SURVEILLANCE METHODS FOR HEALTH CARE & RELATED WORKERS: DEVELOPMENT AND IMPLEMENTATION OF THE DUKE HEALTH AND SAFETY SURVEILLANCE SYSTEM (DHSSS)

Principle Investigator: John M. Dement, Ph.D.
Professor
Division of Occupational & Environmental Medicine
Department of Community & Family Medicine
Duke University Medical Center
2200 W. Main Street, Suite 700
Durham, NC 27705
Tel: (919)-286-3232, Ext 266
FAX: (919)-286-1620
E-mail: John.Dement@Duke.edu

Co-Investigators: Truls Østbye M.D., Ph.D.
Lisa A. Pompeii Ph.D.
Hester Lipscomb, Ph.D.
Carol Epling M.D., MSPH
George Jackson, M.D.
Wayne Thomann, Ph.D.
Debra Hunt, Ph.D.

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ABBREVIATIONS

BBF	Blood and body fluid exposure
BMI	Body mass index
DHSSS	Duke Health and Safety Surveillance System
DUHS	Duke University Health System
DUMC	Duke University Medical Center
FTE	Full time equivalent
HIPAA	Health Insurance Portability and Accountability Act
HCW	Health care worker
HRA	Health risk appraisal
JEM	Job-exposure-matrix
NaSH	National System for Surveillance of Health Care Workers
MSK	Musculoskeletal injury
OESO	Occupational and Environmental Safety Office
PAR	Population at risk
PTC	Pathways-to-Change
STS	Standard Threshold Shift
WC	Workers' compensation

ABSTRACT

A comprehensive occupational safety and surveillance system for health care workers (HCW) and related workers was developed and implemented by this project. This new surveillance system, known as the Duke Health and Safety Surveillance System (DHSSS), represents a unique collaboration across multiple organizational units within a large health system. These organizational groups included Human Resources, Employee Occupational Health, the Occupational and Environmental Safety Office (OESO), employee health promotion programs, and the Department of Community and Family Medicine, Division of Occupational and Environmental Medicine. The DHSSS is a model system for surveillance of occupational and personal risk factors and health outcomes among a large and diverse population of HCWs and provides data useful for problem identification as well as evaluation of intervention/prevention measures.

The DHSSS maximizes use of existing data sources and current coding schemes for important variables such as departments, jobs, and work locations. Linkage of information across multiple data sources allows appropriate group level data analyses, while protecting information confidentiality and individual privacy through use of a HIPAA compliant limited use dataset. This project and the procedures for assuring confidentiality have been reviewed and approved by the Duke University Health System Institutional Review Board.

The DHSSS can be viewed as a 'data warehouse', consisting of multiple data partitions which can be linked to extract individual level variables of interest to form specific population-based analysis datasets. These data sources are updated annually, or more often if needed to address specific project needs. Health claims extraction and HIPAA compliant file generation services for this project are provided by the outside contractor used by Duke Human Resources for health claims data processing. The DHSSS provides data useful for cross-sectional, longitudinal, and case-control study designs.

The DHSSS has been used for a number of internal analyses and reports, as well as peer-reviewed publications. These analyses have included: 1) Workers' compensation analyses addressing overall injuries and illness rates, patient lifting and back injuries, and musculoskeletal injuries; 2) Blood and body fluid exposures and exposure rates; 3) Latex exposures and latex allergy; 4) Health risk factors and predictors of health insurance utilization; 5) Obesity and workers' compensation claims; 5) Analyses of health risk factors from health risk appraisals; and 6) Evaluation of intervention and prevention programs.

Findings from the different descriptive, analytical, and prevention evaluation studies using the DHSSS should be generalizable and have broad application to other health care settings. Furthermore, most of the data sources included in the surveillance system are available in most health care settings; therefore, the surveillance model should have broad application to other health care organizations, and possibly other occupational settings.

HIGHLIGHTS/SIGNIFICANT FINDNGS

The capability of the DHSSS system to examine a broad range of exposures and health outcomes among a large and diverse population of HCWs has been demonstrated through a series of detailed analyses that address project specific aims. Additional studies have been completed that address specific issues raised by investigators, employees, or managers. While this surveillance system has thus far focused on certain targeted HCW concerns, the multitude of data sources allows for the examination of a broad range of end points, some of which have not, or only to a limited extent, been considered for HCWs specifically.

Brief highlights and significant findings of the in-depth analyses completed using data from the DHSSS are summarized below and described in more detail in this report.

- **Workers' Compensation Data Analyses**

  - Nurses' aides, dietary workers, housekeeping, skilled craft workers, lab animal technicians, medical supply and assembly personnel, and radiology technicians experienced the highest injury rates.

  - Much of the increased risk among nurses and nurses' aides was related to patient lifting, which should decrease with implementation of new prevention measures, including mechanical lift devices.

  - Obesity was found to be a very strong risk factor for workers' compensation claims, especially for musculoskeletal injuries and disorders. Severely obese employees (BMI>40) had 50% more workers' compensation claims than recommended-weight employees. The effect on lost-days and costs was even stronger (approximately 10 times higher among the heaviest workers). Falls and overexertion injuries were most strongly related to obesity.

- **Blood and Body Fluid Exposure Analyses**

  - Overall, percutaneous exposure rates among Duke employees have decreased significantly since implementation of a number of preventive measures, including greater use of shapes with safety features. The exception to this trend is suture needle injuries in the operating rooms (OR). These analyses led to more detailed studies to better define risk factors for these OR exposures and to evaluate prevention measures, such as use of blunt suture needles and use of neutral or safety zones for transfer of instruments between the surgeon(s) and other scrubbed personnel.

- **Latex Exposures and Latex Allergy**

  - Overall, 6.0% of health care providers reported symptoms consistent with latex reactivity, and 2.7% were confirmed clinically as having latex allergy. Latex

reactivity was significantly associated with female gender, African-American race, atopy, and allergies to foods, medication or environmental aeroallergens. Duration of work in health care conferred significantly increased risk for latex reactivity and allergy with risk estimates rising with longer duration of work history. Working as a nurse, medical or lab technician, physician's assistant, nursing care assistant, other clinical professional and housekeeper was significantly associated with latex reactivity.

- **Personal Health Risk Factors and Health Claims Analyses**

  - The prevalence of obesity (BM I ≥ 30) among Duke employees was found to be 25.9% and an additional 29.3% of employees were found to be overweight (BMI ≥ 25 and < 30). Obesity prevalence was considerably higher among females (32.5%) and African-Americans (48.4%) and among employees in several occupational groups including housekeeping staff (46.9%), laundry staff (54.6%), office support (45.9%), clerical support (42.2%), and medical support (45.0%).

  - The prevalence of unrecognized or under-controlled hypertension was found to be 12.2% among Duke employees. An additional 41.5% of Duke employees were found to have elevations sufficient to be classified as 'Pre-Hypertensive' by current guidelines. African-American employees (male and female) were found to have a substantially higher prevalence of hypertension compared to the U.S. population based on NHANES III data.

  - Among participants in the Live-for-Life *Pathways-to-Change*, an intervention program for hypertension and elevated cholesterol, the overall prevalence of hypertension improved from 47.1% to 21.3%, with significant improvement observed for both males and females. The prevalence of elevated total cholesterol also improved for both male and female program participants, with average decreases of 14.8 mg/dL for males and 13.9 mg/dL for females. *Pathways-to-Change* program participants with hypertension were found to be over 7.3 times more likely to improve their status to non-hypertensive compared to hypertensive employees not participating in one of the Duke health promotion programs.

  - Obese employees at Duke were found to have approximately a 23% higher rate of health care utilization, after controlling for gender, age, race, tobacco use, work-related stress, and family-related stress. Employees with diabetes and/or hypertension, two conditions closely linked to obesity, also were found to have significantly increased rates of health care utilization. These data support obesity and related risk factors as important contributors to increased health care costs.

  - Self-reported work-related stress was found to be significantly elevated among house staff, nurse managers, and faculty. Analyses of health care utilization found higher utilization among employees reporting elevated work or family stress.

- Less than 25% of Duke employees 50 and older had any form of annual CRC screening in compliance with current guidelines and only 45% had any CRC screening during a 3-year follow-up period. Annual CRC screening rates below 20% were observed among many occupational groups. An NIH grant application to evaluate methods for increasing screening and compliance with NIH colon cancer screening guidelines has been developed and submitted.

Both the breadth and the depth of analyses that have been undertaken using the DHSSS have demonstrated the utility of the surveillance system.

TRANSLATION OF FINDINGS

This project has demonstrated that existing record systems, many which have been established for administrative and financial purposes, although sometimes diverse in structure and purpose, can be linked and used for surveillance of health and safety issues among health care workers. The utility of the system established by this project will increase as data are added longitudinally.

Results of our detailed studies using the DHSSS have identified several issues requiring greater attention with regard to intervention and prevention programs. These include increased risks of injuries among several nurses and nursing aides who lift and re-position patients, and increased risk of blood and body fluid exposures among operating room personnel. Addressing both of these issues effectively will require a range of control measures to including engineering interventions, work practices changes, use of personnel protective equipment, and employee training.

Our studies also have been useful in identifying the complex relationships that exist between personal risk factors, such as obesity, and occupational risk factors. Our analyses suggest interaction between some of these risk factors to significantly increase injury risks. Worksite intervention programs will be most effective when both work factors and personal risk factors are addressed collectively.

OUTCOMES/REVELANCE/IMPACT

The findings from the different descriptive, analytical, and prevention evaluation studies using the surveillance system developed by this project should be generalizable and have broad application to other health care settings. Furthermore, most of the data sources included in the surveillance system are available in most health care settings; therefore, the surveillance model should have broad application to other health care organizations, and possibly other occupational settings.

SCIENTIFIC REPORT

CHAPTER 1: BACKGROUND AND SPECIFIC AIMS

BACKGROUND

Private hospitals in the U.S. employ 45% of all health care workers including physicians, nurses, and health technicians as well as large numbers of administrative and secretarial staff, maintenance workers, housekeepers, and food service staff [BLS, 2002]. Many of these health care workers (HCWs) are highly mobile within the hospital environment and some groups have high turnover rates, characteristics that place them at risk of exposure to a large number of hazardous agents varying by work location and job responsibilities. For example, housekeepers in hospitals are exposed to cleaning agents that can cause skin rashes and respiratory irritation, as well as bloodborne and airborne pathogens present among patient care units and laboratories where they work.

Infectious airborne agents are numerous in the hospital environment, with at least 15 agents having been reported transmitted to health care workers since 1983, including varicella, measles, influenza, and respiratory syncytial virus infection [Sepkowitz, 1996a]. Tuberculosis has been identified as one of the most prevalent hospital airborne agents with nurses, housekeeping, laundry staff, dietary workers, nurses, and laboratory workers at greatest risk of exposure [NIOSH 1999; Kao et al., 1997; Miller et al., 2002]. Severe acute respiratory syndrome (SARS) is the most recently discovered airborne agent that hospital employees are at risk of contracting while at work [MMWR, 2003].

Exposure to *blood and body fluids* through needlestick injuries and splashes places the HCWs at risk for numerous bloodborne pathogens including HIV, hepatitis B (HBV), and hepatitis C (HCV) [Sepkowitz, 1996b; Perry et al., 2003]. The CDC [1997] reports that approximately 800,000 blood and body fluid exposure incidents occur annually in the U.S. resulting from needlesticks, spills, and lacertations. Furthermore, there are 400,000 annual needlesticks among 4 million HCWs in the U.S. The CDC [1997] estimates that HBV exposure results in 125 to 190 deaths annually among HCWs in the U.S.

Ergonomic stressors such as to patient lifting and transfers place HCWs at increased risk for back and upper extremity injuries. Nurses and nurses' aides have been identified as workers at high risk for injuring their backs on the job [Choi et al., 1996; Engkvist et al., 2000]. Among workers most likely to lose time due to occupational back pain, nurses' aides, orderlies, and nurses rank among the highest [U.S. DOL, 2002]. Other HCWs such as administrative and data management personnel are at risk of repetitive motion injuries especially carpal tunnel syndrome [NIOSH, 1997].

Latex allergy can result from exposures to proteins in natural rubber latex through skin contact or inhalation and reactions can begin within minutes to hours after exposure [NIOSH, 1997]. Eight to 12% of HCWs regularly exposed to latex are sensitized, compared to 1 to 6% of the general population [NIOSH, 1997; Hamilton et al., 1998].

Exposures to vapors from *organic solvents* (e.g. benzene, toluene, xylene, ethers, dioxane, etc.), chemotherapeutic agents, and mercury are potential hazards for HCWs, especially those who work in laboratories. Increased adverse pregnancy outcomes such as spontaneous abortion among laboratory workers exposed to toluene, xylene and formalin have been observed. Furthermore, epidemiologic data suggest that laboratory workers are at increased mortality risk for certain cancers such as malignant lymphoma, leukemia and cancers of the gastrointestinal [Dement & Cromer, 1992; Taskinen et al., 1994; McMartin et al., 1998]

Various skilled trade workers perform *maintenance and alterations* on institutional facilities including hospitals, laboratories, animal facilities, and utilities and have many of the same potential occupational exposures as professional and technical HCWs. In addition, maintenance and craft workers may be exposed to other building related materials such as silica, asbestos, cement, wood, man-made mineral fibers, and drywall finishing dusts, which may place them at increased risk for lung disorders such as bronchitis, emphysema, asthma, and chronic airways obstruction. Craft workers may be exposed to solvents, paints, coatings, glues, fillers, and cutting and welding fumes and workers involved in renovations also may be exposed to molds, dust mites, and other organic dusts [Lipscomb & Dement 1998]. Excess deaths due to lung cancer have been reported among carpenters (NIOSH, 1974; Firth et al., 1993) and generally among construction workers [Robinson et al., 1996; NIOSH, 2002]. An association between asthma, chronic obstructive lung disease (COPD), and pneumoconiosis, has been reported with various construction trades [Lipscomb & Dement, 1998; NIOSH, 2003; Hnizdo et al., 2002].

In addition to the hazardous exposures HCWs encounter on a regular basis, changes in the health care system in the U.S. over the past decade have resulted in increased work responsibilities for HCWs in the hospital setting resulting in greater work stress. A shift in patient care from hospitals to home health services has occurred in an effort to decrease the cost of patient care [Bureau of National Affairs, 1998], requiring nursing personnel, technicians, and other HCWs to become more skilled in order to care for sicker patients that require hospitalization. Cost savings efforts have also led to downsizing of hospital staff, decreasing the ratio of registered nursing personnel per hospital bed by more than 50 percent between 1983 and 1994 [Engel, 1999], thus further increasing the work load for HCWs. A recent study reported that nurses employed in hospitals with the highest patient-nurse ratios were more than twice as likely to report job dissatisfaction and burnout compared to nurses employed in hospitals with lower ratios (Aiken et al., 2002).

Hospital workers are at high risk for experiencing *violence* in the workplace. According to the Bureau of Labor Statistics (BLS), 2,637 nonfatal assaults on hospital workers occurred in 1999 and the resulting rate of 8.3 assaults per 10,000 hospital workers is significantly higher than the rate of 2 per 10,000 for all private-sector industries [NIOSH, 2002]. A case-control study identified several risk factors for assaults on nurses including high patient-to-nurse ratio, working with psychiatric patients, and working with patients who stay in the hospital long term (> 4 weeks vs. 1 day) [Su-hsing et al., 1999].

A complete enumeration of exposures experienced by HCWs and their associated health and injury risks is beyond the scope of this review. However, it is clear that the occupational hazards among HCWs are increasing. The mobile nature of this work force, in combination with the

complexity of the work environment, make surveillance of work-related exposures, injuries, and illnesses important but challenging for health facility managers, occupational health and safety professionals, and researchers.

SPECIFIC AIMS

The major objective of this research was to develop and implement a comprehensive system for health, injury, and hazard surveillance of health care workers. This was accomplished through the combination of population-based and case-based data. The system has been implemented for surveillance of a cohort of over 20,000 health care and related employees of the Duke University Health System (DUHS), which is comprised of the Duke University Hospital and its affiliated health clinics, Durham Regional Hospital, Raleigh Community Hospital, Triangle Hospice, Duke and St. Joseph Home Care, and Duke Community Infusion Service. Project specific aims were as follows:

Specific Aim 1: To develop a model surveillance system which uses both population-based and case-based model tools for health, injury, and hazard surveillance of health care workers.

Specific Aim 2: To expand the current National Surveillance System of Hospital Health Care Workers (NaSH) model for case-based surveillance of blood and body fluid exposures to include collection of detailed information on occupational injuries, musculoskeletal injuries during patient lifting and handling, and active medical surveillance for latex allergy.

Specific Aim 3: To develop a job-exposure-matrix (JEM) for health care workers in order to characterize potential chemical, biological, physical, and ergonomic exposures.

Specific Aim 4: To apply the model surveillance system to over 20,000 employees of the Duke University Health System. These analyses will: 1) determine the overall rates and patterns of defined work-related injuries and illnesses by age, gender, occupation/skill, work location, and exposures, 2) define high risk sub-groups for different types of events, and 3) identify possible prevention strategies for a large cohort of health care workers.

Specific Aim 5: To evaluate the utility and efficiency of the model surveillance system through detailed studies of conditions of importance to health care workers. Specific conditions to be addressed will include musculoskeletal injuries, latex allergy, latex allergy, and work-related stress

CHAPTER 2: SURVEILLANCE SYSTEM DEVELOPMENT AND IMPLEMENTATION

OVERVIEW

The surveillance system developed by this project has been named the Duke Health and Safety Surveillance System (DHSSS). The DHSSS covers employees of the Duke University Health System (DUHS), which is comprised of the Duke University Hospital and its affiliated health clinics, Durham Regional Hospital, Raleigh Community Hospital, Triangle Hospice, Duke and St. Joseph Home Care, and Duke Community Infusion Service. The DHSSS was developed around several ongoing programs and data sources including human resources, employee health benefits, industrial hygiene, radiological hygiene, hazardous waste management, emergency preparedness, occupational medicine, workers' compensation, and employee health promotion. While no single data source satisfied all information needs, collectively, the available information sources defined the population of HCWs and their demographics, occupations, work locations, potential exposures, and health outcomes. Several overriding principles guided the selection of data sources as well as the process of surveillance system development:

- The system should provide comprehensive surveillance of occupational exposure hazards, occupational injuries, and occupational diseases.
- The system should make maximum use of existing data sources as well as current coding schemes for important variables such as departments, jobs, and work locations.
- Linkage of data across datasets should allow individual level data analyses, while protecting information confidentiality and individual privacy.
- The surveillance system should be well integrated and sustainable at a moderate cost after initial funding for development.

Initially, we established a comprehensive inventory of existing data sets and information sources, including technical and administrative contact persons for each data source. The data sets deemed to be of most relevance to occupational injuries and diseases were identified for inclusion into the DHSSS (Table 2-1). The system consists of a large number of data tables linkable at the individual level using an assigned identification number.

A conceptual model of the DHSSS is shown in Figure 2-1. A key characteristic of the DHSSS is the ability to integrate data for purposes of routine reporting as well as for ad hoc analyses based on specific research or surveillance questions. Routine reports and data extracts can be generated and formatted within Microsoft Access for detailed statistical analyses and modeling using SAS or other statistical packages. Each data source is briefly described below as well as the data integration process.

POPULATION DEFINITION AND DEMOGRAPHIC DATA

Human resources data were used to define the total population of persons employed by the DUHS at any time starting in calendar year 1997. Human resources data provide worker demographics (age, race, sex), employment information (date if hire, job, work location, date of termination), and work schedule. Calendar year 1997 was chosen in order to define population characteristics for specific retrospective analyses, such as exposures to bloodborne pathogens

and workers' compensation data. For analyses of health outcomes using medical insurance health claims data, the study population may be further restricted to employees participating in one of the Duke health insurance plans. Over 90 percent of eligible employees participate in one of the Duke health insurance plans. The medical insurance participant file defines the starting and ending dates of coverage during a calendar year as well as the number of months covered.

POTENTIAL EXPOSURES - DEVELOPMENT OF THE JOB-EXPOSURE MATRIX

A JEM is central to the DHSSS. Our surveillance system builds upon a JEM developed by the Duke University Occupational and Environmental Safety Office (OESO) to identify and track employees needing specific types of training and certification (e.g. hazard communication training, blood and body fluid exposure prevention, tuberculosis testing, industrial lift truck operation, etc.) or who have potential occupational exposures. Exposure or training categories included in the JEM of December 2005 are shown in Appendix I. While some of these categories relate to administrative requirements such as compliance training required by the Health Insurance Portability and Accountability Act (HIPAA), most of the categories relate to potential exposures or hazards. The JEM includes information relating to exposures to animals, asbestos, blood and body fluids, chemicals, hazardous drugs, ethylene oxide, lasers, lead, noise, pesticides, refrigerants, tuberculosis, radioisotopes, external ionizing radiation, and formaldehyde. Employees also are characterized as to work in laboratories, use of respiratory protection, and exposures to selected physical hazards such as the use of ladders, driving of industrial lift trucks, driving of fleet vehicles, and work in confined spaces. The exposure categories may not be mutually exclusive, as many are based on performance of work tasks associated with potential for exposure. For example, employees may perform a number of the tasks with potential exposures to blood and body fluids and are assigned to each category where appropriate. The JEM is a dynamic tool, with updates occurring as new exposures and/or training requirements are identified. The DHSSS tracks these changes in the JEM annually and maintains a history of changes for longitudinal analyses.

When a new employee is hired, or a current employee changes jobs within the DUHS, initial exposure assignments are made based on the JEM. The OESO then sends the supervisor a new employee orientation form to provide additional information that will better define potential exposures for their new employee. Using the supervisor's response, the employee's initial assignment to specific exposure categories and levels of exposure is adjusted. This procedure allows for better refinement of potential employee exposures based on actual work circumstances and reflects a refinement of the initial JEM exposure assignments.

An example of blood and body fluid (BBF) exposure level assignments for all HCWs and selected jobs is given in Table 2-2 and several items should be noted. First, the general occupational title 'nurse' can be sub-categorized by work location and function, and this table shows data for inpatient nurses. Although not shown in this table, our data allows us to develop ad hoc subgroups based on combinations of department, job title, and work location. Secondly, employees are placed in multiple levels for potential BBF exposures. Nearly all inpatient nurses have potential exposures to blood and body fluids and perform direct patient care activities. Housekeeping and laundry workers are less likely to perform direct patient care activities;

however, they have potential exposures to BBF through the handling of body fluids and contaminated materials.

OUTCOMES DATA SOURCES

Outcomes in the DHSSS include active and passive surveillance components with the objective of capturing information on both occupational injuries and diseases possibly related to work. Duke University is self-insured for workers' compensation coverage and data from this program provide our primary general coverage of reported occupational injuries and illnesses. Additional reporting and data collection mechanisms for exposures to BBF and injuries occurring during patient lifting and transfers supplement workers' compensation data. Monitoring and evaluation of occupational BBF exposures have been ongoing at DUMC since 1992 and a 24-hour hotline for timely reporting and evaluation of exposures was introduced in 1996. Since January 1998, Duke has participated in the National Surveillance System for Hospital Health Care Workers (NaSH) administered by the Centers for Disease Control and Prevention (CDC), and these data have been used to prioritize and evaluate prevention programs. Data from the NaSH program have been integrated into the overall surveillance program with data links to individual cases.

Duke employee health insurance benefits include inpatient and outpatient, pharmacy, and mental health services provided through several vendors. Staff members who work 20 hours or more per week are eligible to participate in the health care plans and faculty members working more than 1,000 hours per year are eligible to participate. Over 90% of eligible employees participate in one of the Duke health care plans. Individual level health claims for inpatient and outpatient services, mental health services, and pharmacy services are collected and integrated into the DHSSS. These data provide information concerning the dates of service, procedures, diagnoses, and associated costs. Health care utilization data supplement existing workers' compensation and other injury data sources in the DHSSS for surveillance of work-related and non-work related injuries and health conditions.

PERSONAL RISK FACTORS - HEALTH RISK APPRAISALS

Duke University has an active employee health promotion program with includes health risk appraisals, health education classes, personal health assistance for high blood pressure, high cholesterol and/or smoking, and personal consultation in nutrition and/or fitness. Duke has offered the Johnson & Johnson INSIGHT™ health risk assessment (HRA) to employees who are eligible for health benefits since 1989 and these data have been included in the DHSSS. The HRA questionnaire includes data on a number of important personal risk factors including tobacco use, nutrition, physical activity, stress management, automobile safety, alcohol use, and medical history. The HRA biometric data includes blood pressure, cholesterol, height, weight, and body mass index.

DATA LINKAGE AND CONFIDENTIALITY

The DHSSS links many data sources at the individual level; therefore, procedures to ensure data confidentiality and individual privacy are essential. The Duke University Human Subjects Institutional Review Board (IRB) reviewed the project and approved procedures to be used for

protection of Human Subjects and compliance with the Health Insurance Portability and Accountability Act of 1996 (HIPAA). While data are linkable at the individual level, all data are de-identified per HIPAA requirements for a limited use dataset using an external, independent contractor experienced with data management and linkage in environments with high confidentiality. The DHSSS operating and analysis files relating to individual employees all contain a unique identifier, which allows investigators to link different records relating to the same individual over time within one database and across different databases, but do not allow identification of specific individuals. These de-identified data sets are stored in a Microsoft Access relational database on a secured server with access strictly limited to authorized users.

DHSSS SYSTEM SUMMARY AND POPULATION DEMOGRAPHICS

Table 2-1 summarizes information on the various data sources that comprise the DHSSS through calendar year 2004. Data updates through calendar year 2005 are underway.

As of calendar year 2004, the DHSSS included over 85,000 individuals employed at any time since 1997, the starting date for the retrospective component of the surveillance system. The mean age of Duke employees in 2004 (N=42,656) was 38.2 years (std. dev.=13.5 years) with 61.2% being female and 38.8% male. The racial composition of this population is 67.8% white, 21.1% black, and 11.1% other; the average duration of employment at Duke of 6.8 years (std. dev.=8.7 years). The surveillance population encompasses the broad spectrum of managerial, professional, clerical, skilled crafts needed to provide patient care and service as well as to maintain health care facilities and site utilities (e.g., in 2004, 1052 house staff, 8662 faculty, 4465 nurses, 895 nursing aides, and 2246 service or craft employees). The list of specific jobs and job levels within the DHSSS is in excess of 3000; however, these have been grouped into occupational groups for many analyses (Appendix II).

The DHSSS has been used for a number of internal analyses and reports, as well as peer-reviewed publications. Some of the more detailed analyses are summarized in other chapters in this report.

DISCUSSION AND CONCLUSIONS

The capability of the DHSSS system to examine a broad range of exposures and health outcomes among our population of HCWs has been demonstrated through a series of detailed studies addressing a broad range of occupational issues faced by HCW. While this surveillance system has thus far focused on certain targeted HCW concerns, the multitude of data sources allows for the examination of a broad range of end points, some of which have not, or only to a limited extent, been considered for HCWs specifically.

Utilizing occupational health and safety data systems that already have been established for administrative and financial purposes, the DHSSS has been relatively inexpensive to assemble and maintain. However, these data were collected from numerous departments within the medical center with each having its own method of collection and coding. In fact, some departments used different coding schemes for similar variables such as job title and job location. We faced additional challenges when we learned that coding schemes within a

particular set of data changed between years, and a limited number of code numbers for occupational titles were recycled and reused for multiple jobs. Accuracy of data entry and data quality control also varied between datasets. Data collected through the human resources department for payment and employment purposes were of high quality; however, workers' compensation data collected primarily for compliance and regulatory purposes were of lower quality and less complete. We believe that the development of this integrated surveillance system can act as a vehicle for closer collaboration among the different departments and stakeholders, thus making the systems more compatible and encouraging uniformity in coding and classification.

Strong support throughout the DUHS has been essential to the success of this program. Because this project has required the use of data collected through various departments within the DUHS, we had to identify stakeholders within each department that would be willing to collaborate. This process involved not only department managers and administrators, but also technical staff most familiar with the data (and coding schemes). Collaboration with personnel from Human Resources was especially critical to the project's success since the demographic data needed to define the population-at-risk are collected and managed through this department.

The collaboration with various departments has also helped us to identify additional necessary resources. For example, the Human Resources department had already established a relationship with an outside data management company that was contracted to de-identify health insurance claims data. As a result, we were able to utilize the same company to link numerous data sets and de-identify all personal information as required by HIPAA. Furthermore, the health claims data and demographic data provided by Human Resources were directly transferred to this outside company for de-identification, alleviating concerns from the Human Resources department as to how the data would be handled as part of the surveillance project.

The surveillance system allows us to capture relevant exposure and outcome information on the majority of the employees within the DUHS. However, for various analyses, the study population has been defined as employees who are enrolled in one of the Duke health insurance plans. About 10% of eligible employees are not covered under these plans, either because they receive coverage elsewhere (e.g., through spouse's insurance) or because they choose not to be covered. Furthermore, part-time employees who work less than 20 hours per week are not eligible for coverage. Using additional information in the DHSSS we are able to assess, through comparison of demographic and occupational characteristics, the extent to which the excluded group is systematically different from those employees who are included.

A limitation of this surveillance system is that contract and some temporary staff are not included in the DHSSS. For example, temporary workers hired outside of the Duke human resources department are not tracked in the current DHSSS. These workers may be hired through agencies for numerous jobs including nursing care, housekeeping, and carpentry. Currently, there is no method for tracking the exposures of these workers to determine if they are at any greater risk of work-related injury or illness compared to workers included in the DHSSS. These workers may be more susceptible to occupational injuries and illnesses, especially if they have the least attractive jobs, are not properly trained for their job, or are unfamiliar with hospital protocols and equipment.

A primary goal of this project was to further evaluate the utility of the DHSSS in our setting while continuing to define program elements, such as data requirements, data linkages, linkage procedures, analytical tools for data analyses, and performance characteristics of a model surveillance system. The process of refining the current DHSSS will allow the program to be replicated or adapted in other health care institutions. Many of the data elements that were linked to develop this system such as human resources demographic information, workers' compensation, hearing conservation, and health care claims typically are collected within many companies. The use of similar systems in other health care institutions will make it possible for performing comparative studies for research purposes as well as for quality assurance and benchmarking.

The development of the DHSSS promoted expansion of the job exposure matrix (JEM) used by the Occupational and Environmental Safety Office (OESO) previously. An example is expansion of the JEM to include exposure levels or domains for selected ergonomic hazards (e.g., patient lifting and transfers, repetitive motion).

Important information that currently is not included in the DHSSS includes absenteeism, as well as related issues such as disability due to injuries or illnesses unrelated to work. Attendance information is collected within the DUHS; however, it is not currently available in a consistent computerized format for all employees. The information on lost work time in the DHSSS is limited to data from workers' compensation claims.

The findings from the different descriptive, analytical, and prevention evaluation studies using the DHSSS should be generalizable and have broad application to other health care settings. Furthermore, most of the data sources included in the surveillance system are available in most health care settings; therefore, the surveillance model should have broad application to other health care organizations, and possibly other occupational settings.

Table 2-1

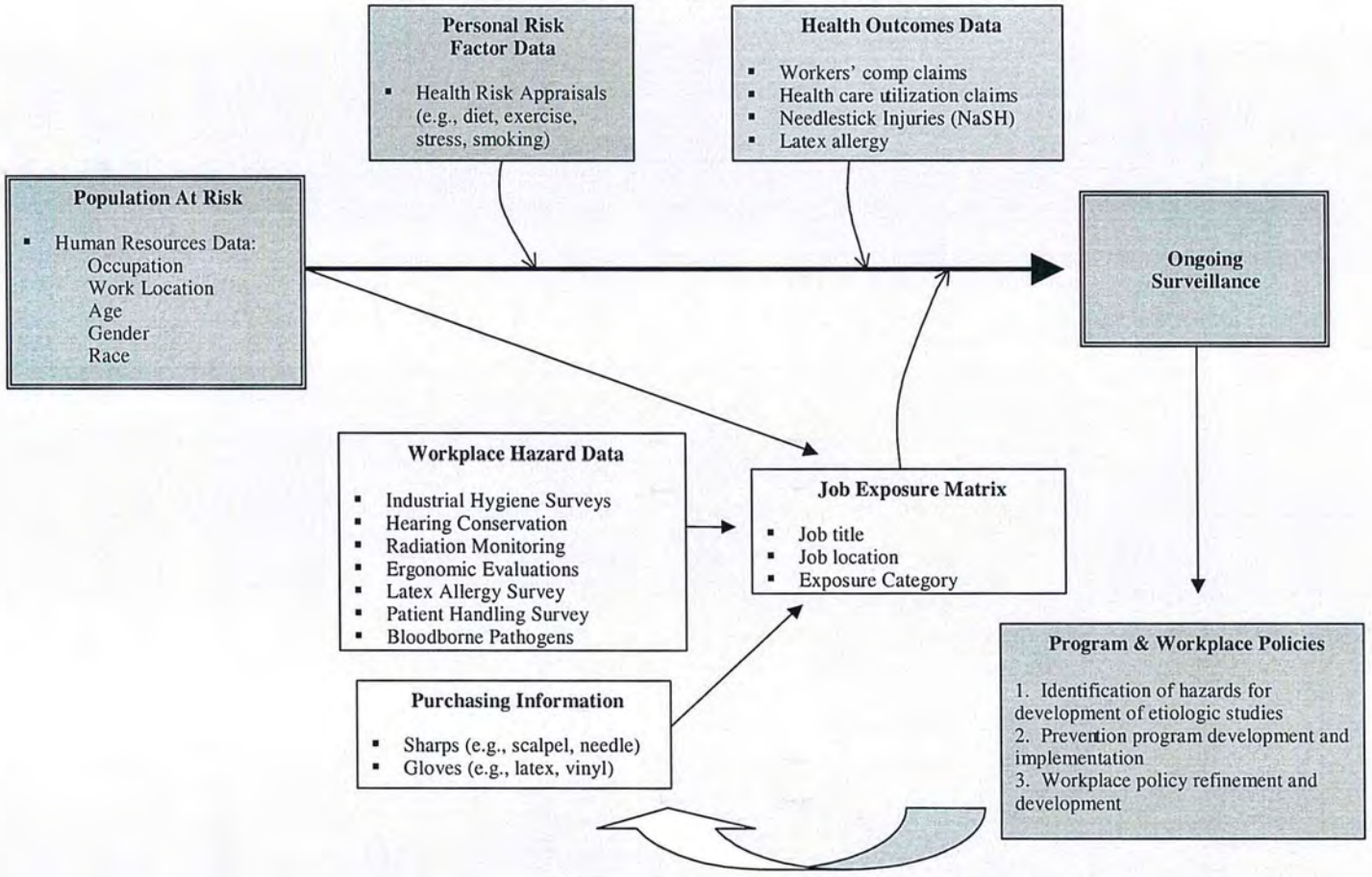
Data Sources Comprising the Duke Health & Safety Surveillance System
Status as of November 2006

Data Set	Description of Data Elements	Inclusive Years as of Coverage	Number of Records
Population Definition			
Human Resources	Age, race, sex, date of hire, department, division, job title, work location, work schedule, and termination date	1997-2004	85,839 Duke employees
Medical Insurance	Defines coverage by a Duke Health Plan and dates of plan membership	2001-2004	28,925 covered employees
Potential Exposures			
Duke OESO Exposures	Individually assigned exposures based on job-exposure matrix and supervisor questionnaire	1997-2004	64,183 Duke employees
Work Stress	Work stress questions from Health Risk Appraisals	1997-2004	28,925 appraisals
Latex Baselines	Latex exposure questionnaires for all workers with patient contact or contact with blood and body fluids	2002-2004	4584 individuals
Patient Lifting	Special survey of patient lifting and transfers done by nurses and nursing aids	2004	504 nursing personnel
Personal Risk Factors			
Health Risk Appraisals	Information on smoking, nutrition, physical activity, stress management, automobile safety, alcohol use, selected medical history, height, weight, cholesterol, and blood pressure	1997-2004	30,980 appraisals
Outcomes			
Workers' Compensation	Injury and illness records coded as to injury data, job title, work site location at time of injury, body part injured, agent of injury, cause of injury, lost time, costs, and free text injury description	1997-2004	24,121 claims for all Duke employees
Health Claims	Inpatient and outpatient health claims with data on dates of treatment, procedures, diagnoses, & costs	2001-2004	2.04 million claims
Pharmacy Claims	Prescription drug claims with data on National Drug Code, quantity, date or service, and costs	2001-2004	1.01million claims
Mental Health Claims	Inpatient and outpatient mental health claims with data on dates of treatment, procedures, diagnoses, & costs	2001-2004	65,828 claims
Blood & Body Fluid Exposures	Detailed records on blood and body fluid exposures using NIOSH NaSH data system	1997-2004	3,884 incidents
Latex Allergy Assessments	Medical surveillance information for employees tested and/or treated for latex allergy	2002-2004	469 with telephone interviews & 136 clinic visits

Table 2-2
Example of Blood and Body Fluid Exposure Classifications in the JEM
Duke Health Care Workers

Occupational Group	Blood and Body Fluid Exposure Category and Percentage of Employees**					
	None	1	2	3	4	5
All Health Care Workers in 2001*	34.1%	41.9%%	43.5%	41.5%	31.4%	1.5%
Inpatient Nurses	<0.1%	90.7%	90.7%	90.6%	90.6%	1.4%
Housekeeping Staff	14.6%	12.7%	74.2%	73.9%	0.4%	0.3%
Laundry Workers	12.5%	4.2%	70.8%	79.2%	0.0%	0.0%

Figure 2-1
Duke Health & Safety Surveillance System (DHSSS)
A Conceptual Model



CHAPTER 3: OCCUPATIONAL MUSCULOSKELETAL INJURY SURVEILLANCE

METHODS

Population and Time at Risk

The DHSSS provided data on a dynamic cohort of health care workers employed at the medical center from 1997 through 2003, including their occupation, duration of employment, gender, race, and years of age. To provide a measure of time at risk, work time, expressed as full-time equivalents (FTEs) were estimated for each worker by year of follow-up using the worker's usual work schedule (hours per week) and duration of employment at the medical center for each year. A worker employed for 40 hours per week and employed for the entire year contributed one FTE (1 FTE = 2,000 work hours per year per worker).

Outcomes of Interest - Workers Compensation Claims

Reported cases of work-related injuries and disorders were captured through the workers' compensation (WC) claims data provided through the medical center's self-insured compensation program for the seven years of observation. Initially we identified claims accepted for workers' compensation coverage with the nature of injury coded as pain/inflammation, sprain/strain, carpal tunnel syndrome or dislocation. Claims were then further restricted to include only those with a cause code of fall/slip, exertion, lifting, push/pull, repetitive motion, or bodily reaction. The WC database was used to define restricted and lost workday injuries, and the total number of days lost per claim.

Analyses

Descriptive statistics were generated to describe the population of health care workers based on gender, race, occupational group, and time varying variables of age and years of employment at the medical center, and time at risk for work-related injuries or disorders (FTEs). After identifying all claims meeting our definition of MSK injuries and disorders, frequencies of overall claims as well as those resulting in restricted and/or lost workdays, and the total number of work days lost were calculated. The distribution of mechanism of injury was assessed for each occupational group.

Crude rates of MSK claims filed through WC were stratified by age, gender, race, and employment tenure allowing for comparisons across demographic and employment characteristics. Incidence density rates were calculated separately for all MSK injury claims and those that resulted in restricted and/or lost workdays. The rates of injury over the seven year observation period were examined. To better estimate the burden of these injuries and disorders, rates of the total number of days lost from work per 100 FTEs were calculated. Confidence intervals (95%) were calculated as described by Haenzel et al. [1962] assuming a Poisson distribution.

Multivariate models were constructed for the purpose of identifying occupational groups at higher risk for MSK injuries and disorders through WC. To provide relatively stable injury

rates, occupational groups with at least 200 FTEs in size, who had overall injury rates of at least 2.0 per 100 FTEs, were selected to be included in these analyses. The reference group for the occupational variable included all jobs where the crude rate for MSK claims was 1.0 per 100 FTEs or less [Smaller occupational groups (< 200 FTEs) with injury rates of at least 2.0/100 FTEs, as well as larger occupational groups (> 200 FTEs) with injury rates between 1.0– 2.0/100 FTEs were not highlighted in the analyses]. Because of significant differences in gender and racial distributions within several occupational groups, we were concerned that the variables of race and gender would serve as surrogates for exposures if placed in the model. Therefore, we chose to stratify the analyses by gender prior to constructing the multivariate models. Within these gender specific models we excluded race as a possible confounder in order to avoid over adjustment.

Adjusted rate ratios and 95% confidence intervals were calculated using Poisson regression [Nizim, 2000] with the log of FTEs included as an offset term. When assessing the risk of total days lost from work, we used generalized estimating equations (GEE) [Liang and Zeger, 1986; Zeger et al, 1988] in the Poisson model to account for statistical dependence between days lost from work per employee. Years of age and duration of employment were assessed as possible confounders and were retained in the model if they changed any level of the explanatory variable (occupational group) or other covariates in the model by more than 10%, or if they were independently associated with the rate of injury (based on the Type 3 likelihood ratio statistic). All analyses were conducted using SAS Version 9.1.3 (2004).

RESULTS

Description of the cohort

Over seven years of observation the medical center employed an average of 20,349 workers per year. Demographic characteristics of the overall cohort, and those of the 14 occupational groups with the highest rates of WC MSK injury and disorders (and the reference group) are presented in Table 3-1. Women comprised more than half (66%) of the cohort. The majority of workers were white (68%); the non-white population was predominantly black (24%). The mean age of workers over this time period was 39.9 years for both men and women. They averaged 8.6 years of employment at the medical center over the seven years with 50% having been employed for five years or less. As expected, some of those at higher risk occupational groups are responsible for direct patient care including nurses' aides, inpatient nurses, radiology technicians, and physical/occupational therapists. Several other high risk occupations do not involve patient care such as secretarial staff, housekeepers, laundry, dietary services and medical supply assemblers (sterilize and package surgical supplies).

There were marked differences in the gender and racial distributions of these high risk occupational groups. With the exception of patient transporters, lab animal technicians, and skilled craft workers, women made up more than half of the higher risk groups, with several groups consisting of at least 70% women. Half of the workgroups consisted of 63% to 99% black workers.

Work-Related Musculoskeletal Claims

In Table 3-2 we present the reported frequencies and rates of all work-related MSK claims and those that resulted in restricted or lost time from work, as well as the number and rate of lost work days, by the demographic characteristics of the cohort. A total of 2,849 WC claims were filed among 102,669 FTEs resulting in an overall crude rate of 2.8 (95% CI: 2.7, 2.9) per 100 FTEs. More than half (56%; n = 1,582) of the MSK claims resulted in restricted (n =1510; 53%) and/or lost workdays (n = 452; 16%). A total of 48,911 days were lost by workers due to a MSK injury or disorder representing 47.6 lost workdays per 100 FTEs overall.

Higher overall rates of injury, as well as injuries that resulted in restricted/lost workdays, were seen among female and black workers compared to male and white workers, respectively (Table 3-2). Black workers were almost three-times more likely to report a work-related injury and to be restricted and/or lose time away from work as a result of injury relative to white workers. The burden of injury with respect to the number of days lost from work was significantly higher among women and black workers than their male and white counterparts. Rates of injury were similar across age groups and years of service; however, an increase in the number of days lost from work was seen with increasing age. Those working less than five years at the medical center or more then 20 years had lower rates of lost workdays compared to those who worked six through 20 years.

Mechanism of Injury

Approximately 90% of all MSK injuries and disorders resulted equally from lifting, pushing or pulling of work equipment (31%), patient handling (31%), or slips, trips and falls (30%) while significantly fewer injuries resulted from walking or body movement (6%) or computer work (4%). As expected, patient handling injuries were concentrated among workers responsible for direct care including nurses' aides, inpatient nurses, radiology technicians, physical/occupational therapists, and patient transporters. Moreover, a small number of secretaries incurred patient handling injuries. Unexpectedly, almost half of all injuries incurred by secretarial support resulted from slips, trips and falls while few (13%) resulted from computer work, such as typing and data entry.

Rates of injury declined slightly over time from 3.3/100 FTEs in 1997 to 2.4/100 FTEs in 2003. The rates of injury declined among women and black workers, however, blacks consistently had injury rates 2.5 times higher than other workers, and women had rates approximately 1.8 times higher than men over the seven years of observation. Among the highest risk work groups (Figure 3-1), the most obvious decline occurred among nurses' aides. With the exception for a decline in injury rates for housekeepers in 1999, the rates of injury have steadily increased since then. Rates among nurses, outpatient nurses and secretarial staff (data not shown) were consistent over time. Some work groups were too small to allow calculation of stable injury rates over time including patient transporters, laundry workers, skilled craft workers, and physical/occupational therapists.

Injury Rates Stratified by Gender

We wanted to highlight large high-risk groups, where effective interventions may have the greatest population impact, as well as smaller, special populations of workers at risk. Consequently, in Tables 3-3 and 3-4, where results are presented for women and men, respectively, we consistently categorized the workgroups by FTE size ($\geq$ 400 or < 400 FTEs) and then ordered them by their overall rate of MSK WC injury and disorder. These tables allow comparisons of overall MSK injury rates, those that resulted in lost or restricted workdays and the burden of total days lost. While the crude rates by occupational group can be compared directly across these tables, when comparing rate ratios for male and female workgroups it is important to note that the female reference group (which includes the same occupational groups as the male reference group) had an overall injury rate (0.77/100 FTEs) and restricted/lost workday injury rate (0.36/100 FTEs) that was more than double the rates for the male reference group (0.30/100 FTEs and 0.15/100 FTEs, respectively) even though they included the same occupational groups; however, these reference groups had comparable rates for days lost from work.

For a number of occupational groups, the gender specific injury rates and rates of lost workdays were similar while for others they were different. For example, among both female (Table 3-3) and male (Table 3-4) workers, nurses' aides, housekeepers, radiology technicians, dietary services, and inpatient nurses were among those with the highest rates of MSK injury and disorder. Female medical supply assemblers and lab animal technicians had injury rates at least twice as high as their male counterparts in the same occupational groups, while male laundry workers and patient transporters had injury rates that were 70% and 40% higher, respectively, than female workers in the same job.

Both male and female nurses' aides had particularly high rates of days lost from work (344.8/100 FTEs and 297.3/100 FTEs, respectively), as did female housekeepers (607.9/100 FTEs) and male patient transporters (651.8/100 FTEs, based on 5 cases). Female inpatient and outpatient nurses both lost substantial days, but days lost from work by the outpatient nurses were incurred by only 11 cases. Radiology technicians had notably low rates of lost workdays relative to their high rates of injury. In contrast, secretarial staff had high rates of lost workdays compared to their low overall rates of injury.

DISCUSSION AND CONCLUSIONS

We used data from DHSSS which allowed us to link multiple data sources on an individual level to evaluate reported work-related MSK injuries and disorders among diverse work groups within a large tertiary care medical center over a seven-year time period. Our findings document significant disparities in MSK health among female and black workers. Black workers represented only 26% of the cohort but filed 44% of the claims; while female workers, who made up 66% of the workforce filed 78% of the claims. The findings reflect, at least in part, the nature of the jobs predominantly held by these workers. For example, women and black workers were significantly concentrated in most of the high-risk jobs that we identified in this cohort. We recognize that some of the gender differences we observed may reflect differences in health care seeking behaviors among men and women [Bertakis et al., 2000]. However, several studies

have reported that men and women with the same job titles, such as housekeepers and secretaries, perform very different tasks and have different types of work-related exposures [Hooftman et al., 2005; Messing et al., 1994; Saleh et al., 2001].

Our findings are consistent in a number of ways with the reports of others. Several workgroups we identified as high risk have been described in previous hospital-based studies [Goldman et al., 2000; Khudar et al., 1999]. Nursing personnel, particularly nurses' aides [Eriksen, 2003] and inpatient nurses [Engkvist et al., 2000; Fuortes et al., 1994] are known to be at high-risk. National surveillance reports [U.S. Department of Labor, 2005b], as well as observational studies [Engkvist et al., 2000; Fuortes et al., 1994; Menzel et al., 2004] have also reported high MSK injury and disorder rates and lost workday injuries for nurses' aides, regardless of gender, as well as higher rates for nurses' aides compared to inpatient nurses. These high injury rates among nurses' aides are consistent with reports [Videman et al., 1984] that aides perform more lifting, bending and twisting compared to nurses, and their work is mostly concentrated in direct patient care activities at the bedside [Spilsbury and Meyer, 2004]. Nurses also have higher decision latitude than nurses' aides [Seago and Faucett, 1997] which influences not only what they do, but how their work is structured. All of these issues underscore the importance of looking at these health care providers separately instead of grouped together as 'nursing personnel'.

Our findings also indicate that workers who are often not considered part of the health care team, such as housekeepers, dietary workers and skilled craft workers are at significant risk for MSK injuries in this environment.

The burden of injury, as measured by rates of lost/restricted workdays and number of days lost from work, was highest among the larger workgroups for both male and female housekeepers and nurses' aides, as well as laundry staff and lab animal technicians among the smaller workgroups. Prior studies have reported that the availability of restricted or light duty tasks available for housekeepers (Messing et al., 1998) and nurses' aides [Eriksen, Bruusgaard et al., 2003] was limited, which could result not only in a delayed return to work, but possibly an inability to return at all [Dasinger et al., 1999; Krause et al., 2001; Tate et al., 1999]. Employees with low skill levels have few opportunities within this work environment for transferring into a job that is not physically demanding, placing them at risk for job loss. The negative financial and/or psychological consequences of a MSK injuries and disorders among these low-skilled workers could be significant [Lipscomb et al., 2005; Dembe, 2001].

For some occupational groups, the patterns of lost workday rates did not correlate with the overall rates of MSK claims. For example, outpatient clinic nurses had significantly lower rates of MSK injury claims compared to inpatient nurses; however, their rates of lost days from work, incurred from a smaller number of cases, were similar. These findings may reflect a pattern of migration among seasoned inpatient nurses to the outpatient clinical setting, especially when the physical demands of their job are too great. Radiology technicians, including sonographers and x-ray technicians, had low rates of lost workdays relative to their overall injury rate, which is not unique to our study [Magnavita et al., 1999]. Although radiology technicians perform similar patient handling tasks as other patient care providers, their work is not concentrated in constant patient care. Perhaps the nature of their work allows them to modify their work load

in a way that enables them to remain at work, however, these findings need to be further explored.

An unexpected finding was the high rate of lost workdays among both male and female secretarial staff, in addition to a high proportion of injuries resulting from slips, trips and falls compared to those incurred from computer work. The high rate of lost workdays is consistent with prior studies indicating that workers with low back pain have difficulty returning to jobs that require prolonged sitting [Krause et al., 2001]; however, the nature of the injuries that these workers are experiencing are not consistent with what is known about their work tasks. These findings need to be further explored within this environment in order to develop appropriate prevention strategies.

Conclusion

Injury experiences varied substantially among the employees of this large tertiary care medical center, largely reflecting differences in job exposures. With this in mind, prevention strategies need to be developed and tested that are specific to the demands of each work group. The growing interest in the use of patient lift equipment to prevent injuries among nursing personnel, internationally as well as at this particular medical center, is very appropriate based on the size of the population at risk. The shift to the use of mechanical devices from brute strength has already demonstrated some success [Chhokar et al., 2005; Evanoff et al., 2003]. However, there is a marked lack of information about successful injury prevention strategies and return-to-work programs for other work groups, including housekeepers whose injury rates are on the rise in our cohort.

Similar to our study, others dating back more than 20 years, document nurses' aides, housekeepers, dietary workers, as well as others as high-risk [Jensen et al., 1986; Jensen et al., 1987-in Kaplan and Deyo, 1988]. In contrast, we intentionally chose to present our findings in the context of occupational health disparities. Some of the gender and racial distributions among these high-risk jobs may reflect our particular geographic area; however, in the health care industry in general it is not unusual for jobs to be highly segregated by race and gender, and for workers of color to typically hold the physically demanding jobs [Gluck and Oleinick, 1998; King, 1992; U.S. Department of Labor, 2005a]. When work groups are highly segregated by race and gender, differential risk associated with work tasks becomes an issue of health disparity that should be recognized as such.

Table 3-1
Demographic Characteristics of the Dynamic Cohort of Hospital Workers in the Duke Health and Safety Surveillance System: 1997-2003

Occupation	All Workers FTES	Gender % Female	Race % Black	Years of Age Mean; Median	Years Employed at Hospital Mean; Median
All Workers	102669	66	24.4	39.9 ; 39.0	8.6; 4.8
Secretarial Staff	18679	88	45.2	40.8; 41.0	10.3; 6.9
Inpatient Nurse	10624	89	17.0	38.5; 38.0	7.7; 4.6
Clinical Technician	6671	70	29.2	39.6; 39.0	9.4; 6.9
Outpatient Nurse	4293	94	15.7	44.2; 45.0	11.8; 10.3
Housekeeper	2932	58	91.0	43.0; 42.0	10.0; 8.0
Nurses' Aide	2192	80	67.7	37.3; 36.0	6.0; 2.6
Radiology Technician	1765	68	28.0	37.1; 36.0	7.6; 4.6
Dietary Service	1298	79	95.8	41.6; 41.0	14.5; 13.9
Physical/Occupation Therapist	707	72	3.8	36.3; 35.0	5.3; 3.4
Skilled Craft	581	11	39.6	43.7; 45.0	13.0; 13.1
Patient Transporter	328	48	81.7	40.9; 40.0	9.0; 5.3
Medical Supply Assembler	332	62	82.0	42.9; 41.0	13.1; 14.0
Laundry Staff	282	66	98.1	46.8; 47.0	13.9; 12.9
Lab Animal Technician	241	40	55.4	39.5; 38.0	10.3; 6.4
Other workgroups[a]	4821	77	31.0	40.8; 40.0	8.0; 4.2
Reference hospital workgroups[b]	46923	49	17.7	39.5; 38.0	7.5; 4.0

[a]occupational groups that did not meet study criteria for inclusion in the reference group (injury rate $\leq$ 1.0/100 FTEs) or as a high-risk workgroup (injury rate $\geq$ 2.0/100 FTEs and workgroup size of at least 200 FTEs).
[b]reference category: occupational groups whose overall rate of WC MSK claims $\leq$ 1.0/100 FTEs

Table 3-2
Crude Rates of Workers' Compensation Musculoskeletal Claims by Demographic Characteristics 1997-2003: Overall Claims, Claims that Resulted in Restricted and/or Lost Workdays, and Total Number of Days Lost from Work

	FTEs	Injury Claims All Workers		Restricted/Lost Workday Injuries		Number of Lost Workdays		
		No.	Crude Rate[a] (95% CI)	No.	Crude Rate[a] (95% CI)	No. Claims with Lost Workdays	No. Lost Days	Crude Rate[b] (95% CI)
All Workers	102669	2849	2.8 (2.7, 2.9)	1582	1.5 (1.4, 1.6)	452	48911	47.6 (47.2, 48.1)
Gender								
Female	68219	2236	3.3 (3.1, 3.4)	1229	1.8 (1.7,1.9)	327	38358	56.2 (55.7, 56.8)
Male	34450	613	1.8 (1.6, 1.9)	353	1.0 (0.92,1.1)	125	10553	30.6 (30.1, 31.2)
Race								
Black	26041	1340	5.2 (4.9, 5.4)	834	3.2 (3.0,3.4)	249	27202	104.5 (103.2, 105.7)
White	69467	1407	2.0 (1.9, 2.1)	694	1.0 (0.92,1.1)	184	21372	30.8 (30.4,31.2)
Other	7162	102	1.4 (1.2, 1.7)	54	0.75 (0.55,0.96)	19	337	4.7 (4.2,5.2)
Age (years)								
<25	5186	132	2.6 (2.1, 3.0)	69	1.3 (1.0, 1.6)	16	145	2.8 (2.3, 3.3)
25-34	28374	699	2.5 (2.3, 2.7)	398	1.4 (1.3, 1.5)	101	7293	25.7 (25.1,26.3)
35-44	31340	899	2.9 (2.7, 3.1)	503	1.6 (1.5, 1.8)	148	13352	42.6 (41.9,43.3)
45-54	25909	793	3.1 (2.9, 3.3)	441	1.7 (1.5, 1.9)	132	18173	70.1 (69.1,71.2)
≥55	11860	326	2.8 (2.5, 3.1)	171	1.4 (1.2, 1.7)	55	9948	83.9 (82.2,85.5)
Years Employed at Medical Center								
≤ 5	45417	1168	2.6 (2.4, 2.7)	660	1.5 (1.3, 1.6)	176	13477	29.7 (29.2, 30.2)
6-10 years	19137	486	2.5 (2.3, 2.8)	282	1.5 (1.3, 1.6)	79	14227	74.3 (73.1, 75.6)
11-15 years	14152	437	3.1 (2.8, 3.4)	233	1.7 (1.4, 1.9)	72	10914	77.1 (75.7, 78.6)
16-20	8942	292	3.3 (2.9, 3.6)	167	1.9 (1.6, 2.2)	61	6814	76.2 (74.4, 78.0)
> 20	15019	466	3.1 (2.8, 3.4)	240	1.6 (1.4, 1.8)	64	3479	23.2 (22.4, 23.9)

[a]crude rate = no. WC MSK claims per 100 FTEs
[b]crude rate = no. days lost from work per 100 FTEs

Table 3-3
Crude Rates and Adjusted Rate Ratios of Workers' Compensation Musculoskeletal Claims by Female Work Groups 1997-2003: Overall Claims, Claims that Resulted in Restricted and/or Lost Workdays, and Total Number of Days Lost from Work

	Occupational Group (FTEs)	Overall MSK Claims			Restricted/Lost Workday Claims			Number of Days Lost from Work			
		No. Claims	Crude Rate[a]	Rate Ratio[c]	No. Claims	Crude Rate[a]	Rate Ratio[c]	No. Lost Day Claims	No. Days Lost	Crude Rate[b]	Rate Ratio[c]
	All Female Workers (68219)*	2236	3.3		1229	1.8		327	38358	56.2	
≥ 400 FTEs	Nurses' Aide (1758)	213	12.1	15.8 (14.5,17.2)	139	7.9	22.2(20.3,24.2)	40	5226	297.3	67.1 (12.5, 359.7)
	Dietary Service (1020)	110	10.8	13.9 (12.6,15.4)	70	6.9	20.0 (18.0,22.0)	22	580	56.9	12.9 (2.6, 64.2)
	Housekeeper (1706)	166	9.7	12.3 (11.3,13.5)	112	6.6	18.3 (16.6,20.1)	55	10368	607.9	102.8 (23.2, 455.0)
	Radiology Technician (1201)	85	7.1	9.3 (8.4,10.4)	40	3.3	9.5 (8.4,10.7)	4	20	1.7	----
	Inpatient Nurse (9504)	624	6.6	8.6 (8.0,9.2)	322	3.4	9.6 (8.8,10.4)	84	7120	74.9	15.3 (3.4, 68.8)
	Physical/Occupation Therapist (511)	21	4.1	5.4 (4.5,6.5)	10	2.0	5.5 (4.4,6.8)	1	6	1.2	----
	Clinical Technician (4682)	146	3.1	4.0 (3.7,4.4)	64	1.4	3.9 (3.5,4.3)	20	1531	32.7	6.6 (0.86, 51.1)
	Outpatient Nurse (4017)	103	2.6	3.2 (2.9,3.5)	47	1.2	3.2 (2.9,3.6)	11	2604	64.8	11.2 (1.6, 86.2)
	Secretarial Staff (16484)	368	2.2	2.9 (2.7,3.1)	214	1.3	3.7 (3.4,4.0)	45	8024	48.7	10.0 (2.2, 45.9)
<400 FTEs	Lab Animal Technician (97)	25	25.9	34.6 (29.1,41.1)	17	17.6	51.4 (43.3,61.0)	7	85	88.0	24.9 (4.1, 152.3)
	Medical Supply Assembler (207)	31	15.0	19.2 (16.4,22.5)	21	10.1	29.3 (25.0,34.4)	5	341	164.5	34.2 (3.0, 38.7)
	Laundry Staff (186)	21	11.3	14.5 (12.0,17.5)	16	8.6	24.7 (20.7,29.5)	6	139	75.0	11.5 (1.5, 87.5)
	Skilled Craft (66)	5	7.8	10.0 (7.0,14.5)	4	6.2	----	----	----	----	----
	Patient Transporter (157)	9	5.7	7.3 (5.5,9.6)	5	3.2	9.0(6.7,12.1)	3	29	18.4	----
	Reference Female Hosp. Workers (22917)[d]	177	0.77	1.0	82	0.36	1.0	12	1110	4.8	1.0

[a]crude rates = no. claims per 100 FTEs

[b]crude rates = no. days lost from work per 100 FTEs

[c]adjusted for age and years employed at hospital

[d]reference category: occupational groups whose overall rate of WC MSK claims ≤ 1.0/100 FTEs

---- no claims, or too few claims to calculate

female workers in the "other workgroup" category not included in this table (WC claims = 132, FTEs = 3709)

Table 3-4
Crude Rates and Adjusted Rate Ratios of Workers' Compensation Musculoskeletal Claims by Male Work Groups 1997-2003: Overall Claims, Claims that Resulted in Restricted and/or Lost Workdays, and Total Number of Days Lost from Work

		Overall MSK Claims			Restricted/Lost Workday Claims			Number of Days Lost from Work			
		No. Claims	Crude Rate[a]	Rate Ratio[c]	No. Claims	Crude Rate[a]	Rate Ratio[c]	No. Lost Day Claims	No. Days Lost	Crude Rate[b]	Rate Ratio[c]
	All Male Workers (34450)*	613	1.8		353	1.0		125	10553	30.6	
≥400 FTEs	Nurses' Aide (434)	51	11.8	38.6 (34.6,43.1)	37	8.5	59.8 (53.4,66.9)	10	1497	344.8	71.0 (8.3,603.6)
	Radiology Technician (565)	45	8.0	2602 (23.2,29.1)	23	4.1	28.1 (24.6,31.9)	7	113	20.0	1.5 (0.47,39.9)
	Housekeeper (1226)	83	6.8	22.1 (20.1,24.4)	51	4.2	29.3 (26.4,32.6)	24	1855	151.3	30.7 (3.6,264.1)
	Skilled Craft (517)	35	6.8	21.8 (19.2,24.7)	20	3.9	27.2 (23.8,31.2)	11	536	103.7	17.5 (2.5,121.7)
	Inpatient Nurse (1120)	58	5.2	17.0 (15.2,18.8)	24	2.1	14.3 (12.6,16.2)	7	381	34.0	7.0 (0.70,70.0)
	Secretarial Staff (2196)	59	2.7	8.8 (7.9,9.8)	41	1.9	13.0 (11.6,14.5)	21	2624	119.6	25.3 (3.0,214.9)
	Clinical Technician (1989)	38	1.9	6.1 (5.4,6.9)	22	1.1	7.6 (6.6,8.6)	5	133	6.7	1.3 (0.14,11.2)
<400 FTEs	Laundry Staff (96)	18	18.7	61.0 (51.9,72.4)	6	6.3	43.1 (34.8,53.4)	1	50	52.1	6.5 (0.44,94.1)
	Lab Animal Technician (144)	19	13.2	43.1 (36.9,50.3)	16	11.1	76.7 (66.4,88.6)	4	33	22.9	4.5 (0.42,48.6)
	Dietary Service (278)	25	9.0	28.8 (25.1,33.1)	15	5.4	37.2 (32.0,43.2)	2	31	11.2	2.5 (0.20,32.7)
	Patient Transporter (170)	14	8.2	26.9 (22.6,32.0)	11	6.5	45.3 (38.3,53.4)	5	1110	651.8	128.1 (12.6,1307.3)
	Medical Supply Assembler (125)	7	5.6	18.1 (14.3,23.9)	2	1.6	----	0	0	---	------
	Physical/Occupational Therapy (196)	7	3.6	11.7 (9.2,14.8)	4	2.0	----	0	0	----	----
	Outpatient Nurse (276)	3	1.1	----	3	1.1	----	1	2	0.72	----
	Reference Male Hosp. Workers (24006)[d]	73	0.30	1.0	35	0.15	1.0	9	1232	5.1	1.0

[a]crude rates = no. claims per 100 FTEs

[b]crude rates = no. days lost from work per 100 FTEs

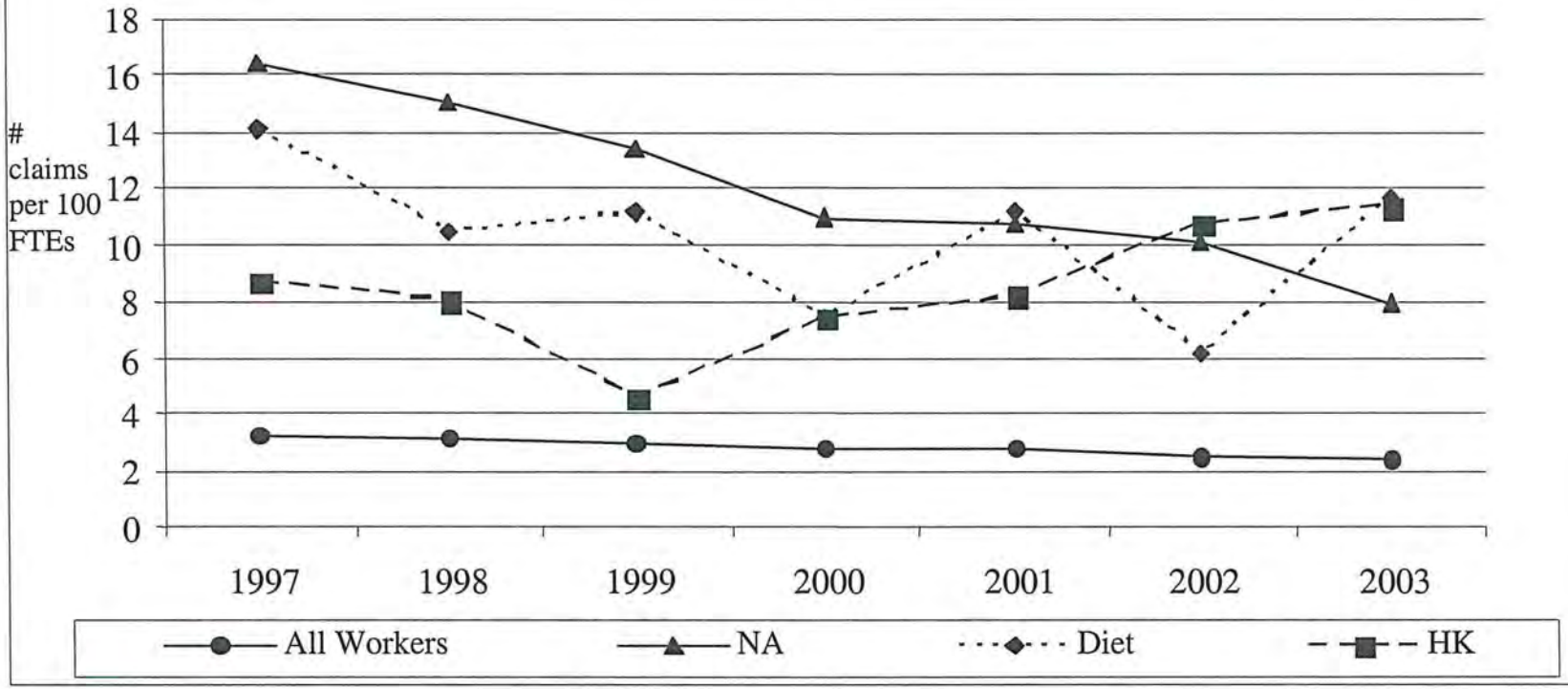
[c]adjusted for age and years employed at hospital

[d]reference category: occupational groups whose overall rate of WC MSK claims ≤ 1.0/100 FTEs

---- no claims, or too few claims to calculate

male workers in the "other workgroup" category not included in this table (WC claims = 78, FTEs = 1112)

Figure 3-1: Rates of WC MSK Injuries and Disorders Stratified by Selected Occupations: 1997-2003



NA=nurses' aide Diet=dietary service worker HK= housekeeper

CHAPTER 4: OBESITY AND WORKERS' COMPENSATION CLAIMS

INTRODUCTION

Obesity represents a large and increasing public health problem [Ogden et al., 2006], being a risk factor for overall mortality [Allison et al., 1999], as well as for most chronic diseases, including cancer, diabetes, cardiovascular disease, and musculoskeletal disorders [Must et al., 1999; Field et al., 2001; Calle et al., 2003]. The economic costs related to obesity are also substantial, and affect the obese individuals themselves as well as society as a whole [Finkelstein et al., 2003; Robbins et al., 2002].

Because many Americans receive health insurance through their workplaces, the health care costs of obesity are a significant concern for employers of working-age adults [Finkelstein et al., 2005]. Increasing Body Mass Index (BMI) is associated with increased costs to employee health plans [Burton et al., 1998; Wang et al, 2003], with obese workers having up to 21% higher health care costs than those of recommended weight [Anderson et al., 2000]. In 1994, the estimated cost of obesity to US businesses was $12.7 billion dollars, including $7.7 billion in health care costs alone [Thompson et al.,1998].

Less is known about more direct costs of obesity to employers, such as work-related illness and injury. While some studies assess the impact of indirect costs such as absenteeism [Aldana and Prink, 2001; Tucker and Friedman, 1998] and presenteeism [Goetzel et al., 2004; Burton et al., 2004], workers' compensation is not often included in such analyses but does represent real health-related costs. In California in the year 2000, workers' compensation accounted for almost one quarter of all direct and indirect employer health care costs attributable to obesity [Chenoweth, 2005]. Little is known about the impact of body mass on workers' compensation claims, despite evidence that health risk factors in general are associated with increased claims [Burton et al., 2004], and that obesity increases the likelihood of unintentional injury [Xiang et al., 2005].

Certain kinds or causes of injuries may also be associated with increased weight. Obesity is associated with musculoskeletal problems, especially in the lower back [Leboeuf et al., 1999; Han et al., 1997; Deyo et al., 1889], knee [Felson et al., 1997; Manek et al., 2003], hip [Cooper et al., 1998; Lievense et al., 2002] and wrist [Oliveria et al., 1999; Geoghgan et al., 2004]. It is therefore of interest to consider which injuries and illnesses appearing most frequently in the workplace for employees of differing weight.

Using a unique, integrated surveillance system based on administrative data from a large health system and university, the objectives of the current study were to: 1) investigate, longitudinally, the relationships between body mass and workers' compensation claims, associated costs, and lost-days, 2) determine whether these relationships are confounded by demographic, work-related, and other health risk factors, and 3) investigate the primary drivers (body part, nature, and cause of illness or injury) of any relationships found.

MATERIALS AND METHODS

Cohort Definition and Follow-Up

The DHSSS includes data from the Johnson & Johnson INSIGHT ™ health risk assessment (HRA), available annually to all employees eligible for health benefits. Participation is voluntary. The HRA includes questions about physical activity, nutrition, and tobacco use, and height (portable SECA stadiometer), weight (standardized Tanita BWB 800S scale), total cholesterol, blood pressure, and non-fasting glucose are measured.

The study cohort was defined as all employees with at least one HRA between 01/01/1997 and 12/31/2004. The first available HRA was used to define the start date of follow-up for each cohort member, and time-at-risk was accumulated until employee termination, disability, or the study end date (12/31/2004). The first HRA was used to determine obesity classification and cigarette smoking status (fixed covariates). Individual demographic and job characteristics (gender, age, race, duration of employment, and job classification) were updated for each year of follow-up (time-varying covariates). Employment dates and work schedules were used to estimate full-time equivalents (FTEs) for each cohort member by follow-up year (each employee contributes one FTE per year of full time employment.)

To assess selection bias and generalizabilty of the study results, we compared the study cohort to the population of all Duke employees in the study period (1997-2004). For that population, follow-up began on 01/01/1997, or the first date of employment if later.

Health Outcomes - Workers' Compensation Claims

Workers' compensation claims were the primary outcome measure. The workers' compensation benefit program provides medical care, income replacement (indemnity), and rehabilitation services to all full-time or part-time employees who are injured or contract occupational diseases in the course of employment. Workers' compensation is a state-legislated program administered by the North Carolina Industrial Commission. Duke self-insures for workers' compensation.

For each claim, the body site affected, nature, and cause of the illness or injury are recorded, as is the number of days off work (lost-days). Routine medical services associated with the claims are provided by Duke's own occupational health service, and these costs are not itemized. Medical costs are recorded in aggregate per workers' compensation claim, and only recorded for referrals for more serious illness and injury. Referrals represent approximately 25% of the claims, though being the more serious and expensive cases, represent greater than 25% of total medical costs. While recorded costs in our claims represent an underestimate of the total medical costs, these data are useful for comparisons of relative costs within the cohort. All indemnity costs are recorded.

All workers' compensation medical and indemnity claims in the study period were analyzed. 'Report only' and first-aid only cases (including most blood and body fluid exposures – previously reported[30]) are thus excluded. Only claims on or after each individual's follow-up start date are included.

Analyses

Body Mass Index (kg/m^2) was categorized as follows: <18.5 (underweight), 18.5-24.9 (recommended weight), 25-29.9 (overweight), 30-34.9 (obesity class I), 35-39.9 (obesity class

II), 40+ (obesity class III) [NHLBI, 1998]. Smoking status was categorized as no smoking, or smoking less than 3, 4-9, or 10+ cigarettes/day. Covariates included age group (15-34, 35-54, 55+), gender, race (white, black, other), duration of employment (i.e., years with current employer, <1, 1-4, 5-9, 10+) and job category (see Table 1).

Overall rates of medical and indemnity claims (per 100 FTEs) were calculated by category of BMI and of each covariate. Lost workday rates (days per 100 FTEs) were calculated by multiplying these stratum-specific claims rates by their corresponding average number of lost-days per claim. Similarly, multiplying the claims rate by the stratum-specific mean dollar costs (including both amount already paid as well as amount reserved) permitted calculation of cost rates (dollars per 100 FTEs), separately for medical and indemnity costs. Confidence intervals were calculated assuming the number of events followed a Poisson distribution.

Claims per 100 FTE by BMI category were also broken down by body part affected, nature, and cause of illness or injury. Given the limited number of claims for underweight employees, they were grouped with recommended-weight employees in these analyses. For each body part, nature, and cause, a Chi-square test for trend (Mantel extension) [Schlesselman 1982] was used to determine whether there was a BMI effect.

Multivariate Poisson regression models were developed to assess the relative effect of BMI category on claim rates controlling for the other covariates. Similar models were developed for relative rates of lost-days, medical costs and indemnity costs. These latter models were overdispersed (i.e., the variance was greater than predicted by the Poisson distribution); therefore, confidence intervals for the rate ratio estimates were adjusted by a scaling factor (square root of the model deviance/degrees of freedom).

An additional multivariate Poisson regression model interacting BMI (<25, 25-29.9, 30+) with job category (low, middle and high risk) was also developed. This model used fewer categories for both BMI and job category to achieve convergence of the Poisson model and assure greater model stability.

To evaluate potential selection bias, we performed several additional analyses. First, we compared the demographic characteristics of the study cohort with all Duke employees. Secondly, we compared workers' compensation claim rates, lost-day rates, and cost rates between the two cohorts, stratified by BMI, smoking, and the demographic covariates. Lastly, we developed Poisson regression models for both cohorts using those variables available for both cohorts from human resources data (i.e., all variables except BMI and smoking). This allowed comparison of rate ratios after adjustment for differences in the distribution of demographic characteristics.

RESULTS

The study cohort included 11,728 employees (34,858 FTEs over the study period). Table 4-1 shows their characteristics at inception and compares them to the population of all employees (74,060 individuals with 152,796 FTEs). The study cohort consisted of more females, more blacks, and was slightly older. The distribution by occupational group reflected the higher

proportion of females in the study group, with more employees in jobs with higher female representation (i.e., secretarial and nursing staff).

Crude rates of workers' compensation claims, lost-days, and associated medical and indemnity costs for the study population and all employees are shown in Table 4-2. Overall, employees who completed an HRA were significantly more likely to submit a claim, but had fewer lost-days and somewhat lower claim costs.

There was a clear linear relationship between BMI group and claims rate (Table 4-3), with the rate for the heaviest employees being twice that of recommended-weight employees. Since the average number of lost-days and costs per claim also increase rapidly with BMI (Figure 4-1), the effects of BMI on lost-days and costs were even stronger. The number of lost-days was nearly thirteen times higher, medical costs were seven times higher, and indemnity costs were eleven times higher among the heaviest employees compared to those of recommended weight.

Large differences in claims rates were also observed by occupational group. Jobs in the low-risk referent group included faculty, house staff, and scientific and administrative personnel. Much higher rates of claims were observed for physically demanding jobs involving lifting or other ergonomic stress. Very high rates were observed among laundry staff, housekeepers, laboratory animal technicians, and medical supply assembly employees. Nurses and nurses' aides also had higher claim rates, reflecting tasks such as patient lifting and re-positioning. Higher rates were also found among skilled craft employees involved with facility maintenance activities. The heterogeneous category 'other high risk occupations' included employees involved with hospital sterilization, patient services, clinical supplies, and parking/traffic operations. Employees in a number of the high-risk occupations were heavier than average (data not shown), emphasizing caution in the interpretation of the bivariate relationships.

Table 4-4 shows the relationship between BMI group and the claims rate ratio (RR), adjusted for covariates. Similar multivariate models are shown for lost-days, medical costs, and indemnity costs. These models show a strong effect of BMI group on claims, and an even stronger effect on lost-days and costs. It is notable that females have a significantly lower RR for lost-days and costs. The RR's for lost-days and costs, but not claims, were significantly elevated for employees older than 55 years. Blacks were found to be at increased risk, possibly reflecting greater concentration in higher risk jobs. Duration of employment had a protective effect on all outcomes. The multivariate analyses substantiated the much higher risks for workers' compensation claims in selected occupational groups, including medical supply assembly workers, nurses' aides, skilled crafts, inpatient nurses, housekeeping, and laundry. The effects of smoking are mixed and difficult to interpret. In the model interacting BMI groups with job category (not shown), employees with a BMI >=30 and employed in high risk occupations had a claims RR of 7.04 (95% CI=5.95-8.33) compared to employees with normal BMI and low risk jobs.

The BMI effect is present for illness or injuries to most parts of the body, but claims relating to the lower extremity (knee, foot and hip), back, neck/shoulder, and wrist/arm are common and significantly associated with BMI group. Finger injuries, although very common, were not significantly associated with body mass. In terms of the nature of the work injury/illness, pain/inflammation, sprain/strain and contusion/bruise were the strongest drivers of the BMI effect (blood and body fluid exposure was significantly *inversely* related to body mass). Claims

caused by falls/slips, exertion (a heterogeneous category) and lifting were most significantly affected by BMI (Figure 4-2).

There were differences in the demographic characteristics of the study population compared to all employees; these differences would be expected to affect overall crude rates but should have less impact on stratified rates and rate ratios observed in the Poisson models, which simultaneously adjust for demographic covariates. Poisson regression models were also developed for the study cohort and the population of all employees. These models (not shown) resulted in comparable parameter estimates and RRs, providing additional assurance that study results are valid for the population as a whole.

DISCUSSION AND CONCLUSIONS

Our results show that the effect of excess body mass on health care use extends into the workplace, with a strong effect of BMI on work illness and injury as reflected in rate of workers' compensation claims. Since the number of lost-days and costs associated with each claim also increase rapidly with BMI, the adverse effects on these outcomes are even stronger.

Obesity is associated with low back pain in general [Leboeuf et al., 1999; Han et al., 1997], as well as disability and health insurance claims for back pain on the job [Hagen et al., 2002; Fransen et al., 2002]. This association is confirmed in our data, with back a common body site of injury and pain/inflammation a common nature of injury in obese workers. Obesity also adversely affects the lower extremities (knee [Felson et al., 1997; Manek et al., 2003], hip [Cooper et al., 1998; Lievense et al., 2002], ankle [Peltinen et al., 2003]), wrists [Oliveria et al., 1999; Geoghgan et al., 2004], and shoulder [Lipscomb et al., 2000], all of which are reflected in our study.

Our analyses also identified several occupational groups at greatly increased risk for workers' compensation claims, pointing to the need to identify causal factors and develop appropriate interventions to reduce risks. Most high-risk jobs were associated with lifting and other ergonomic hazards. Those newly hired had higher injury rates. This could be due to "selective survival," but is more likely related to lack of training and experience [Lipscomb et al., 2000; Saliminen et al, 1994].

To further reduce the rates of work injuries and illness, a two-pronged approach is required: continued general interventions to make all jobs as safe as financially and practically possible, and an increased focus on improving workers' health. It is increasingly common for employers to support healthy lifestyle interventions such as healthy cafeteria food, encouragement of physical activity during work breaks, and on-site fitness facilities [Glanz et al., 1996; Shephard, 1996]. Our study lends support to the notion that such programs may not only improve the health of employees, but may also be financially beneficial [Pelletier, 1997]. Increased workers' compensation costs are only part of the overall health-related costs to employers [Ricci and Chee, 2005]; the overall magnitude of such benefits should be confirmed in intervention studies.

The economic benefits of reduced obesity should extend to employees as well. Employers are increasingly transferring health care costs to their employees through higher premiums, copayments and deductibles. While most of these costs likely fall on the obese workers themselves, some are carried by normal-weight employees who are cost-sharing.

Based on our findings of an adverse synergistic effect between obesity and certain job types and job situations, work-based health promotion and weight control programs should not only target physical activity and healthy eating, but should also address the types of injuries obese individuals are more likely to sustain than their colleagues of recommended weight. Programs could also focus explicitly on preventing injuries to the body parts where obese workers are at particularly high risk, namely lower extremity, wrist/hand and back.

Conclusions

The National Institute of Occupational Safety and Health has traditionally targeted occupational safety issues. This focus has recently been complemented by increased attention to the overall health of workers: health protection combined with health promotion [NIOSH, 2004]. Several ongoing initiatives target lifestyle issues including tobacco control, alcohol and substance use, the prevention of chronic disease, and most relevant from the point of view of our study: obesity reduction through improved nutrition and increased physical activity.

Maintaining healthy weight should be of strong interest not only to workers, but also to their employers and to the workers' compensation system.

Table 4-1
Baseline Characteristics: Study Cohort Compared With Population of All Duke Employees 1997-2004

	Employees *with* HRAs (Analysis Sample)	All Employees*
Average years of follow-up	2.97	2.44
Body Mass Index (kg/m^2)		
Under 18.5	2.0%	Not available
18.5-24.9	42.3%	
25-29.9	29.9%	
30-34.9	14.2%	
35-39.9	6.8%	
40 and over	4.9%	
Gender		
Male	30.5%	40.2%
Female	69.5%	59.8%
Age group (years)		
15-34	44.5%	63.1%
35-54	48.1%	31.4%
55+	7.5%	5.5%
Race		
White	65.1%	67.3%
Black	27.1%	21.5%
All Other	7.7%	11.2%
Smoking status		
None	82.9%	Not available
Occasional (1-3)	2.1%	
Light (4-9)	3.5%	
Heavy (10+)	6.5%	
Unknown	5.0%	
Years with current employer		
Less then 1 year	24.1%	63.3%
1-4	41.7%	19.3%
5-9	12.7%	6.7%
10+	21.5%	10.7%
Occupational group		
Laundry	0.3%	0.1%
All secretarial staff	21.2%	10.2%
Dietary service	1.1%	0.8%
Housekeeping	2.8%	1.6%
Inpatient nurse	9.9%	7.3%
Laboratory animal technician	0.4%	0.1%
Medical supply assembly	0.3%	0.1%
Nurses' aide	2.6%	2.3%
Odd job	2.2%	13.5%
Other clinical technicians	6.9%	4.5%
Outpatient nurse	3.1%	1.4%
Skilled craft	1.9%	0.9%
Other high risk occupations	4.4%	2.5%
Low risk referent group	43.2%	54.8%
Missing job information	<0.1%	<0.1%

*χ^2 test for differences in study cohort and population of all employees found significant differences ($p<0.05$) for all characteristics.

Table 4-2. Workers' Compensation Claims, 1997-2004.

	Employees *with* HRAs (Analysis sample)	All employees
Workers' compensation claims, 1997-2004	2,539	11,452
Workers' compensation claims per 100 FTEs	7.28 (7.00-7.56)	5.47 (5.37-5.57)
Lost-days, 1997-2004	19,828	146,159
Lost-days per 100 FTEs	54.00 (53.23-54.78)	69.82 (69.46-70.18)
Medical claims costs,* 1997-2004	$5.1 Million	$32.0 Million
Medical claims costs* per 100 FTEs (in thousands)	$14.46 (14.44-14.46)	$15.26 (15.25-15.27)
Indemnity claims costs, 1997-2004	$5.4 Million	$38.0 Million
Indemnity claims costs per 100 FTEs (in thousands)	$15.41 (15.39-15.43)	$18.17 (18.16-18.18)

*Medical claims costs are for referrals to outside providers, i.e., generally serious and non-routine medical services.

Table 4-3
Crude Rates of Workers' Compensation Claims, Lost-Days, and Claims Costs

Variables	Claims per 100 FTEs	Lost-days per 100 FTEs	Medical claims costs* per 100 FTEs	Indemnity claims costs per 100 FTEs
Body Mass Index (kg/m^2)				
Under 18.5	5.53	40.97	$7,109	$3,924
18.5-24.9	5.80	14.19	$7,503	$5,396
25-29.9	7.05	60.17	$13,338	$13,569
30-34.9	8.81	75.21	$19,661	$23,633
35-39.9	10.80	117.61	$23,373	$34,293
40 and over	11.65	183.63	$51,091	$59,178
Gender				
Male	6.99	64.78	$18,626	$21,064
Female	7.41	49.30	$12,629	$12,945
Age group (years)				
15-34	7.36	35.32	$9,810	$7,820
35-54	7.30	53.74	$15,578	$17,517
55+	7.02	100.46	$20,443	$23,991
Race				
White	5.47	43.43	$12,353	$12,571
Black	11.61	86.33	$20,417	$23,303
All other races	5.95	12.59	$8,339	$8,018
Smoking status (cigarettes per day)				
None	6.65	51.22	$13,826	$14,709
Occasional (1-3)	11.99	182.75	$28,676	$46,808
Light (4-9)	10.81	36.25	$18,418	$15,703
Heavy (10+)	11.53	60.63	$15,778	$14,854
Years with current employer				
Less than 1	9.82	78.59	$19,404	$19,222
1-4	7.67	38.02	$11,360	$9,748
5-9	6.82	30.52	$10,797	$8,509
10+	6.92	81.00	$19,118	$24,636
Occupational group				
Laundry	27.72	129.90	$41,982	$89,457
All secretarial staff	4.88	56.31	$12,869	$14,107
Dietary service	21.14	64.53	$13,401	$9,361
Housekeeping	25.33	137.02	$29,807	$27,893
Inpatient nurse	12.27	123.12	$30,633	$41,515
Lab animal technician	62.91	62.91	$26,483	$13,482
Medical supply assembly	35.83	375.64	$56,714	$25,619
Nurses' aide	19.60	287.44	$36,377	$46,999
Odd job	17.97	184.81	$29,310	$15,303
Other clinical technicians	9.62	14.01	$11,234	$9,038
Outpatient nurse	7.30	20.44	$17,465	$7,940
Skilled craft	17.16	296.83	$75,009	$92,121
Other high risk occupations	12.07	103.53	$26,960	$38,247
Low risk referent group	2.97	8.68	$5,084	$3,907
Overall	7.28	54.00	$14,451	$15,412

*Medical claims costs are for referrals to outside providers, i.e., generally serious and non-routine medical services.

Table 4-4
Relative Rates of Workers' Compensation Claims, Lost-Days, Medical Claims Costs, and Indemnity Claims Costs Paid Through Workers' Compensation; Multivariate Models

Variables	Claims Rate Ratio (95% CI)	Lost-days Rate Ratio (95% CI)	Medical claims costs* Rate Ratio (95% CI)	Indemnity claims costs Rate Ratio (95% CI)
Body Mass Index (kg/m^2)[a]				
Under 18.5	0.81 (0.57, 1.16)	3.21(1.90, 5.43)	1.02 (0.58, 1.77)	0.78 (0.34, 1.80)
25-29.9	1.09 (0.98, 1.21)	3.43 (2.81, 4.17)	1.46 (1.26, 1.68)	1.94 (1.63, 2.32)
30-34.9	1.21 (1.08, 1.37)	3.39 (2.74, 4.20)	1.95 (1.67, 2.29)	2.95 (2.45, 3.55)
35-39.9	1.33 (1.15, 1.53)	5.43 (4.34, 6.80)	2.44 (2.03, 2.94)	4.55 (3.72, 5.56)
40 and over	1.45 (1.23, 1.70)	8.04 (6.42, 10.07)	5.36 (4.54, 6.34)	7.71 (6.33, 9.39)
Gender[b]				
Female	1.02 (0.93, 1.13)	0.68 (0.59, 0.79)	0.59 (0.53, 0.67)	0.50 (0.44, 0.57)
Age group (years)[c]				
35-54	1.04 (0.94, 1.14)	1.05 (0.90, 1.24)	1.63 (1.36, 1.96)	1.48 (1.25, 1.76)
55+	1.08 (0.93, 1.25)	1.81 (1.49, 2.20)	1.28 (1.11, 1.47)	1.12 (0.82, 1.53)
Race[d]				
Black	1.28 (1.16, 1.41)	0.91 (0.80, 1.04)	0.98 (0.87, 1.10)	1.04 (0.91, 1.17)
All other races	1.22 (1.01, 1.47)	0.50 (0.31, 0.81)	0.99 (0.76, 1.30)	1.12 (0.82, 1.53)
Smoking status (cigarettes per day)[f]				
Occasional (1-3)	1.14 (0.92, 1.43)	2.56 (2.04, 3.21)	1.58 (1.23, 2.03)	2.32 (1.84, 2.91)
Light (4-9)	1.10 (0.93, 1.30)	0.56 (0.39, 0.79)	1.15 (0.92, 1.45)	1.01 (0.76, 1.33)
Heavy (10+)	1.27 (1.12, 1.44)	0.76 (0.62, 0.94)	0.85 (0.70, 1.02)	0.74 (0.60, 0.91)
Years with current employer[e]				
1-4	0.88 (0.73, 1.05)	0.57 (0.44, 0.74)	0.65 (0.51, 0.82)	0.55 (0.42, 0.72)
5-9	0.76 (0.62, 0.92)	0.43 (0.32, 0.57)	0.57 (0.44, 0.73)	0.43 (0.32, 0.58)
10+	0.64 (0.53, 0.78)	0.82 (0.64, 1.07)	0.74 (0.58, 0.93)	0.88 (0.67, 1.14)
Occupational Group[g]				
Laundry	7.35 (5.14, 10.50)	8.80 (4.62, 16.77)	5.80 (3.50, 9.64)	12.15 (7.97, 18.53)
All secretarial staff	1.44 (1.24, 1.66)	5.37 (4.19, 6.88)	2.31 (1.93, 2.75)	3.12 (2.53, 3.85)
Dietary service	5.58 (4.41, 7.07)	4.69 (2.83, 7.77)	1.90 (1.18, 3.05)	1.40 (0.74, 2.63)
Housekeeping	6.44 (5.42, 7.64)	10.19 (7.47, 13.89)	4.21 (3.27, 5.41)	4.17 (3.09, 5.63)
Inpatient nurse	4.01 (3.46, 4.64)	15.01 (11.65, 19.35)	6.70 (5.59, 8.03)	12.04 (9.79, 14.81)
Lab animal technician	17.36 (13.74, 21.93)	6.94 (2.97, 16.23)	4.74 (2.62, 8.57)	3.07 (1.21, 7.78)
Medical supply assembly	9.18 (6.39, 13.18)	22.34 (13.91, 35.87)	6.18 (3.72, 10.26)	2.63 (1.15, 6.04)
Nurses' aide	4.98 (4.03, 6.15)	26.94 (20.12, 36.06)	5.82 (4.42, 7.67)	9.06 (6.75, 12.16)
Jobs not elsewhere classified	4.54 (3.59, 5.75)	14.90 (10.64, 20.86)	4.05 (2.93, 5.61)	2.55 (1.56, 4.18)
Other clinical technicians	3.13 (2.66, 3.69)	1.39 (0.86, 2.25)	2.07 (1.60, 2.67)	1.97 (1.43, 2.72)
Outpatient nurse	2.53 (2.01, 3.18)	2.17 (1.28, 3.66)	3.63 (2.76, 4.77)	2.02 (1.31, 3.11)
Skilled craft	5.43 (4.46, 6.60)	20.24 (15.49, 26.44)	9.37 (7.70, 11.41)	11.96 (9.57, 14.95)
Other high risk occupations	3.65 (3.07, 4.35)	9.25 (6.95, 12.30)	4.47 (3.61, 5.54)	7.27 (5.76, 9.17)

*Medical claims costs are for referrals to outside providers, i.e., generally serious and non-routine medical services.
Reference categories: a) 18.5-24.9; b) Male; c) 15-34; d) White; e) Less than 1; f) None; g) Low risk referent group.

Figure 4-1. Average Number of Lost-Days, medical Costs, and Indemnity Costs per Claim by BMI Group

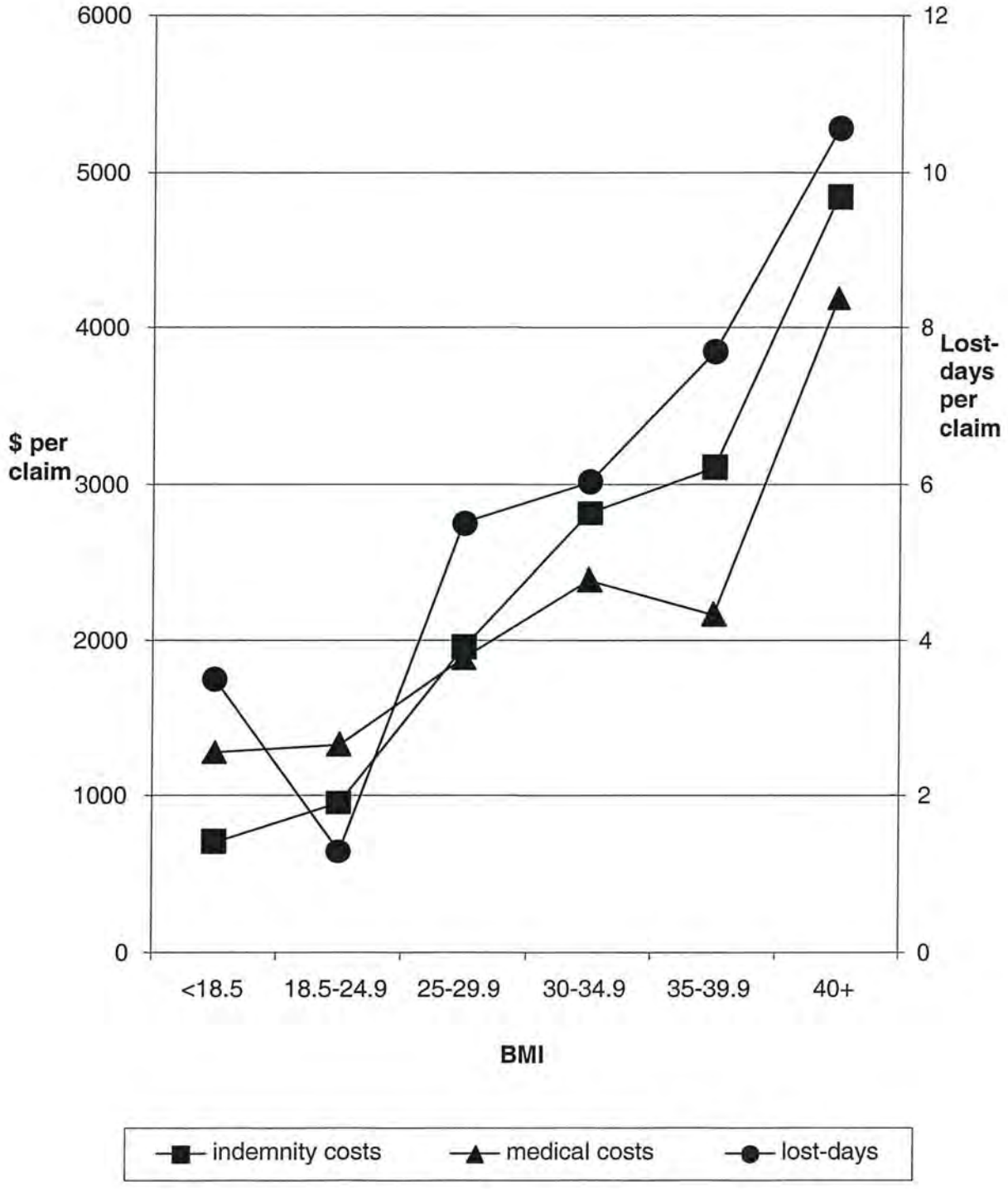
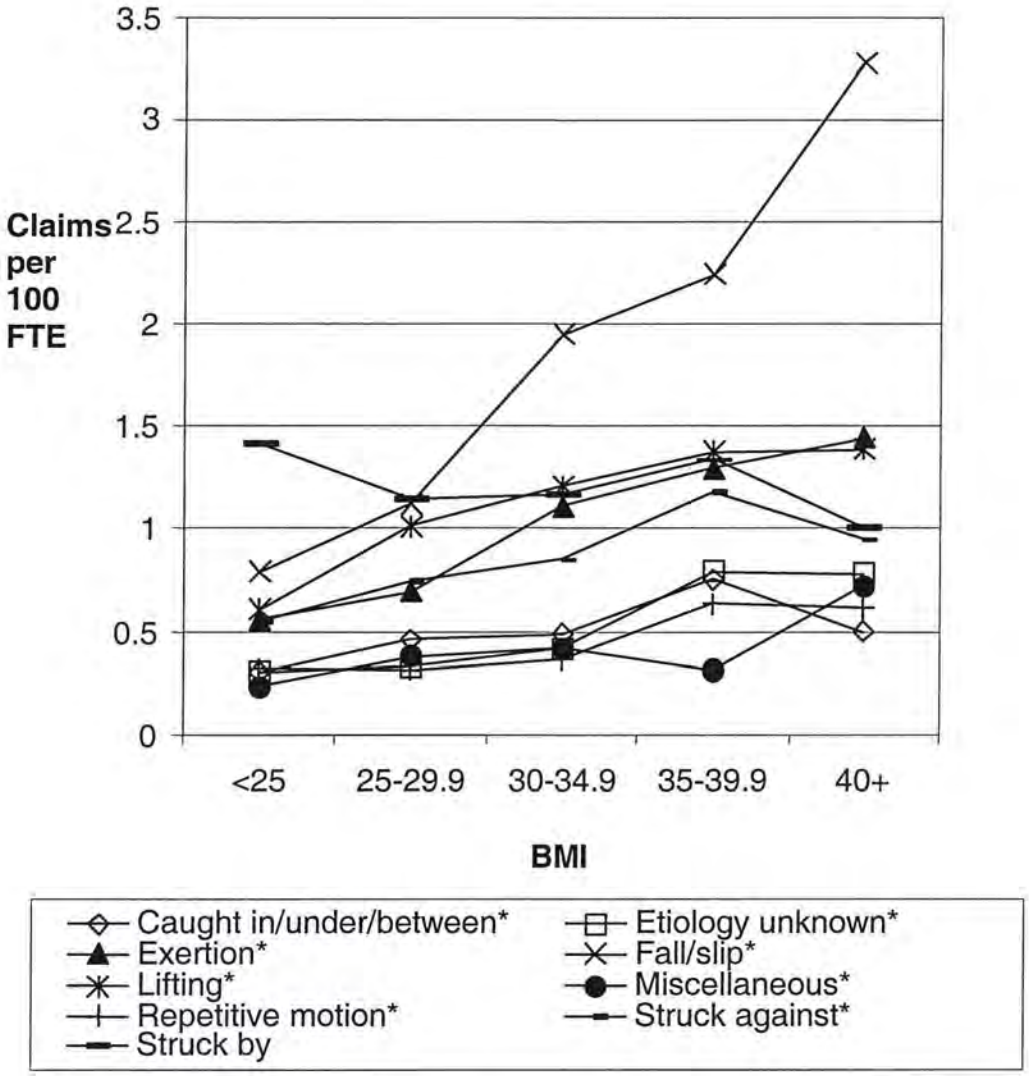


Figure 4-2 Cause of Illness or Injury by BMI Group†



†Includes only categories with 100+ claims in total; *chi-square for trend: p<0.01

CHAPTER 5: SURVEILLANCE OF BLOOD AND BODY FLUID (BBF) EXPOSURES

METHODS

Population at Risk

For the BBF analyses, study population demographics and time-at-risk were based on human resources data. The study cohort was dynamic, defined as all HCWs employed by the DUHS (excluding Durham Regional Hospital and Raleigh Community Hospital) at any time during the period 1998 to 2002 and with anticipated exposure to blood and body fluids (i.e., included in the Duke University Bloodborne Pathogen Program). Calendar year 1998 was chosen as the starting year for these analyses since this was the first complete year of data collection for DUHS as a participant in the National System for Surveillance of Health Care Workers (NaSH) [Campbell et al. 2000].

The employee file provided employee level demographic information (gender, race, date of birth, hire date, termination date), as well as job code, job title, work location, and hours worked per week for each calendar year of follow-up. This cohort of workers was further restricted to DUHS employees with anticipated BBF exposures based on job and work location using a Job-Exposure Matrix (JEM), initially developed by the Duke Occupational and Environmental Safety Office (OESO) and incorporated into the DHSSS [Dement et al., 2004]. BBF exposure categories in the JEM are as follows: 0 - No Exposure; 1 - Direct patient care activities; 2 - Handles human body fluids; 3 - Handles contaminated materials or wastes; 4 - Routine administration of first aid; 5 - Other likely or anticipated exposures. All employees who were included in at least one of these five BBF exposed categories were included in the current analyses and formed the population at risk (PAR).

Exposure Events

BBF exposure events are captured at Duke through two systems, workers' compensation and NaSH. NaSH is a case-based surveillance system that collects information through a 24-hour hotline available for employees who experience a BBF exposure. Employees who call are asked to provide detailed information about the circumstances and events related to the exposure as well as the type of device used. Criteria for reporting exposures vary slightly between NaSH and workers' compensation. NaSH captures events where the employee reports BBF exposure through percutaneous, mucous membrane, or non-intact skin (e.g., cut, abraded, or otherwise non-intact), whereas workers' compensation includes all of these types of exposures as well BBF exposures to intact skin. Of primary interest for the current study were risk factors leading to exposure events (regardless of skin condition at time of exposure); therefore, we combined NaSH and workers' compensation exposure events to form a pool of all cases for analyses.

In order to capture all reported BBF cases for these analyses we first identified all events recorded in NaSH that occurred in the PAR during the study period. We then identified all BBF exposure events in the PAR during the same time period reported to the workers' compensation program. We used an algorithm that identified potential BBF cases in the workers' compensation data by considering information on nature, agent, and cause of injury

(administrative variables used by workers' compensation administrators). This initial selection of potential BBF cases was intended to have a high degree of sensitivity in the selection of cases for more detailed review. Free text descriptions in the workers' compensation file were reviewed in order to classify any questionable BBF cases. Finally, NaSH and workers' compensation cases were matched by individual and exposure date in order to eliminate duplicate BBF cases. Although NaSH is a voluntary reporting system, 86% of reported BBF cases that occurred from 1998 to 2002 were captured through both systems, 12% were captured in workers' compensation only, and 2% were captured in NaSH only. All workers' compensation only events were classified as to nature of the exposure (e.g. percutaneous exposure, mucous membrane exposure, skin exposure, or human bite) in order to categorize exposure information consistent with NaSH.

Descriptive Analyses

The PAR was described by gender, race, age, work location, and job family. The NaSH reporting system provides much detail with regard to the circumstances surrounding BBF exposures; therefore, all NaSH reported cases for 1998-2002 were summarized by exposure type (suture, hollow bore needlestick, or mucous membrane exposures), job title, work location and calendar year. For sharps injuries, the type of needle or sharp, as well as timing and activity associated with the exposure event, were tabulated.

BBF Exposure Rates -- Stratified Analyses

Crude stratified BBF exposure rates were calculated using annual full-time equivalents (FTEs) as the time-at-risk parameter (denominator) for rates and expressing annual rates as exposure events per 100 full-time equivalents (Events/100 FTEs). FTEs were estimated for each worker by year of follow-up using the worker's usual work schedule (hours per week) and duration of DUHS employment for each year. For these analyses, a worker employed for 40 hours per week (full-time) and employed for the entire year contributed one FTE. BBF exposure events and FTEs were stratified by age, race, gender, years of DUHS employment, job category, and work location in order to calculate stratum-specific BBF exposure rates. Confidence intervals for stratified rates were calculated by assuming the number of observed events followed a Poisson distribution.

Multivariate Analyses

Poisson regression models were developed to further explore occupation as a risk factor for BBF exposures (by exposure type) while controlling for potential confounders. Independent variables of interest included age, gender, race, job category, and years of DUHS employment. We began building the main effects model by constructing univariate Poisson models for each of the parameters identified as candidates by the stratified analyses [Hosmer and Lemeshow, 1989]. Reference cell coding was used for the regression models in order to generate appropriate internal comparisons of rate ratios. The reference cell for the occupational variable was defined as the combination of all jobs where the crude BBF exposure rate was 1.0 event/100 FTEs or less.

Following the univariate Poisson regression modeling, covariates for inclusion in the multivariate model were selected. We used a moderate level of statistical significance (Type III likelihood ratio p-value <0.25) for initial inclusion of parameters into the model. We chose this level to ensure the most parsimonious model and to address the possibility that a collection of variables, each with a weak association with risk of BBF exposures, might be an important predictor of exposure risk. Covariates included in the final models were chosen with care in order to avoid 'over control'. For example, control for gender in these models might dampen the effects of 'nursing' as a job title since the nurses were predominately female. We assessed the possibility of statistical interaction by changes in the beta coefficients for all covariates with and without a given parameter in the model, with changes of >20% suggesting interaction.

Data management was performed using Microsoft Access and for statistical analyses we used SAS [SAS, 1999]. The SAS GENMOD procedure was used for Poisson regression analyses using the log link function and log(FTEs) as the offset variable.

RESULTS

Study Population Demographics

A total of 24,425 workers were employed in jobs with potential BBF exposures during 1998-2002, with 64.4% being female and 35.6% male. The predominant race/ethnic group was White (68.0%) followed by Black (22.3%), Asian/Pacific Islander (7.9%), and Hispanic (1.5%). The mean age at the start of follow-up was 36.1 years, and, on average, these workers had been employed in some capacity in the DUHS for 5.1 years. A wide range of occupational groups are represented, with inpatient nurses being the predominant group (15.4%), followed by faculty (14.7%), house staff (8.1%), and scientific and electronics staff (8.1%).

Descriptive Analyses

Of the 2,730 events included in these analyses, 2,406 were reported in NaSH and an additional 324 cases were captured through workers' compensation (Table 5-1). A review of the additional cases identified through workers' compensation found the majority to be skin exposures without mention of a cut or abrasion. The predominate type of BBF exposure was a percutaneous injury (72.1%), followed by mucous membrane exposure (17.7%), skin exposure (11.8%), and human bite (0.8%).

Of the 2,406 NaSH events, 1,846 percutaneous exposures were associated with specific devices as shown in Figure 5-1. Hypodermic needles accounted for 29.8% of the devices followed by sutures (28.7%), scalpels (7.9%), and butterflies (6.8%). Only a small proportion of the percutaneous exposures occurred before use of the device (2.2%), with the majority of exposures occurring during device use (52.3%), a third after use and prior to disposal (31.4%), and fewer during or after disposal (11.8%). Information concerning activities associated with percutaneous injuries found that 31.1% occurred in the operating field, 23.2% occurred during equipment handling, 17.6% were associated with manipulation of the device or sharp, and 10.2% were associated with accidental collision with a sharp. Disposal of sharps was associated with 6.1%

of percutaneous exposure events. Analyses by purpose of the procedure found that most percutaneous events were associated with suturing (28.8%) and blood sampling (23.2%).

Yearly rates of percutaneous exposures associated with hollow needles or suture needles from NaSH are shown in Figure 5-2. These data show a downward trend in exposures associated with hollow needles, which is of borderline statistical significance ($p = 0.10$ linear regression slope); however, rates for suture related exposures have remained relatively constant or perhaps increased slightly. As part of DUHS's participation in the NaSH project with the CDC between 1998 and 2001, surveys were conducted to assess the number and level of reporting of percutaneous injuries occurring among nursing staff, house staff, attending physicians, housekeepers, and phlebotomists. These groups represented 93% of HCWs reporting exposures during 1998. The survey asked if the staff had sustained any percutaneous injuries within the past year, and, if so, how many of those injuries were reported to occupational health or the emergency department. The percentage of those surveyed who experienced at least one injury within the previous year declined from 24% in 1998 to 10% in 2001. These findings are reflected in the decrease in percutaneous injuries reported to NaSH, even as the proportion of reporting to NaSH increased from 26% in 1998 to 64% in 2001. The increase in reporting during the study period further supports a significant decline in rate of percutaneous injuries among DUHS HCWs.

BBF Exposure Rates -- Stratified Analyses

The study population contributed 50,013 FTEs during the follow-up period, resulting in a crude overall annual BBF exposure rate of 5.5 events/100 FTEs, and rates of 3.9 for percutaneous exposures, 1.0 for mucus membrane exposures, 0.7 for skin exposures, and <0.1 for human bites (Table 5-2). The rates of all BBF exposures as well as those by type of exposure were found to be reasonably stable over the five-year follow-up period, with the exception of an overall trend of decreasing rates for percutaneous exposures, as previously described.

BBF exposure rates by gender, race/ethnicity, age, and duration of DUHS employment are presented in Table 5-2. Overall annual BBF exposure rates were significantly higher for males than females with the same trend holding for percutaneous exposures; however, the mucous membrane or skin exposure rates were significantly higher among females. When data were stratified by race/ethnicity, several groups were found to have higher overall BBF exposure rates, with the highest rates being observed for Hispanic employees followed by American Indian/Alaskan Natives and Asian/Pacific Islanders. These same trends were observed for percutaneous and mucous membrane/skin exposures. In all exposure categories, Black employees experienced the lowest rates of exposure. BBF exposure rates stratified by age found rates to be highest among employees 25-34 years of age, with rates decreasing thereafter with age. Overall exposure rates for employees older than 35 years were found to be significantly lower than the rate for all ages combined. A decrease in the rate of exposure was observed as years of employment at DUHS increased, with a greater rate being observed among workers with less than five years experience.

Stratified exposure rates were calculated for occupational groups as well as for departments/ administrative work groups (Tables 5-3 and 5-4). Among occupational groups with ten or more

BBF cases between 1998 and 2002, much higher overall rates were observed for surgical-operating room technicians, house staff, nurse anesthetists, inpatient nurses, phlebotomists, respiratory care technicians, and physician assistants. Exposure rates for surgical-operating room technicians were nearly eight times the average rate for all occupational groups combined. House staff exposures are noteworthy for both the large number of observed cases (n=777) as well as a highly elevated rate of exposure (20.5 events/100 FTEs). Inpatient nurses also experienced a high number of cases as well as an exposure rate nearly double the overall average.

The patterns of mucous membrane or skin exposure shown in Table 5-3 are slightly different from those observed for percutaneous exposures. Highest rates of mucous membrane or skin exposures were observed among respiratory care technicians, inpatient nurses, house staff, clinical laboratory technicians, and nurses' aides.

Stratified rates by department or administrative work group revealed several interesting patterns. While elevated rates were observed for all house staff, OB-GYN house staff and surgical house staff rates were close to ten times the overall rate for DUHS HCWs and double the rate for all house staff. In addition to higher rates for all BBF exposures, OB-GYN house staff, surgical house staff and Department of Medicine house staff also experienced significantly higher rates for mucous membrane or skin exposures. Employees in several clinical laboratories, respiratory therapy, nursing services (largely nurses and nurse's aides), general surgical nurses, the pediatric bone marrow transplant unit, and the medical/pediatric unit also experienced higher exposure rates.

Multivariate Analyses

In univariate models, age, gender, race/ethnicity, duration of DUHS employment, and occupational group were found to be important predictors of BBF exposures. Age and duration of DUHS employment were found to be correlated; therefore, age was entered as a dichotomous variable (<45 years and 45+ years). The 45-year cut point for age was chosen based on results of the stratified analyses, which found crude BBF exposure rates for employees older than 45 to be significantly reduced compared to younger workers. No significant interactions were found.

Poisson regression model results are presented in Table 5-5. Employees over 45 years of age were found to have significantly reduced risks of all BBF exposures. Compared to White employees, Black employees were at significantly decreased risk and Hispanic employees were found to be at increased risk for all BBF exposures. Decreasing trends in risks were observed with increased duration of DUHS employment, which was statistically significant for those employed more than 10 years. Since house staff are generally employed at DUHS four years or less, we were concerned that the observed trend with duration of DUHS employment might be heavily influenced by inclusion of house staff. To further explore this possibility, the Poisson model was run excluding house staff (not shown), resulting in similar trends and rate ratios.

For all BBF exposures, highly elevated rate ratios (>20.0) were observed for a number of occupational groups including house staff, nurse anesthetists, inpatient nurses, phlebotomists, and surgical/operating room technicians. The same Poisson model was fit to the subset of cases

only identified in the NaSH data (not shown). The risk ratios observed using only NaSH data were very close to those using NaSH plus workers' compensation data, suggesting little systematic bias in NaSH reporting.

DISCUSSION AND CONCLUSIONS

The Duke Health and Safety Surveillance System (DHSSS) integrates information from a number of data systems, allowing comprehensive surveillance of adverse occupational events. For current analyses of BBF exposures, the DHSSS extended traditionally case-based reporting systems (e.g. NaSH and workers' compensation) to allow population-based analyses of rates. While the rates of BBF exposures for all HCWs were reasonably low and consistent with other published data, highly elevated exposure rates and rate ratios were observed for surgical-operating room technicians, house staff, nurse anesthetists, inpatient nurses, phlebotomists, respiratory care technicians, and physician assistants. In addition to operating rooms, elevated rates were observed in the pediatric bone marrow transplant unit, medical/pediatric unit, emergency department, and several laboratories. Multivariate analyses, which adjusted occupational rate ratios for differences in age, gender, race/ethnicity, and duration of DUHS employment, substantiated the results of stratified analyses. Our stratified analyses suggest a downward trend in the rate of all percutaneous exposures, especially those associated with hollow-bore needles. The downward trend in percutaneous exposures is further supported by data from the hospital employee surveys, which show an increasing proportion of percutaneous exposures being reported. Unfortunately, the rate of percutaneous exposures through suture needles has not shown this desirable trend. With the exception of blunt suture needles for suturing certain internal tissues, safety devices for prevention of suture needle injuries are not available [Montz et al., 1991].

Hispanic employees were found to have a significantly increased risk of BBF exposures. A review of the occupations of DUHS Hispanic employees found some patterns different from the overall cohort. For example, a higher proportion of Hispanic employees were employed in some occupational groups including house staff (13.5%), research and scholarship (13.5%), housekeeping (4.9%), and nursing aides (2.7%), with reduced representation among inpatient nurses (7.0%). The observed elevated risk among all Hispanic employees also was seen in all occupational subgroups with five or more exposures. The BBF exposure rate for Hispanic house staff (40.3 cases/100 FTEs) was nearly double the already high rate for all house staff.

Results of the current investigation should be viewed in the context of prevention strategies and programs at the DUHS. DUHS has developed several strategies since 1988 to implement safer devices, including a needleless IV heplock system in 1993. In 1998, a Safety Device Steering Committee (SDSC) was organized to formally evaluate and implement additional safety devices, targeting those devices associated with higher risk exposures. Higher risk exposures (i.e. percutaneous exposures from hollow-bore, blood-filled devices) have been found to be associated with occupational HIV infection [CDC, 1995]. The DUHS approach was one of risk assessment with a goal of preventing bloodborne pathogen infection, not just injury.

Between 1998 and 2002, a number of additional safety devices were implemented at DUHS (e.g. safety winged steel needles, safety IV catheter insertion needles, Mylar-coated capillary tubes,

safety shielded phlebotomy needles, needless blood transfer devices, safety PICC catheter stylets, blood gas needle holding devices, and shielded hypodermic needles/syringes). Limitations of the safer devices included: the safety features had to be activated by the user, the method of activation was not intuitive, and non-safety versions of the devices continued to be stocked for special clinical procedures for which the safety devices were inadequate. Consequently, employees experienced a "learning curve" for these two devices throughout the rest of 1999 and 2000. All of the implemented safety devices thus far have been hollow-bore needles or high-risk capillary tubes. Data for the DUHS indicates that the percentage of reported exposures due to high-risk devices (e.g. hollow-bore, blood-filled devices) has declined by 48% since 1998 and the rate of exposures to hollow-bore needles has declined since 1998, compared with the increase in exposure to suture needles (not yet targeted by the SDSC). Most importantly, no occupational blood-borne infections have been documented among DUHS personnel since 1999.

Our overall rates of BBF exposures are reasonably consistent with other published reports. The overall BBF exposure rate of 5.5/100 FTEs is higher than the rate of 3.5/100 FTEs from a multi-site French cohort of 24,000 hospital workers [Denis et al., 2003]; however, this is likely due to our ability to more carefully define the employees at risk of exposure as well as the availability of a 24-hour hotline for reporting exposures. Our results agree with the Poisson regression results of Denis et al., showing increased risk of reported exposures to be associated with male gender, age < 45 years, and length of service less than two years. A Higher risk for HBV exposures among HCWs during the first five years of employment was observed by Syndman et al. [1984].

The overall percutaneous exposure rate of 3.9/100 FTEs found in the current study is lower than rates in some published studies. Beekman et al. [2001] observed an overall rate of 5.3/100 FTEs for percutaneous exposures among 28,552 community hospital workers in Virginia and Iowa, and the published literature show a range of 7.6-18.78/100 FTEs among tertiary care hospitals from 1981-1997 [Beekman et al., 1994; McCormick et al., 1991; Linnemann et al., 1991; Ruben et al., 1983; McCormick and Maki, 1981]. Our findings may indicate a point on the continuum of an observed decline in rates since 1981. However, unlike the survey of 153 hospitals in Virginia and Iowa, our data included physicians, who may report fewer exposures than other occupational groups [Denis et al., 2003]. Sohn et al. [2004] observed a percutaneous injury rate of 3.4/100 FTEs prior to implementation of safety devices at the Memorial Sloan-Kettering Cancer Center and a rate of 1.4/100FTEs post-intervention. Our overall rate of percutaneous exposures is similar to the mean rate of 4.0/100 FTEs calculated from eight studies in the USA, UK, Scotland, Italy, India, and Australia [Trim and Elliott, 2002].

Data available in our study allow for assessment of exposure risk among large occupational groups comprising all employees in a tertiary care hospital and its affiliated clinics over five years. We observed very high exposure rates among certain occupations compared to other studies, at least partially explained by our ability to carefully define the occupational groups at risk and to more accurately account for time-at-risk. However, other studies have reported elevated exposure rates among surgeons, operating room and emergency room technicians, laboratory/microbiology personnel, and nurses [Beekman et al.,2001; Denis et al., 2003; Eisenstein and Smith, 1992]. A direct observational study of 1,382 surgical procedures

described the risk for percutaneous exposure among operating room staff. Surgery house staff and attending surgeons experienced ten times the number of exposures per person-procedure compared to other operating room staff [Tokars et al., 1992].

In the current study, 52% of percutaneous exposures occurred during use of a sharp device and approximately 42% of exposures occurred after device use or during disposal. This differs from an earlier report that showed 70% of percutaneous exposures occurred while preparing for disposal [Jagger et al., 1988]. This variation may reflect more effective prevention efforts focused on introduction of safer devices not requiring disassembly after use, an emphasis on avoidance of recapping used needles, and introduction of a needlebox retrieval system based on bar-coded, documented daily surveys of needleboxes in use to assure no overfilling occurs. Recent data from the Exposure Prevention Information Network (EpiNet) found that 43.8% of percutaneous injuries from 58 hospitals occurred during use of the sharp device, a pattern of percutaneous exposures similar to our study [Perry and Jagger, 2003; Perry et al., 2003].

Our study has several limitations including underreporting of BBF exposures [Aiken, 1997]. The extent of underreporting has been estimated through several surveys conducted among institutions participating in NaSH, including Duke as previously described. Underreporting of BBF exposures could potentially affect comparisons of rates with other institutions; however, in the absence of differential reporting by occupational groups, our internal comparisons of rate ratios should be less affected. In addition, use of combined data from NaSH and workers' compensation should ensure more complete reporting. Another limitation of our study is lack of specific risks (e.g. number of surgeries, syringes used per day, etc) for individuals. Collection of such data would be impractical for an overall surveillance project but could be implemented as a follow-up assessment of jobs or work locations identified as high risk. Finally, we were not able to account for overtime work in the calculation of rates. This is not a major issue for most occupational groups; however, house staff work extended hours and inclusion of overtime FTEs would reduce exposure rates (per 100 FTEs/ year) in this group, although not sufficiently to account for the elevated BBF exposure rates observed for this group.

An important strength of this study is the enumeration of a population of over 24,000 HCWs with potential BBF exposures using integrated human resources data and a JEM to define exposures. Use of the JEM minimized exposure misclassification by eliminating employees with little potential for BBF exposures. In addition, BBF cases were defined using two independent but complementary reporting systems over a follow-up period of five years. Finally, we were able to categorize BBF exposures and time-at-risk by occupational groups and work areas for calculation of more detailed rates and rate ratios through multivariate analyses.

Table 5-1
Sources and Types of Reported BBF Exposure Events, 1998 - 2002

Sources of BBF Exposure Events	Number and (%) of Reported Events
Total BBF Events Analyzed, 1998-2002	**2730**
All Events in NaSH	2406 (88.1%)
Additional Events in Worker's Compensation Only	324 (11.9%)
Type of Reported BBF Exposure	
Percutaneous Exposure	1967 (72.1%)
Mucous Membrane Exposure	482 (17.7%)
Skin Exposure	323 (11.8%)
Human Bite	21 (0.21%)
Unclassified	57 (2.1%)

Note: Some events involved multiple types of exposures and are counted in each classification.

Table 5-2
BBF Exposures in 1998 - 2002 Using NaSH and Workers' Compensation Data
Annual BBF Exposure Rates by Gender, Race/Ethnicity, Age, and Employment Duration

Gender	FTEs (%)	All BBF Exposures (%)	Exposure Rate (Events/100 FTEs) and 95% CI ( )		
			All BBF Exposures	Percutaneous Exposure	Mucous Membrane or Skin Exposure
All DUHS	**50013**	**2730**	**5.5 (5.3-5.7)**	**3.9 (3.8-4.1)**	**1.4 (1.3-1.5)**
Age Group					
<25	3018 (6.0%)	145 (5.3%)	4.8 (4.0-5.6)	2.7 (2.1-3.3)	1.9 (1.4-2.4)
25-34	14705 (29.4%)	1262 (46.2%)	8.6 (8.1-9.1)	6.3 (5.9-6.7)	2.1 (1.9-2.3)
35-44	15256 (30.5%)	744 (27.3%)	4.9 (4.5-5.2)	3.5 (3.2-3.8)	1.3 (1.1-1.5)
45-54	11867 (23.7%)	464 (17.0%)	3.9 (3.6-4.3)	2.9 (2.6-3.2)	0.9 (0.8-1.1)
55-64	4403 (8.8%)	108 (4.0%)	2.5 (2.0-2.9)	1.9 (1.5-2.3)	0.4 (0.2-0.6)
65+	765 (1.5%)	7 (0.3%)	0.9 (0.2-1.6)	0.7 (0.1-1.2)	0.1 (0.0-0.4)
Gender					
Female	31578 (63.1%)	1635 (59.9%)	5.2 (4.9-5.4)	3.5 (3.2-3.7)	1.6 (1.5-1.7)
Male	18434 (36.9%)	1095 (40.1%)	5.9 (5.6-6.3)	4.8 (4.4-5.1)	1.0 (0.9-1.2)
Race/Ethnicity					
Asian/Pacific Islander	3270 (6.5%)	208 (7.6%)	6.4 (5.5-7.2)	4.5 (3.8-5.3)	1.6 (1.2-2.0)
Black	11870 (23.7%)	402 (14.1%)	3.4 (3.1-3.7)	2.5 (2.2-2.8)	0.8 (0.6-1.0)
Hispanic	648 (1.3%)	60 (2.2%)	9.3 (6.9-11.6)	7.1 (5.19.2)	2.0 (0.9-3.1)
American Indian/Alaskan Native	129 (0.3%)	10 (0.4%)	7.8 (3.0-12.6)	6.2 (1.9-10.5)	1.6 (0.0-3.7)
White	34095 (68.2%)	2050 (75.1%)	6.0 (5.8-6.3)	4.3 (4.1-4.5)	1.6 (1.4-1.7)
DUHS Employment					
< 1 Year	4013 (8.0%)	301 (11.0%)	7.5 (6.7-8.4)	4.9 (4.2-5.6)	2.4 (1.9-2.9)
1-4 Years	19404 (38.8%)	1306 (47.8%)	6.7 (6.4-7.1)	4.9 (4.6-5.2)	1.6 (1.4-1.8)
5-9 Years	9160 (18.3%)	457 (16.7%)	5.0 (4.5-5.5)	3.6 (3.2-4.0)	1.2 (1.0-1.5)
≥ 10 Years	17435 (34.9%)	666 (24.2%)	3.8 (3.5-4.1)	2.8 (2.5-3.0)	1.0 (0.8-1.1)

Table 5-3
BBF Exposures in 1998 - 2002 Using NaSH and Workers' Compensation Data
Annual BBF Exposure Rates by Duke Occupational Groups
All Occupational Groups with Potential BBF Exposures and 10 or More Events

Duke Occupational Group	FTEs (%)	All BBF Exposures (%)	Exposure Rate (Events/100 FTEs) and 95% CI ( )		
			All BBF Exposures	Percutaneous Exposure	Mucous Membrane or Skin Exposure
All DUHS	**50013**	**2730**	**5.5 (5.3-5.7)**	**3.9 (3.8-4.1)**	**1.4 (1.3-1.5)**
Surgical - Operating Room Tech	117 (0.6%)	51 (1.9%)	43.7 (31.7-55.6)	40.3 (28.8-51.7)	3.4 (0.1-7.8)
House Staff	3792 (7.6%)	777 (28.5%)	20.5 (19.1-21.9)	16.5 (15.2-17.8)	3.4 (2.8-4.0)
Nurse Anesthetist	254 (0.5%)	32 (1.2%)	12.6 (8.2-17.0)	9.8 (6.0-13.7)	2.8 (0.7-4.8)
Nursing, Inpatient	7363 (14.7%)	854 (31.3%)	11.6 (10.8-12.4)	6.9 (6.3-7.5)	4.4 (3.9-4.9)
Phlebotomist or Tech	333 (0.7%)	33 (1.2%)	9.9 (6.5-13.3)	9.6 (6.3-12.9)	0.3 (0.0-0.9)
Respiratory Care Tech	440 (0.9%)	35 (1.3%)	8.0 (5.3-10.6)	2.7 (1.2-4.3)	5.2 (3.1-7.4)
Physician's Assistant or Associate	401 (0.8%)	28 (1.0%)	7.0 (4.4-9.6)	6.5 (4.0-9.0)	0.5 (0.0-1.2)
Clinical Lab Tech	1823 (3.7%)	103 (3.8%)	5.7 (4.6-7.7)	2.5 (1.8-3.3)	3.1 (2.3-3.9)
Skilled Crafts (Maintenance Workers)	229 (0.5%)	10 (0.4%)	4.4 (1.7-7.1)	4.4 (1.7-7.1)	0.0 (0.0-0.0)
Nurses' Aides	1559 (3.1%)	66 (2.4%)	4.2 (3.2-5.3)	1.9 (1.2-2.5)	2.0 (1.3-2.7)
Faculty	9628 (19.3%)	380 (13.9%)	4.0 (3.6-4.4)	3.4 (3.0-3.8)	0.5 (0.3-0.6)
Nursing, Admin & Ambulatory Care	2688 (5.4%)	100 (3.7%)	3.7 (3.0-4.5)	3.0 (2.5-3.7)	0.6 (0.3-0.9)
Housekeeping Staff	2087 (4.2%)	63 (2.3%)	3.0 (2.3-3.8)	2.9 (2.2-3.7)	0.1 (0.0-0.1)
Services- General	789 (1.6%)	21 (0.8%)	2.7 (1.5-3.8)	2.0 (1.0-3.0)	0.5 (0.0-1.0)
Radiology & Imaging Tech and Staff	1304 (2.6%)	28 (1.0%)	2.2 (1.4-3.0)	0.9 (0.4-1.4)	1.2 (0.6-1.7)
All Other-Clinical or Professional NEC	1840 (3.7%)	27 (1.0%)	1.5 (0.9-2.0)	1.3 (0.7-1.8)	0.3 (0.0-0.5)
Scientific/Electronics/Research Technology	4059 (8.1%)	30 (1.1%)	0.7 (0.5-1.0)	0.6 (0.3-0.8)	0.1 (0.0-0.2)

Note: Percent values for FTEs and All BBF Exposures do not add to 100% as only occupational groups with 10 or more BBF exposures are shown

Table 5-4
BBF Exposures in 1998 - 2002 Using NaSH and Workers' Compensation Data
BBF Exposure Rates by Departments or Administrative Work Group
Groups with 10 or More BBF Events and Rates > Overall Mean

Department or Administrative Work Group	FTEs	All BBF Exposures	Exposure Rate (Events/100 FTEs) and 95% CI ( )		
			All BBF Exposures	Percutaneous Exposure	Mucous Membrane or Skin Exposure
All DUHS	**50013**	**2730**	**5.5 (5.3-5.7)**	**3.9 (3.8-4.1)**	**1.4 (1.3-1.5)**
House Staff (ALL)	**3792**	**777**	**20.5 (19.1-21.9)**	**16.5 (15.2-17.8)**	**3.4 (2.8-4.0)**
OB-GYN – House Staff	135	80	59.3 (46.3-72.3)	45.9 (34.5-57.4)	13.3 (7.2-19.5)
Surgery-House Staff	852	386	45.3 (40.8-49.8)	38.0 (33.9-42.2)	5.5 (3.9-7.1)
Anesthesia-House Staff	209	46	22.0 (15.6-28.4)	19.1 (13.2-25.1)	2.9 (0.6-5.2)
Ophthalmology-House Staff	64	12	18.9 (8.3-29.5)	17.3 (7.2-27.5)	1.6 (0.0-4.6)
Pediatrics-House Staff	389	52	13.4 (9.8-17.0)	10.3 (7.1-13.5)	2.8 (1.2-4.5)
Dept of Medicine-House Staff	1207	148	12.3 (10.3-14.2)	8.9 (7.2-10.5)	2.9 (1.9-3.1)
Pathology-House Staff	111	12	10.8 (4.7-16.9)	8.1 (2.79-13.4)	2.7 (0.0-5.8)
Radiology - House Staff	247	25	10.1 (6.2-14.1)	8.5 (4.9-12.2)	1.6 (0.1-3.2)
Other Departments or Work Groups					
Pediatrics Bone Marrow Transplant Unit	78	11	14.2 (5.9-22.5)	10.3 (3.2-17.4)	3.9 (0.0-8.2)
Medical Pediatrics	105	12	11.5 (5.0-17.9)	7.6 (2.4-12.9)	3.8 (0.1-7.6)
Emergency Department	557	60	10.8 (8.1-13.5)	7.6 (5.3-9.8)	3.1 (1.6-4.5)
Nursing Services	7430	776	10.4 (9.7-11.2)	6.4 (5.8-7.0)	3.8 (3.3-4.2)
Central Laboratory Collections	232	22	9.5 (5.5-13.5)	9.1 (5.2-12.9)	0.4 (0.0-1.3)
General Surgical-Nurses	849	79	9.3 (7.3-11.4)	4.2 (2.9-5.6)	4.8 (3.4-6.3)
Clinical Microbiology	186	17	9.2 (4.8-13.5)	3.2 (0.7-5.8)	5.4 (2.1-8.7)
Anesthesia	944	81	8.6 (6.7-10.5)	6.9 (5.2-8.6)	1.7 (0.9-2.5)
Ambulatory Surgery Center	266	22	8.3 (4.8-11.7)	7.5 (4.2-10.8)	0.8 (0.0-1.8)
Surgery	2623	209	8.0 (6.9-9.1)	6.7 (5.7-7.7)	1.2 (0.8-1.6)
GI Endoscopy Unit	131	10	7.6 (2.9-12.4)	3.8 (0.5-7.2)	3.8 (0.5-7.2)
Blood Bank – Transfusion Service	226	17	7.5 (3.9-11.1)	1.8 (0.0-3.5)	5.8 (2.6-8.9)
OB-GYN	650	48	7.4 (5.3-9.5)	6.8 (4.8-8.8)	0.6 (0.0-1.2)
Respiratory Therapy	463	34	7.3 (4.9-9.8)	2.8 (1.3-4.3)	4.5 (2.6-6.5)
North Clinical Laboratory	274	20	7.3 (4.1-10.5)	2.2 (0.4-3.9)	5.1 (2.4-7.8)
Department Of Sterile Processing	186	12	6.4 (2.8-10.1)	5.4 (2.0-8.7)	1.1 (0.0-2.6)
Ophthalmology	546	32	5.9 (3.8-7.9)	5.9 (3.8-7.9)	0.0 (0.0-0.0)

Note: House staff FTEs and BBF exposures do not sum to the total as groups with < 10 BBF exposures and rates less than the overall mean are not shown in this table.

Table 5-5
Predictors of BBF Exposures Using NaSH and Workers' Compensation Data

Poisson Regression Model Parameter and Level	All BBF Exposures Rate Ratio and 95% CI ( )
Age	
<45	1.00
45+	0.71 (0.63-0.79)
Gender	
Male	1.00
Female	0.95 (0.86-1.04)
Race/Ethnicity	
White	1.00
American Indian/Alaskan Native	1.54 (0.83-2.88)
Hispanic	1.42 (1.09-1.83)
Asian/Pacific Islander	0.93 (0.81-1.08)
Black	0.76 (0.67-0.87)
Duration of DUHS Employment	
< 1 Year	1.00
1-4 Years	0.91 (0.80-1.03)
5-9 Years	0.88 (0.76-1.02)
10+ Years	0.85 (0.73-0.98)
Occupational Group	
Reference (Crude Rate <1.0 Event/100 FTEs)	1.00
Surgical – Operating Room Tech	101.8 (70.4-147.4)
House Staff	36.2 (28.0-46.9)
Nurse Anesthetist	29.9 (19.5-45.9)
Phlebotomist/Tech	24.5 (16.0-37.5)
Nursing, Inpatient	23.2 (18.0-30.0)
Respiratory Care Tech	16.7 (11.0-25.2)
Physician's Assistants or Associates	14.2 (9.1-22.1)
Clinical Lab Tech	12.7 (9.3-17.3)
Cardiac Cath – Cardiology Tech or Associate	11.4 (5.6-22.8)
Skilled Crafts	10.6 (5.4-20.6)
Nurses' Aides	10.2 (7.2-14.5)
Faculty	8.6 (6.3-11.8)
Nursing, Admin & Ambulatory Care	8.5 (6.5-11.1)
Housekeeping Staff	8.3 (3.6-19.2)
Services- General	7.0 (4.2-11.5)
Radiology & Imaging Tech and Staff	4.5 (2.9-7.0)
All Other-Clinical, Professional NEC	3.2 (2.1-5.1)

Note: Rate ratios are shown only for occupational groups with 10 or more BBF exposures over the 5 years of follow-up

Figure 5-1

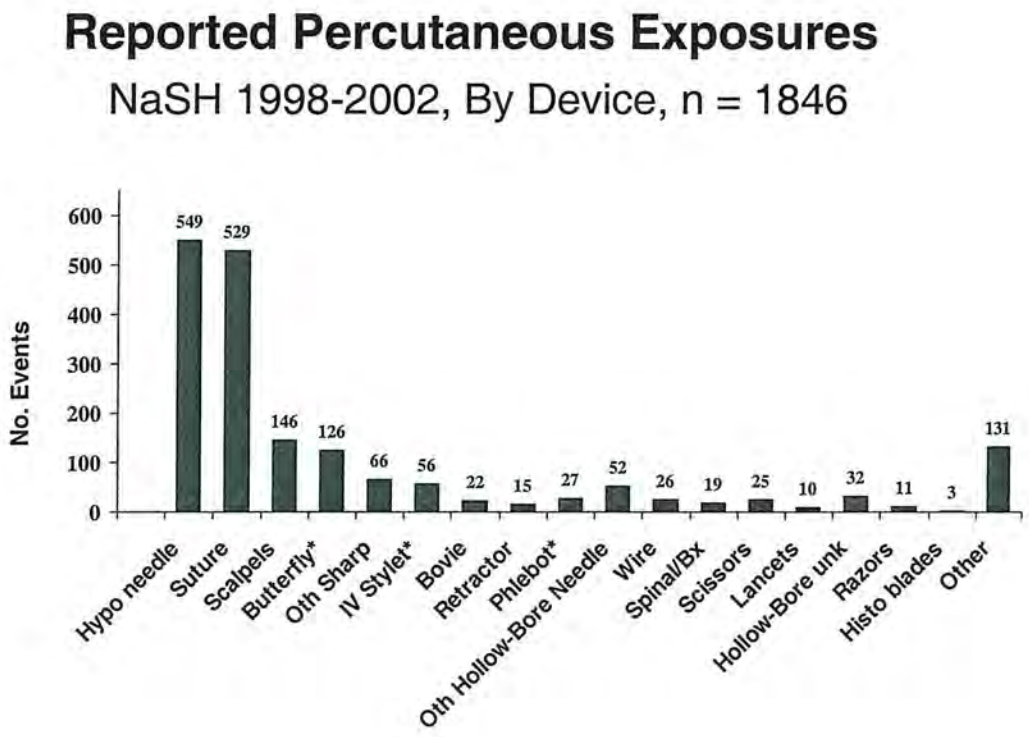
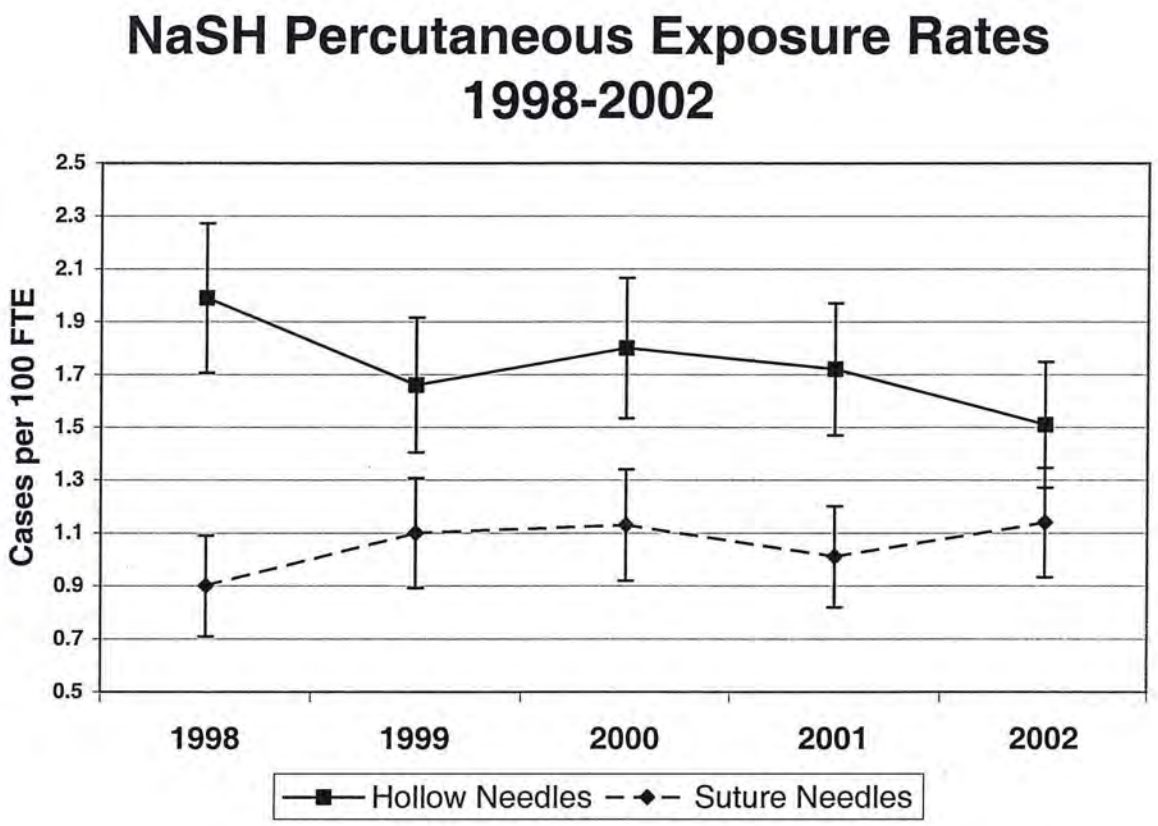

Reported Percutaneous Exposures
NaSH 1998-2002, By Device, n = 1846
No. Events
600
500
400
300
200
100
0
549
529
146
126
66
56
22
15
27
52
26
19
25
10
32
11
3
131
Hypo needle
Suture
Scalpels
Butterfly*
Oth Sharp
IV Stylet*
Bovie
Retractor
Phlebot*
Oth Hollow-Bore Needle
Wire
Spinal/Bx
Scissors
Lancets
Hollow-Bore unk
Razors
Histo blades
Other

Figure 5-2


NaSH Percutaneous Exposure Rates
1998-2002
Cases per 100 FTE
2.5
2.3
2.1
1.9
1.7
1.5
1.3
1.1
0.9
0.7
0.5
1998
1999
2000
2001
2002
Hollow Needles
Suture Needles

CHAPTER 6: WORK-RELATED STRESS AND HEALTH CARE UTILIZATION AMONG HEALTH CARE WORKERS

METHODS

Prevalence of Self-Reported Work Stress among Health Care Workers

The DHSSS includes data from the Johnson & Johnson INSIGHT ™ health risk assessment (HRA), available annually to all employees eligible for health benefits. New employees also are offered the HRA at employment. Participation is voluntary. The HRA includes questions about physical activity, nutrition, and tobacco use, and height (portable SECA stadiometer), weight (standardized Tanita BWB 800S scale), total cholesterol, blood pressure, and non-fasting glucose are measured. A series of questions also are included in the HRA concerning work and family stress and stress management. The specific question used for our analyses of work stress prevalence was as follows: "How much stress do you feel with your work/job?" The level of self-reported work related stress was recorded on a five-point scale (None, Little, Some, A Lot, and Overwhelming).

For our analyses of self-reported work stress, we defined our study population to include all Duke employees who completed at least one HRA during 2000-2002. For prevalence analyses, we selected the most current HRA for each employee, thus our analyses represent the period prevalence of work stress during 2000-2002.

Our analyses of work stress prevalence included both descriptive data summaries, calculation of the prevalence of elevated work stress by sex, age, race, and occupational classification, and multivariate analyses. For these analyses, the work stress scale was dichotomized into a low work stress category (None, Little or Some from the HRA scale) and elevated work stress (A Lot or Overwhelming from the HRA scale). Unconditional logistic regression models were used to explore the prevalence of work stress by occupational group, while controlling for age, race, and sex as potential confounders.

Self-Reported Work Stress and Health Care Utilization

We have explored self-reported work stress, obesity, and other HRA risk factors as predictors of outpatient health services among Duke employees. Employees (N=6367) completing a HRA and participating in one of the Duke health care plans during 2001-2003 were selected for these analyses. participants were then restricted to employees during calendar year 2001. HRA data were merged with Human Resources employee demographics data in order to identify the race, sex, age, and the occupational family of study participants. All outpatient health claims for participants in Duke health plans during 2001-2003 were available for analysis. In addition to claims information, the number of months of insurance coverage for each participant during 2001-2003 was available for these analyses.

Crude rates of outpatient health care utilization (claims per year) as well as age, race, and sex specific utilization rates were calculated using the claims file merged with the file defining workers having insurance coverage. In these analyses, each line item claim defined the event of

interest (health claim) for the rate numerator and number of months of insurance coverage was used as the denominator. Rates were then expressed as the number of claims per year (claims/year). Negative binomial, fixed effects regression models were used to model the rate of outpatient health care utilization stratified by age, race, sex, tobacco use, obesity, and cardiovascular risk factors associated with obesity (hypertension, diabetes, and elevated serum cholesterol) [Ozminkowski et al., 2002].

RESULTS

Prevalence of Self-Reported Work Stress among Health Care Workers

A total of 4651 employees completed at least one HRA during 2000-2002, with 76.0% of participants being female. The distribution by race was 62.6% white, 30.2%, and 7.2% all other race groups. The mean age of participants was 39.9 years (std. dev 11.1 years).

The overall period prevalence of elevated work stress during 2000-2002 was 26.1% (Table 6-1). Crude prevalence stratified by age, gender, and race found relatively little difference in the prevalence of elevated work-related stress; however, several occupational groups demonstrated elevated prevalence. House staff and inpatient nursing administrators/managers reported 50% more elevated work stress compared to the overall average for all employees.

Results of the multivariate logistic regression analyses are shown in Table 6-2. The logistic results were very similar to crude results. No significant differences were observed by age, gender or race. Deviation for the mean coding was used for occupational groups; therefore, each occupational group was compared to the overall prevalence among all duke employees. The odds ratios for self-reported work-related stress were in excess of two for house staff and inpatient nursing administrators/managers, after adjustment for age, gender, and race. Increased risk for work related stress also was observed for faculty (OR=1.51, 95% CI=1.14-1.98). While not statistically significant, odds-ratios in excess of 1.0 were also observed for food services staff, physician's assistants, faculty, administrators or managers, and inpatient nurses.

Self-Reported Work Stress and Health Care Utilization

Table 6-1 provides results of the multivariate model for outpatient health care utilization among Duke employees during 2001-2003. Females had significantly higher utilization rates than males and no significant differences were observed by race. The expected pattern of increased health care utilization with increasing age was observed, becoming significantly increased for employees over 45 years of age.

Obesity was found to be a significant predictor of increased health care utilization (RR=1.24, 95% CI=1.12-1.37), as were hypertension (RR=1.13, 95% CI=1.01-1.26) and a history of diabetes (RR=1.60, 95% CI=1.37-1.88). Both self-reported work stress and family stress were found to increase overall health care utilization and were of borderline statistical significance. These are only preliminary analyses and should be interpreted with caution. Further analyses will be conducted using health claims covering 5 years of follow-up.

Table 6-1
Prevalence of Self-Reported High Work Stress (Scale >3)
Latest HRA for DUHS Employees 2000-2002

Strata	Prevalence of Elevated Work Stress Number (%)
Age Group	
< 25	7 (20.59%)
25-34	95 (24.2%)
35-44	321 (28.7%)
45-54	369 (27.1%)
55-64	351 (25.6%)
65+	70 (19.0%)
Gender	
Male	921 (26.1%)
Female	292 (26.1%)
Race	
White	829 (28.5%)
Black	300 (21.3%)
Other	249 (25.2%)
Years Employed	
<1	109 (18.4%)
1-4	427 (25.9%)
5-9	221 (26.7%)
10+	456 (29.9%)
Occupational Group	
Administrator or Manager	118 (32.3%)
All Other-Clinical & Professional	58 (24.6%)
Faculty	108 (35.0%)
Food Services Staff & Supervisors	11 (36.7%)
House Staff	71 (39.2%)
Housekeeping/Laundry	29 (21.0%)
Medical & Lab Technicians	128 (24.2%)
Nursing - Admin & Ambulatory Care	62 (28.8%)
Nursing - Inpatient	158 (28.7%)
Nursing- Inpatient- Admin/Manager	19 (47.5%)
Office Support	237 (23.2%)
Physician's Assistant or Associate	7 (36.8%)
Research & Scholarship	37 (26.6%)
Scientific, Electronic & Res. Technicians	127 (20.8%)
Service, Nursing Care	20 (16.8%)
Services- General	9 (17.3%)
Skilled Crafts & Supervisors	7 (15.2%)
Students & Student Services	2 (18.2%)
Unclassified	5 (12.8%)
OVERALL PREVALENCE	**1213 (26.1%)**

Table 6-2
Logistic Regression Analysis of Self-reported High Work Stress (Scale >3)
Latest HRA for DUHS Employees 2000-2002

Parameter	Rate Ratio	Lower 95% CL	Upper 95% CL
Age			
< 25	Ref		
25-34	1.13	0.84	1.53
35-44	1.18	0.87	1.61
45-54	1.22	0.88	1.68
55-64	0.97	0.66	1.42
65+	0.86	0.35	2.10
Gender			
Male	Ref	1.00	1.00
Female	1.11	0.93	1.32
Race			
White	Ref		
Black	0.72	0.61	0.85
Other	0.81	0.61	1.07
Years Employed			
<1	1.00		
1-4	2.00	1.55	2.59
5-9	2.06	1.54	2.75
10+	2.38	1.79	3.16
Occupational Group (Ref= All Employees) [1]			
House Staff	2.72	1.90	3.90
Nursing- Inpatient- Admin/Manager	2.08	1.13	3.83
Food Services Staff & Supervisors	1.82	0.87	3.77
Physician's Assistant or Associate	1.56	0.63	3.87
Faculty	1.51	1.14	1.98
Administrator or Manager	1.21	0.94	1.56
Nursing - Inpatient	1.13	0.89	1.42
Research & Scholarship	1.07	0.72	1.60
Nursing - Admin & Ambulatory Care	0.99	0.72	1.37
All Other-Clinical & Professional	0.90	0.66	1.24
Medical & Lab Technicians	0.87	0.69	1.10
Housekeeping/Laundry	0.85	0.56	1.31
Office Support	0.83	0.68	1.02
Students & Student Services	0.72	0.16	3.15
Scientific, Electronic & Research Technicians	0.71	0.56	0.90
Service, Nursing Care	0.68	0.42	1.11
Services- General	0.61	0.30	1.24
Skilled Crafts & Supervisors	0.48	0.22	1.05

[1] **Note:** Deviation from the mean coding was used for occupational groups; therefore, each occupational group's risk of elevated work stress is compared to the mean risk for all occupational groups.

Table 6-3
Negative Binomial Regression Model Results
Outpatient Health Care Utilization 2001-2003

Parameter and Category		Rate Ratio	Lower CI	Upper CI
Gender	Female	1.64	1.48	1.82
	Male	1.00	1.00	1.00
Race	Non-White	0.99	0.89	1.10
	White	1.00	1.00	1.00
Age	65+	3.16	2.23	4.47
	55-64	1.98	1.58	2.48
	45-54	1.51	1.22	1.87
	35-44	1.22	0.99	1.51
	25-34	1.01	0.82	1.26
	<24	1.00	1.00	1.00
Tobacco Use	Tobacco Use=Yes	1.09	0.98	1.22
	Tobacco Use=No	1.00	1.00	1.00
Obesity	Obese (BMI>30)	1.24	1.12	1.37
	Non-Obese	1.00	1.00	1.00
Hypertension	Hypertension=Yes	1.13	1.01	1.26
	Hypertension=No	1.00	1.00	1.00
Serum Cholesterol	Elevated =Yes	0.93	0.84	1.03
	Elevated = No	1.00	1.00	1.00
Diabetes	Diabetes=Yes	1.60	1.37	1.88
	Diabetes=No	1.00	1.00	1.00
Work Stress	Elevated Stress=Yes	1.08	0.98	1.20
	Elevated Stress=No	1.00	1.00	1.00
Family Stress	Elevated stress=Yes	1.09	0.97	1.22
	Elevated Stress=No	1.00	1.00	1.00

CHAPTER 7: SURVEILLANCE OF LATEX EXPOSURES AND LATEX ALLERGY

INTRODUCTION

Previous research has demonstrated that glove substitution using low protein/low powder natural rubber latex (NRL) gloves reduces risk for latex allergy among health ca e workers (HCWs).[Hunt, et al. 2002, Liss and Tarlo, 2001;Saary, et al. 2002] Current prevention guidelines call for such glove substitution as a primary prevention method.[Bernstein, 2002; NIOSH, 1997] However, even after glove substitution, studies have revealed high rates of latex glove-associated dermatitis among HCWs. Furthermore, HCWs have reported continuing to wear them despite experiencing latex-related dermatitis, often citing personal preference for latex gloves.[Trapé, et al., 2000] Thus, researchers have called for systematic post-hire evaluations by occupational health professionals to identify and protect HCWs allergic to latex.

Many studies of HCWs have documented the prevalence of latex immune sensitization, measured by the presence of antilatex IgE antibody or positive skin prick test, and some have investigated rates among the general population. Less is known about latex-related symptoms and their association with exposure to NRL. Researchers have highlighted the importance of future studies examining the relationship between NRL exposure and actual reactivity rates, as opposed to studies exclusively examining sensitization rates.[McCall , et al., 2003] In addition, few studies have evaluated the possible contribution of age, gender, and race to latex sensitization or reactivity.[Garabrant and Schweitzer, 2002]

As part of an ongoing project funded by the National Institute for Occupational Safety and Health (NIOSH), researchers in the Duke University Health System (DUHS) have developed and implemented the Duke Health and Safety Surveillance System (DHSSS). Details of this comprehensive surveillance system for health care workers are described elsewhere.[Dement, et al. 2004] Integral to the DHSSS is the surveillance of latex allergy. The main objectives of the current analyses are to estimate the prevalence of latex reactivity and allergy among new and current heath care workers in a tertiary care medical center, and to quantify risk factors for these outcomes, including duration of work as a HCW, history of latex glove exposure, history of allergic illness, occupational group, gender, age, and race.

METHODS

Population at Risk/Surveillance Program

The study cohort was derived from the active surveillance of current and newly hired HCWs in the DUHS, including employees in the large tertiary care medical center from October 2002 through October 2003. DUHS workers in the two community hospitals were excluded for these analyses. Only HCWs with anticipated exposure to blood and body fluids necessitating glove use were included. The employee file from human resources provided employee level demographic information (gender, race, date of birth), as well as job code and job title.

Newly hired HCWs with anticipated exposure to blood and body fluids were asked to complete a questionnaire assessing potential latex allergy at the time of their post-hire clinical assessment at Duke Employee Occupational Health and Wellness (EOHW) clinic. Current HCWs completed the survey at the time of annual tuberculin skin testing. In addition, employees who presented to EOHW for evaluation of possible glove-related symptoms were asked to complete the survey.

Questionnaire and Clinical Evaluation of Latex Reactivity and Allergy

The latex allergy questionnaire inquired about the number of years of latex glove use, current and 12-month history of latex-related symptoms, history of physician diagnosed latex allergy, and prior latex allergy skin and blood testing. Employees were also asked questions about their history of hayfever, eczema, asthma, food allergies, pollen and/or dander allergies, skin and serology testing for allergies, surgery with general anesthesia, spina bifida, and smoking. Subjects who endorsed potentially latex-related symptoms were asked to undergo further evaluation, either via telephone interview (if a current worker reported skin or upper respiratory symptoms occurring no more than once a month) or by clinical assessment by an EOHW physician or physician's assistant. EOHW clinic visits were conducted for all new employees who endorsed potentially latex-related symptoms and for current workers who reported ongoing skin or upper respiratory symptoms occurring more frequently than once a month or having potentially latex-related lower respiratory symptoms at any frequency. Those who underwent clinical assessment also had blood drawn for measurement of serum antilatex allergen IgE antibody by the quantitative Turbo-MPTM Modified RAST (radioallergosorbent test) immunoassay.[Hamilton, et al.,1999; Kontis, 2003]

Latex Reactivity and Latex Allergy

Latex reactivity was defined as either self-report of physician diagnosed latex allergy or skin or respiratory symptoms associated with latex exposure coupled with at least one strict latex-related symptom: urticaria after latex exposure, rash within one hour of latex exposure, rash spreading proximal to the glove line, or respiratory symptoms due to latex exposure confirmed by clinical assessment. Latex allergy was defined based on clinical and serologic criteria: meets criteria for latex reactivity and has confirmation of latex allergy by one of the following: clinical impression of latex allergy at time of surveillance clinic visit, positive quantitative antilatex IgE antibody (class >0), or self-report of positive antilatex antibody or skin prick test.

Data Analysis

Questionnaire and clinical data were linked to the DHSSS and then de-identified for analysis by gender, race, age, and occupation. Descriptive analyses were used to characterize demographics of the study population including age, gender, race, smoking history, current occupation, years of work in health care, duration of latex glove use, history of atopic illness, allergic history, surgical history, and employment status (whether a new or current employee). The prevalence of latex symptoms, reactivity, and allergy was calculated separately for new and current employees. Stratified analyses were used to explore trends in the prevalence of latex reactivity and latex allergy by the population demographic parameters described above.

Unconditional logistic regression was used to further explore occupation, years of latex glove use, and duration of work as a HCW as risk factors for latex reactivity or latex allergy while controlling for potential effects of age, gender, race, history of atopy, history of allergies to medication, food or pollen, and employment status. Separate models were developed for latex reactivity and latex allergy by our case definitions. In these models, all parameters were entered as categorical variables using reference cell coding for internal contrasts. Occupational groups in the lowest one-third of latex reactivity risk by stratified analyses were used to form the reference category for occupational group comparisons. (The overall prevalence of latex reactivity and allergy in the occupational reference groups were 1.9% and 0.7%, respectively.)

The model building strategy involved first performing univariate logistic regression for each of the parameters identified as candidates for inclusion in the preceding stratified analyses. Main effects multivariate logistic regression models were next constructed using parameters found to be statistically significant in the univariate analyses. We chose a moderate level of statistical significance ($p<0.25$) for initial inclusion of parameters into the multivariate logistic model. With all variables in the model, we refined the model to arrive at the set of biologically plausible covariates which best predicted the risk of latex reactivity or latex allergy. Our primary tool for assessing the contribution of any given covariate was the change in the model -2 log likelihood function with and without the variable and changes in the β coefficients for the remaining covariates. The final models include all parameters with a Wald Type III Chi-Square of 0.1 or less. SAS Proc logistic regression procedures and associated regression diagnostics were used.[SAS Institute Inc, 2000]

RESULTS

Sample Characteristics

Demographic characteristics of HCWs by employment status are shown in Table 7-1. A total of 4584 workers (60% of the eligible population) were surveyed for latex allergy, with 3633 being current employees and 951 being newly hired workers. The entire group included 72.6% females and the largest race/ethnic group was White (62.4%) followed by Black (31.1%), Asian/Pacific Islander (5.2%), and Hispanic (1.2%). The mean age at the start of the surveillance program was 39.1 years among current employees and 34.0 years for newly hired workers. Among current employees, 58.5% reported working as a HCW for longer than 10 years. A wide range of occupational groups were represented, with inpatient nurses being the predominant group (22.5% inpatient nurses and 1.1% nursing admin/managers), followed by medical and laboratory technicians (15.9%), office support (11.9%), housekeepers (6.4%), house staff (6.2%), faculty (5.8%), and other clinical/professional staff (5.4%).

Table 7-2 presents latex glove exposure and previously described risk factors for latex allergy by employment status. Current glove use was reported by 78.6% of current employees. On average, current employees had worn latex gloves 10.9 years while newly hired employees reported an average of 7.3 years of latex glove use. History of allergic conditions diagnosed by a physician was similar among current and newly hired workers with 16.6% of the entire group reporting hayfever, 11.4 % asthma, and 7.3% eczema. Food allergies were reported by 9.5% of the sample. More than half (55.0%) reported having had surgery with general anesthesia.

Current smoking was reported by 13.3% while 33.5% reported having ever smoked. A total of 153 (3.3%) HCWs reported a history of latex allergy diagnosed by a physician.

Latex Reactivity and Allergy -- Stratified Analyses

The prevalence of latex-related symptoms, serologic and skin test results are detailed in Table 7-3. Many more workers reported general latex-related symptoms than actually met stricter criteria for latex reactivity (85 new hires and 541 current workers). Skin rash or hives was the most frequent latex-associated symptom among current employees with 12.4% reporting a history of skin rash and 5.3% ongoing problems with rash. Upper respiratory symptoms associated with latex exposure were common among current employees (ranging from 6.5% reporting a history of coryza to 4.6% reporting a history of sneezing spells). Lower respiratory latex-associated symptoms were less common. Some workers in each group reported a history of anaphylaxis associated with latex exposure. Current latex-associated symptoms were less frequent than past symptoms among both groups. Compared to current HCWs, new employees reported lower frequencies of past and present latex-associated symptoms.

Current and new employees reported similar frequencies of latex-related urticaria (2.5% and 2.2% respectively), rash developing within an hour of latex exposure (5.0% and 4.0%), rash extending proximal to the area of direct skin contact (3.0% and 2.9%), and lower respiratory symptoms associated with latex exposure (1.9% in both groups). A clinical diagnosis of latex allergy was made for 2.0% of current employees and for 2.4% of new employees. Positive antilatex IgE antibody levels were found in 0.5% of current employees and 1.6% newly hired workers.

Among the entire cohort, 6.0% (n=276) were latex reactive and 2.7% (n=122) met criteria for latex allergy which required serologic or clinical confirmation (Table 7-4). The mean age of HCWs meeting criteria for latex reactivity was 41.3 years, while the subset of this group meeting criteria for latex allergy had a mean age of 42.5 years. The predominance of females was greater for the group having latex reactivity than for those with latex allergy and the two groups did not differ by race. Among HCWs meeting criteria for latex reactivity, mean duration of work in health care was 15.3 years and average time wearing latex gloves was 11.1 years. Those who met criteria for latex allergy had a mean duration of employment in health care of 16.1 years and an average time wearing latex gloves of 11.6 years. Personal risk factors were more common among those with latex reactivity than among those with latex allergy. The prevalence of latex reactivity and latex allergy demonstrated an increasing trend with years of health care work and years of latex glove use.

Multivariate Analyses

Table 7-5 shows multivariate risk estimates for latex reactivity and latex allergy by demographic, occupational, and atopic characteristics for all HCWs undergoing surveillance. Significant predictors of latex allergy paralleled those for latex reactivity. Females were significantly more likely than males, and Blacks were significantly more likely than Whites, to meet criteria for latex reactivity and latex allergy while adjusting for all other risk factors. Age, employment status (new or current worker), and smoking were not significantly associated with either latex

reactivity or latex allergy. Number of years of latex glove use was highly correlated with number of years employed as a HCW. Moreover, as years of work in health care increased, the risk for latex reactivity also increased, in a pattern consistent with dose-response. Workers employed in health care for more than 20 years were 2.7 times (95% C. I. 1.1 – 7.0) more likely to have latex allergy than those who had worked in health care less than 3 years. Having a physician diagnosis of hayfever, asthma, or eczema was significantly associated with latex reactivity and allergy. History of allergies to food, medication, or environmental aeroallergens was also significantly associated with latex reactivity and allergy among this cohort of HCWs.

Nurses, working either on the inpatient unit or in a managerial role, medical or lab technicians, physician's assistants, nursing care assistants, other clinical professionals and housekeeper/laundry workers had significantly higher odds of latex reactivity than occupations in the lowest strata of risk for latex reactivity while taking into account age, gender, race, duration of work in health care, atopy and other allergies. Risk estimates for latex allergy were significantly elevated for work as an inpatient nurse, physician's assistant, and housekeeper while controlling for other risk factors.

DISCUSSION AND CONCLUSIONS

The 6.0% prevalence of latex reactivity found in this cohort of HCWs is slightly lower than the 8% reported by Zeiss et al.[Zeiss et al., 2003] for a 12-month period prevalence of latex glove-associated symptoms among health care workers. Our criteria for latex reactivity were stricter than those used in the Zeiss study, probably accounting for the lower prevalence estimate. Another recent investigation found a prevalence of latex-related symptoms of 8.1% among 901 HCWs in a multi-center study of latex sensitization and allergy in Russia and eastern Europe.[Nolte et al., 2002] Similar to our study, a smaller proportion of workers (1.9% of HCWs) were latex allergic.

In general, the prevalence of latex reactivity and allergy in our cohort falls within the range reported by several recent reviews of latex allergy among HCWs.[McFadden, 2002; Pooley and Slater, 2000; Ranta and Ownby, 2004] In their comprehensive review, Garabrant and Schweitzer[Garabrant and Schweitzer, 2002] summarized that the prevalence of latex allergy ranges between 0 and 30% with most estimates between 5 and 17% while the annual incidence ranges from 1 to 2.5%.

We found that duration of work in health care conferred a significantly increased risk for latex reactivity and allergy with risk estimates rising with longer duration of health care work. Much controversy exists regarding the potential exposure-response association for latex allergy. A systematic review of the epidemiology of latex sensitization and allergy among healthcare workers found no clear associations between measures of latex exposure and outcome.[Garabrant and Schweitzer, 2002] Researchers analyzing National Heath Interview Survey data found no significant association between occupation as a HCW or in other occupations likely to involve wearing latex gloves and the presence of positive levels of antilatex IgE antibody.[Garabrant et al., 2001] In addition, McCall et al[McCall et al., 2003] observed no statistically significant evidence of an increased prevalence of potential NRL-related conditions among HCWs compared to nonmedical occupations. They also found no trend over time of increasing potential

NRL-related conditions since introduction of universal precautions and increased glove use. Both study's negative results, using existing National Heath Interview Survey data, may have been influenced by inability of surrogate measures to accurately classify workers with regard to exposure and outcome.

Conversely, many scientists argue that there is enough evidence that NRL allergy increases with occupational exposure and that NRL-associated asthma is almost solely due to exposure to powdered latex gloves. [Charous et al., 2002] And there is evidence that intervention reducing latex allergen exposure dose by substituting low protein powder-free NRL gloves throughout a national hospital system was associated with lowering the incidence of suspected occupational asthma among HCWs.[Allmers et al., 2002] Furthermore, some studies have shown increasing latex sensitization with increasing occupational exposure. Zeiss [Zeiss et al., 2003] found that exposure (defined as having an occupation classified as entailing moderate or extensive glove use), race and atopy were the major risk factors for latex glove-associated symptoms. Tarlo [Tarlo et al., 1997] performed a cross-sectional study of dental students and faculty and showed increasing latex allergy measured by skin prick testing associated with tenure in school.

Consistent with other studies, our findings show a significant association between allergy to latex and history of atopic illness and other allergies. Proteins in many fruits cross-link with latex proteins and fruit allergy has been postulated to be a co-phenomenon rather than a true risk factor for developing latex allergy [Cullinan et al. \, 2003; Turjanmaa and Makinen-Kiljunen, 2002]. Although the prevalence of latex allergy is elevated among atopic individuals, the actual relationship between a history of atopy and latex allergy has not been definitively described in a prospective investigation. Our models may over-adjust by considering atopy and fruit allergy as possible independent risk factors for latex reactivity and allergy, thus potentially underestimating the true effects of age, gender, race, and occupational exposure factors.

Several earlier investigations have assessed race and age as potential risk factors for latex-related symptoms. In agreement with our findings, Zeiss [Zeiss et al., 2003] found nonwhite race, atopy, and exposure were significantly associated with latex glove-associated symptoms and sensitization among a study of 1959 HCWs. Also, Grzybowski [Grzybowski et al., 2002] evaluated a general population presenting to an Emergency Department and found that nonwhite race was associated with increased risk of positive IgE to latex. In the general population, adults have shown declining prevalence of latex allergy with age [Cullinan et al., 2003] but few studies have simultaneously considered the potential effects of race, occupation, atopy and other allergies.

Like all studies assessing prevalence of and risk factors for latex-related symptoms, we are limited by the lack of standardized criteria for definitive determination of latex allergy or latex reactivity. Having no standard questionnaire tool and no gold standard for clinical diagnosis or broadly accepted challenge test limits comparability between studies. [Ranta and Ownby, 2004] In addition, self-report of symptoms, years using latex gloves, and years working in health care may be unreliable. However, we have no information that would indicate a likely differential distribution (and subsequent possible bias) of these self-reported items by age, race, gender, or occupation.

Our study may have underestimated latex allergy among current HCWs due to our methods, which allowed current workers with low-level latex-associated symptoms (rash or upper respiratory symptoms occurring no more than once a month) to forego clinic evaluation. This may account in part for the lower prevalence of positive antilatex IgE antibody results among current workers compared to newly hired workers. These current workers with low-level symptoms completed the telephone interview and could be included in the group having latex reactivity but may not have met criteria for latex allergy if they had never had serology or skin testing. Such a possible underestimation could have lessened the likelihood to observe significant associations for potential risk factors for latex allergy. However, our multivariate results were similar for both latex reactivity and latex allergy.

A strength of this study is that we were able to evaluate the risk for latex-related symptoms among defined occupational groups. Many researchers have evaluated risk for latex allergy or sensitization among a few selected occupations including lab workers, nurses, physicians, and dentists. [Grzybowski et al., 1996,; Liss et al., 1997, Tarlo et al., 1997] In our study we were able to evaluate the potential effects for several occupational groups while controlling for known and suspected risk factors for allergy.

Additional strengths of this study include the large size of the population-based sample allowing for multivariate assessment of the potential risk of age, gender, race, duration of work in health care and occupation for latex reactivity and allergy. We conservatively estimate that 60% of the potentially available population of HCWs participated in this surveillance activity. We have no reason to believe that those who participated were biased based on occupation, duration of time working in health care, age, gender, race or other potential risk factor. By integrating data derived from clinical occupational health assessments, survey information, and existing administrative data we maximize information available to evaluate risk factors for latex reactivity and allergy. This work is an example of promising future research combining clinical occupational health surveillance with a comprehensive occupational health surveillance system.

Our conceptual framework for latex allergy clinical surveillance allowed us to capture data efficiently as we attempted to avoid unnecessary clinic visits. We considered specific latex-associated symptoms (required to meet criteria for latex reactive) as an outcome and showed that risk factors for latex reactivity parallel those for latex allergy. Future clinical surveillance may reasonably be based on questionnaire information alone including the specific latex-associated symptoms.

The results of our study will serve as aid for enhancing and evaluating ongoing prevention efforts. Guidelines for latex allergy prevention are already in place in the Duke University Health System and are consistent with those recently summarized by Ranta and Ownby [Ranta and Ownby, 2004]. Employees are encouraged to assess their own risk based on duration of latex glove use and medical history. HCWs should make educated decisions about when and what kind of gloves to use. DUHS encourages those anticipating contact with blood and body fluids for a short period of time to choose synthetic (non-latex) gloves and low-protein, powder-free latex gloves for times when extended wear is needed. Our results will guide future implementation of more targeted periodic allergy surveillance for workers in high risk jobs.

Table 7-1
Demographic Characteristics of DUHS Health Care Workers Cohort with Potential for Latex Glove Exposure 2002 -2004

Variable and Number of Employees with Data	New Hires n=951 (%)	Current Employees/Transfers n=3633 (%)
Age (n=4584)		
< 25	110 (11.6)	162 (4.5)
25-34	495 (52.1)	934 (25.7)
35-44	197 (20.7)	1040 (28.6)
45-54	121 (12.7)	1016 (28.0)
55-64	25 (2.6)	439 (12.1)
65+	3 (0.32)	42 (1.2)
Gender (n=4584)		
Female	657 (69.1)	2671 (73.5)
Male	294 (30.9)	962 (26.5)
Race/Ethnicity (n=4584)		
White	658 (69.2)	2201 (60.6)
Black	182 (19.1)	1243 (34.2)
Other	111 (11.7)	189 (5.2)
Years as health care worker (n=3336)		
<3	324 (43.0)	354 (13.7)
3-9	243 (32.3)	718 (27.8)
10-20	115 (15.3)	689 (26.7)
20+	71 (9.4)	822 (31.8)
Occupational group (n=4584)		
Admin/Manager	2 (0.2)	78 (2.2)
All Other-Clinical & Prof	21 (2.2)	225 (6.2)
Faculty	97 (10.2)	167 (4.6)
Food Services-Nutrition	0 (0.0)	13 (0.4)
House Staff	204 (21.5)	81 (2.2)
Housekeeping/Laundry	33 (3.5)	261 (7.2)
Medical & Lab Tech	114 (12.0)	613 (16.9)
Nursing Inpatient	269 (28.9)	764 (21.0)
Nursing Inpatient –Admin/Manager	10 (1.1)	40 (1.1)
Nursing, Admin & Ambulatory Care	56 (5.9)	219 (6.0)
Office Support	5 (0.5)	539 (14.8)
Physician's Assistant/Associate	22 (2.3)	29 (0.8)
Research & Scholarship	5 (0.5)	31 (0.9)
Scientific, Research Tech	22 (2.3)	140 (3.9)
Nursing Aides	62 (6.5)	139 (3.8)
Services- General	4 (0.4)	147 (4.1)
Skilled Crafts	0 (0.0)	91 (2.5)
Students & Student Services	1 (0.1)	3 (0.1)
Unclassified	24 (2.5)	53 (1.5)

Table 7-2
Characteristics of Latex Exposure, Allergy History, and other Risk Factors

Variable and Number of Employees with Data	New Hires n=951 (%)	Current Employees/Transfers n=3633 (%)
Current glove use (n=4526)	899 (94.5)	2855 (78.6)
Years latex glove use (n=4162)		
None	49 (5.4)	739 (22.7)
<5	382 (42.2)	601 (18.5)
5-14	350 (38.7)	1015 (31.2)
15+	124 (13.7)	902 (27.7)
Physician diagnoses		
Hayfever (n=4461)	174 (18.4)	568 (15.6)
Asthma (n=4431)	109 (11.6)	394 (11.3)
Eczema (n=4390)	71 (7.5)	250 (7.3)
Latex allergy (n=4352)	25 (2.7)	128 (3.8)
Allergies		
Medication (n=4502)	244 (25.8)	1057 (29.7)
Food (n=4462)	89 (9.5)	336 (9.5)
Pollen, animal dander, and other (n=4488)	328 (34.9)	1164 (32.8)
Hx surgery with general anesthesia (n=4497)	502 (53.4)	1969 (55.4)
Ever smoked (n=4508)	237 (25.0)	1273 (35.8)
Born with spina bifida (n=4496)	6 (0.6)	18 (0.5)

Table 7-3
Latex Symptoms, Reactivity, and Allergy

Latex Conditions		Variable	New Hires n=951 (%)	Current Employees and Transfers n=3633 (%)
General Symptoms	A	Physician diagnosis of latex allergy	25 (2.7)	128 (3.8)
	B	Episode of latex allergy in the past 12 months	15 (1.6)	88 (2.6)
	C	Past symptom related to latex		
		Skin rash or hives	76 (8.1)	438 (12.4)
		Watery, itchy eyes	20 (2.1)	228 (6.5)
		Runny or stuffy nose	18 (1.9)	185 (5.3)
		Sneezing spells	12 (1.3)	160 (4.6)
		Frequent cough	5 (0.5)	65 (1.9)
		Wheezing in chest	7 (0.8)	63 (1.8)
		Shortness of breath	5 (0.5)	58 (1.7)
		Anaphylaxis	2 (0.2)	13 (0.4)
	D	Current symptoms related to latex		
		Skin rash or hives	42 (4.4)	189 (5.3)
		Watery, itchy eyes	10 (1.1)	90 (2.5)
		Runny or stuffy nose	9 (1.0)	73 (2.1)
		Sneezing spells	4 (0.4)	55 (1.6)
		Frequent cough	4 (0.4)	16 (0.5)
		Wheezing in chest	2 (0.2)	12 (0.3)
		Shortness of breath	2 (0.2)	16 (0.5)
Reactivity	E	Latex related urticaria	21 (2.2)	90 (2.5)
	F	Rash within 1 hr of latex exposure	38 (4.0)	180 (5.0)
	G	Rash proximal to glove line	28 (2.9)	109 (3.0)
	H	Respiratory symptoms confirmed	18 (1.9)	68 (1.9)
Allergy	I	Clinical diagnosis of latex allergy	23 (2.4)	74 (2.0)
	J	Antilatex IgE antibody > class 0	15 (1.6)	19 (0.5)
	K	Self report of positive antilatex IgE antibody	8 (0.8)	30 (0.8)
	L	Self report of positive latex skin prick test	2 (0.2)	34 (0.9)

Latex Reactivity: reports A or B or C or D **and** E or F or G or H
Latex Allergy: meets criteria for Reactivity **and** I or J or K or L
Total population that meet case definition criteria (new hires, current employees/transfers): Reactivity=52, 224; Allergy=26, 96

Table 7-4
Prevalence of Latex Reactivity and Allergy by Demographics and Other Risk Factors

Variable	Number of Cases and Prevalence (%)	
	Latex Reactivity # Cases=276	Latex Allergy # Cases=122
Age		
< 25	6 (2.2)	2 (0.7)
25-34	68 (4.8)	22 (1.5)
35-44	98 (7.9)	47 (3.8)
45-54	81 (7.1)	39 (3.4)
55-64	21 (4.5)	12 (2.6)
65+	2 (4.4)	0 (0.0)
Gender		
Male	31 (2.5)	11 (0.9)
Female	245 (7.4)	111 (1.3)
Race/Ethnicity		
White	170 (6.0)	74 (2.6)
Black	87 (6.1)	44 (3.1)
Other	19 (6.3)	4 (1.3)
Years as health care worker (quartiles)		
<3	19 (2.8)	9 (1.3)
3-9	60 (6.2)	25 (2.6)
10-20	79 (9.8)	31 (3.9)
20+	83 (9.3)	43 (4.8)
Years of latex glove use		
None	18 (2.3)	11 (1.4)
<5	55 (5.6)	22 (2.2)
5-14	95 (7.0)	40 (2.9)
15+	88 (8.6)	43 (4.2)
Personal risk factors		
Hx allergy to medication, food, or aeroallergens	205 (9.0)	97 (4.2)
Hx of general anesthesia	187 (7.6)	83 (3.4)
Ever smoked	89 (5.9)	42 (2.8)
Born with spina bifida	3 (12.5)	0 (0.0)
Physician diag hayfever, asthma, or eczema	146 (12.1)	74 (6.1)
Employment status		
Current employees	224 (6.2)	96 (2.6)
New employees	52 (5.5)	26 (2.7)
Occupational group		
Admin/Manager	1 (1.3)	1 (1.3)
All Other-Clinical & Prof	22 (8.9)	4 (3.2)
Faculty	10 (3.8)	5 (1.9)
Food Services-Nutrition	0 (0.0)	0 (0.0)
House Staff	4 (1.4)	1 (0.4)
Housekeeping/Laundry	17 (5.8)	9 (3.1)
Medical & Lab Tech	57 (7.8)	19 (2.6)
Nursing Inpatient	91 (8.8)	42 (4.1)
Nursing Inpatient –Admin/Manager	5 (10.0)	4 (8.0)
Nursing, Admin & Ambulatory Care	24 (8.7)	14 (5.1)
Office Support	13 (2.4)	4 (0.7)
Physician's Assistant/Associate	5 (9.8)	4 (7.8)
Research & Scholarship	2 (5.6)	1 (2.8)

Variable	Number of Cases and Prevalence (%)	
	Latex Reactivity # Cases=276	**Latex Allergy # Cases=122**
Scientific, Research Tech	3 (1.9)	1 (1.2)
Nursing Aides	15 (7.5)	9 (4.5)
Services- General	4 (2.7)	2 (1.3)
Skilled Crafts	1 (1.1)	0 (0.0)
Students & Student Services	0 (0.0)	0 (0.0)
Unclassified	2 (2.6)	1 (1.3)

Table 7-5
Multivariate Logistic Regression Models for Latex Reactivity and Allergy

Model Parameter[1]	Latex Reactivity Odds-Ratio (95% CI)	Latex Allergy Odds-Ratio (95% CI)
# Cases and (non-cases) in model	238 (3035)	105 (3168)
Age group		
<25	1.0	1.0
25-34	1.65(0.6-4.0)	1.3 (0.3-5.9)
35-44	1.7 (0.6-4.6)	2.7 (0.6-13.0)
45-54	1.7 (0.6-4.0)	1.4 (0.3-7.3)
55-64	0.7 (0.2-2.1)	1.2 (0.3-5.9)
65+	1.0 (0.2-6.2)	-----
Gender		
Male	1.0	1.0
Female	1.9 (1.2-2.9)	2.2 (1.1-4.2)
Race		
White	1.0	1.0
Black	1.5 (1.1-2.1)	2.0 (1.2-3.2)
Other	1.5 (0.8-2.6)	0.4 (0.1-1.6)
Years of health care work (quartiles)		
<3	1.0	1.0
3-9	2.1 (1.2-3.7)	1.7 (0.7-3.9)
10-20	2.8 (1.5-5.2)	1.5 (0.6-3.6)
20+	3.7(1.9-7.4)	2.7 (1.1-7.0)
History of medication, food or pollen allergies		
No	1.0	1.0
Yes	1.8 (1.3-2.5)	2.0 (1.2-3.5)
Reported physician diagnosis of hayfever, asthma, or eczema		
No	1.0	1.0
Yes	2.7 (2.1-3.7)	3.5 (2.2-5.5)
Occupational group[2]		
Lowest Risk Third Of Groups	1.0	1.0
All Other-Clinical & Prof	4.7 (2.3-9.5)	1.5 (0.4-5.2)
Faculty	1.4 (0.6-3.4)	1.9 (0.6-6.3)
Housekeeping/Laundry	5.5 (2.3-12.7)	4.9 (1.5-15.3)
Medical & Lab Tech	3.5 (1.9-6.4)	2.0 (0.8-5.0)
Nursing Inpatient	3.5 (2.0-6.3)	3.4 (1.5-7.9)
Nursing Inpatient –Admin/Manager	3.5 (1.2-10.5)	5.8 (1.5-22.0)
Nursing, Admin, Ambulatory Care	2.3 (1.2-10.3)	2.7 (1.0-7.3)
Physician's Assistant/Associate	3.4 (1.1-10.3)	6.8 (1.8-25.6)
Research & Scholarship	4.6 (0.9-22.6)	5.3 (0.6-49.4)
Nursing Aides	2.9 (1.2-6.8)	3.2 (1.0-10.1)
Services- General	1.9 (0.4-8.8)	1.8 (0.3-15.5)
Unclassified	3.8 (0.8-18.0)	4.8 (0.6-42.2)

Notes: [1] The final model includes all parameters (class or individual) with a Wald Type III Chi-Square of 0.10 or less. [2] Occupational groups in the lowest one-third of latex allergy risk by stratified analyses were grouped to form the reference category for occupational group comparisons. The overall prevalence of latex reactivity and latex allergy in the reference category was 1.9% (22 cases) and 0.7% (8 cases), respectively.

CHAPTER 8: GENERAL HEALTH RISK FACTOR SURVEILLANCE

METHODS

Live-for-Life HRA-Based Analyses and NHANES Comparisons

Surveillance of general health risk factors has included descriptive analyses of risk factors from the health risk appraisals (HRAs) and detailed analyses of hypertension. All Life-for-Life HRAs among Duke employees during calendar years 2001-2004 were extracted from the DHSSS. Analyses of general health risk factors and hypertension prevalence were limited to the most current HRA by employee with systolic and diastolic blood pressure (BP) measurements. Each HRA was linked to human resources data to define employee demographics, including age, gender, race/ethnicity, and occupational group. A total 9204 HRAs were available for analysis with 7566 HRAs with BP measurements. Definitions of health conditions used for data summaries are provided in Table 8-1. Several additional definitions of hypertension and pre-hypertension based on BP measurements were also used (Table 8-2). The cut points for pre-hypertension and hypertension by Stage were chosen to be consistent with the "Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure" (JNC VII) [Chobanian et al., 2003]. To avoid imprecise estimates to due small numbers, occupational group prevalence analyses were limited to groups with at least 10 HRAs during 2001-2004.

In addition to analyses using the BP measures made as part of the Live-for-Life HRAs, analyses also were undertaken using HRA information on a self-reported history of hypertension. In these additional analyses an employee was considered to have hypertension if their BP measurements placed them into Stage I or Stage II hypertension, as defined in Table 1, or if they answered positively to the question --- "Has your doctor, or other health professional, ever told you that you have had any of the following (make all that apply) ---- high blood pressure'. In order to compare the prevalence of hypertension among Duke employees with published data from NHANES [Hajjar and Kotchen, 2003], prevalence values by race and gender using this case definition were age-adjusted using the 2000 U.S. Census for direct standardization weights, with a population breakdown by 10-year increments. Age-adjustments were only applied to whites and blacks by gender due to small numbers when other race/ethnicity groups were stratified by gender and age category.

Health Insurance Medical Claims-Based Analyses

The period prevalence of hypertension based on outpatient health insurance medical claims was estimated using 2004 data from the DHSSS. These analyses were restricted to employees who participated in one of the Duke health plans for all of 2004. An employee was classified as hypertensive if they had one or more outpatient health claims with an ICD-9 CM three digit diagnosis code of 401 'Essential Hypertension" or 402. 'Hypertensive Heart Disease' [Muhajarine et al., 1991; Robinson et al, 1997; Roos and Mustard, 1997]. Health claims data in the DHSSS were linked to human resources data to define employee demographics, including age, gender, race/ethnicity, and occupational group. Prevalence estimates by occupational group

were limited to groups with at least 10 health plan participants during 2004 in order to avoid imprecise prevalence estimates.

Multivariate Regression Models

In order to further explore the association between occupational group and hypertension prevalence, multivariate logistic models were developed. It was hypothesized that observed elevated crude hypertension prevalence in certain occupational groups could be at least partially explained by the demographic characteristics of employees in these positions (e.g. age, sex, gender/ethnicity). The primary objective of the multivariate logistic analyses was to explore the association between elevated hypertension prevalence by occupational group after simultaneous adjustment for gender, race/ethnicity, and age. Occupational groups with a hypertension prevalence equal to or less than the overall prevalence for the Duke population based on the stratified analyses were grouped together and used as the internal referent cell in the logistic regression models. For the logistic regression models using HRA data, an employee was considered to have hypertension if their BP measurements placed them into Stage I or Stage II hypertension, as defined in Table 1, or if they answered positively to the question --- "Has your doctor, or other health professional, ever told you that you have had any of the following (make all that apply) ---- high blood pressure'. A separate logistic model was also developed using the health claims data. Logistic models were fit using SAS PROC LOGISTIC, which generates parameter estimates by maximum likelihood methods.

RESULTS

Live-for-Life HRA-Based Analyses

The summary of the overall period prevalence of health conditions among Duke employees is presented in Table 8-2. Several risk factors are of note. The prevalence of hypertension (>=140/90) was 12.18%, 28.57% of employees were obese, elevated total cholesterol was observed in 41.52% of employees, all risk factors for cardiovascular disease. Additionally, 22.78% of employees reported elevated work stress and 10.80% of employees reported elevated stress levels associated with their home environment. Elevated stress represents an additional cardiovascular risk factor, especially in connection with poor aerobic exercise habits (43.75%).

More detailed analyses of hypertension is provided in the remainder of this Chapter. Tables 8-4 through 8-8 provide the stratified hypertension prevalence estimates using the HRA BP measurement data for 2001-2004. The data in these tables, using case definitions based on BP measurements alone, should be interpreted as potentially 'unrecognized or uncontrolled hypertension' as some employees were already undergoing hypertension treatment at the time of their HRA. The final column in Tables 8-4 through 8-8 provides prevalence estimates based on BP measurements or history of a hypertension diagnosis from a health care provider.

Using HRA BP measurement data, the overall prevalence of Stage I hypertension was 9.3% and Stage II hypertension 2.9% (Table 8-4), resulting in an overall Stage I or Stage II prevalence of 12.2% (95% CI=11.4-12.9%). The BP measurements from the HRA data found 41.5% of Duke employees to have elevations sufficient to be classified as 'Pre-Hypertensive'. Hypertension

prevalence was higher among males (Table 8-4), among blacks (Table 8-5), and increased sharply with age (Table 8-6). Occupational groups with crude hypertension prevalence well above the overall average (>15% for Stage I and Stage II combined) (Table 8-8) from the HRA data included anesthesia technicians, cardiology technicians, food services staff, housekeeping, laundry staff, nurse anesthetists, office support staff, public safety, general services, skilled crafts, and other technical personnel.

Using BP measurements or a self-reported history of a hypertension diagnosis resulted in a much higher prevalence of hypertension as shown in the last columns of Tables 8-4 through 8-6. The overall prevalence using this case definition was 22.7% with the same general patterns by gender, race, and age as observed using BP measurements alone. A review of the HRA data found that only 48.5% of employees with Stage I or Stage II hypertension reported having ever been told they had hypertension by a physician or other health professional.

The HRA hypertension case definition using both BP measurements and a positive history of hypertension is a better approximation of the true population prevalence and is more appropriate for comparison with NHANES data. A further breakdown of hypertension prevalence using this definition by gender and race/ethnicity combine is provided in Table 8-7 along with 95% confidence intervals for the point estimates. Black males were found to have the highest prevalence of hypertension (37.0%) followed by black females (34.1%). Employees grouped in the 'other' race/ethnicity category (i.e. not white or black) were found to have the lowest hypertension prevalence for males and females.

Health Insurance Claims-Based Analyses

Results of the medical claims analyses are presented in Tables 8-9 through 8-13. Using outpatient medical claims for 18,842 Duke employees covered by one of the Duke health insurance plans for all of 2004 (Table 8-9), the overall prevalence of hypertension was estimated to be 17.2% (95% CI=16.7-17.8%), with females having a higher prevalence than males. While prevalence estimates using health claims data were generally higher than the HRA-based estimates, health insurance claims analyses demonstrated similar patterns of hypertension prevalence by race/ethnicity and age. Blacks were found to have a very high prevalence of hypertension (28.8%) using the health claims data, as were employees older about 45 years of age. Occupational groups with a crude prevalence of hypertension well above the overall average based on the claims data (i.e. >20%) were generally consistent with the same groups observed at increased risk using the HRAs. The claims data identified a few additional occupational groups including all other clinical and professional, clinical laboratory technicians, ophthalmic technicians, and nursing aides (Service, Nursing Care).

A more detailed breakdown of hypertension prevalence by race/ethnicity and gender combined using the claims data is presented in Table 9. While the claims data estimates are consistently lower than HRA-based estimates shown in Table 5, the same overall patterns were observed by race/ethnicity. However, these analyses found females within race/ethnicity group except 'other' to have a higher prevalence than males.

Comparison of HRA and Medical Claims Prevalence Estimates

Figures 1-3 provide a graphical comparison of hypertension prevalence by gender, race, and age from the HRA and health claims analyses. Stage II and I hypertension from the HRA analyses were combined for these comparisons. Several interesting patterns emerged. Health claims-based prevalence estimates were generally higher than estimates of Stage I and Stage II hypertension using HRA BP data, when stratified by gender and race (Figures 8-1 and 8-2). The health claims prevalence estimates were far below the HRA estimates of pre-hypertension, suggesting employees with pre-hypertension are generally not getting a hypertension diagnosis in their claims data. These Figures also show that the use of HRA BP measurements in combination with a self-reported history of hypertension results in prevalence estimates more consistent with estimates from the health claims data.

The pattern with age was different, as shown in Figure 8-3. Before the age of approximately 45 years, the HRA prevalence estimates for Stage I or Stage II hypertension using BP measurements alone are the same or slightly higher than the health claims based estimates. However, after the age of 45 years, the claims-based estimates were higher than the HRA estimates using BP measurements alone. These data suggest that the generally greater frequency of interaction with the health care system with increasing age results in greater probability of having a hypertension diagnosis, and likely treatment for hypertension. Analyses of blood pressure measurements alone from HRAs among employees over the age of approximately 45 years will generally underestimate the true prevalence of hypertension due to the effects of hypertension drug therapy. The overall prevalence of hypertension by age from NHANES III is shown in this Figure for comparison purposes. The NHANES III case definition includes Stage I or Stage I hypertension from BP measurements or a reported history of anti-hypertension medication use.

Age-Adjusted Comparison with NHANES III

The hypertension case definition based on HRA BP measurements (Stage I or Stage II) or a self-reported history of high blood pressure most closely approximates that used for many analyses of NHANES data [Hajjar and Kotchen, 2003; Fields et al., 2004]. Table 8-14 provides a comparison of the age-adjusted prevalence of hypertension among Duke employees by gender and race/ethnicity compared to NHANES participants during 1999-2000 [Hajjar and Kotchen, 2003; Fields et al., 2004]. Compared to NHANES, white female Duke employees had a lower prevalence of hypertension compared to NHANES whereas the black females at Duke had a substantially higher prevalence than NHANES. White male Duke employees are comparable to NHANES but black males had a greater prevalence of hypertension compared NHANES.

Logistic Regression Analyses

The logistic regression model results are shown in Table 8-15 and 8-16. In building these models, gender, race/ethnicity, and age were investigated as primary effects based on published data and results of the stratified analyses. In building the models, these primary effects were entered first followed by the inclusion of occupational group. Both models found a strong interaction between gender and race/ethnicity; therefore, the final models included parameters for these variable combinations with white females serving as the referent category.

The logistic regression analyses provided support for findings obtained by the stratified analyses. Black males and black females were found be have substantially elevated risk of hypertension after controlling for age and occupational group. Several occupational groups were found to have a statistically significant increased risk of hypertension, after controlling for gender, race/ethnicity, and age. The results from both analyses are summarized below. In this summary, an occupational group is listed if either analysis produced a statistically significant finding. The findings from both analyses are remarkably similar. A number of occupational groups were found to have increased risk in both analyses. A common thread appears to be increased risk among service and support personnel.

Occupational Group	Odds-Ratio and 95 % CI HRA-Based Analyses	Odds-Ratio and 95 % CI Health Insurance Claims-Based Analyses
All Other-Clinical/Prof	1.51 (1.10-2.06)	1.60 (1.29-1.99)
Cardiac Cath - Cardiology Tech/Associate	2.58 (1.01-6.58)	2.45 (1.22-4.89)
Housekeeping Staff	1.53 (1.13-2.08)	1.40 (1.14-1.74)
Office Support – Medical	1.36 (1.01-1.84)	1.52 (1.24-1.86)
Office Support-General	1.99 (1.61-2.46)	1.50 (1.30-1.70)
Office Support-Secretarial	1.60 (1.24-2.08)	1.40 (1.17-1.67)
Groundskeeper	2.66 (1.10-6.41)	1.22 (0.58-2.59)
Service, Nursing Care	1.46 (1.02-2.07)	1.12 (0.83-1.50)
Services- General	1.95 (1.37-2.77)	1.24 (0.95-1.62)
Clinical Lab Tech	2.03 (1.37-3.00)	1.31 (0.99-1.73)
Nursing, Admin & Ambulatory Care	1.25 (0.89-1.76)	1.26 (1.01-1.58)
Ophthalmic Tech	Not Increased	5.22 (2.09-13.03)
Public Safety	1.44 (0.83-2.48)	2.30 (1.40-3.77)
Skilled Crafts	1.42 (0.99-2.03)	1.92 (1.51-2.44)

DISCUSSION

Hypertension is major health concern in the U.S. with prevalence risking over time [Fields et al., 2004]. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) found the risk of stroke and other cardiovascular mortality increase to increase progressively and linearly with BP [Chobanian et al., 2003]. The World Health Organization reports that sub optimal BP (>115 mm Hg SBP) is responsible for 62% of cerebrovascular disease and 49% of ischemic heart disease. In the U.S., racial/ethnic disparities exist with regard to prevalence, treatment, and control of hypertension [CDC, 2005].

The analyses presented in this report provide a benchmark for hypertension prevalence among Duke employees using HRA and health claims data. Both analyses found blacks to have a much higher prevalence than whites. The prevalence of hypertension among white males and white females at Duke were comparable or lower (females) than NHANES III; however, the prevalence among blacks (males and females) was higher than observed in NHANES.

Because of the new data on lifetime risk of hypertension and the impressive increase in the risk of cardiovascular complications associated with levels of BP previously considered 'normal', the JNC 7 report introduced a new classification that includes the term "pre-hypertension" (120 to 139 mm Hg systolic and/or 80 to 8 mm Hg diastolic). This new designation is intended to identify those individuals in whom early intervention by adoption of healthy lifestyles could reduce BP, decrease the rate of progression of BP to hypertensive levels with age, or prevent hypertension entirely [Chobanian et al., 2003]. Among Duke employees, the prevalence of pre-hypertension was estimated to be 41.5%. Interventions to prevent or reduce progression of hypertension among these employees could produce substantial long-term health benefits and reduced health costs.

Several occupational groups were found to be at increased risk of hypertension, after controlling for gender, race/ethnicity, and age. Results were remarkably similar using HRA and health claims data. Additional analyses of the HRA risk factor data (e.g. exercise, diet, work stress, family stress, etc.) might help explain these results.

The Duke workforce has the potential to serve as a model for hypertension prevention, intervention, and outcomes research. Several factors make the Duke workforce and the Duke environment unique:

- The Duke workforce is large and diverse with regard to race/ethnicity, gender, and education, factors that allow generalization to the community as a whole.
- Duke has a longstanding health promotion program with well-structured hypertension prevention and intervention programs.
- More than 90% of eligible employees participate in one of the Duke provided health insurance plans, thus providing excellent access to care as well as data for evaluation of health care utilization and drug compliance. Among employees with Stage I or Stage II hypertension observed in the HRA data for 2004, 86.5% were found to be participants in Duke provided health insurance.

The Duke Health and Safety Surveillance System (DHSSS) provides an integrated health risk factor and outcomes data system which can provide information to inform and evaluation prevention and intervention programs.

Table 8-1
Operational Definitions for High-Risk Status and Health Conditions
Duke Live-for-Life INSIGHT Health Risk Appraisals for 2001 and 2004

Risk Category or Health Status	Definition of High Risk or Presence of Health Conditions
Poor aerobic exercise habits	Fewer than three periods of aerobic exercise per week lasting at least 30 minutes
Tobacco Use	Any smoking of cigarettes, cigars or pipes or use of smokeless tobacco
High Body Weight	Body mass index >30
High Blood Pressure	Values 140/90 mm Hg or greater
High Total Cholesterol	Values 200 mg/dL or higher
Poor Seat Belt Use Habits	Often fails to use sea t belts
Drinking and Driving	Consumes alcoholic beverages while driving or is driven by someone who is drinking
Alcohol Problem	Reported history of alcohol abuse
Some to Overwhelming Work Stress	Reported 'a lot' or 'overwhelming' to the question – "How much stress do you feel with your work/job?"
Some to Overwhelming Family Stress	Reported 'a lot' or 'overwhelming' to the question – "How much stress do you feel with your family?"
History of Chronic Bronchitis or Emphysema	Reported history of health professional diagnosis
History of Cancer	Reported history of health professional diagnosis
History of Depression	Reported history of health professional diagnosis
History of Diabetes	Reported history of health professional diagnosis
History of Heart Attack	Reported history of health professional diagnosis
History of Osteoporosis	Reported history of health professional diagnosis
History of Colon Polyps	Reported history of health professional diagnosis

Table 8-2
Overall Prevalence of High Risk Status and Health Conditions
Duke INSIGHT Health Risk Appraisals for 2001-2004

HRA participants	No.	Overall Prevalence (%)
HIGH RISK STATUS		
Poor Aerobic Exercise Habits	8945	43.75
Tobacco Use	9204	23.75
High Body Weight (BMI>30)	8939	28.57
High Blood Pressure: >= 140/90 mm Hg	7566	12.18
High Total Cholesterol: >= 200 mg/dL	7334	41.52
Poor Seat Belt Use Habits	7796	17.23
Drinking and Driving	8018	24.35
Alcohol Problem	7857	2.02
Elevated Work Stress	8813	22.78
Elevated Family Stress	8632	10.80
REPORTED HEALTH CONDITIONS		
History of Chronic Bronchitis or Emphysema	9204	1.64
History of Cancer	9204	2.19
History of Depression	9204	11.11
History of Diabetes	9204	3.12
History of Heart Attach	9204	0.62
History of Osteoporosis	9204	1.39
History of Colon Polyps	9204	2.34

Table 8-3
HRA Hypertension Case Definitions (JNC VII Criteria)

HYPERTENSION CATEGORY	DIASTOLIC BP mm Hg	SYSTOLIC BP mm Hg
Normal	<80	<120
Pre-Hypertension	80-89	120-139
Hypertension Stage I	90-99	140-159
Hypertension Stage II	>=100	>=160

Table 8-4
HRA Hypertension Prevalence (%) By Gender

GENDER	NUMBER HRAS	PRE-HYPERTENSION	HYPERTENSION STAGE I	HYPERTENSION STAGE II	STAGE I OR STAGE II OR HISTORY
Female	5158	1892 (36.7%)	418 (8.1%)	131 (2.5%%)	1101 (21.4%)
Male	2408	1247 (51.8%)	283 (11.8%)	87 (3.6%)	614 (25.5%)
OVERALL	**7566**	**3139 (41.5%)**	**701 (9.3%)**	**218 (2.9%)**	**1715 (22.7%)**

Table 8-5
HRA Hypertension Prevalence (%) By Race/Ethnicity

RACE/ ETHNICITY	NUMBER HRAS	PRE-HYPERTENSION	HYPERTENSION STAGE I	HYPERTENSION STAGE II	STAGE I OR STAGE II OR HISTORY
Asian	550	198 (36.0%)	23 (4.2%)	3 (0.5%)	62 (12.0%)
Black	2236	1006 (45.0%)	290 (13.0%)	132 (5.9%)	779 (34.8%)
Hispanic	131	43 (32.8%)	5 (3.8%)	2 (1.5%)	11 (8.4%)
White	4638	1888 (40.7%)	383 (8.3%)	81 (1.8%)	861 (18.6%)

Table 8-6
HRA Hypertension Prevalence (%) By Age Group

AGE CATEGORY	NUMBER HRAS	PRE-HYPERTENSION	HYPERTENSION STAGE I	HYPERTENSION STAGE II	STAGE I OR STAGE II OR HISTORY
<25 Years	613	183 (29.9%)	11 (1.7%)	5 (0.8%)	34 (5.6%)
25-34 Years	2415	894 (37.0%)	114 (4.7%)	35 (1.5%)	251 (10.4%)
35-44 Years	2020	868 (42.0%)	193 (9.6%)	62 (3.1%)	431 (21.3%)
45-54 Years	1691	743 (44.0%)	256 (15.1%)	70 (4.1%)	620 (36.7%)
55-64 Years	737	410 (55.6%)	109 (14.8%)	41 (5.6%)	333 (45.2%)
65+ Years	90	41 (45.6%)	18 (20.0%)	5 (5.6%)	46 (51.1%)

Table 8-7
HRA Hypertension Prevalence (%) By Race/Ethnicity And Gender Combined
Stage I or Stage II Or Self-Reported Hypertension

RACE/GENDER COMBINATIONS	NUMBER HRAS	PREVALENCE	LOWER 95% CI	UPPER 95% CI
White Female	3092	15.9%	14.6%	17.2%
Black Female	1679	34.1%	31.9%	36.4%
Other Female	387	9.3%	6.4%	12.2%
White Male	1546	23.9%	21.7%	26.0%
Black Male	557	37.0%	33.0%	41.0%
Other Male	305	12.8%	9.0%	16.5%

Table 8-8
HRA Hypertension Prevalence (%) By Duke Occupational Group
(Groups With 10+ Participants)

OCCUPATIONAL GROUP	# HRAS	PRE-HYPERTENSION	HYPERTENSION STAGE I	HYPERTENSION STAGE II
Admin/Manager	683	287 (42.0%)	67 (9.8%)	22 (3.2%)
All Other-Clinical/Prof	287	121 (42.2%)	31 (10.8%)	7 (2.4%)
Anesthesia Tech/Associate	10	6 (60.0%)	2 (20.0%)	0 (0.0%)
Cardiac Cath – Cardiology Tech	23	11 (47.8%)	2 (8.7%)	2 (8.7%)
Clinical Lab Tech	156	72 (46.2)	11 (7.1%)	8 (5.1%)
External Affairs	27	9 (33.3%)	2 (7.4%)	0 (0.0%)
Faculty	610	272 (44.6%)	51 (8.4%)	12 (2.0%)
Food Services-Nutrition Staff	83	33 (39.8%)	11 (13.3%)	8 (9.6%)
Groundskeeper	24	7 (29.2%)	6 (25.0%)	2 (8.3%)
House Staff	443	159 (35.9%)	16 (3.6%)	2 (0.5%)
Housekeeping Staff	265	126 (47.6%)	37 (14.0%)	15 (5.7%)
Information Technology	338	187 (55.3%)	29 (8.6%)	12 (3.6%)
Lab Animal Tech/Caretaker	44	19 (43.2%)	6 (13.6%)	1 (2.3%)
Laundry Staff	24	13 (54.2%)	4 (16.7%)	3 (12.5%)
Neurodiagnostic Tech	11	4 (36.4%)	0 (0.0%)	1 (9.1%)
Nuclear Med/Rad Therapy Tech	14	5 (35.7%)	1 (7.1%)	1 (7.1%)
Nurse Anesthetist	13	2 (15.4%)	2 (15.3%)	0 (0.0%)
Nursing Inpatient	801	261 (32.6%)	50 (6.2%)	11 (1.4%)
Nursing Inpatient- Admin/Manager	51	18 (35.3%)	4 (7.8%)	2 (3.9%)
Nursing, Admin & Ambulatory Care	221	84 (38.0%)	23 (10.4%)	5 (2.3%)
Office Support – Medical	326	136 (41.7%)	25 (7.7%)	10 (3.1%)
Office Support-General	657	321 (48.9%)	87 (13.2%)	27 (4.1%)
Office Support-Secretarial	412	186 (45.2%)	49 (11.9%)	13 (3.2%)
Ophthalmic Tech	17	5 (29.4%)	0 (0.0%)	0 (0.0%)

OCCUPATIONAL GROUP	# HRAS	PRE-HYPERTENSION	HYPERTENSION STAGE I	HYPERTENSION STAGE II
Pharmacy-Dosimetry Tech	96	39 (40.6%)	2 (2.1%)	3 (3.1%)
Phlebotomist/Tech	35	19 (54.3%)	5 (14.3%)	2 (5.7%)
Physical-Occup Therapy Tech	57	18 (31.6%)	2 (3.5%)	0 (0.0%)
Physician's Assistant/Associate	40	10 (25.1%)	1 (2.5%)	1 (2.5%)
Public Safety	79	44 (55.7%)	12 (15.2%)	1 (1.3%)
Radiology & Imaging Tech	103	33 (32.0%)	8 (7.8%)	6 (5.8%)
Research & Scholarship	258	101 (39.2%)	14 (5.4%)	4 (1.5%)
Respiratory Care Tech	40	13 (32.5%)	4 (10.0%)	0 (0.0%)
Scientific/Electronics/Technology	515	198 (38.5%)	31 (6.0%)	5 (1.0%)
Service, Nursing Care	217	77 (35.5%)	21 (9.7%)	8 (3.7%)
Services- General	166	67 (40.4%)	28 (16.9%)	10 (6.0%)
Skilled Crafts	168	85 (50.6%)	29 (17.3%)	7 (4.2%)
Student	12	2 (16.7%)	1 (8.3%)	0 (0.0%)
Student Services	33	13 (39.4%)	2 (6.1%)	0 (0.0%)
Surgical- OR Tech	22	7 (31.8%)	3 (13.6%)	0 (0.0%)
Technical- General	72	27 (37.5%)	11 (15.3%)	4 (5.6%)
Unclassified	103	39 (37.9%)	10 (9.7%)	2 (1.9%)

Table 8-9
Medical Claims Hypertension Prevalence (%) By Gender

GENDER	NUMBER INSURANCE MEMBERS	HYPERTENSION PREVALENCE NUMBER
Female	12165	2218 (18.2%)
Male	6677	1023 (15.3%)
OVERALL	18842	3241 (17.2%)

Table 8-10
Medical Claims Hypertension Prevalence (%) By Race/Ethnicity

RACE/ETHNICITY	NUMBER INSURANCE MEMBERS	HYPERTENSION PREVALENCE NUMBER
Asian	1061	65 (6.1%)
Black	4667	1346 (28.8%)
Hispanic	253	18 (7.1%)
American Indian	37	5 (13.5%)
White	12824	1807 (14.0%)

Table 8-11
Medical Claims Hypertension
Prevalence (%) By Race/Ethnicity and Gender Combined

RACE/GENDER COMBINATIONS	NUMBER INSURANCE MEMBER	PREVALENCE	LOWER 95% CI	UPPER 95% CI
White Female	8011	14.2%	13.4%	14.9%
Black Female	3475	30.0%	28.5%	31.5%
Other Female	679	5.9%	4.1%	7.7%
White Male	4813	13.9%	13.0%	14.9%
Black Male	1192	25.5%	23.0%	28.0%
Other Male	672	7.1%	5.2%	9.1%

Table 8-12
Medical Claims Hypertension Prevalence (%) By Age Group

AGE CATEGORY	NUMBER INSURANCE MEMBERS	HYPERTENSION PREVALENCE NUMBER
<25 Years	360	11 (3.1%)
25-34 Years	3978	147 (3.7%)
35-44 Years	5482	588 (10.7%)
45-54 Years	5755	1314 (22.8%)
55-64 Years	2928	1036 (35.4%)
65+ Years	339	145 (42.8%)

Table 8-13
Medical Claims Hypertension Prevalence (%) By Duke Occupational Group
(Groups With 10+ Insured In 2004)

OCCUPATIONAL GROUP	NUMBER INSURANCE MEMBERS	HYPERTENSION PREVALENCE NUMBER
Admin/Manager	2265	383 (16.9%)
All Other-Clinical/Prof	629	136 (21.6%)
Anesthesia Tech/Associate	24	6 (25.0%)
Cardiac Cath - Cardiology Tech/Associate	46	13 (28.3%)
Clinical Lab Tech	366	78 (21.3%)
DUML Ship's Crew	11	1 (9.1%)
Emergency Med Tech/Paramedic	11	1 (9.1%)
External Affairs	96	8 (8.3%)
Faculty	2557	297 (11.6%)
Food Services-Nutrition Staff	162	42 (25.9%)
Groundskeeper	50	10 (20.0%)
House Staff	562	7 (1.3%)
Housekeeping Staff	536	182 (34.0%)
Information Technology	945	151 (16.0%)
Lab Animal Tech/Caretaker	47	9 (19.2%)
Employees on Long Term Disability	27	13 (48.1%)
Neurodiagnostic Tech	21	2 (9.5%)
Nuclear Med/Rad Therapy Tech	41	5 (12.2%)
Nurse Anesthetist	53	6 (11.3%)
Nursing Inpatient	1783	262 (14.7%)
Nursing Inpatient- Admin/Manager	160	28 (17.5%)

OCCUPATIONAL GROUP	NUMBER INSURANCE MEMBERS	HYPERTENSION PREVALENCE NUMBER
Nursing, Admin & Ambulatory Care	616	122 (19.8%)
Office Support – Medical	688	176 (25.6%)
Office Support-General	1644	387 (23.5%)
Office Support-Secretarial	948	214 (22.6%)
Ophthalmic Tech	24	9 (37.5%)
Pharmacy-Dosimetry Tech	236	30 (12.7%)
Phlebotomist/Tech	67	19 (28.4%)
Physical-Occup Therapy Tech	127	9 (7.1%)
Physician's Assistant/Associate	106	11 (10.4%)
Physician, DUAP, DRH, RCH	19	2 (10.5%)
Public Safety	102	27 (26.5%)
Radiology & Imaging Tech/Staff	312	38 (12.2%)
Research & Scholarship	767	41 (5.4%)
Respiratory Care Tech	98	17 (17.4%)
Scientific/Electronics/Research Technology	1205	156 (13.0%)
Service, Nursing Care	328	72 (22.9%)
Services- General	355	90 (25.4%)
Skilled Crafts	419	117 (27.9%)
Student Services	129	25 (19.4%)
Surgical- OR Tech	64	8 (12.5%)
Technical- General	147	23 (15.7%)
Unclassified	32	5 (15.6%)

Table 8-14
Age-Adjusted Hypertension Prevalence (%) By Gender And Race Duke Employees Compared To NHANES III

GENDER	RACE/ETHNICITY	NUMBER HRAS	DUKE HRA STAGE I OR STAGE II OR SELF-REPORTED HISTORY	NHANES PREVALENCE 1999-2000
Female	White	3092	19.7%	26.6%
Female	Black	1679	41.8%	39.5%
Male	White	1546	28.8%	27.4%
Male	Black	557	42.4%	37.5%

Notes: Age-Adjusted to 2000 US Census. NHANES data from Fields et al. [2004]. The NHANES data are for Non-Hispanic whites and Non-Hispanic blacks.

Table 8-15
Logistic Regression Model
Duke HRA Stage I Or Stage II Hypertension Or Self-Reported History

PARAMETER	PARAMETER ESTIMATE	ODDS RATIO	LOWER CI	UPPER CI
RACE/GENDER COMBINATIONS				
White Female	Reference	1.00	--	--
Black Female	0.9534	2.60	2.20	3.06
Other Female	-0.3949	0.67	0.47	0.98
White Male	0.5854	1.80	1.51	2.13
Black Male	1.1266	3.09	2.44	3.90
Other Male	0.1861	1.21	0.83	1.75
AGE CATEGORY				
<25 Years	Reference	1.00	--	--
25-34 Years	0.6699	1.95	1.34	2.85
35-44 Years	1.4077	4.09	2.83	5.91
45-54 Years	2.2309	9.31	6.45	13.44
55-64 Years	2.6051	13.53	9.22	19.87
65+ Years	2.9457	19.02	10.93	33.11
OCCUPATIONAL GROUPS WITH SIGNIFICANTLY INCREASED HYPERTENSION PREVALENCE				
All Other-Clinical/Prof	0.4102	1.51	1.10	2.06
Cardiac Cath - Cardiology Tech/Associate	0.9464	2.58	1.01	6.58
Clinical Lab Tech	0.7078	2.03	1.37	3.00
Groundskeeper	0.9767	2.66	1.10	6.41
Housekeeping Staff	0.4281	1.53	1.13	2.08

PARAMETER	PARAMETER ESTIMATE	ODDS RATIO	LOWER CI	UPPER CI
Office Support – Medical	0.3095	1.36	1.01	1.84
Office Support-General	0.6871	1.99	1.61	2.46
Office Support-Secretarial	0.4723	1.60	1.24	2.08
Service, Nursing Care	0.3757	1.46	1.02	2.07
Services- General	0.6662	1.95	1.37	2.77

Table 8-16
Logistic Regression Model
Hypertension Using Health Insurance Claims Data

PARAMETER	PARAMETER ESTIMATE	ODDS RATIO	LOWER CI	UPPER CI
RACE/GENDER COMBINATIONS				
White Female	Reference	1.00	--	--
Black Female	1.0116	2.75	2.46	3.08
Other Female	-0.6127	0.54	0.39	0.76
White Male	-0.0549	0.95	0.84	1.06
Black Male	0.6806	1.98	1.67	2.34
Other Male	-0.3376	0.71	0.52	0.98
AGE CATEGORY				
<25 Years	Reference	1.00	--	--
25-34 Years	0.2193	1.25	0.67	2.33
35-44 Years	1.3256	3.76	2.05	6.93
45-54 Years	2.2439	9.43	5.14	17.30
55-64 Years	2.9315	18.76	10.20	34.48
65+ Years	3.4619	31.88	16.74	60.70
OCCUPATIONAL GROUPS WITH SIGNIFICANTLY INCREASED HYPERTENSION PREVALENCE				
All Groups ≤ Overall Prevalence	Reference	1.00	--	--
All Other-Clinical/Prof	0.4713	1.60	1.29	1.99
Cardiac Cath - Cardiology Tech/Associate	0.8913	2.45	1.22	4.89
Housekeeping Staff	0.3392	1.40	1.14	1.74
Employees on Long Term Disability	1.1690	3.22	1.47	7.07
Nursing, Admin & Ambulatory Care	0.2342	1.26	1.01	1.58

PARAMETER	PARAMETER ESTIMATE	ODDS RATIO	LOWER CI	UPPER CI
Office Support – Medical	0.4156	1.52	1.24	1.86
Office Support-General	0.4018	1.50	1.30	1.70
Office Support-Secretarial	0.3335	1.40	1.17	1.67
Ophthalmic Tech	1.6530	5.22	2.09	13.03
Public Safety	0.8325	2.30	1.40	3.77
Skilled Crafts	0.6510	1.92	1.51	2.44

FIGURE 8-1: Duke Employee Hypertension Prevelance by Gender

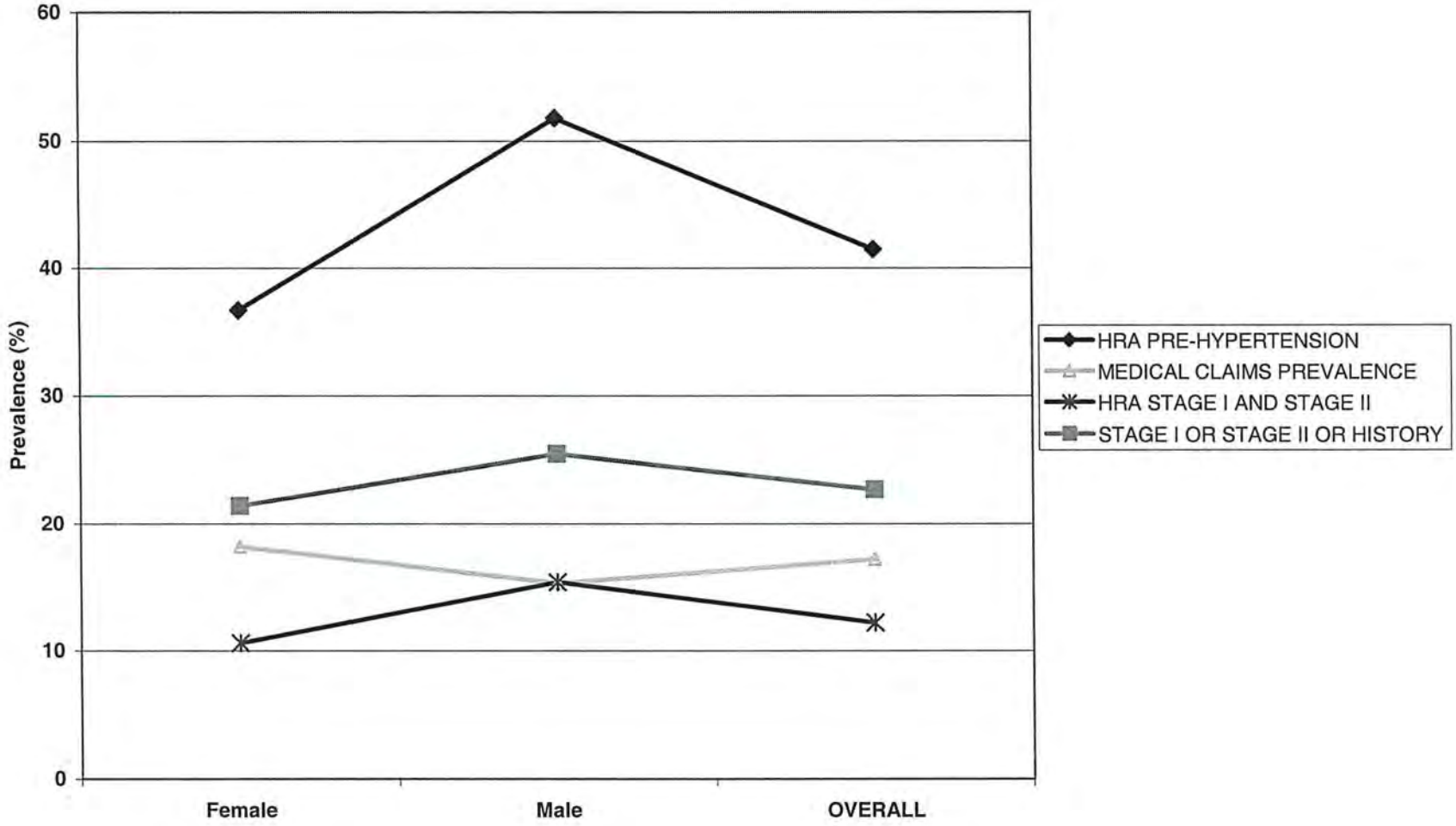


FIGURE 8-2: Duke Employee Hypertension Prevalence by Race/Ethnicity

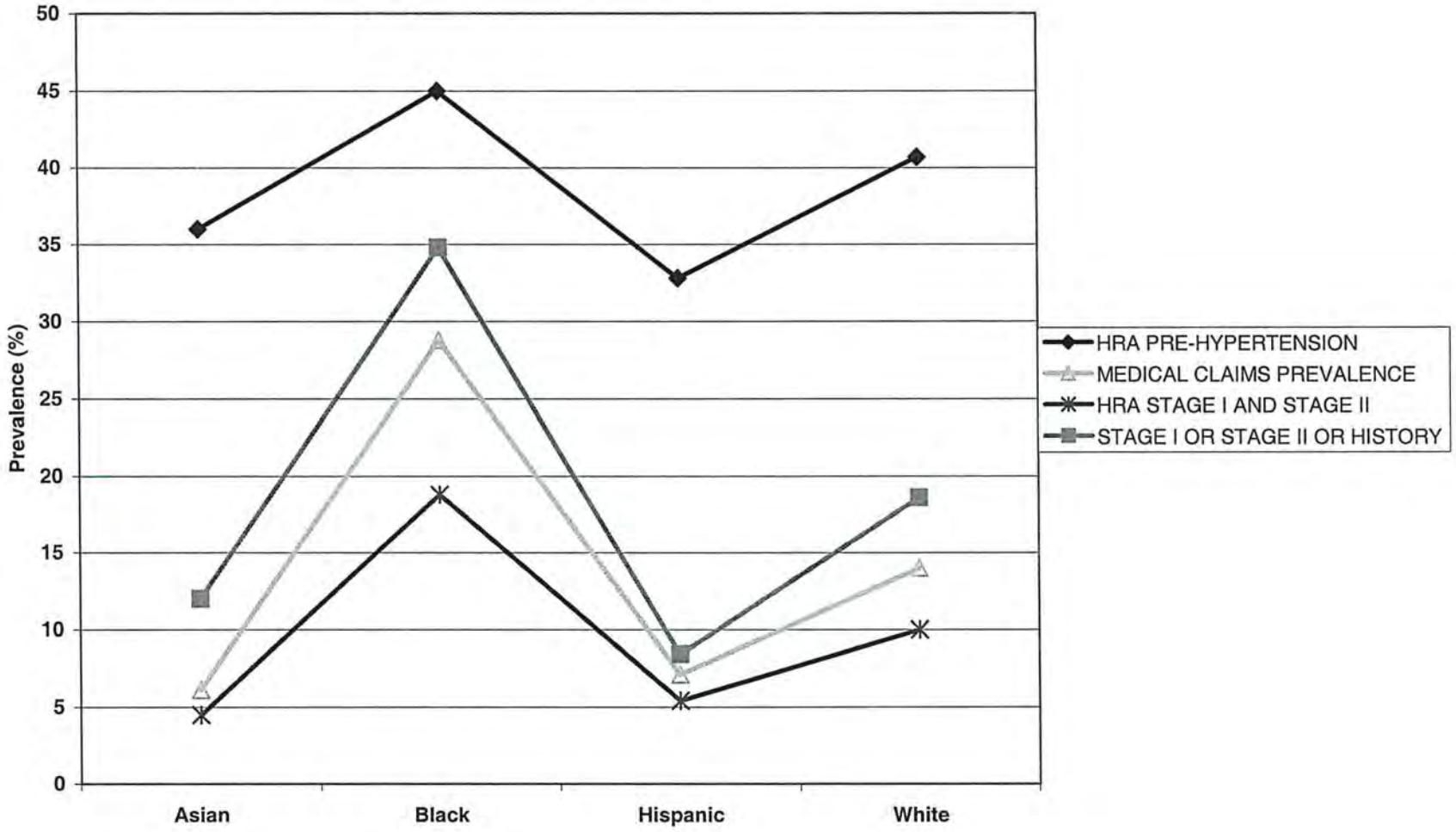
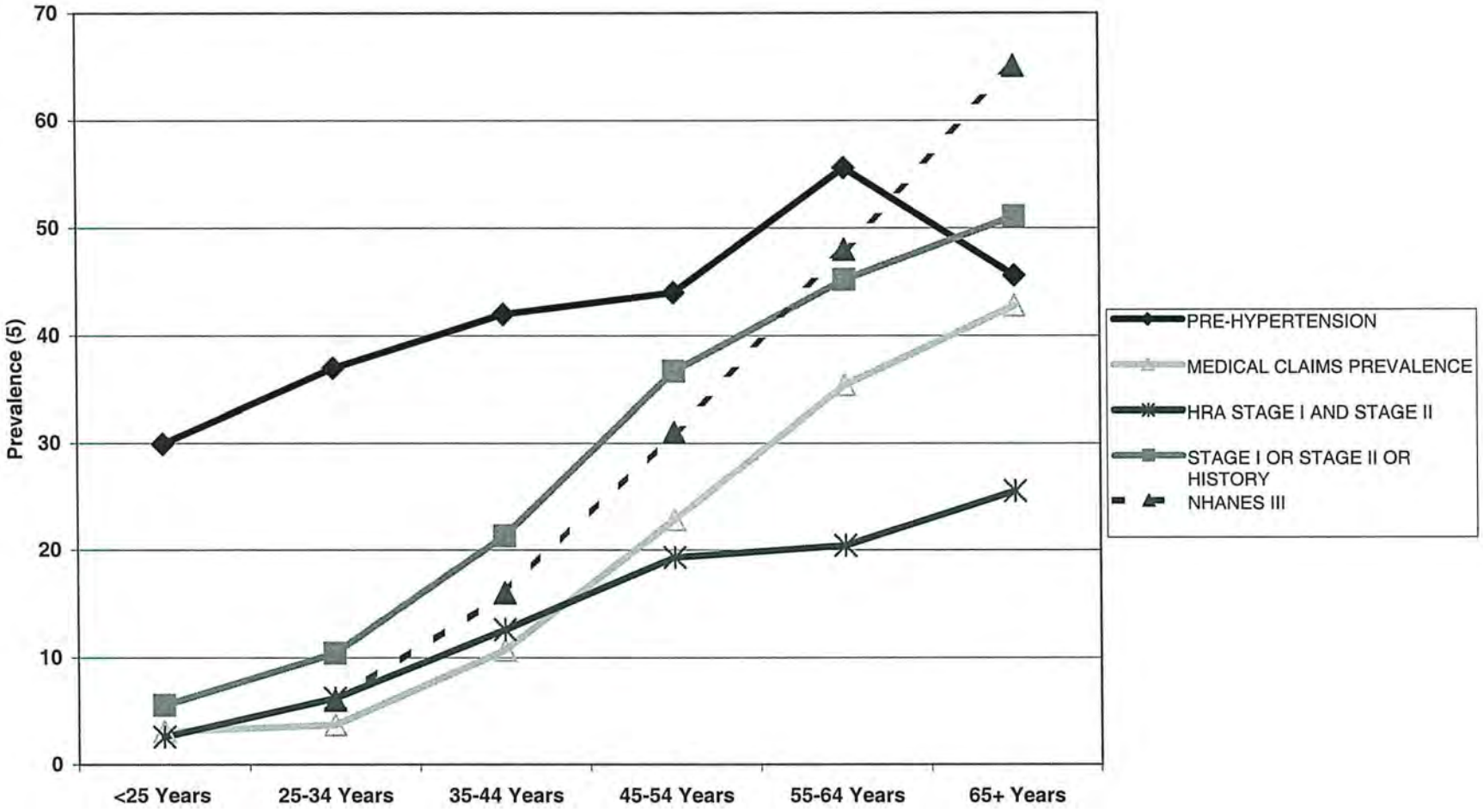


FIGURE 8-3: Duke Employee Hypertension Prevalence by Age



CHAPTER 9: BRIEF SUMMARIES OF OTHER ANALYSES USING DHSSS DATA

Duke Hearing Conservation Program Evaluation

Occupational hearing loss is the second most common self-reported occupational disease [NIOSH, 2003] and hearing conservation programs (HCPs) can reduce the incidence of disease. Among the DUHS population in 2001, 192 employees were categorized as having either short-term or time-weighted-average exposures in excess of 85 dbA and were included in Duke's HCP. The employees enrolled in this HCP came from a variety of departments with potentially hazardous noise exposures, such as maintenance, construction, fire safety, and medical helicopter operations. All employees in the HCP were required to have a baseline audiogram within the first six months of employment in a noise-exposed job and an annual audiogram thereafter. For the evaluation of the Duke HCP, baseline and annual audiometric testing data were linked to demographic and employment data in the DHSSS to identify 786 participants in the HCP program between 1981 and 2001. Due to the small number of females included in the HCP, analyses were restricted to 155 males followed for five years, and 117 males followed for 10 years. Hearing loss was defined to be a standard threshold shift (STS), defined by the Occupational Safety and Health Administration as a change in hearing threshold in either ear relative to baseline of 10dB or more at the averaged hearing thresholds of 2000, 3000, and 4000 hertz. The cumulative incidence of STS among DUHS employees was compared to the incidence of companies with an 'excellent' HCP from the American National Standards Institute (ANSI) database of audiograms from 22 diverse industrial companies throughout most regions of the U.S. and Canada [Adera and Gaydos, 1997; Adera et al., 2000]. Hazard ratios were estimated using the Cox proportional hazards model with adjustments for age and race.

Among the HCP program participants, 16.8% of the 5-year and 53.8% of the 10-year study populations had an STS. Adjusted hazard ratios were 0.81 (95% CI=0.47-1.38) for the 5-year and 1.57 (95% CI=0.92-2.66) for the 10-year group. While none of the hazard ratios reached statistical significance, the DUHS HCP participants at 10 years of follow-up demonstrated a greater incidence of hearing loss compared to the companies with HCPs judged to be excellent, likely reflecting a less effective prevention program in the early years of program implementation.

Evaluation of Colon Cancer Screening among Health Care Workers

As part of our ongoing analyses of health promotion activities, we have analyzed health claims data for 2001-2003 in order to determine rates of CRC screening among Duke employees. For these analyses, we used the DHSSS to link human resources information with a file that defined the periods of heath insurance coverage by employees for 2001-2003. We restricted the study cohort to include the 6515 employees who were 50 years and older at any time during 2001-2003 and were insured by one of the Duke health plans. We examined the health claims for each employee to determined use of any health services related to CRC screening (FOBT, sigmoidoscopy, or colonoscopy) based on a range of appropriate CPT codes. Using months of health insurance for each employee, we calculated rates of CRC screening by calendar year and also determined whether or not employees had any form of CRC screening during the entire 3-year follow-up period.

Overall, we found that less than 25% of Duke employees 50 and older had any form of annual CRC screening and only 45% had any CRC screening during the entire 3-year follow-up. Among those covered by a Duke health plan for the entire 36 months of follow-up, only 54% had any form of CRC screening. Annual CRC screening rates were very similar by sex and race; however, annual CRC screening rates below 20% were observed among many occupational groups (e.g. Food Service 16%, Lab Animal Technicians 6%, Neuro-Diagnostic Technicians 14%, Inpatient Nurses 19%, Pharmacy Technicians 19%, Radiology Technicians 19%, Respiratory Care Technicians 19%, Surgical Technicians 15%).

These data demonstrate the need for additional measures to increase CRC screening among the Duke employee population. In addition, our preliminary analyses have demonstrated the utility of the DHSSS data for identifying target populations for targeted interventions as well as to provide data for longitudinal study designs to evaluate interventions.

Evaluation of Hypertension and Elevated Serum Cholesterol Intervention Programs

We have completed preliminary analyses of outcomes for employees participating in a worksite intervention program for hypertension and/or elevated serum cholesterol. This program is known as 'Pathways-to-Change (PTC)', which currently recruits participants through results obtained from health risk appraisals (HRAs).

For these analyses, the employees who completed the PTC program through December 2003 were selected for study. The HRA most closely matched (± 3 months) to each employee's PTC recruitment date was selected to define baseline parameters for each individual. Follow-up parameters were defined by the HRA collected within one year (± 3 months) of the recruitment date. For comparison purposes, employees who completed at least two HRAs but who did not participate in the PTC program were selected. For the comparison employees, their most recent HRA were selected as well as an initial HRA collected within one year (± 3 months) prior to the most recent HRA.

These data were analyzed by summarizing the prevalence of hypertension and elevated serum cholesterol in PTC participants and non-participants on initial HRAs and at their one-year follow-up HRA. Hypertension was defined as a either a diastolic blood pressure (Dbp)>90 mm Hg or a systolic blood pressure (Sbp)>140 mm Hg. Elevated serum cholesterol was defined as a total cholesterol >200 mg/dL.

Among PTC participants, the overall prevalence of hypertension improved from 47.1% to 21.3%, with significant improvement observed for both and female participants (Table 9-1) and by age groups (Table 9-2). The prevalence of elevated total serum cholesterol also improved for both male and female PTC participants (Table 9-3) and by age group (Table 9-4), with average decreases of 14.8 mg/dL for males and 13.9 mg/dL for females (Table 9-5). The prevalence of elevated cholesterol (>200 mg/dL) was 77.3% among PTC participants at recruitment and dropped to 69.3% following PTC participation. The comparison group of non-PTC participants with demonstrated negligible improvement in hypertension or elevated serum cholesterol status.

A preliminary multivariate logistic regression model with hypertension as the outcome found hypertension program participation to be positively associated with decreased hypertension, after controlling for sex, race, and age. Hypertension program participants were found to be 7.3 (95% CI=5.1-10.3) times more likely to change from being hypertensive to being non-hypertensive over the one-year follow-up period when compared to non-participants.

These analyses provide useful information concerning the efficacy of the PTC program for hypertension and elevated serum cholesterol. Based on this program's success, a similar program is underway for obesity as the primary adverse health outcome of interest.

Table 9-1
Prevalence of Hypertension (Dbp>90 mm Hg or Sbp>140 mm Hg) by Gender
Pathways-to-Change (PTC) Participants and Non-Participants
Employees with HRAs One Year (± 3 Months) Apart

Gender	PTC Participants			PTC Non-Participants		
	No.	Prevalence (%) & (95% CI)		No.	Prevalence (%) & (95% CI)	
		First HRA	Second HRA		First HRA	Second HRA
Male	155	51.0 (43.1-58.8)	23.9 (17.2-30.6)	477	9.9 (7.2-12.5)	10.1 (7.4 -12.8)
Female	254	44.5 (38.8-51.0)	19.7 (14.8-24.6)	830	5.9 (4.3-7.5)	4.8 (3.4-6.3)
Overall	409	47.1 (42.4-52.0)	21.3 (17.3-25.2)	1307	7.4 (5.9-8.8)	6.9 (5.4-8.1)

Table 9-2
Prevalence of Hypertension (Dbp>90 mm Hg or Sbp>140 mm Hg) by Age
Pathways-to-Change (PTC) Participants and Non-Participants
Employees with HRAs One Year (± 3 Months) Apart

Age Group	PTC Participants			PTC Non-Participants		
	No.	Prevalence (%) & (95% CI)		No.	Prevalence (%) & (95% CI)	
		First HRA	Second HRA		First HRA	Second HRA
20-29	29	44.8 (26.7-62.9)	13.8 (1.2-26.3)	293	2.4 (0.6-4.1)	4.1 (1.8-6.4)
30-39	106	34.9 (25.8-44.0)	21.7 (13.9-29.5)	397	3.8 (1.9-5.7)	2.8 (1.1-4.4)
40-49	150	51.3 (43.3-59.3)	23.3 (16.6-30.1)	357	8.1 (5.3-11.0)	7.8 (5.1-10.6)
50-69	106	51.9 (42.3-61.4)	19.8 (12.2-27.4)	206	15.1 (10.2-19.9)	12.1 (7.7-16.6)
60+	18	61.1 (38.6-83.6)	22.2 (3.0-41.4)	54	25.9 (14.2-37.6)	22.2 (11.1-33.3)
Overall	409	47.1 (42.4-52.0)	21.3 (17.3-25.2)	1307	7.4 (5.9-8.8)	6.9 (5.4-8.1)

Table 9-3
Prevalence of Elevated Total Cholesterol (>200 mg/dL) by Gender
Pathways-to-Change (PTC) Participants and Non-Participants
Employees with HRAs One Year (± 3 Months) Apart

Gender	PTC Participants			PTC Non-Participants		
	No.	Prevalence (%) & (95% CI)		No.	Prevalence (%) & (95% CI)	
		First HRA	Second HRA		First HRA	Second HRA
Male	146	80.1 (73.7-86.6)	69.9 (62.4-77.3)	467	48.4 (43.9-52.9)	43.9 (39.4-48.4)
Female	254	75.6 (70.3-80.9)	68.9 (63.2-74.5)	811	35.8 32.5-39.1)	38.2 (34.9-41.5)
Overall	400	77.3 (73.1-81.4)	69.3 (64.7-73.8)	1278	40.4 (37.7-43.1)	40.3 (37.6-43.0)

Table 9-4
Prevalence of Elevated Total Cholesterol (>200 mg/dL) by Age
Pathways-to-Change (PTC) Participants and Non-Participants
Employees with HRAs One Year (± 3 Months) Apart

Age Group	PTC Participants			PTC Non-Participants		
	No.	Prevalence (%) & (95% CI)		No.	Prevalence (%) & (95% CI)	
		First HRA	Second HRA		First HRA	Second HRA
20-29	28	60.7 (42.6-78.8)	60.7 (42.6-78.8)	290	24.5 (19.5-29.4)	25.2 (20.2-30.2)
30-39	101	76.2 (67.9-84.5)	67.3 (58.2-76.5)	384	33.0 (28.3-37.8)	35.7 (30.9-40.5)
40-49	146	80.1 (73.7-86.6)	71.9 (64.6-79.2)	348	47.7 (42.5-53.0)	46.8 (41.6-52.1)
50-69	108	78.7 (71.0-86.4)	71.3 (62.8-79.8)	201	59.7 (52.9-66.5)	57.2 (50.4-64.1)
60+	17	76.5 (10.3-96.6)	58.9 (11.9-35.4)	55	58.2 (45.2-71.2)	49.1 (35.9-62.3)
Overall	400	77.3 (73.1-81.4)	69.3 (64.7-73.8)	1278	40.4 (37.7-43.1)	40.3 (37.6-43.0)

Table 9-5
Mean Change in Total Serum Cholesterol by Gender
Pathways-to-Change (PTC) Participants and Non-Participants
Employees with HRAs One Year (± 3 Months) Apart

Gender	PTC Participants			PTC Non-Participants		
	No.	Cholesterol Change (mg/dL)		No.	Cholesterol Change (mg/dL)	
		Mean	Std. Dev.		Mean	Std. Dev.
Male	146	-14.8	32.8	467	-2.2	24.6
Female	254	-13.9	34.3	811	-0.4	28.0
Overall	400	-14.2	33.7	1278	-1.1	26.7

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2. Dement JM, Epling C, Pompeii LA, Østbye T, Hunt DL : [2004] Blood and Body Fluid Exposure Risks Among Health Care Workers: Results From the Duke Health and Safety Surveillance System. Am. J. Ind. Med. 46:637–648.

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INCLUSION OF GENDER AND MINORITY SUBJECTS

TARGETED/PLANNED ENROLLMENT: Number of Subjects			
Ethnic Category	**Sex/Gender**		
	Females	**Males**	**Total**
Hispanic or Latino	1062	999	2061
Not Hispanic or Latino	34329	23842	58171
Ethnic Category Total of All Subjects*	35391	24841	60232
Racial Categories			
American Indian/Alaska Native	67	52	119
Asian	4899	5367	10266
Native Hawaiian or Other Pacific Islander	0	0	0
Black or African American	12741	5839	18580
White	35391	24841	60232
Racial Categories: Total of All Subjects *	53098	36099	89197

INCLUSION OF CHILDREN

Not applicable

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS

None

APPENDIX I

DHSSS EMPLOYEE POTENTIAL EXPOSURES AND TRAINING CATEGORIES

JOB-EXPOSURE MATRIX AS OF DECEMBER 2005

Potential Exposure/Training Category	Exposure Level	Description
AIRBORNE PATHOGENS	AIRBORNEXP1	Works in low risk Pt Care area
AIRBORNE PATHOGENS	AIRBORNEXP2	High Risk N95 Respirator Users
AIRBORNE PATHOGENS	AIRBORNEXP3	High Risk PAPR Respirator Users
AIRBORNE PATHOGENS	AIRBORNEXP4	High Risk - Annual TB Screening
AIRBORNE PATHOGENS	AIRBORNEXP5	Medical /Nursing Students
AIRBORNE PATHOGENS	AIRBORNEXP6	Works with non-TB mycobacteria
AIRBORNE PATHOGENS	AIRBORNEXP7	Low Risk - PAPR Instructions
ANESTHESIOLOGY PATIENT SAFETY TRAINING	ANESTEXP1	Training required
ANIMAL CONTACT	ANMLCONT1	Animal Contact
ANIMAL CONTACT	ANMLCONT2	Works with non-human primates other than macaques
ANIMAL CONTACT	ANMLCONT3	On protocol - no animal exposure
ANIMAL CONTACT	ANMLCONT4	Works with Macaques
ASBESTOS	ASBEXP1	Housekeepers
ASBESTOS	ASBEXP2	Auto Mechanic
ASBESTOS	ASBEXP3	Maintenance Worker
ASBESTOS	ASBEXP4	Abatement Worker
BLOODBORNE PATHOGENS	BBPEXP1	Direct patient care activities
BLOODBORNE PATHOGENS	BBPEXP2	Handles human body fluids
BLOODBORNE PATHOGENS	BBPEXP3	Handles contaminated equipment, materials, or waste
BLOODBORNE PATHOGENS	BBPEXP4	Routine administration of First Aid
BLOODBORNE PATHOGENS	BBPEXP5	Ancillary Personnel without Exposure
BLOODBORNE PATHOGENS	BBPEXP6	Medical /Nursing Students
CHEMICALS	CHEMEXP1	Potential occupational exposure to chemicals.
EES EUTHANASIZE ANIMALS USING CO2	CO2 EUTHANASIA1	EEs use CO2 to euthanize animals
DUHS COMPLIANCE	COMPEXP1	Compliance Training Required - General
DUHS COMPLIANCE	COMPEXP2	Compliance Training Required - PDC
DUHS COMPLIANCE	COMPEXP3	Compliance Training Required - PDC Physicians
DUHS COMPLIANCE	COMPEXP4	Require Compliance Update Only
CONFINED SPACE	CONFSPEXP1	Work around confined space but do not enter
CONFINED SPACE	CONFSPEXP2	People who enter confined space

Potential Exposure/Training Category	Exposure Level	Description
CONFINED SPACE	CONFSPEXP5	Employees who supervise confined space entry
CONTAINER MANAGEMENT	CONTAINER1	Requires container management training
ENVIRONMENT OF CARE	EOC1	EOC applicable
ETHYLENE OXIDE	ETHOXEXP1	Exposure to EtO
HANDS-ON FIRE EXTINGUISHER	FIREEXP1	Hands-On Fire Extinguisher Training Required.
HANDS-ON FIRE EXTINGUISHER	FIREEXP2	Hands-On Fire Ext - Clinical Labs
HANDS-ON FIRE EXTINGUISHER	FIREEXP3	Duke Hospital FS Training
HANDS-ON FIRE EXTINGUISHER	FIREEXP5	DHRH FS training
FLEET SAFETY	FLTSAFEXP1	Drives a Duke vehicle
FLEET SAFETY	FLTSAFEXP2	Need CDL
FORMALDEHYDE	FORMEXP1	Solutions greater than 0.1 percent
FORMALDEHYDE	FORMEXP2	Air levels >0.1 ppm but <0.5ppm
GLOBAL ERGO AND FIRE SAFETY - ALL EMPLOYEES	GLOBALEXP1	Exposure
GROSS CHEMISTRY	GRCH1	Primary work area is in Gross Chem labs
ANIMAL FACILITIES	HAZANML1	Animal caretaker, vet or vet tech
HAZARDOUS MATERIALS TRAINING FOR TRANSPORTATION	HAZDOT1	Requires HM DOT Security Part I
HAZARDOUS MATERIALS TRAINING FOR TRANSPORTATION	HAZDOT2	Requires HM DOT Security Part II
HAZARDOUS MATERIALS TRAINING FOR TRANSPORTATION	HAZDOT3	Requires DOT Transportation
HAZARDOUS DRUGS	HAZDRUGEXP1	Exposure to hazardous drugs
HOSPITAL EMERGIENCY INCIDENT COMMAND SYSTEM	HEICS1	HEICS APPLICABLE
HOSPITAL EMERGIENCY INCIDENT COMMAND SYSTEM	HEICS2	Code Pink Revision-General
HOSPITAL EMERGIENCY INCIDENT COMMAND SYSTEM	HEICS3	HEICS for DHRH applicable
HIPAA PATIENT CONFIDENTIALITY	HIPPA1	HIPAA Required
HAZARDOUS MATERIALS SHIPPING	HMSHIPEXP1	Ships Biohazardous Materials
HAZARDOUS MATERIALS SHIPPING	HMSHIPEXP3	Ships Radioactive Materials
HAZARDOUS MATERIALS SHIPPING	HMSHIPEXP4	Drives RAM
HAZ MAT OPS FOR HOSPITAL	HOSHAZMAT1	Designated as awareness level first responder
HAZ MAT OPS FOR HOSPITAL	HOSHAZMAT2	Designated as Ops level support
HAZ MAT OPS FOR HOSPITAL	HOSHAZMAT3	Designated as Ops level responder
HOUSESTAFF AIRBORNE PATHOGENS	HSAIRBORNEXP1	Primary Assignment Pt Care Area/Direct Pt Care
HOUSESTAFF BLOODBORNE PATHOGENS	HSBBPEXP1	Direct Patient Care Activities
HOUSESTAFF BLOODBORNE PATHOGENS	HSBBPEXP2	Handles Human Body Fluids
HOUSESTAFF BLOODBORNE PATHOGENS	HSBBPEXP3	Handles Contaminated Materials,

Potential Exposure/Training Category	Exposure Level	Description
		Equipment or Waste
HOUSESTAFF BLOODBORNE PATHOGENS	HSBBPEXP4	Routine Administration of First Aid
HOUSESTAFF BLOODBORNE PATHOGENS	HSBBPEXP5	Other potential exposures
HAZARDOUS WASTE WORKERS AND RESPONDERS	HWWREXP1	Hazardous waste worker
INDUSTRIAL TRUCK	INDTRKEXP1	Operator - Lift Truck
INDUSTRIAL TRUCK	INDTRKEXP2	Operator - Motorized Pallet Jack
INDUSTRIAL TRUCK	INDTRKEXP3	Operator - Order Picker
INFECTION CONTROL	INFECTIONEXP0	No Infection Exposure
INFECTION CONTROL	INFECTIONEXP1	Infection Control required
POTENTIAL FOR EXP TO INFLUENZA VIRUS	INFLUENZAEXP1	VACCINE RECOMMENDED
WORKS IN ANATOMICAL LABS	LABANT1	Works in an Anatomical Teaching Lab
LAB CHEMICAL WASTE MANAGEMENT	LABCHEMWASTE1	Works in lab producing chem waste
LASER	LASEREXP1	Clinical Laser User
LASER	LASEREXP2	Non Clinical Laser Users
LASER	LASEREXP3	Anesthesiology Laser Users
LASER	LASEREXP4	Bronchoscopy Laser Users
LASER	LASEREXP5	Perioperative Services Laser Users
LASER	LASEREXP6	Otolaryngology Laser Users
LASER	LASEREXP7	Dermatology Laser Users
LASER	LASEREXP8	Urology Laser Users
LOCK OUT TAG OUT	LCKTGEXP1	Authorized Employees
LOCK OUT TAG OUT	LCKTGEXP2	Affected Employees
LADDER	LDREXP1	Uses a Ladder
LEAD	LEADEXP1	Potential lead exposure
LIFT EQUIOMENT FOR HANDLING PATIENTS	LIFT 1	DH-Requires lift overview training
LIFT EQUIOMENT FOR HANDLING PATIENTS	LIFT 2	Require lift equipment hands-on for coaches
LIFT EQUIOMENT FOR HANDLING PATIENTS	LIFT 3	DRH-Requires lift overview training
METHYLENE CHLORIDE	MECL1	Potential exposure
MEDICAL GAS TRAINING FOR E&O	MEDGAS1	Works with medical gas
MRI SAFETY	MRIEXP1	Works with MRI
MRI SAFETY	MRIEXP2	Works around MRI
NOISE	NoiseExp1	Short term noise exposure > 85 dBA
NOISE	NOISEEXP2	Day long noise exposure > 85 dBA TWA
O2 ENRICHED ENVIRONMENT	O2ENV1	Works in O2 Enriched environment
ORGAN PROCUREMENT	ORGANEXP1	Medical Personnel Requiring Organ Donor Training
PESTICIDES	PESTEXP1	Work with pesticides
RADIATION	RADEXP1	RAM User

Potential Exposure/Training Category	Exposure Level	Description
RADIATION	RADEXP2	AU - RAM User
RADIATION	RADEXP3	AU - Non RAM User
RADIATION	RADEXP5	Ancillary Staff
RADIATION	RADEXP6	HCP not radiologists or radiographers
RADIATION	RADEXP7	Exempt per RSO from RS Update Training
RADIATION MACHINES	RADMACHEXP1	Uses X-ray machines
RADIATION MACHINES	RADMACHEXP2	Uses blood irradiators
REFRIGERATION	REFRIGEXP1	Works in mechanical rooms containing chillers
REFRIGERATION	REFRIGEXP2	Handles refrigerant
RESPIRATORY PROTECTION	RESPEX13	Duke Police & Security RRPAS
RESPIRATORY PROTECTION	RESPEXP1	Voluntary dust mask only
RESPIRATORY PROTECTION	RESPEXP10	Requires Escape Only Respirator
RESPIRATORY PROTECTION	RESPEXP11	HEPA PAPRs - Pharmacy
RESPIRATORY PROTECTION	RESPEXP12	First Responder PAPR
RESPIRATORY PROTECTION	RESPEXP2	Voluntary Air Purifying
RESPIRATORY PROTECTION	RESPEXP3	Requires Loose-Fitting Respirator
RESPIRATORY PROTECTION	RESPEXP4	Requires Filtering Facepiece
RESPIRATORY PROTECTION	RESPEXP5	Requires AP Half Face
RESPIRATORY PROTECTION	RESPEXP6	Requires AP Full Face
RESPIRATORY PROTECTION	RESPEXP7	Requires PAPR Full Face
RESPIRATORY PROTECTION	RESPEXP9	Requires SCBA
SPILL RESPONSE TEAM	SPILL2	CORE Lab response team member
SPILL RESPONSE TEAM	SPILL3	Requires Contingency training only
TIME-OUT TRAINING FROM ACCREDITATION OFFICE	TIMEO1	Required annually
TIME-OUT TRAINING FROM ACCREDITATION OFFICE	TIMEO2	Medical Faculty - one time
TRENCHES AND EXCAVATIONS	TRENCHEXP1	Works in Trenches & Excavations
VACCINIA VIRUS	VACCINIAEXP1	Works with vaccinia virus
WORK LOCATION	WKLOCATION0	Not clinic, lab, or hospital
WORK LOCATION	WKLOCATION1	Clinic or DUAP
WORK LOCATION	WKLOCATION2	Hospital
WORK LOCATION	WKLOCATION3	Laboratory
WORKS IN A LABORATORY	WORKSLAB1	Laboratory worker
WORKS IN A LABORATORY	WORKSLAB2	Ancillary Worker
WORKS IN A LABORATORY	WORKSLAB3	Works with HIV
WORKS IN A LABORATORY	WORKSLAB4	Works in High Containment Area
WORKS IN A LABORATORY	WORKSLAB5	Other lab work
X-RAY	XRAYEXP1	Potential x-ray exposure

APPENDIX II

DHSSS OCCUPATIONAL GROUPS

DHSSS Occupational Groups- Alpha List[1]
Administrative/Manager
All Other-Clinical/Professional
Anesthesia Technician/Associate
Autopsy or Morgue Technician/Supervisor
Cardiac Cath - Cardiology Technician/Associate/Supervisor
Clinical Lab Technician/Supervisor
Dental Assistant/Technician/Hygienist
DUML ship's crew (Marine Biology Research)
Emergency Med Technician/Paramedic
External Affairs
Faculty
Food Services-Nutrition Staff/Supervisor
Groundskeeper/Supervisor
House Staff
Housekeeping Staff/Supervisor
Information Technician
Lab Animal Technician/Caretaker/Supervisor
Laundry Staff/Supervisor
Long Term Disability (Other)
Long Term Disability (Biweekly)
Long Term Disability (Monthly)
Neuro-diagnostic Technician/Supervisor
Nuclear Medicine/Radiation Therapy Technician/Supervisor
Nurse Anesthetist
Nursing Inpatient
Nursing Inpatient- Admin/Manager
Nursing, Administrative & Ambulatory Care
Office Support - Medical
Office Support-General
Office Support-Secretarial
Ophthalmic Technlcian/Supervisor
Pharmacy-Dosimetry Technician/Supervisor
Phlebotomist/Technician/Supervisor
Physical-Occupational Therapy Technician/Supervisor
Physician, DUAP, DRH, RCH
Physician's Assistant/Associate
Public Safety

DHSSS Occupational Groups- Alpha List[1]
Radiology & Imaging Technician/Staff/Supervisor
Research & Scholarship
Respiratory Care Technician/Supervisor
Scientific/Electronics/Research Technology
Service, Nursing Care
Services- General
Skilled Crafts/Supervisor
Student
Student Services
Surgical- OR Technician
Technical- General
Unclassified

[1] While occupational groups are included in the DHSSS, detailed job descriptions are retained in the data to allow more detailed analysis by specific Duke job categories or formation of ad hoc groups as needed to address questions raised in specific analyses.