.0542)	0.0778 (0.0541)
Less than High School	-0.1572 (0.089)+.	-0.163 (0.089)+
Associate/Bachelor's Degree	0.1474 (0.061)*	0.1393 (0.0611) *
Graduate Degree	0.2042 (0.0938)*	0.184 (0.0942)+
Self-Employed	0.1327 (0.0817)	0.118 (0.0819)
Insured	0.1404 (0.0784)+	0.1443 (0.0783)+
Manager	-0.1058 (0.0715)	-0.1046 (0.0715)
Job Tenure-0-3 Years	-0.1168 (0.0634)+	-0.1214 (0.0634)+
Job Tenure-greater than 10 years	-0.1294 (0.0713)+	-0.1314 (0.0712)+
Autonomy	0.034 (0.0118)**	0.0338 (0.0118)**
Low Social Cohesion	-0.1289 (0.0824)	-0.1471 (0.0827)+
Good Social Cohesion	0.1562 (0.0699)*	0.1499 (0.0699)*
Excellent Social Cohesion	0.0876 (0.0689)	0.075 (0.069)
Skill Utilization	0.0252 (0.014)+	-0.1653 (0.0876)+
Repetitive Hand Movements	-0.0639 (0.056)	-0.065 (0.056)
Heavy Lifting	-0.1059 (0.0588)+	-0.1066 (0.0587)+
Working Fast	0.0196 (0.0321)	0.0149 (0.0321)
Hours Worked	0.0019 (0.0019)	0.0016 (0.0019)
Perceived Safety Climate	0.0253 (0.0118)**	0.0231 (0.0119)+
High Risk Industry	-0.0644 (0.061)	-0.063 (0.0609)
Low Risk Industry	0.133 (0.0805)+	0.1298 (0.0805)
Skill*Skill		**0.0079 (0.0036) ***
Intercept	2.7073****	3.878****
Adjusted R-Square	0.0809	0.0832
Incremental F	N/A	3.97*

+ <.10 probability; *<.05 probability; **<.01 probability; *<.001 probability; ****<.0001 probability (two-tailed test).**

Calculation of the inflection point in a second order polynomial. Because the significant skill² term suggests non-linear effects, I determine the inflection point.[30] This is also another way of ascertaining the point where the value of the independent variable, skill, has no effect on the dependent variable, health status. For this regression equation, the calculated inflection point is at the 10.46 level of skill.

Recall that the skill utilization index ranges from a minimum score of 4 to a maximum of 16. Using whole number values in increments of 2, I calculated the effects of skill on health (Table 6.7). Note that when the skill utilization index equals 10, its effect on health is at its lowest (-.0073). The direction of the slope changes to a positive number (0.0243) in the next calculation (skill level 12).

Table 6.7: Inflection Point: Effects of Skill Utilization on Health Status

Skill Level	Effect of Skill on Health
4	-0.1021
6	-0.0705
8	-0.0389
10	-0.0073
12	0.0243
14	0.0559
16	0.0875

[30] The inflection point was determined as follows: $y = b_0 + b_1x_1 + b_2x_1^2 + e$. Effect of $x_{1:}$ $b_1 + 2\ b_2x_1$
Inflection point : $x_1 = -b_1/2b_2$

Computing values for non-linear effects of skill on health status. Using the second order polynomial regression equation, I calculate predicted values of health. The results (Figure 6.4) depict the non-linear nature of the effects of skill utilization on health status[31]. Note that the lowest point is at level 10, as anticipated by the inflection point.

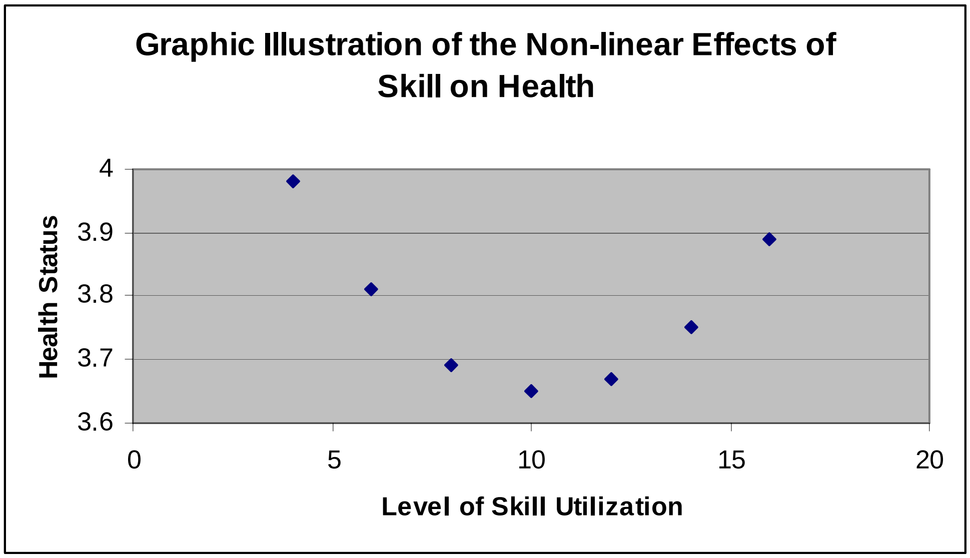

Figure 6.4. Non-Linear Effects of Skill on Self-reported Health Status

I had expected that both extremely low and extremely high levels of labor process control would be harmful to health, resulting in an inverted U-curve. That is not the case here. Although the effects are curvilinear, the U-curve is upright (Figure 6.4). Recall that the inflection point on the U-curve is at skill utilization level 10.46, which is approximately one standard deviation below the mean.[32] This tells us that skill utilization at a slightly below average level is worse for health status than either minimum skill utilization (4) or maximum skill utilization (16). This finding should be interpreted cautiously, particularly because the

[31] The model equation for predicting the effect of skill utilization on health status =4.516+ -0.16527(skill) + .0079 (skill²).
[32] The mean for skill utilization =13.01; the standard deviation=2.22.

predicted values occur across a very small range of health values. The plotted values represent a limited view. Skill utilization may be correlated with unobserved or unmeasured aspects of jobs or tasks and exposures. Because health is multi-faceted, there may also be lifestyle or life course stresses associated with skill. Time sequence issues also exist, for example the model does not control for pre-existing health conditions.

However possible explanations exist. Skill utilization is about choice and freedom. For some workers, perhaps the optimum job entails freedom from choice. Perhaps for some, low skill equals a low stress job: "easy work". This line of reasoning in terms of the unintended effects of skill utilization deserves further consideration

Interaction Effects of Socio-demographics and Labor Processes on Health Status

None of the multiplicative effects of socio-demographic variables (race and gender) and the labor process factors are significant. Individual parameter estimates, model adjusted R-squares and incremental F statistics for the interaction models appear in Appendix C, Table 11.

Interaction Effects of Task Exposures and Labor Processes on Health Status

None of the product interaction terms for task exposures (repetitive hand movements and heavy lifting) and the labor process factors are significant. Individual parameter estimates, model adjusted R-squares and incremental F statistics for the interaction models appear in Appendix C, Table 12.

6.8 Health Status: Summary and Discussion

Drawing from theories of non-alienated labor, I hypothesize that worker labor process control has beneficial effects on general health. The addition of labor process factors to the standard epidemiologic triad does improve the specification of health status. Autonomy on the job improves health status- both in Model 3 and in the main effects model (Model 6). This suggests that workplace autonomy influences not just work-related outcomes, but general health outcomes as well.

The effects of social cohesion on health, net of other salient factors, are less clear. The addition of the socio-demographic and job status variables erodes the effects of social cohesion on health (Model 3). The addition of exposures and environments in the main effects model also erodes the cohesion effects. In the main effects model, only good cohesion retains statistical significance. This may indicate that there are threshold effects for cohesion on health: that when cohesion is very low or very high it is not a significant predictor, but at good levels it is optimum.

Skill utilization at work is beneficial for general health when controlling for socio-demographics and job status variables. However, in the main effects model, when exposures and environments are added, the effects of skill utilization on general heath are eroded to borderline significance (p=.07). The exposures variables are not generally statistically significant predictors of health, suggesting that it is the environment, particularly perceived safety climate, which may moderate the effects of skill utilization on health.

I also hypothesize that worker labor process control may have unintended consequences: there may be a point where worker autonomy, social cohesion, and skill utilization are no longer beneficial to health. For autonomy and cohesion, this hypothesis is not supported. However, the effects of skill utilization on health are curvilinear, which supports the hypothesis.

Many factors influence health, making it difficult to effectively specify models predicting general health status. Notably missing from the preceding models are the so-called “lifestyle factors”, such as smoking, excessive alcohol consumption, poor eating and exercise habits. Although these factors may lead to adverse health outcomes, variables measuring them were not included in the 2002 GSS. Also, I was not able to control for preexisting health conditions (e.g., asthma, heart disease, obesity, etc). The cross-sectional nature of the design also is a problem. Time series measures rather than cross-sectional data would also improve the predictive ability of the models. Despite the limitations of the data, the importance of workplace organization on the general health of workers is demonstrated here. Of particular importance is the ways in which labor process control at work spills over into everyday life.

Summary of Chapter 6

In this chapter, I reported the results of the a series of additive models with attention toward the differential effects of socio-demographics, job status characteristics, labor processes, exposures, and environments on workplace injury, persistent pain, exhaustion, and health status. For each dependent I reported the results of additive multivariate models, models testing for non-linear effects, and interaction effects for socio-demographic and task exposures and labor process variables, followed by a discussion/overview of each dependent variable. In the next chapter, I use evidence from the analyses in this section to assess research questions and hypotheses.

CHAPTER 7

DISCUSSION AND CONCLUSIONS

In this section, I review and discuss the research questions about worker labor process control and the positive and negative effects it has on self-reported occupational health outcomes (injury, pain, exhaustion) and general health status. I discuss the confirmation or disconfirmation of hypotheses (Table 7.1) for the labor process variables. Hypotheses 1-3 assert that self-reported occupational and general health outcomes vary as a function of worker labor process control, with the expectation that workers with high levels of labor process control (i.e., autonomy, skill, and control over the social relations at work) will be less likely to experience adverse occupational health outcomes or lowered health status than workers with low levels of labor process control. Hypothesis 4 deals with the non-linear effects of the labor process variables on each of the dependent variables. Hypothesis 5 focuses on interaction effects between the socio-demographic variables of race and gender and the labor process variables on each of the dependent variables. Hypothesis 6 examines the interaction effects of task exposures and the labor process variables on each of the dependent variables.

All of the hypotheses are discussed for labor process factors to which they pertain. During the discussion of each labor process variable, I consider the ways in which the dissertation findings have elucidated the original research questions. I also discuss limitations and the ways in which the empirical models can be improved. I conclude this chapter with a consideration of the contributions to the literature and recommendations for public policy.

Table 7.1. List of Research Hypotheses

Hypothesis 1: There are negative relationships between the indicators of worker labor process autonomy and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.
Hypothesis 1A: There are positive relationships between the indicators of worker labor process autonomy and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis.
Hypothesis 2: There are negative relationships between the indicators of worker labor process control in terms of social cohesion and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.
Hypothesis 2A: There are positive relationships between the indicators of worker labor process control in terms of social cohesion and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis.
Hypothesis 3: There are negative relationships between the indicators of worker labor process skill utilization and the dependent variables measuring workplace injury, persistent pain, and exhaustion at the bivariate and multivariate levels of analysis.
Hypothesis 3A: There are positive relationships between the indicators of worker labor process skill utilization and the dependent variable measuring general health status at the bivariate and multivariate levels of analysis.
Hypothesis 4: There are non-linear relationships between the indicators of worker labor process control (worker autonomy, social cohesion, skill utilization) and the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status net of the effects of the other variables in the model.
Hypothesis 5: The level of worker labor process control (worker autonomy, social cohesion, skill utilization) in the workplace has different effects on the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status for whites versus non-whites and for males versus females.
Hypothesis 6: The level of worker labor process control(worker autonomy, social cohesion, skill utilization) in the workplace has different effects on the dependent variables measuring workplace injury, persistent pain, exhaustion, and general health status for those who perform the task exposures of repetitive hand movements and heavy lifting as compared to those who do not.

7.1 Hypotheses Concerning Autonomy

In this section, I review all hypotheses concerning labor process autonomy (Hypotheses 1, 1A, 4-6). A summary (Table 7.2) is included at the end of this section.

There is a negative relationship between worker autonomy and workplace injury. The data analysis provides limited and weak support for the hypothesis of a negative relationship between worker autonomy and workplace injury. As anticipated, at the bivariate level, workers with high autonomy have fewer workplace injuries. The effects of worker autonomy are not statistically significant in the multivariate models for the injury dependent variable. Recall from the discussion of the bivariate correlations that self-employment status and managerial status are correlated with autonomy, indicating potential overlap between the job status characteristics in Model 2 and labor process autonomy.[33] In order to investigate if this overlap confounds the worker autonomy effect, models without the managerial status variable or with autonomy added separately to the model (i.e., instead of concurrent with social cohesion and skill utilization) should be explored in future analyses. The managerial status variable may also be reconfigured to reflect a range of managerial duties, as opposed to a managerial class.

The main effects workplace injury model includes measures of task exposures (repetitive hand movements and heavy lifting), a measure of hours worked, and an estimation of the pace of work. Exposure variables alone are salient predictors of injury, as is perceived safety climate. It was expected that since autonomous workers are able to control the conditions of work, therefore, they should be able to remove themselves from hazardous conditions, and therefore, experience fewer workplace injuries. However, autonomy at work was not found to be protective against workplace injuries. Paradoxically, the data show that

[33] The bivariate correlations for autonomy and self-employment: r=.30; autonomy and managerial status: r=.20.

autonomous workers may put themselves at higher risk for occupational injuries under certain situations.

Perceived safety climate was a significant predictor variable in the main effects model, lending initial support to the importance of safety environment in reducing workplace injuries. This provides support for health and safety promotion interventions that focus on changes in the safety environment in concert with the epidemiologic model (Haddon 1980). However, the safety climate measure also reflects the ways in which workers perceive managerial commitment to safety (Zohar 1980). The belief that management puts "safety before production" can influence worker consent, thus allowing workers to accept the dangers and exploitive natures of jobs (see Hall 1993). Worker perception that management cares about safety may divert workers from recognizing sources of potential harm in the workplace. Future empirical research on workplace injury should examine the role of perceived safety climate as a measure of consent and its possible moderating effects on labor process autonomy and exposures in terms of workplace injuries. In addition, a measure of organizational commitment can be used to develop the relative importance of labor process control and consent in terms of the production of workplace injuries.

There is a negative relationship between worker autonomy and persistent pain. The data analysis shows a weak and limited confirmation of this hypothesis. At the bivariate level, the results were as expected: workers with high levels of autonomy are less likely to experience persistent pain. However, net of the effects of the other variables in the models, the parameter estimate for autonomy was not statistically significant in the multivariate models.

As stated earlier, I chose four different dependent variables for the dissertation analyses because each measures a different facet of occupational and general health. Unlike workplace injury, persistent pain measures a chronic problem that may take years to develop. Because duration may be a factor, possible interaction effects between autonomy at work and years on the job may confound the models. There may also be interaction effects between exposures and job tenure as a measure of exposure duration. The socio-demographic variables of education and race are significant independent variables in the persistent pain models. Further research should investigate this more fully, including possible interaction effects of race and education and job tenure and exposures on persistent pain.

There is a negative relationship between worker autonomy and exhaustion. Data analyses show partial support for this hypothesis. There is a significant negative bivariate relationship between autonomy and exhaustion, confirming the hypothesis that as worker autonomy increases, levels of exhaustion decrease. The relationship between worker autonomy and exhaustion maintains statistical significance when socio-demographic and job status variables are added to the model (Model 3). In the main effects model, however, autonomy is no longer a statistically significant independent variable. Further research revealed that the variables measuring safety climate and social cohesion contributed to the loss of autonomy's statistically significant effects on exhaustion. Pace of work and hours worked are significant contributors to exhaustion. Future research could examine the possible moderating effects of autonomy on these exposures in terms of exhaustion.

There is a positive relationship between worker autonomy and health status. This hypothesis is supported by the bivariate and multivariate data results. Autonomy at work improves health status at the bivariate level. Labor process autonomy at work also improves health status at the multivariate level in the main effects model that includes socio-demographics, job status characteristics, exposures and environmental factors. This finding has particularly important implications considering the central nature of work in our lives. Labor process conditions spill over into other areas of life to influence general health. This is particularly salient as adults in the United States spend an increasing proportion of their lives at work (Schor 1991).

There are non-linear relationships between worker autonomy and workplace injury, persistent pain, exhaustion, and general health status. Is there a point where increased worker autonomy is actually harmful to health? I tested for non-linear effects by squaring autonomy and adding it as an independent variable to the main effects model for each of the dependent variables. None of the squared terms were significant and the model specification did not improve, therefore, data analyses do not confirm the hypothesis. As it stands, autonomy has linear effects on occupational and general health. However, under certain types of workplace conditions, autonomy may have unintended (i.e., non-linear) effects on worker health.

Post-Fordist models of workplace organization advocate enhanced employee involvement and participation techniques such as Total Quality Management (TQM) or Continuous Quality Improvement (CQI), where workers gain opportunities to make labor process decisions (Applelbaum and Batt 1994). During the 1990's many firms in the US were quick to jump on the employee participation bandwagon (see Smith 1997) as the solution to problems in American industry (Peters and Waterman 1984). In addition to measuring level of autonomy, elements of the autonomy index may reflect employee involvement.[34] Recent research has shown that although highly touted, autonomy in self-directed teams has not always been beneficial to worker health and safety (Adler, Goldoftas and Levine 1997). From a critical sociological viewpoint, employee involvement programs may strengthen management's capacity to extract additional effort from workers by concealing job speedups and work intensification through the language of employee job enrichment (Smith 1996). Future research should investigate the intended and unintended effects (e.g., relative occupational harm or merit) of worker autonomy in the employee participation model of workplace organization.

The level of labor process autonomy in the workplace has different effects on occupational and general health outcomes for whites versus non-whites and for males versus females. None of the product interaction models were statistically significant improvements over the main effects models. Therefore, this hypothesis is not supported. This is particularly surprising given the statistical significance of race and/or gender and autonomy in the exhaustion dependent variable model. Race and gender are different yet interlocking axes of social structure (Anderson and Collins 1998). It may be the case that instead of interacting with labor process autonomy, race and gender *interact with one another* in terms of adverse health outcomes. This is consistent with the idea of interlocking systems of oppression which are theorized to form a "matrix of domination", where race and gender statuses are multiplicative in their effects (Anderson and Collins 1998; Collins 1990).

The level of labor process autonomy in the workplace has different effects on occupational and general health outcomes for those who perform repetitive hand movements and heavy lifting as compared to those who do not. Data analyses provide

[34] Autonomy index items included: "I have a lot of say about what happens on my job" "I am given a lot of freedom to decide how to do my own work" "How often are you allowed to change your starting and quitting times on a daily basis?" "How often do you participate with others in helping set the way things are done?"

partial support for this hypothesis. The interaction of the autonomy and heavy lifting variables is significant for the workplace injury dependent variable models. None of the other product interaction terms are significant. This finding illustrates the non-beneficial consequences of autonomy under conditions of hazardous exposure. However, these preliminary results need to be reexamined because of questions about the relationship between labor process autonomy, consent, and health outcomes.

Consent to capitalism is generated when workers feel that they have the ability to exercise choice on the job (Burawoy 1979). In this case, worker autonomy under conditions where consent to dangerous work is high may have adverse effects on worker health. Autonomous workers may try to do too much (i.e., lift too much) resulting in bodily harm to achieve production goals. The autonomy and exposure interaction could also harm workers who ignore safety mandates in order to increase piecework pay rates or to facilitate other types of production related "games" (Burawoy 1979; Dwyer 1991). Of particular interest is the way in which perceived safety climate as a measure of workplace consent moderates the effects of task exposures or the effects of autonomy on occupational health. The examination of other measures of consent (e.g., organizational commitment) may help to elaborate these relationships more fully.

Table 7.2. Summary of Hypotheses Concerning Labor Process Autonomy

Autonomy Hypothesis:	**Dependent Variable**			
	Workplace Injury	**Persistent Pain**	**Exhaustion**	**Health Status**
Bivariate Significance	YES	YES	YES	YES
Multivariate Significance	no	no	YES in Model 3 No in Main effects	YES
Non-Linear Effects	no	no	no	no
Interaction with Race	no	no	no	no
Interaction with Gender	no	no	no	no
Interaction with Repetitive Hand Movements	no	no	no	no
Interaction with Heavy Lifting	YES	no	no	no

7.2 Hypotheses Concerning Social Cohesion

In this section, I address hypotheses concerning social cohesion (Hypotheses 2, 2A, 4-6). The results are summarized in Table 7.3.

There is a negative relationship between social cohesion and workplace injury. Initially, I had planned to use the social cohesion index as a continuous level independent variable. Initial examination of the distribution of the cohesion index indicated that the responses tended to cluster toward the high end of the index, meaning that most of the respondents tended to agree with the social cohesion items. I created a four category dummy variable reflective of levels of cohesion with "Adequate" cohesion as the omitted category. Therefore, the above hypothesis should be modified to reflect the categorical levels. The revised hypothesis states that "Good" or "Excellent" levels of social cohesion are hypothesized to decrease injury while "Low" cohesion is hypothesized to increase injury as compared to the baseline.

Because social cohesion provides social support, it was hypothesized to be largely beneficial for workers health. No statistically significant negative relationships between social cohesion at work and workplace injury were found at either the bivariate or multivariate levels. Therefore, this hypothesis is not supported by the data analyses. There are several possible reasons for this non-significant result. Under certain conditions social cohesion may have unintended effects on worker health. Workers take risks that result in workplace injury to keep co-workers happy, for example, overriding safety protocols to keep production running smoothly (Nichols 1997). In certain occupational cultures taking injury risks is the norm, particularly in dangerous and male dominated occupations like construction. I conclude that even in socially cohesive workplaces, whether one is injured or not is still largely a function of task exposure and environment. It is this line of reasoning that leads to questions of possible interaction effects of cohesion and task exposure (Hypothesis 6).

There is a negative relationship between social cohesion at work and persistent pain. The data analyses provide limited support for this hypothesis**.** The level of social cohesion at the workplace is a significant predictor of persistent pain at the bivariate level. As expected, statistically significant parameter estimates are found for pain at the bivariate level when cohesion is good or excellent (as compared to the baseline, adequate cohesion). Low cohesion increases in the odds of persistent pain at the bivariate level, however, the significance level is not significant at the .05 level (p<.06).

Subsequent multivariate regression analyses tested for the effects of social cohesion on pain net of the effects of socio-demographic characteristics, job status characteristics, exposures, and environments. The results for Model 3 (Labor Process) and Model 6 (Main Effects) are similar. The multivariate models indicate that good or excellent levels of social cohesion at work lower the odds of persistent pain, net of the effects of the other variables in the model. However, the effect of social cohesion on the odds of persistent pain in the multivariate models is <u>not</u> significant for workers who report low social cohesion at work, lending only partial support for the hypothesis. The non-significance of the low level of social cohesion may be an artifact of the way in which the categorical variable was created. Alternately, this may point toward possible cumulative effects of social cohesion on persistent pain in the multivariate models. For example, at low levels of social cohesion, there is no effect on persistent pain, but as cohesion improves, it has protective effects on persistent pain.

There is a negative relationship between social cohesion and exhaustion. The data analyses partially support this hypothesis. At the bivariate level, low social cohesion increases exhaustion, while excellent social cohesion decreases exhaustion, as hypothesized. In the case of good social cohesion, however, the bivariate relationship is not significant.

In the multivariate Labor Process Model (Model 3), all levels of social cohesion are statistically significant. As expected, low levels of social cohesion increase exhaustion and good or and excellent social cohesion decrease exhaustion, net of the other variables in the models. This demonstrates the benefits of socially cohesive workplace relationships in decreasing worker exhaustion.

When exposures and environments are added to the model, (Main Effects Model 6), the effects of social cohesion on exhaustion change somewhat. As expected, low cohesion increases exhaustion and excellent cohesion decreases it, net of the effects of the other variables in the model. However, in the Main Effects Model (Model 6), good social cohesion falls just short of statistical significance (p=.053). Generally, speaking, this still supports the assertion of the benefits of social cohesion. This may be an artifact of measurement error, for example, the way in which the categorical variable was created. The trend may also reflect a curvilinear relationship between social cohesion and exhaustion where only the extreme ends of the spectrum (e.g., low or excellent) have statistically significant effects.

There is a positive relationship between social cohesion and health status. This hypothesis is partially supported by the data analyses. In the bivariate regression, good and excellent levels of social cohesion improve health status ratings, while low levels of cohesion decrease health status ratings, as expected. In the multivariate Labor Process Model (Model 3), only good cohesion has statistically significant effects at the .05 level. Low cohesion is not significant. A similar finding occurs in the Main Effects Model, where good cohesion improves health status, net of the effects of the other variables in the model, but low and excellent levels are not significant.

This pattern differs from the effects of cohesion in previous models with other dependent variables, reinforcing the importance of evaluating labor process effects for different dependent variables. As in the persistent pain models, low cohesion does not have adverse effects on general health. However, in the health status model, the benefits of cohesion begin at lower levels (i.e. good versus excellent). Social cohesion loses statistical significance when it reaches excellent levels, suggesting that once the level of good cohesion is reached, there are no additional benefits in terms of improving health. There may also be some measurement error involved in the creation of the cohesion categories, suggesting that statistically significant differences between good and excellent levels are artifacts of measurement.

There are non-linear relationships between social cohesion workplace injury, persistent pain, exhaustion, and general health status. As suggested previously, the relationships between social cohesion and occupational/ general health status are non-linear. For example, high levels of social cohesion may have unintended effects because of the development of distinctive group norms related to labor process control. Hypothesis 4 investigates the possible non-linear effects of social cohesion on occupational and general health status by adding the continuous measure of social cohesion and its square to a main effects model with the continuous version of the social cohesion variable.   Non-linear effects were not evident. Therefore, the hypothesis is not confirmed.

Although non-linear effects for the social cohesion were not found, further research is needed to adequately assess the effects of social cohesion on occupational and general health in a variety of workplace settings. Managerial innovations that seek to formalize informal worker relationships (e.g., employee involvement, self-directed work teams) may have unintended effects on co-worker relationships with implications for occupational and general health outcomes. Systems of workplace democracy such as self-directed teams have not necessarily made the workplace more cohesive; workers often complain that their co-workers have simply replaced management as agents of labor process control (Hodson 1995; Smith 1996), thus negating the potential benefits of social cohesion on occupational and general health.

The level of social cohesion in the workplace has different effects on occupational and general health for whites versus non-whites and for males versus females. Because occupational and general health status can differ by race and by gender, I investigated possible interaction effects between social cohesion and race and gender. There were no statistically significant interaction effects for social cohesion and gender and for social cohesion and race on occupational or general health at the multivariate level. This hypothesis is not confirmed for any of the dependent variables. It may be that the interactions are between the socio-demographic factors (e.g., race and gender or gender and education) and not the types of labor process control. Future models should examine the possible interaction effects.

The level of social cohesion in the workplace has different effects on occupational and general health for those who perform repetitive hand movements and heavy lifting as compared to those who do not. Data analyses provide partial support for this hypothesis.

As noted in the results section, no significant interaction effects between social cohesion and repetitive hand motions were found for the injury, persistent pain, and exhaustion and general health multivariate models. Interaction effects between the labor process variables and heavy lifting were not found for the persistent pain, exhaustion, or general health dependent variables. However, a significant interaction effect exists between social cohesion and heavy lifting for the injury multivariate model, indicating that the level of social cohesion at work has different effects on injury for workers who do heavy lifting on the job versus those who do not.

As graphically noted in Figure 6.2, regardless of cohesion levels, workers who perform heavy lifting at work are more likely to experience workplace injury. However, when there is no exposure to heavy lifting, the effects of social cohesion are positive (i.e., decreasing number of injuries), especially at the level of good social cohesion. When heavy lifting is involved, social cohesion does not have protective effects. The model shows that as cohesion goes up, there is an increase in number of injuries.

The ability to control the social relations of work and to feel solidarity with co-workers is essential to non-alienated labor. The results of the cohesion and lifting interaction models indicate that under certain conditions, social cohesion may have unintended effects, particularly in occupational cultures where taking risks is normative. Future research will address these preliminary findings.

Table 7.3. Summary of Hypotheses Concerning Social Cohesion

Social Cohesion *Hypothesis*:	**Dependent Variable**			
	Workplace Injury	**Persistent Pain**	**Exhaustion**	**Health Status**
Bivariate Significance	No-all levels	YES -all levels	YES -Excellent YES -Low (no-Good)	YES -all levels
Multivariate Significance	no	YES –Good and Excellent (no Low)	YES -Excellent YES Low (Good cohesion marginal)	YES -Good (Excellent marginal (p=.052) in main effects only) (no Low)
Non-Linear Effects	no	no	no	no
Interaction with Race	no	no	no	no
Interaction with Gender	no	no	no	no
Interaction with Repetitive Hand Movements	no	no	no	no
Interaction with Heavy Lifting	YES	no	no	no

7.3 Hypotheses Concerning Skill Utilization

In this section, I discuss the hypotheses concerning skill utilization (Hypotheses 3, 3A; 4-6). The results of the hypothesis tests are summarized in Table 7.4.

There is a negative relationship between skill utilization and workplace injury. The hypothesis that there is a negative relationship between skill utilization at work and workplace injury is not supported at the bivariate or multivariate levels. The skill utilization variable does not differentiate between different types of jobs or occupationally-based skill. It does not measure the ways in which skill utilization can be influenced by context and exposures. High levels of skill utilization for some workers may include responsibility for large amounts of money. For others, it may mean skill in wielding a hammer.

In terms of workplace injury, the effects of exposure and environment may be more salient than skill. Skilled craft workers, such as construction trade workers, who seemingly posses craft –based control over essential labor processes, are frequently injured at work. Other types of skilled workers, such as executive managers, are rarely injured. Skill utilization may interact with exposures, which is the basis of Hypothesis 6.

There is a negative relationship between skill utilization at work and persistent pain. This hypothesis is weakly supported by the data analyses. At the bivariate level of analysis, skill utilization reduces the odds of persistent pain. However, skill utilization is not statistically significant in the multivariate logistic regression models that include measures of socio-demographic characteristics, job status characteristics (Model 3), exposures, and environments (Main Effects-Model 6). Using skill at work may decrease alienation; however, it is not necessarily protective against the chronic physical conditions such as persistent pain.

There is a negative relationship between skill utilization at work and exhaustion. Data analyses provide limited support for this hypothesis. At the bivariate level, the relationship between skill utilization and exhaustion is not statistically significant. However, in the multivariate Labor Process Model (Model 3) where socio-demographic and job status characteristics are included in the model, skill utilization becomes statistically significant. However, the direction of the slope for the parameter estimate for skill utilization is *positive*. Skill utilization is found to significantly *increase* exhaustion, net of the effects of socio-demographics and job status factors. This finding represents an unintended consequence of skill utilization.

Blauner thought that skill utilization in continuous process industries could decrease alienation because workers would gain dignity and benefit from heightened responsibility (1964:182). As a form of "upgrading", new workplace modes would usher in an era of increased workplace egalitarianism. Certainly, workers are using skills (as evidenced by the increase in professional and semi-professional types of workers). Instead of having beneficial effects, increased skill utilization is exhausting. Workers may be coerced or they may push themselves toward organizational production goals.

The effects of skill utilization on exhaustion drop to non-significant levels in the Main Effects Model (Model 6) where exposures and environmental factors are included, although the direction of the slope coefficient remains positive. Recall that in the Exposure Model (Model 4) both pace of work and hours worked were statistically significant predictors of exhaustion. Interaction effects between skill utilization and pace of work and hours worked may exist. Future research could further examine the impact of pace and hours on exhaustion independent from the task exposures of heavy lifting and repetitive hand movements.

There is a positive relationship between skill utilization and health status. Data analyses results provide partial support for this hypothesis. At the bivariate level, the relationship between skill utilization and health status is statistically significant ($p<.0001$). In the Labor Process Model (Model 3) skill utilization maintains significant ($p<.01$) positive effects on health status. However, in the Main Effects Model (Model 6), the statistical significance of skill utilization is eroded to marginal levels ($p=.07$). Exposures such as heavy lifting, repetitive hand movements, pace of work, and hours, while generally significant in the occupational health dependent variable models, are not significant in terms of general health in the Main Effects Model. However, the perceived safety climate variable maintains a significant positive relationship to general health status in the multivariate models.

In terms of general health, it may be that the most salient features of the workplace are not exposures, but the workers' perception of how well the employer manages their safety. In addition to providing information about the safety environment, the safety climate items may reflect a belief in the benevolence of the employer. The safety climate index also measures workplace consent; it reflects a human relations model where the employer cares about the working conditions. Thus, belief in a caring employer may have protective effects on health, perhaps moderating the effects of exposures. This line of reasoning should be pursued in future research.

There are non-linear relationships between worker skill utilization and workplace injury, persistent pain, exhaustion, and general health status. This hypothesis is partially supported. I had suggested that there might be a point where skill utilization may have non-linear effects on occupational and general health status. To test this hypothesis (Hypothesis 4) I created a squared term for skill utilization and added it separately to the main effects models for each of the dependent variables. For the models with dependent variables measuring workplace injury, persistent pain, and exhaustion, non-linear effects for skill utilization were not found. However, for the health status dependent variable, a statistically significant non-linear effect does exist at the multivariate level.

I predicted that the effects of skill utilization on health would be non-linear, but that the harmful effects on health would occur at extremely low and extremely high levels of skill, resulting in an inverted, rather than upright, U-curve (Figure 6.4). Instead, the multivariate model shows that skill utilization at below average levels (around 10) is more harmful for health than extreme low or high skill utilization.

The labor process theory framework considers worker skill utilization to be the opposite of repetitive or low skilled work, where workers do not get to fully develop talents and abilities. For Braverman, the concept of skill is linked to craft mastery and knowledge of work processes; his definition of skilled labor emphasizes conception and execution (Braverman 1974). Under advanced capitalism, perhaps the benefits of skill utilization need to be reframed as a non-linear process. The curvilinear relationship between skill utilization and health shows that contrary to prediction, low skill utilization is *beneficial* in the multivariate model for health status. Considering the ways in which skill utilization is part of the neo-Fordist model of worker participation, it makes sense that for some workers, low skill utilization may mean “low stress”, or “easy” work, which workers may find amenable. Instead of freedom *of* choice, which may require active decision- making and effort, freedom *from* choice is preferable and thus, beneficial to health. It also lends support to the epidemiologic model in that once exposure is controlled, skill is less meaningful. However, the finding that high skill utilization is beneficial to health is in agreement with theories of non-alienated labor: high skill utilization is self-actualizing and satisfying, leading to health benefits. This is a preliminary result and it deserves further investigation. There may be intervening variables (such as stress level or job satisfaction) which could improve the model specification.

The level of skill utilization in the workplace has different effects on occupational and general health outcomes for whites versus non-whites and for males versus females. None of the product interaction models were significant improvements over the main effects models for any of the dependent variables. Therefore, the hypothesis is not supported by the data analyses.

The level of skill utilization in the workplace has different effects on occupational and general health outcomes for those who perform repetitive hand movements and heavy lifting as compared to those who do not. Data analyses show limited support for this hypothesis. There were no significant interaction effects between repetitive hand movements and skill utilization for any of the dependent variables. In terms of heavy lifting, no significant interaction effects were found between skill utilization and heavy lifting for the persistent pain, exhaustion, and health status multivariate models. However, skill utilization and heavy lifting interact for the workplace injury multivariate model, suggesting that there are unanticipated consequences associated with skilled labor in concert with task exposure.

As shown I figure 6.3, at low levels of skill, workers who perform heavy lifting, as well as those who do not, have virtually similar injury outcomes. The slopes illustrate that for those who do not perform heavy lifting, as skill levels increase, injuries decline. The opposite effect takes place when workers are exposed to heavy lifting: as the slope indicates, as skill levels go up, injuries increase. This is a preliminary finding. Although skilled manual labor reflects a sort of craft ideal, where workers are in control of both the mental and physical aspects of work, the data suggest that utilizing skill does not necessarily protect workers from the effects of heavy lifting.

Table 7.4. Summary of Hypotheses Concerning Skill Utilization

Skill Utilization *Hypothesis*:	**Dependent Variable**			
	Workplace Injury	**Persistent Pain**	**Exhaustion**	**Health Status**
Bivariate Significance	no	YES	no	YES
Multivariate Significance	no	no	YES in Model 3 (direction is positive, not negative) No in Main Effects	YES in Model 3 Marginal in main effects (.07)
Non-Linear Effects	no	no	no	YES
Interaction with Race	no	no	no	no
Interaction with Gender	no	no	no	no
Interaction with Repetitive Hand Movements	no	no	no	no
Interaction with Heavy Lifting	YES	no	no	no

7.4 Revisiting Occupational Harm: Discussion

In this chapter, I addressed each of the research questions about the effects of labor process autonomy, social cohesion, and skill utilization on occupational and general health outcomes. Of particular interest is the differential importance of labor process factors in terms of workplace injury, persistent pain, exhaustion, and self-reported health. Throughout this chapter, I suggest ways in which the empirical models could be improved, offering avenues for further research.

In developing the theoretical framework for this dissertation, I elaborated a model of workplace organization that utilizes both core epidemiological concepts as well as sociological models of work and labor process control. This research builds on an epidemiological model that features an interaction between host/ human factors, job characteristics, production-related exposure agents, and environments. I extended the epidemiologic model to include worker labor process control. I argued that the sociological aspects of labor process control are linked to adverse and occupational health outcomes and that the addition of these factors to empirical analyses improves upon models containing only the standard epidemiologic triad. For each of the dependent variables, Model 5 includes the basic epidemiologic factors (host, exposure agents, and environment). The empirical results show that the labor process variables enhance and improve upon basic epidemiologic models. For the dependent variables of persistent pain, exhaustion, and health status, the addition of the labor process variables to the epidemiologic factors found in Model 5 produced a statistically significant improvement in specification (i.e., Main Effects Model 6). Only in the case of workplace injury dependent variable, did the addition of labor process factors fail to improve the model specification. However, interaction effects were found for all the labor process variables and the heavy lifting variable for the workplace injury model. These results raise additional questions about the relationships between epidemiologic exposures and worker labor process control.

A Discussion of Labor Processes and Occupational Health

Studies of the relationship between work and health date back to Marx. With the advent of medical sociology, sociologists have tended to focus on alienation as more of a psycho-social state than an embodied one (see Suchman 1963). The use of labor process control theory to predict adverse physical states is a possible way to expand the concept of alienated labor to include physical outcomes. This research opens the avenue for such inclusion.

Many of the hypothesized benefits of worker labor process control on general and occupational health were not found in the empirical analyses. The theoretical framework used in these analyses relies heavily on a 19^{th} century way of looking at the struggle between labor and capital. Labor process theory has been critiqued because of its over-simplistic view of worker versus owner struggles for labor process control and for dichotomizing craft and mass production (Smith 1994). While a valuable launching point for any discussion of the negative effects of work on health, the same sort of dualistic thought is embedded throughout this dissertation.

Other critiques assert that the patterns of the Fordist workplace hierarchy which form the basis of labor process theory have become obsolete (Sable 1982). Post-Fordists view increased flexibility as a rational response to market conditions (e.g., Zuboff 1988) that has ushered in new forms of workplace organization in advanced capitalism. When firms use worker participation models, workers gain greater control over labor processes and firms benefit-a purported win-win situation However, as noted earlier, such forms of workplace organization are not the panacea that they are purported to be.

Autonomy, social cohesion, and skill utilization are all elements of non-alienated labor. Ironically, under new forms of workplace organization these elements of fulfilling work have been co-opted by management (see Vallas 1999). This is not necessarily beneficial to all workers, as noted in the dissertation analyses. As capitalism advances, less reliance on coercion is needed as workers consent to the system of wage labor exchange. The consideration of worker consent adds the dimension of worker agency to the labor process, but complicates the story because workers submit to their own exploitation. An underestimation of worker consent is a deficiency in this project, although admittedly, worker consent is hard to measure empirically. Purported as a measure of consent, the perceived safety climate and its future consideration will amend this somewhat.

Both Marx and Weber would agree that increased rationalization of work results in a loss of control over the conditions of work. The use of scientific management techniques in industry in concert with bureaucracy has resulted in an increase in worker alienation (Braverman 1974, Clawson 1980). Similar principles, where freedom *from* choice is the essence of rational efficiency, are also incorporated into safety ergonomics. The same sorts of protections that keep workers safe also decrease worker discretion and choice (Elling 1989; Hall 1993; Wooding and Levenstein 1999) thus complicate the picture.

According to labor process theory, workers with high levels of labor process control have both the power and freedom to manage exposures. The empirical results of the multivariate models indicate that labor process control generally did not have direct effects on occupational and general health. Instead, the effects of worker labor process control were often moderated through exposure, and were situational in nature. Thus, under certain situations (e.g., heavy lifting at work) paradoxically as autonomy increases, so do the predicted number of workplace injuries. This may be because autonomous workers with high degrees of control over the labor process consent to production dangers or disregard safety rules. This is consistent with previous research that suggests autonomous workers may also ignore safety mandates when the conflict with potential workplace rewards (Dwyer 1991; Nichols 1997). For example, workers disable safety devices in the interest of maintaining incentive rate when income is tied to rate-based systems like piecework or when payment is "by the job"(Dwyer 1991; Nichols 1997).

The largely beneficial effects of social cohesion in terms of decreasing exhaustion and persistent pain are consistent with previous research that documents the benefits of positive social relationships at work in overcoming the negative effects of alienation (Tausky 1992). My research also documents the protective effects of social cohesion at work on general health, giving evidence to the central importance of socially cohesive workplaces.

Social cohesion is a type of social support. When considered in this manner, the positive findings are consistent with the large body of literature that documents the positive benefits of social support on health (Cobb 1976; House 1981). However, the social cohesion measure differs from general social support in that it is <u>workplace specific</u> in focus. Although my findings indicate that social cohesion has potentially beneficial effects on health, the mechanisms underlying the effects are not clear. As a type of workplace social support, the benefits may be due to underlying social-psychological processes such as selfesteem or self-efficacy. Physical mechanisms such as the release of serotonin or other endorphin-like substances may play a role, however these hormonal measures are beyond the scope of this analysis.

The significance of social cohesion in the empirical models demonstrates the importance of social groups and workplace cultures in determining occupational and general health outcomes. The opposite of social cohesion is bureaucratic impersonality, where workers don't know one another and may compete against one another for promotions and jobs (Blauner 1964, Edwards 1974; Doeringer and Piore 1971). Although workers in socially cohesive situations may come together to improve working conditions, cohesive groups may also normalize risk taking. This is consistent with case study research of workers in high risk fields (Applebaum 1981, 1991; Cherry 1974; Riemer 1979; Wallace 1987).

Although formal vocational training may teach workers safe and correct ways of performing dangerous tasks, once on the job, workers encounter informal sources of workplace knowledge through co-workers. Workers learn "the way we really do things around here", which may differ significantly from workplace rules. The situational nature of social cohesion in terms of its interaction effects with task exposures in the production of adverse occupational health (e.g., interaction of cohesion and heavy lifting) offers evidence to support this unintended consequence.

Skill utilization at work is generally beneficial according to labor process theory (Blauner 1964; Braverman 1974; Simpson 1985). Skill utilization is the opposite of deskilled, monotonous labor, and as such, is hypothesized to protect against adverse occupational health outcomes. For the persistent pain and general health dependent variables, I found this to be largely true, until the hazardous exposures and environments were included in the models. The empirical findings indicate that the positive effects of skill utilization are not direct, but are moderated by epidemiologic factors. While skill utilization is part of the craft worker identity, part of that skill set includes working under dangerous conditions. In the production of workplace injury, the effects of skill utilization were moderated through exposure and were situational (e.g., the interaction of heavy lifting and skill utilization).

This research has also demonstrated the unintended consequences of skill utilization. As a response to changing economic conditions, capitalist firms have advocated new forms of workplace organization, where worker skill utilization and input into work processes are enhanced (Zuboff 1988). In doing so, workers have greater control over the labor process. Firms do not do this out of benevolence, but out of a desire to stay profitable. Although the ability to retain skill in the face of capitalist labor process control is essential to decreasing worker alienation, skill utilization at work can also be exhausting, particularly when worker skills and abilities are harnessed to improve the organizational bottom line.

Post-Fordists contend that the separation between workers and managers has become less dichotomous as economic necessity forces firms to utilize worker talents and abilities (Piore and Sable 1984; see Vallas 1999). However, this research demonstrated that as skill utilization went up, exhaustion increased, which is not the beneficial effect expected under labor process or Post-Fordist paradigms. Increased use of skill may stand in opposition to the deskilling trend, but it is not necessarily an indication that Fordism has ended.

Prechel (1994) deems today’s state of capitalism as “Neo-Fordist”, rather than post–Fordist, because new methods are emerging to ensure managerial control, even under the guises of more egalitarian forms of capitalism. Although the underlying framework of this dissertation has been largely based on a 19th century notion of exploited labor, it also draws from recent works that build on these models to include a consideration of worker consent, human relations, and post-Fordism. Having considered the findings in a variety of paradigms, I agree with Prechel that neo-Fordism is occurring. A neo-Fordist paradigm helps explain why autonomy, social cohesion and skill utilization had limited protective effects on occupational and general health. Although individual elements of labor process control may have beneficial effects for workers, they cannot be completely removed from organizational and historical context. Capitalist control over the labor process is a struggle in which new capitalist forms emerge. In the struggle for control, ultimately capitalists are successful through new methods of labor process control that are not necessarily based on coercion. Control of work becomes increasingly consent-based as through systems where formal incentives for promotion and advancement garner worker commitment to the production goals of the firm. Thus, although workers may not feel coerced, the same negative effects identified in an industrial model of workplace organization may still occur in new participatory forms.

A common critique of the early labor process work is that it has tended to minimize the significant role that both race and gender play in shaping workplace organization (Smith 1994; Vallas 2001; Wardell 1999). I had anticipated that because of the gendered and racialized nature of occupations that I would find evidence that labor processes are also gendered and raced. Within jobs, normative risks differ for and women, particularly in gender-typed jobs and occupations, where gender norms may influence the willingness of workers to submit to certain types of workplace hazards. Interaction effects for the labor process factors of autonomy, social cohesion and skill would show that these labor process factors operate differently for men and women for white and non-whites in terms of occupational and general health outcomes. Although interaction effects between gender, race and labor process factors were not found, I do not abandon this line of inquiry and will continue to find ways to test this theory about labor process and status characteristics. It may be that instead of interacting with labor processes, race and gender may interact with one another in terms of adverse health outcomes, consistent with the idea of interlocking systems of oppression where race and gender statuses are multiplicative in their effects (Anderson and Collins 1998; Collins 1990). Other ways to examine the raced and gendered nature of labor process control systems include case studies of gendered occupations, focus groups, or ethnographic research.

Discussion of Perceived Safety Climate

One of the strengths of this research is the use of four different measures of health as dependent variables. I used the same sets of independent variables for all of the dependent variables in order to identify generic patterns of occupational and general health-influencing factors. Such variables would be identified through their statistical significance in the main effects model for each of the dependent variables. Only the perceived safety climate variable met this criterion.[35]

A central problem for firms under capitalism is how to maintain profits without inducing critical health and safety problems for workers which may lead to sanctions, thus undermining organizational viability (Hall 1993). Taken at face value, the significance of

[35] Other important variable identified were age and social cohesion. Age was significant for all dependent variables except pain. Social cohesion was significant for all dependent variables except workplace injury.

perceived safety climate offers support for the value of safe working conditions for protecting occupational and general health. For each dependent variable, safety climate had intended (positive) effects. Recall, however, that from the literature review, Gillen e al. (2002) found that perceived safety climate was positively correlated with injury severity, indicating that workers tended to view the safety and health conditions at their work site favorably, even when they had been injured.

Although safety interventions have ostensibly made work safer, when scientific management techniques are used to improve safety, the net result may also be a loss of worker freedom: workers simply cannot choose unsafe ways of working. Safety management systems themselves may be a challenging phenomenon which needs to be further explained and scrutinized. The importance of perceived safety climate raises questions about how safety structures operate in the workplace and the ways in which safety mandates are bureaucratized and enforced. For example, some firms offer bonuses or rewards to workers who have not had a workplace accident, thus offering an incentive for non-reporting of injury (Dwyer 1991).

Perceived safety climate not only measures the actual safety environment; it also reflects workers' belief that management cares about safety. When we examine the relative importance of perceived safety climate as compared to the labor process control measures, we see evidence of the struggle for labor process control versus worker consent. This also raises questions about the social bases of normative attitudes toward safety.

Studies by Elton Mayo and associates at the Western Electric plant in Chicago during the 1930s and 40's argued for a Human relations Model of workplace organization that accentuated the social nature of workers (Mayo 1933, 1945). Unlike scientific management's idea that workers were lazy and needed strict managerial control, the Human Relations model starts with the basic idea that people want to work (Drucker 1954). The significance of the perceived safety climate measure invites the inclusion of a human relations model into the study of workplace organization and occupational and general health.

The empirical evidence suggests that worker labor process control is not always as important for occupational and general health as the belief that the employer cares about the safety of employees. In terms of workplace organization, further research is needed to answer questions about the ways in which safety is moderated by labor process control and exposures. Future iterations of the models will include the addition of perceived safety climate prior to the exposure variables to get a sense of potential indirect effects.

7.5 Recommendations and Policy Issues

Despite safety-based legislation and safety ergonomics, adverse effects of working for a living remain problematic. Non-alienated labor, where workers have control over the conditions of work should have beneficial effects on worker health. However, as this research has demonstrated, there are also unintended consequences of worker labor process control on occupational and general health outcomes. At the point of production, workers both consent to and resist official workplace safety systems. They must also negotiate informal work cultures that are learned through their relationships with others. Normative expectations may differ by workplace cultures, which may define risk acceptability differently from formal rule. These considerations should be included in both the sociology of work and epidemiologic models.

The findings of this research align with the research priorities issued by the National Occupational Research Agenda (NORA). It adds to our knowledge about the ways in which workplace organization is related to the health and safety of workers. The findings can be useful for health and safety promotion in workplaces. Industrial and ergonomic planners can also benefit from the knowledge gained about both the anticipated benefits of worker labor process control as well as the unanticipated consequences of worker freedom.

Epidemiologic models are still valuable in explaining workplace adverse health outcomes, particularly for rare events such as occupational injury. Although at the multivariate level, labor process variables were not always significant; the consideration of labor processes, in concert with exposures in determining persistent pain, exhaustion and general health adds the consideration of worker versus managerial power to the epidemiologic models.

Health promotion and safety planning experts approach health interventions with a behaviorist bias, assuming that workers will rationally make safe choices on the job (Becker 1993). Beyond individualist explanations, however, the ways in which work is organized influence the health and safety of workers. My findings demonstrate that the relationships are complex, and not always rational. I highlight the importance of social groups in worker behavior and the effects of social cohesion at work on occupational and general health. Workers and their control over the processes of labor are embedded within the context of production. The consequences of labor process control in production of occupational health contribute to the literature and should be utilized in health behavior interventions. Finally, the importance of perceived safety climate on occupational and general health outcomes should be considered from both epidemiologic as well as worker consent orientations.

Limitations and Avenues for Future Research

In the multivariate models for all dependent variables (with the exception of workplace injury), the results demonstrate the importance and utility of worker labor process control as in relation to adverse physical states, thus enlarging the concept of alienation to include physical health outcomes. These are statistically significant findings, but are they substantive? In some ways the dissertation raises more questions than it answers. Why were some of the labor process factors significant for some of the dependent variables but not for others? For example, why was good cohesion protective for general health, but not for exhaustion? Further empirical research is needed to assess the relative effects. Of particular concern is measurement error. Although face validity and reliability of the variables used is generally good, there are still areas (e.g., perceived safety climate) where the definitive interpretation of the concept being measured is not clear.

Future empirical models will continue to explore the relationships between socio-demographic factors, safety climate, exposures, and labor process factors. The dissertation suggests that the belief that the employer cares about the safety of employees is more important in terms of occupational and general health than is worker labor process control. I will explore this line of reasoning further, looking at safety climate as a measure of normative consent. I will revise the analysis plan so that the addition of the perceived safety climate measure comes prior to the exposure variables to get a sense of possible indirect effects. Of particular interest is how safety is moderated by labor process control and exposures. Future iterations of the models will include interactions between socio-demographic variables such as gender and race. I would also like to run interactions between labor process factors and time-related exposures such as hours worked and pace. Of particular interest are potential interaction between autonomy and pace of work: we may find that workers voluntarily increase the pace of work for a variety of reasons, which should be investigated.

Because of its beneficial significance in the all of the empirical models, safety climate is likely a measure of actual environmental conditions, supporting an epidemiologic paradigm. However, because of the normative nature of the questions, in concert with previous research using similar questions (Zohar 1980), perceived safety climate also measures a belief that the employer cares about safety, which is representative of the human relations model of employee management. The conceptual overlap in such measures makes a definitive statement about the relative paradigmatic importance difficult to ascertain. Possible remedies include the addition of other conceptual measures (such as organizational commitment) to empirical models as a method of determining employee labor process consent.

Some of the questions raised are beyond the scope of this research in its ability to answer. There are limits to the kind of data used. The 2002 GSS is a cross sectional (i.e., non-longitudinal) data source, so that time sequence is an issue. For example, the research shows that that a high level of social cohesion at work decreases the odds of persistent pain. It may be the case that persistent pain precedes social cohesion in time, so that people who are not experiencing pain are more likely to receive help and support from coworkers. Other underlying mechanisms that influence human health such as lifestyle factors, preexisting conditions and blood chemistry laboratory values (e.g., blood glucose, serotonin, cortisol) are not included in the data set. Such gaps in the empirical measures emphasize the need for further study of the links between social relationships at work and the intersection of work, biology, and health outcomes.

I attempted to bring context into the empirical models by using measures of sectoral injury risk. For the most part, these variables were non-significant. Future research should define and develop these indicators. Possible future research could also use multi-level modeling techniques. This analysis would also benefit from the ability to examine context more fully, particularly the political and economic structures that influence the health and safety of workers. For example, some of the negative effects of work on health are related to the structure of labor markets, as several studies demonstrate (Greenlund and Elling 1995; Quinlan, Mayhew and Bohle 2001; Richardson and Loomis 1997). Also part of the external context are changing patterns of work that include movement from a predominantly manufacturing sector to a growing service-based economy, increased use of temporary and part-time laborers. The interconnections between work and health should also include an examination of downsizing of workforces and how this has led to staff reductions with resultant increasing hours of work fro remaining workers and increases in fatigue, stress and injury (Gordon 1996; NORS 2002). Further analyses needs to examine how such changes impact workers of all skill levels.

Occupational injury is a rare event, statistically speaking. Attempts to determine cause using a large national data set is likely not the most optimal method. The epidemiologic technique of case control study would enable one to compare the cases of those workers who had sustained injury to those who had not, and allow for a more in-depth analysis of the underlying reasons for the injury event. The quantitative approach could be improved by a triangulated method where qualitative approaches such as key informant interviews and workplace observation are utilized.

Finally, while I utilized a variety of occupational and general health outcomes as dependent variables, this research does not capture adverse occupational health outcomes such verbal abuse and threats of workplace violence. Additionally, it does not capture incidents of “near misses”, that is, situations where injury almost happened, nor does it describe the conditions under which such events occur.

Summary

The purpose of this research is to add to our understanding of the complex relationships between working conditions and occupational health. Throughout this dissertation, I have taken several critical standpoints regarding control over labor processes. Inherent in such criticism is the supposition of the possibility of a better way of life. To indict a system of workplace organization as harmful to worker health through systems of labor process control, is to imply the possibility and desirability of a systems that does not include such control (see Sayer 1995). As a critical social scientist, I have attempted throughout this research to look at adverse occupational health outcomes and to begin to target both causes and remedies for the problem.

The research suggests that labor process autonomy, social cohesion and skill utilization generally have positive and protective effects on worker occupational health status net of socio-demographic, job status, exposures, and environments, but that the results are not uniform for all measures of occupational and general health. Social cohesion at work decreases persistent pain and exhaustion, and enhances general health, net of the effects of epidemiologic factors, but did not have protective effects on injury. Worker labor process autonomy enhances general health status, but much of its effects were explained by safety climate. Analyses indicate that labor process control is protective for workers who do not perform heavy lifting, but such control may exacerbate workplace injury for those who do perform heavy lifting. Worker skill utilization has non-linear effects on health.

The study concludes that the addition of labor process factors to the epidemiologic triad improves the model specification of persistent pain, exhaustion and general health status, but that there are unintended effects of the interaction between labor process control and heavy lifting in terms of injury. I explain some of the lack of anticipated findings in reference to Neo-Fordist models of production, where employee participation models that purport to utilize worker autonomy, social cohesion, and skill are utilized to improve the organizational bottom line, with few tangible benefits for workers. However, I have not clearly articulated the solution toward eliminating such problems, lacking a clear proposal for capitalist alternatives. A critique of capitalism involves asking whether or not capitalism actually causes the problem (of adverse occupational health), whether other social systems could possibly generate the same problems-or avoid them (Sayer 1995:37). Further assessment of workplace organization, labor process control, and occupational health outcomes is needed to more fully formulate clear directives in answer to these types of questions.

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APPENDIX A

Table 1: Industrial Fatality Rates, 2002

Industry	Fatality Rates (number of fatal injuries per 100,00 employed workers)
Mining	23.5
Agriculture	22.7
Construction	12.2
Transportation	11.3
Wholesale trade	4
Manufacturing	3.1
Gov't	2.7
Retail Trade	2.1
Finance	1.0

Source: United States, Bureau of Labor Statistics. 2003. "National Census of Fatal Occupational Injuries in 2002." U.S. Department of Labor, Washington, DC.

Table 2: Industrial Injury Rates, 2002

Industry	Injury rates per 100 employees (2002)
Manufacturing	7.2
Construction	7.1
Agriculture	6.4
Transportation	6.1
Wholesale/retail trade	5.3
Services	4.6
Mining	4.0
Finance and Public Administration	1.7

Source: United States, Bureau of Labor Statistics. 2004. "Survey of Occupational Injuries and Illnesses, 2002." U.S. Department of Labor, Washington, DC.

Appendix B: Correlation Matrix

	HLT	EXH	INJ	PAIN	M	WTE	EDU	AGE	SEL	INSU	MGR	LIFT	HND	HRS	PAC	SAF	TEN	HI	LO	ATN	COH	SKIL
HLT	1.0																					
EHX	-.18 ****	1.0																				
INJ	-.05	.09 ***	1.0																			
PAIN	-.19 ****	.21 ****	.17 ****	1.0																		
M	.03	-.09 ***	.06 *	-.01	1.0																	
WTE	.03	.04	.01	.04	.07 **	1.0																
EDU	.17 ****	-.01	-.03	-.1 ****	-.04	0.09 ***	1.0															
AGE	-.04	-.13 ****	-.08 **	-.00	-.00	.12 ****	.06 *	1.0														
SEL	.06 *	-.05	-.003	.02	.04	.07 **	.04	.17 ****	1.0													
INSU	.07 **	.02	-.05 *	-.04	-.05 *	.05 *	.17 ****	.17 ****	-.09 ***	1.0												
MGR	.03	.03	-.09 **	-.05 *	-.01	.09 ***	.11 ****	.08 **	.10 ****	.06 *	1.0											
LIFT	-.12 ****	.09 ***	.18 ****	.16 ***	.10 ****	-.07 ***	-.30 ****	-.11 ****	.03	-.15 ****	-.19 ****	1.0										
HND	-.10 ****	.13 ****	.12 ****	.22 ****	.04	.00	-.25 ****	-.08 **	.02	-.09 ***	-.13 ****	.44 ****	1.0									
HRS	.08 **	.16 ****	.06 *	-.01	.22 ****	.04	.09 ***	-.06 *	-.02	.09 ***	.12 ****	-.01	-.01	1.0								

PAC	.02	.23 ****	.04	.04	-.01	.05	-.01	-.19 ****	.02	-.08 **	.06 *	.10 ****	.14 ****	.13 ****	1.0							
SAF	.14 ****	-.12 ****	-.14 ****	-.10 ****	-.00	.06 *	.02	.09 ***	.16 ****	.01	.13 ****	-.05 *	-.06 **	.06 *	-.01	1.0						
TEN	-.02	.02	-.03	.03	.04	.12 ****	-.01	.46 ****	.14 ****	.15 ****	.07 ***	-.04	.01	.09 **	-.05	.04	1.0					
HI	-.06 *	-.01	.04	.02	.32 ****	.02	-.2 ****	-.00	.01	.01	-.03	.15 ****	.13 ****	.09 ***	-.00	.01	.09 ***	1.0				
LO	.07 **	-.04	.01	-.01	.00	.01	.07 **	.01	-.04	.08 ***	.11 ****	-.16 ****	-.07 **	.08 ***	-.02	-.02	.06 *	-.24 ****	1.0			
ATN	.19 ****	-.09 ***	-.06 *	-.06 *	.07 **	.12 ****	.19 ****	.10 ****	.30 ****	.03	.20 ****	-.15 ****	-.13 ****	.09 ***	-.02	.37 ****	.09 ***	-.02	.00	1.0		
COH	.14 ****	-.19 ****	-.04	-.14 ****	-.09 ***	.06 *	.04	.09 **	.09 **	.003	.06 *	-.11 ****	-.10 ****	-.03	-.08 **	.37 ****	.03	-.05 *	.00	.34 ****	1.0	
SKIL	.19 ****	-.00	-.02	-.08 **	-.01	.05	.23 ****	.04	.15 ****	.08 **	.15 ****	-.15 ****	-.10 ****	.20 ****	.15 *****	.37 ****	.05 *	-.09 **	0.1 ***	.48 ****	.32 ****	1.0
	HLT	EXH	INJ	PAIN	M	WTE	EDU	AGE	SEL	INSU	MGR	LIFT	HND	HRS	PAC	SAF	TEN	HI	LO	ATN	COH	SKIL

APPENDIX C

Table 1. Tests for Non-linear Effects for Labor Process Factors Predicting Workplace Injury Unstandardized Estimates (Standard error). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model Log Likelihood	Model Likelihood Ratio Test
Autonomy²	Autonomy* Autonomy	0.0104 (0.0101)	0.1063	-522.2016	1.0616 ns
Cohesion²	Cohesion* Cohesion	0.0025 (0.0377)	-1.4189	-524.4751	.0042 ns
Skill²	Skill* Skill	0.0050 (0.0139)	-0.3620	-522.6684	0.0128 ns

Table 2. Tests for Interaction Effects for Labor Process Factors and Socio-Demographics Predicting Workplace Injury Unstandardized Estimates (Standard error). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model Log Likelihood	Model Likelihood Ratio Test
Autonomy*White	Autonomy*White	-0.004 (0.086)	-1.1205	-522.7311	.0026 ns
Cohesion*Race	Low Cohesion*White	-0.085 (0.663)	-1.1463	-522.6353	0.194 ns
	Good Cohesion*White	-0.272 (0.627)			
	Excellent Cohesion*White	-0.087 (0.602)			
Skill*White	Skill*White	-0.065 (0.101)	-1.7305	-522.5269	1.011 ns
Autonomy*Male	Autonomy*Male	-0.056 (0.070)	-1.4772	-522.4195	0.6258 ns
Social Cohesion*Male	Low Cohesion*Male	0.313 (0.568)	-0.8944	-522.1515	1.1618 ns
	Good Cohesion*Male	0.532 (0.512)			
	Excellent Cohesion*Male	0.167) (0.480)			
Skill * Male	Skill*Male	-0.035 (0.083)	-1.3403	-522.6417	0.1814 ns

Table 3. Negative binomial regressions: Unstandardized estimate (SE) of workplace Injury on Task exposure and labor process interactions

Parameter	Main Model	RepHand * Autonomy	RepHand* Cohesion	RepHand*Skill
Age	-0.0175 (0.0084)*	-0.0178 (0.0084)*	-0.0170 (0.0085)*	-0.0181 (0.0084)*
White	0.235 (0.224)	0.231 (0.224)	0. 216 (0.225)	0.221 (0.224)
Male	0.137 (0.199)	0.162 (0.202)	0.136 (0.200)**	0.156 (0.200)
Less than HS	-0.372 (0.311)	-0.371 (0.311)	-0.373 (0.310)	-0.347 (0.310)
AD/BA Education	0.319 (0.227)	-0.336 (0.228)	0.324 (0.228)	0.342 (0.228)
Graduate Degree	0.639 (0.367)+.08	0.652 (0.368)	0.630 (0.368)	0.677 (0.369)
Self-Employed	0.201 (0.307)	0.190 (0.308)	0.172 (0.308)	0.193 (0.307)
Insured	-0.217 (0.264)	-0.201 (0.265)	-0.189 (0.265)	-0.201 (0.264)
Manager	-1.239 (0.381)**	-1.245 (0.383)***	-1.238 (0.382)****	-1.249 (0.383)**
Job Tenure 0-3 years	0.346 (0.235)	0.357 (0.236)	0.316 (0.235)	0.340 (0.235)
Job Tenure 10+ years	0.183 (0.272)	0.199 (0.273)	0.178 (0.271)	0.192 (0.272)
Autonomy	0.0124 (0.0416)	-0.029 (0.068)	0.011 (0.0417)	0.013 (0.0415)
Low Social Cohesion	-0.1883 (0.289)	-0.1993 (0.290)	-0.206 (0.483)	-0.177 (0.289)
Good Social Cohesion	-0.371 (0.252)	-0.369 (0.252)	-1.040 (0.458)	-0.345 (0.253)
Excellent Cohesion	0.077 (0.248)	0.088 (0.249)	-0.114 (0.380	0.089 (0.248)
Skill Utilization	0.0447 (0.053)	0.044 (0.053)	0.0503 (0.0531)	-0.017 (0.079)
Repetitive Hand	0.386 (0.220)+07	-0.295 (0.922)	0.0467 (0.371)	-0.787 (1.134)
Heavy Lifting	1.487 (0.231)****	1.468 (0.232)	1.520 (0.233)	1.454 (0.232)****
Working Fast	0.0741 (0.112)	0.081 (0.113)	0.068 (0.112)	0.079 (0.112)
Hours Worked	0.0149 (0.0065)*	0.015 (0.0065)	0.0152 (0.0065)	0.015 (0.0065)*
Safety Climate	-0.240 (0.041)****	-0.240 (0.041)	-0.241 (0.041)	-0.242 (0.041)
High Risk Industry	0.351 (0.221)	0.339 (0.221)	0.350 (0.220)	0.342 (0.220)
Low Risk Industry	0.492 (0.303)	0.462 (0.306)	0.503 (0.302)	0.444 (0.307)
RepHand* Autonomy		0.057 (0.075)		
RepHand*Low Cohesion			0.083 (0.560)	
RepHand*Good Cohesion			0.979 (0.552)	
RepHand*Excel Cohesion			0.329 (0.483)	
RepHand*Skill				0.092 (0.087)
Intercept	-1.086	-0.627	-0.953	-0.277
Log likelihood	-522.7324	-533.4429	-520.943	-522.1777
Likelihood Ratio Test/DF	5.588 ns	0.579 ns df=1	3.579 df=3 ns	1.109 df=1 ns

Table 4. Tests for Non-linear Effects for Labor Process Factors Predicting Persistent Pain. Unstandardized Coefficients (Standard error).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model -2 Log Likelihood	Model Incremental Chi-Square
$Autonomy^2$	Autonomy*Autonomy	-0.000428 (0.00635)	-1.0458	2036.672	0.449 ns
$Cohesion^2$	Cohesion*Cohesion	-0.00714 (0.0224)	0.0804	2039.469	0.204 ns
$Skill^2$	Skill*Skill	0.00340 (0.00772)	-0.0245	2036.927	0.194 ns

Table 5. Tests for Interaction Effects for Labor Process Factors and Socio-Demographics Predicting Persistent Pain Unstandardized Estimates (Standard error). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model -2 Log Likelihood	Model Incremental Chi-Square
Autonomy*White	Autonomy*White	0.014 (0.053)	-0.395	2037.048	0.073 ns
Cohesion*Race	Low Cohesion*White	-0.632 (0.395)	-0.6177	2032.258	4.863 ns
	Good Cohesion*White	-0.432 (0.376)			
	Excellent Cohesion*White	0.097 (0.355)			
Skill*White	Skill*White	0.072 (0.058)	0.206	2035.598	1.523 ns
Autonomy*Male	Autonomy*Male	0.03 (0.041)	-0.349	2036.598	0.523 ns
Social Cohesion*Male	Low Cohesion*Male	0.281 (0.34)	-0.435	2035.598	1.523 ns
	Good Cohesion*Male	-0.018 (0.302)			
	Excellent Cohesion*Male	0.242 (0.283)			
Skill * Male	Skill*Male	0.056 (0.048)	-0.1439	2035.764	1.357 ns

Table 6. Tests for Interaction Effects for Labor Process Factors and Task Exposures Predicting Persistent Pain Unstandardized Estimates (Standard error). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model -2 Log Likelihood	Model Incremental Chi-Square
Autonomy* Repetitive Hand Movements	Autonomy* Rephand	0.013 (0.041)	-0.442	2037.032	0.089 ns
Cohesion* Repetitive Hand Movements	Low Cohesion*Rephand	0.176 (0.349)	-0.529	2035.963	1.159 ns
	Good Cohesion*Rephand	-0.166 (0.301)			
	Excellent Cohesion*Rephand	-0.120 (0.279)			
Skill* Repetitive Hand Movements	Skill*Rephand	0.026 (0.049)	-0.331	2036.838	0.283 ns
Autonomy* Lifting	Autonomy* Lifting	0.013 (0.041)	-0.446	2037.028	0.093 ns
Social Cohesion* Lifting	Low Cohesion* Lifting	0.279 (0.342)	-0.448	2036.321	0.8 ns
	Good Cohesion*Lifting	0.075 (0.299)			
	Excellent Cohesion*Lifting	0.172 (0.281)			
Skill * Lifting	Skill* Lifting	0.021 (0.049)	-0.377	2036.929	0.195 ns

Table 7. Tests for Non-linear Effects for Labor Process Factors Predicting Exhaustion Unstandardized Coefficients (Standard error).

Parameter Variable	Parameter estimate	Intercept	Adjusted R-Square	Incremental F
Autonomy*Autonomy	0.0004550 (0.00320)	2.71890	0.1332 less than main model	ns
Cohesion*Cohesion	0.00892 (0.12289)	3.813	0.1345 less than main model	ns
Skill*Skill	-0.0094684 (0.00389)	2.57289	0.1333 less than main model	ns

Table 8. Tests for Interaction Effects for Labor Process Factors and Socio-Demographics Predicting Exhaustion Unstandardized Estimates (SE). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model Adjusted R-square	Model Incremental F
Autonomy*White	Autonomy*White	-0.0294 (0.026)	2.449	0.1339	1.83 ns
Cohesion*Race	Low Cohesion*White	0.145 (0.201)	2.735	0.1351	0.7861 ns
	Good Cohesion*White	-0.253 (0.188)			
	Excellent Cohesion*White	0.122 (0.173)			
Skill*White	Skill*White	-0.049	2.212	0.1348	1.829 ns
Autonomy*Male	Autonomy*Male	-0.023 (0.021)	2.578	0.1339	1.83 ns
Social Cohesion*Male	Low Cohesion*Male	0.249 (0.175)	2.796	0.1337 less than main effects	ns
	Good Cohesion*Male	0.202 (0.152)			
	Excellent Cohesion*Male	0.095 (0.143)			
Skill * Male	Skill*Male	-0.0437 (0.024)	2.418	0.1350	2.196 ns

Table 9. Tests for Interaction Effects for Labor Process Factors and Task Exposures Predicting Exhaustion Unstandardized Estimates (SE). (N=1607).

Model	Interaction Term	Individual Parameter	Model Intercept	Adjusted R-Square	Model Incremental F
Autonomy* Repetitive Hand Movements	Autonomy* Rephand	0.0011 (0.021)	2.720	0.1332 less than main effects	ns
Cohesion* Repetitive Hand Movements	Low Cohesion*Rephand	0.119 (0.178)	2.742	0.1334 less than main effects	ns
	Good Cohesion*Rephand	-0.104 (0.151)			
	Excellent Cohesion*Rephand	0.079 (0.141)			
Skill* Repetitive Hand Movements	Skill*Rephand	-0.0015 (0.025)	2.703	0.1333 less than main effects	ns
Autonomy* Heavy Lifting	Autonomy* Lifting	0.012 (0.021)	2.785	0.1334 less than main effects	ns
Social Cohesion* Heavy Lifting	Low Cohesion* Lifting	0.112 (0.175)	2.751	0.1325 less than main effects	ns
	Good Cohesion*Lifting	0.056 (0.151)			
	Excellent Cohesion*Lifting	0.093 (0.143)			
Skill * Heavy Lifting	Skill* Lifting	0.004 (0.025)	2.743	0.1333 less than main effects	ns

Table 10. Tests for Non-linear Effects for Labor Process Factors Predicting Health Status Unstandardized Coefficients (SE).

Parameter Variable	Parameter estimate	Intercept	Adjusted R-Square	Incremental F
Autonomy*Autonomy	-0.00238 (0.00296)	2.41325****	0.0807	ns
Cohesion*Cohesion	0.00072047 (0.01035)	2.42243****	0.0776	ns
Skill*Skill	0.00790 (0.00358)	3.87818****	0.0832	3.97 * critical F=3.84 see full model

Table 11. Tests for Interaction Effects for Labor Process Factors and Socio-Demographics Predicting Health Status Unstandardized Estimates (SE). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model Adjusted R-square	Model Incremental F
Autonomy*White	Autonomy*White	0.039 (0.024)	3.059	0.0818	1.55 ns
Cohesion*Race	Low Cohesion*White	-0.293 (0.186)	2.703	0.0808 less than main effects	ns
	Good Cohesion*White	-0.04 (0.174)			
	Excellent Cohesion*White	-0.072 (0.159)			
Skill*White	Skill*White	-0.009 (0.027)	2.61	0.0804 less than main effects	ns
Autonomy*Male	Autonomy*Male	-0.006 (0.019)	2.670	0.0804 less than main effects	ns
Social Cohesion*Male	Low Cohesion*Male	-0.023 (0.161)	2.70	0.0795 less than main effects	ns
	Good Cohesion*Male	-0.062 (0.141)			
	Excellent Cohesion*Male	0.035 (0.132)			
Skill * Male	Skill*Male	0.033 (0.022)	2.928	0.0816	1.206 ns

Table 12. Tests for Interaction Effects for Labor Process Factors and Task Exposures Predicting Health Status Unstandardized Estimates (Standard error). (N=1607).

Model	Interaction Term	Individual Parameter estimate	Model Intercept	Model Adjusted R-Square	Model Incremental F
Autonomy* Repetitive Hand Movements	Autonomy* Rephand	0.242 (0.019)	2.86	0.0813	0.689 ns
Cohesion* Repetitive Hand Movements	Low Cohesion*Rephand	0.129 (0.163)	2.79	0.0850	2.36 ns
	Good Cohesion*Rephand	0.399 (0.139)			
	Excellent Cohesion*Rephand	0.318 (0.130)			
Skill* Repetitive Hand Movements	Skill*Rephand	0.0155 (0.023)	2.85	0.0806 less than main effects	ns
Autonomy* Lifting	Autonomy* Lifting	0.016 (0.019)	2.81	0.0809 less than main effects	ns
Social Cohesion* Lifting	Low Cohesion* Lifting	0.345 (0.161)	2.84	0.0834	1.4369 ns
	Good Cohesion*Lifting	0.319 (0.139)			
	Excellent Cohesion*Lifting	0.272 (0.132)			
Skill * Lifting	Skill* Lifting	0.003 (0.023)	2.73	0.0804 less than main effects	ns