# EFFECTS OF LIFESTYLE RISKS ON THREE MAJOR DISEASE OUTCOMES IN SPINAL CORD INJURED ADULTS

by

DIANE SUSAN DAVIES

A thesis submitted to the

Department of Community Health and Epidemiology

in conformity with the requirements for

the degree of Master of Science

Queen's University

Kingston, Ontario, Canada

September 1997

copyright © Diane Susan Davies, 1997

National Library of Canada
Acquisitions and Bibliographic Services
395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale du Canada
Acquisitions et services bibliographiques
395, rue Wellington
Ottawa ON K1A 0N4
Canada

*Your file Votre référence*

*Our file Notre référence*

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-22296-9

Canada

## ABSTRACT

Following spinal cord injury, physiological alterations, sedentary lifestyles, and psychological difficulties have been documented. The majority of research focusing on lifestyle risks in the spinal cord injured population to date has mainly been descriptive in nature. Limited research has examined the relationships between lifestyle risks and morbidity. This study was undertaken to quantify the associations between selected lifestyle risks and morbidity associated with three top causes of mortality in adults with spinal cord injury.

Ninety-seven spinal cord injured patients receiving rehabilitation services at Kingston General Hospital between 1972 and 1992 were interviewed over the telephone to assess morbidity and lifestyle exposure history. Logistic regression modeling was used to quantify the associations between lifestyle risks and cardiovascular, respiratory, and urinary tract disorders. Risk of respiratory morbidity was found to be positively associated with quadriplegia and number of cigarettes smoked per day. Risk of urinary tract morbidity was found to be positively associated with a complete lesion, number of cigarettes smoked per day, and surprisingly, physical activity. Risk of urinary tract morbidity was negatively associated with monthly alcohol consumption and a traumatic injury. Age and duration of cigarette use, while positively associated with cardiovascular morbidity, did not reach significance in the logistic regression modeling.

With respect to the three morbidity outcomes in this study, cigarette smoking emerged as the most damaging lifestyle behaviour. Attention and resources must be

directed towards spinal cord injury specific smoking prevention and cessation programs to halt the development and exacerbation of chronic diseases in this unique population.

ACKNOWLEDGMENTS

I would like to express my deepest gratitude to Dr. Mary Ann McColl, my primary thesis supervisor. Dr. McColl's endless support, enthusiasm, commitment, patience and knowledge created an immensely positive learning environment. Dr. McColl has been a superb role model and mentor. I would like to thank my co-supervisors, Dr. Benny Zee for his methodological and biostatistical advice, and Dr. Judy Durance for her assistance with data collection and for sharing her clinical expertise.

I would also like to express my thanks to the following: Geoff Salter for his assistance with many computer related tasks; Dr. Will King for his careful review of this thesis and his helpful suggestions; the faculty and staff of the Department of Community Health and Epidemiology for a very enriching and thoroughly enjoyable graduate experience; and, the study participants who provided their time and shared their personal health information.

TABLE OF CONTENTS

LIST OF TABLES

# 1.0 INTRODUCTION

Every year in Canada, approximately 1000 people experience spinal cord injuries (SCI) (Canadian Paraplegic Association, 1996). The Canadian Paraplegic Association (1996) estimates a prevalence of 1.17 people with SCI per 1000 Canadians. The majority of spinal cord injuries are experienced by males in their late twenties and early thirties with approximately half of the injuries resulting in paraplegia and half in quadriplegia. Car accidents account for 35 percent of Canadian SCI with falls being the second most frequent cause at 16.5 percent (Canadian Paraplegic Association, 1996).

Prior to the 1950's a large proportion of people experiencing a SCI did not survive, and those who did survive were destined to live out the remainder of their lives in institutional settings (Menter, 1993). Today, with advances in acute care and rehabilitation, SCI survivors are returning to the community and living into old age (Samsa, 1993). Along with living to an older age comes an increased risk of suffering from chronic diseases. Causes of death in the SCI population have become more similar to the general population as mortality due to renal disease, once the primary killer of people with SCI, is decreasing (Hackler, 1977; Le & Price, 1982; DeVivo et al, 1989). Better bladder management techniques and improved antibiotics have accounted largely for decreases in renal disease (Bauman et al, 1992; Whiteneck et al,1992).

Since the release of the Lalonde report in 1974, entitled A New Perspective on the Health of Canadians, emphasis has been placed on lifestyle as a determinant of health, and the Canadian public has been encouraged to play a more active role in determining their own health (Lalonde, 1974). Decreases in health funding for acute

care in the last decade have placed additional emphasis on public health and disease prevention. A large amount of research has been conducted examining lifestyle risk in the general population, yet little work has examined the disabled population. In 1983, the Ontario Secretariat for Disabled Persons suggested that a lack of knowledge of the prevalence and effects of lifestyle health risks on the disabled population is a major barrier to effective lifestyle counseling and health promotion. Since 1983 the body of literature on SCI and lifestyle risks has grown moderately, yet many questions remain unanswered. The majority of the research in this field has been descriptive in nature. Very little work has examined the relationships between lifestyle risks and disease outcomes in the SCI population.

The SCI population is a unique group which exhibits specific physiological and mobility characteristics. Thus, conclusions from lifestyle research conducted with the general population cannot always be generalized to the SCI population (Komura et al, 1994). This study was undertaken to assess the associations between several major lifestyle risks and three highly prevalent health disorders in the SCI population: cardiovascular, respiratory, and urinary tract disorders. As many people with SCI are living a large portion of their lives with a disability, it is imperative that lifestyle risks be systematically addressed to facilitate the establishment of prevention programs in the early post-injury phase. The financial and psychosocial costs of SCI are staggering alone without the added burden of chronic disease.

Lifestyle is only one of the many determinants of health. It is known that genetics, the environment, economic, social, and psychological factors interact in a complex fashion to impact upon health. This study was in no way an attempt to explain complete etiologies but rather to gain additional insight into specific lifestyle risks and

how they relate to three categories of health problems experienced in the SCI population.

# 2.0 LITERATURE REVIEW

## 2.1.0 Causes Of Death

Prior to World War II, victims of SCI usually did not survive their injuries (Whiteneck et al, 1992). With large numbers of WW II servicemen experiencing SCI, improvements in acute care were developed and the modern era of spinal cord injury rehabilitation unfolded (Munro, 1954; Lammertse & Yarkony, 1991). Rehabilitation methods began to be devised to deal with the numerous resultant health challenges faced by the SCI survivor. Reviewing records of WW II and Korean War Veterans, Hackler (1977) found that urinary system complications accounted for 43 percent of reported deaths. Renal deaths usually occurred within the first decade after injury (Lammertse & Yarkony, 1991). Deaths due to renal disease have decreased considerably over the past thirty years (Le & Price, 1982; DeVivo et al, 1989). According to Lammertse & Yarkony (1991) data from the American National Spinal Cord Injury Database indicated that death due to diseases of the genitourinary systems accounted for 3.2 percent of deaths.

Causes of death in the SCI population have grown more comparable to those in the non SCI population (Whiteneck et al, 1992). Deaths caused by urinary system complications have decreased, and deaths caused by cardiovascular and respiratory disease have increased (Hackler, 1977; Le & Price, 1982; DeVivo et al, 1989). Cardiovascular, respiratory, and urinary tract disease are the leading cause of death in the spinal cord injured population (Geisler et al, 1983; Bauman et al, 1992; Whiteneck et al, 1992; DeVivo et al, 1993). Among 362 deaths studied by Whiteneck and colleagues (1992), the genitourinary system accounted for 24.3 percent of deaths,

closely followed by cardiovascular deaths (23.2%), and the respiratory system was third, accounting for 13.8 percent of deaths. However, for those surviving more than 30 years, as well as those 60 years of age and older, cardiovascular disease was found to be the most frequent cause of death (Whiteneck et al, 1992). Lammertse & Yarkony (1991), using data from the American National Spinal Cord Injury Database, reported that respiratory disease is the leading cause of death accounting for 20.5 percent of deaths, followed by heart disease. These results were confirmed by DeVivo and colleagues (1993) who studied the causes of death during the first twelve years after SCI and found the leading cause of death to be pneumonia.

There is no consensus in the literature regarding the order of magnitude of the top three causes of death in the SCI population: cardiovascular, respiratory, and urinary tract disorders. Few studies examining this issue have studied cohorts of different ages, different eras of rehabilitation, for different lengths of follow-up.

### 2.2.0 Cardiovascular Disease

Cardiovascular disease in the general population has been studied aggressively worldwide over the past forty years. From this research three primary risk factors have been determined: cigarette smoking, high blood pressure, and high serum cholesterol (Kannel, W.B., 1992; Noreau & Shepard, 1995). Smoking has been found to decrease presence of protective high density lipoproteins, plus encourage platelet aggregation and release of catecholamines leading to disruption in the myocardium (Kannel et al, 1984). Other lifestyle risk factors which seem play an important role in cardiovascular disorders have been identified. Diets high in saturated fat and deficient in fiber and linolenic acid have been shown to lead to hypertension and dyslipidemia (Grundy et al, 1982). Obesity leads to a disruption of the ratio of total cholesterol to high density

lipoprotein (HDL) cholesterol, glucose intolerance, and hypertension (Higgins et al, 1987). Abdominal obesity, in particular, increases risk of cardiovascular disease (Bjorntorp, 1985). It has been observed that exercise yields a protective effect by increasing HDL, decreasing blood pressure, and improving glucose tolerance (Kannel et al, 1985). Excessive alcohol consumption has been correlated with elevated serum cholesterol, obesity, high blood pressure and premature death from cardiovascular disease (Cunnane, 1993; Cairns et al, 1984). Conversely, low and moderate alcohol intake has been shown to have a positive association with HDL (Wilson et al, 1980) and significantly lower mortality from cardiovascular disease (Gronbaek et al, 1995). Kannel (1992) emphasizes that cardiovascular disease has multifactorial causality, an interaction of atherogenic traits exacerbated by lifestyle.

Conflicting findings have been presented regarding the prevalence of cardiovascular disease in the SCI population (Bauman et al, 1992). Levi and colleagues (1995) found no significant difference in the reported prevalence of cardiovascular disease in the SCI population in comparison to a general population control. Yekutiel and colleagues (1989) and Bauman and colleagues (1992) found a greater incidence of cardiovascular disease in the SCI population. Levi and colleagues (1995) suggest their results might be accounted for by the fact they used diagnosed cardiovascular conditions, and did not include subclinical or as yet undiagnosed conditions. In a comparison with general population age-matched controls, Yekutiel and colleagues (1989) found that persons with SCI have a significantly increased incidence of ischemic heart disease. The authors suggested that it may be the sedentary lifestyle of the spinal cord injured patient which causes ischemic heart disease. It has also been suggested that the age of onset of cardiovascular disease

among those with a SCI appears to be younger than the general population (Yekutiel et al, 1989).

While incidence and prevalence data for cardiovascular disease in the SCI population remains somewhat unclear, the high prevalence of risk factors for cardiovascular disease has been quite well documented. Bauman and colleagues (1992) have suggested that decreased physical activity and changes in body composition lead to metabolic alterations which increase progression and severity of cardiovascular disease. A high prevalence of obesity in the SCI population has been documented (Dearwater et al, 1986; Nuhlicek et al, 1988; McColl and Skinner, 1992). Research on alcohol use following SCI has suggested that the SCI population consumes more alcohol and has a higher prevalence of alcohol abuse than the general population (McColl & Skinner, 1992; Young et al, 1995). Sweeney and Foote (1982) suggest that increased alcohol use following SCI results from pain, incontinence, paralysis, and the irreversibility of damage.

Several articles published in the 1980's have focused on metabolic abnormalities in the SCI population, specifically high density lipoproteins (Heldenberg et al, 1981; Vaziri et al, 1982;). These articles indicate that the SCI population, particularly quadriplegics, have been reported to have low levels of HDL placing them at increased risk for cardiovascular disease. More recently, Bauman (1992) concluded that carbohydrate and lipid metabolism disorders are reflected in paraplegics by impaired glucose tolerance, elevated low density lipoproteins levels, and depressed high density lipoprotein levels. However, Cardus and colleagues (1992) looking at lipid profiles in both paraplegics and quadriplegics suggest that the SCI population has similar blood lipids to the general population. In comparison with a non SCI, non physically trained population, Cardus and colleagues (1992) found that the SCI

population did not have higher level of LDL or lower levels of HDL. The authors conclude that levels of cholesterol increase with age as in the general population, regardless of duration of injury or level of lesion.

In further research taking a multivariate approach, assessing not only metabolic mechanisms, but also age, sex, blood pressure, presence of diabetes, cigarette smoking, and electrocardiographic abnormalities, Cardus and colleagues (1992) concluded that the SCI population shows a risk of cardiovascular disease similar to the risk estimated in non-physically trained, age-matched, able bodied individuals. Krum and colleagues (1992) assessed cardiovascular disease risk by looking at age, sex, blood pressure, total cholesterol, and smoking. The authors conclude that the reported increased incidence of cardiovascular disease in the SCI population cannot be explained by blood pressure, total cholesterol, or smoking, but rather low HDL may contribute to risk as well as other risk factors that remain to be established.

### 2.3.0 Respiratory Disease

The dominant lifestyle risk for respiratory disease in the general population is smoking (Dodge, 1980; Lebowitz, 1977). Longitudinal studies have shown that a dose-response relationship is present between amount of cigarettes smoked and changes in ventilatory function (Jaakkola et al, 1991; Beaty, 1984). Death due to chronic obstructive lung diseases, which includes emphysema, chronic airways obstruction, and chronic bronchitis, are ten times greater in smokers than non smokers (Higgins, 1991). Alcohol consumption has been associated with chronic bronchitis and lower lung function independent of smoking. Sherrill and colleagues (1990) suggest alcohol and smoking interact to create a detrimental synergistic effect on lung function. Mason & Nelson (1992) present a plethora of physiological effects alcohol has on the

respiratory track to suppress normal immune reactions to pathogens. Alcohol predisposes the lower lung to gram-negative bacteria colonization, as well as decreases the function of alveolar macrophages. Other risk factors for respiratory disease include occupational history, family health history, pediatric respiratory diseases, and environmental hazards (Helsing et al, 1979; Ferris, 1978; Jaakkola et al, 1993; Senthilselvan, 1993; Brodkin et al, 1993).

Respiratory disease is a leading cause of death among the spinal cord injured population (DeVivo, 1989; Gausch et al, 1991). Beyond the normal reduction in lung function due to aging, additional problems are experience by those with SCI leading to increased risk of respiratory difficulties (Wilmot & Hall, 1993). Progressive spinal deformities such as scoliosis and kyphosis can worsen with age leading to compromised respiration caused by limited mobility of the chest and spine (Wilmot & Hall, 1993). Obesity and osteoporosis caused by sitting in a wheelchair accelerate kyphosis in the SCI population (Wilmot & Hall, 1993). Additionally, when aging with a SCI, respiratory muscle fibres may deteriorate inhibiting full respiration (Frick & Bruno, 1986). Expelling secretions from the lungs is a particular problem in the SCI population due to the paralysis of chest and abdominal muscles (Stover, 1994).

Work by Spungen and colleagues (1995) studying the prevalence of tobacco use in a group of male veterans with SCI found that the number of current smokers was comparable to the general population, with exception of a lower number of subjects who never smoked. It is suggested by the author that the lower number of subjects who never smoked reflects the smoking habits of the veteran population. McColl & Skinner's lifestyle survey (1992) also found the prevalence of smoking among a sample of SCI subjects to be comparable to the general population.

Level of lesion is a well documented risk factor in respiratory disorder for the SCI population. In persons with high paraplegia and quadriplegia, spasticity of the abdominal and chest musculature can cause increased abdominal pressure impairing full movement of the diaphragm. In 165 paraplegics and quadriplegics Almenoff and colleagues (1995) documented significantly decreased pulmonary function in smokers and in high quadriplegics (C4 and above). Waist and neck enlargements after quadriplegia were documented by Frisbie & Brown (1994). It is suggested by the authors that these enlargements may relate to impaired breathing in quadriplegics. Green and colleagues (1994) assessed the association between fatal pulmonary embolism and characteristics that might predict the event. They found significant differences between cases and controls for level of injury, spasticity, and body mass index. Cases had higher levels of injury, less spasticity, and higher BMI scores.

Additionally, quadriplegics are at increased risk of sleep induced respiratory failure, known as sleep apnea. Reasons for this increased risk includes paralysis and weakening of muscles involved in inspiration, use of sedating anti-spasticity medication, and obesity which may narrow the upper airway and cause increased load on respiratory muscles (Flavell et al, 1992). Star & Osterman (1988) suggest that obesity contributes to sleep apnea possibly by causing mechanical obstruction of the upper airways by adipose tissues (Star & Osterman, 1988).

### 2.4.0 Urinary Tract Disease

Unlike cardiovascular and respiratory disease, urinary tract disease in the general population is not strongly associated with lifestyle. Research in the general population indicates that hypertension and type II diabetes mellitus (DM) cause an increase in glomerular pressure leading to an increased risk of renal disease (Ferguson

& Morrisey, 1993). Hypertension and type II DM, while not being lifestyle risk themselves, are directly related to obesity, exercise, and smoking. Hypertension, left ventricular hypertrophy, lipid abnormalities, and glucose intolerance are more frequently found in patients with renal failure than the general population (Ma et al, 1992). In comparative studies, the prevalence of hypertension in the SCI population has been found to be greater than the general population (Imai et al, 1994).

Prior to the mid-1970's renal disease was the primary cause of death in the SCI population (Geisler et al, 1983; Lanig, 1993). The introduction of intermittent catheterization and improvements in regular screening for renal disease, as well and improved antibiotics (Bauman et al, 1992) has markedly decreased renal deaths (Whiteneck et al, 1992). Although renal disease is no longer the leading cause of death in the SCI population, urinary tract infections remain a primary cause of morbidity (Whiteneck et al, 1992). Urinary tract infections account for 19.8 percent of all procedures and diagnoses following initial hospitalization for a SCI (Whiteneck et al, 1992). If left untreated, urinary tract infections can lead to serious complications including end stage renal disease. Treated too late or incorrectly, these infections produce frequent illness that can interfere with all aspects of daily living.

Risk factors for chronic bladder infections identified in the SCI population include over-distention of the bladder, post-void residuals, presence of stones, and outlet obstruction which can result from improper bladder management (Anonymous, 1993). High storage pressure is believed to cause deterioration of bladder form and function (Yokoyama et al, 1996). Method of bladder drainage may also influence risk of bladder infections (Cardenas, 1995). Specifically, indwelling catheterization methods may lead to persistent bacteriuria (Anonymous, 1993). It is suggested that clean intermittent catheterization provides optimal bladder management (Chai et al, 1995).

Physical fitness and sports participation in people with SCI has been related to fewer urinary tract complications (Dearwater et al, 1986; Stotts, 1986). The goal of bladder management is to ensure adequate bladder drainage, low-pressure urine storage, and low-pressure voiding, obtained by the integration of proper bladder management techniques into one's lifestyle (Perkash, 1993).

Urinary complications are more frequent in those with higher levels of injury, a complete injury, a younger age of onset, longer duration of disability, and longer hospitalization time following injury (Morita et al, 1994; Herruzo et al, 1994). Although the majority of research has been conducted on males, there is some evidence that SCI females are at a greater risk of infection. Bennett et al (1995) suggest this increased risk is related to the proximity of stool contamination.

It has been suggested by several researchers, that a causal relationship exists between bladder cancer and chronic inflammation and/or infection (Broeker, 1981; Stonehill et al, 1996). It was thought that initial correlations between indwelling catheters and bladder cancer may be weakened with improved bladder management, yet in a recent publication, Stonehill and colleagues (1996) concluded that an indwelling catheter and a history of bladder stones were statistically significant risk factors for bladder tumours. It has been proposed that the association between chronic cystitis and bladder cancer may, in part, be due to the production of nitrosamines by bacteria and macrophages (Lanig, 1993).

### 2.5.0 Summary

While there is a vast amount of literature addressing the associations between lifestyle risks and chronic disease in the general population, much fewer studies have focused on lifestyle risks and disease outcomes in the SCI population. The literature

suggests the SCI population may be at greater health risk due to lifestyle risks and that the impact of lifestyle risks is exacerbated by the existence of a SCI. Through increased knowledge of lifestyle risks and disease outcomes in the SCI population, improvements in health education and disease prevention programs will improve the quality of life for the SCI population and spare limited health care resources.

## 3.0 OBJECTIVES

The goal of this study was to quantify the associations between lifestyle risks, selected based on the literature, and three major causes of mortality in adults with a spinal cord injury. A multivariate approach was used, accounting for the effects of demographic and injury related variables. The specific objectives of the study were:

i To assess the risk of cardiovascular morbidity in a SCI population relative to four lifestyle risk factors: physical activity, body mass index, cigarette use, and alcohol consumption.

ii To assess the risk of respiratory morbidity in a SCI population relative to three lifestyle risk factors: cigarette use, alcohol consumption, and body mass index.

iii To assess the risk of urinary tract morbidity in a SCI population relative to five lifestyle risk factors: physical activity, body mass index, cigarette use, alcohol consumption, and bladder management.

# 4.0 METHODS

## 4.1.0 Study Design

A cross-sectional design was chosen to address the objectives. The design contained a retrospective element as subjects were asked to report specific morbid events occurring since the onset of their SCI to the time of the interview. The lifestyle data were also both retrospective and cross-sectional in nature as subjects were asked to report past and current lifestyle behaviours.

## 4.2.0 Study Population

The population for the study consisted of 130 individuals, all of whom incurred a segmental, non-progressive SCI and received rehabilitation at Kingston General Hospital in the period between January 1, 1972, and December 31, 1992. Subjects were identified using the Bawden Rehabilitation Unit SCI Database, derived from patient medical records. The database consisted of 140 subjects, yet 10 were known to be deceased. For the purposes of the study, spinal cord injury included traumatic spinal cord injury, benign tumors, transverse myelitis, vascular infarcts, and congenital defects. A map illustrating the catchment area for the Bawden Rehabilitation Unit is located in Appendix A.

## 4.3.0 Power Calculation and Sample Size

Previous research using the Bawden SCI database randomly selected a sample of 51 subjects from the 130 surviving subjects in the database (Harley, 1994). Of the 51 subjects selected, two (3.9%) were found to be deceased. Of the remaining 49, 28 (57.1%) were successfully contacted by telephone, and of those contacted two (7.1%)

refused to participate. Projecting these values to the entire database, approximately five subjects were expected to be deceased and of the remaining 125, approximately 71 subjects were expected to be reached by telephone. Of the 71 subjects reached, approximately 66 were expected to agree to participate in the study.

A ten percent random sample was computer generated to pilot test the disease screening questionnaire. Of the thirteen subjects chosen, all were successfully contacted by telephone and willing to participate. According to the disease screening questionnaire, 3 subjects (23%) reported cardiovascular disorders, 6 subjects (46%) reported respiratory disorders, and 9 subjects (69%) reported chronic urinary tract disorders. Projecting these numbers to the 66 subjects expected to complete the telephone interview, it was anticipated that approximately 15 cases of cardiovascular disorder, 30 cases of respiratory disorder, and 46 cases of urinary tract disorder would be reported.

Hsieh's (1989) sample size tables for logistic regression were consulted to determine the odds ratio that could be detected for each of the three morbidity outcomes based on a projected sample size of 66 subjects. A significance level of $\alpha$ = .05 and power of $1-\beta$ = .80 were selected. For cardiovascular disorder, with an event probability of 0.23 based on the pilot study, an extrapolated odds ratio of approximately 3. 5 was expected to be detected. For respiratory disorder, with an event probability of 0.46 based on the pilot study, an odds ratio of 2.3 was expected to be detected. And for urinary tract disorder, with an event probability of 0.69 based on the pilot study, an extrapolated odds ratio of 1.8 was expected to be detected.

Heish's tables are based on univariate logistic regression. To apply to multiple logistic regression, the value from the table is to be divided by $1 - \rho^2$, where $\rho$ is the

multiple correlation coefficient relating the specific covariate to remaining covariates (Heish, 1989). The above odds ratios were determined based on a multiple correlation coefficient of 0.1 obtained from previous research using the Lyndhurst Computerized Health Risk Assessment with an unrelated yet demographically similar SCI population (McColl & Skinner, 1992).

### 4.4.0 Data Collection

Telephone interviewing was chosen as a data collection method as it offers higher response rates and improved accuracy over mailed questionnaires, and exhibits greater cost-effectiveness than face-to-face interviews over a large geographical area. According to Statistics Canada (1995), 98.5 percent of Canadian households have telephones. Prior to initial telephone contact, information packages were mailed to all subjects not confirmed deceased (n=130). Information packages included an introductory letter, a study information sheet, two consent forms, and a self-addressed stamped envelope. Interested participants were asked to keep one consent form for their files and return the completed consent form in the envelope provided. Once the consent form was received initial telephone contact was established to conduct the interview at that time or to scheduled an interview at a more convenient time. The information package contents are located in Appendix B.

### 4.4.1 Screening For Morbidity

Morbidity screening was accomplished using selected sections from the London School of Hygiene Questionnaire on Chest Pain and Intermittent Claudication (Rose et al, 1977), the American Thoracic Society Questionnaire on Respiratory Symptoms (Ferris, 1978), and a urinary tract morbidity questionnaire purposefully developed for

the present study. Subjects were asked to report cardiovascular, respiratory, and urinary tract morbidity since the onset of their SCI. The morbidity screening instrument and definitions of case classification are located in Appendix C.

(i) Cardiovascular Morbidity

In 1962, G. A. Rose developed an instrument to diagnose ischemic heart pain in field surveys which has been widely used in epidemiological studies (Cook et al, 1989). The Rose cardiovascular questionnaire on chest pain has been shown to identify those at high risk for developing complications from cardiovascular disease during the succeeding five years or those at a high risk of dying from cardiovascular disease. A self-administered version of the instrument was introduced by Rose and colleagues in 1977 (Rose et al, 1977). Cook and colleagues (1989) have shown that prevalence rates of angina are similar using both the administered questionnaire and the self-administered questionnaire. For the purpose of this study the self-administered version was chosen, yet it was administered over the telephone by the researcher. The self-administered version was chosen over the administered version because the latter requires observations of the subject made by the researcher. The questionnaire has been validated against physician diagnosis in the general and patient populations (Garber et al, 1992). As an epidemiological tool for measuring angina pectoris it has exhibited specificity ranging from 48-98 percent and sensitivity from 25-83 percent (Garber et al, 1992).

(ii) Respiratory Morbidity

The presence of chronic respiratory symptoms and morbidity was assessed using the American Thoracic Society and the Division of Lung Diseases (ATS-DLD)

questionnaire (Ferris, 1978), developed for use in epidemiological studies. The ATS-DLD questionnaire was designed to elicit more precise information about chronic obstructive pulmonary morbidity than provided by previously developed questionnaires, such as the British Medical Research Council (MRC) questionnaire and the National Heart and Lung Institute (NHLI) questionnaire (Ferris, 1978). In comparison to the NHLI questionnaire, the ATS-DLD has demonstrated less variation in symptomatology when conducted by telephone and had a lower percentage of misunderstood questions than the MRC and NHLI questionnaires (Helsing et al, 1979).

(iii) Urinary Tract Morbidity

Because of innervation problems in the SCI population, urinary tract questionnaires developed for the general population are inappropriate. Literature reviews revealed no urinary tract questionnaires specific to the SCI population. Therefore, in consultation with a clinician in the SCI field (J. Durance, personal communication, 04/94), a urinary tract morbidity questionnaire was developed. Pilot testing with 13 randomly chosen subjects established face and content validity.

4.4.2 Assessment Of Exposure

Exposure data were collected using selected sections of McColl and Skinner's (1992) Lyndhurst Computerized Health Risk Assessment (LCHRA): physical activity, obesity, cigarette use, alcohol use, and bladder management. Subjects were asked to report their current lifestyle characteristics and any variation in lifestyle since the onset of their SCI to the time of the interview. The LCHRA is a modified version of Skinner and colleagues' (1985) Computerized Lifestyle Assessment (CLA). To modify the CLA

for the SCI population, McColl and Skinner added disability-specific modules and re-calibrated response choices to be appropriate for the disability. In the development of the LCHRA, McColl and Skinner (1992) performed measurement analyses including item analysis, inter-item correlations, principal components analysis and reliability analyses to confirm subscale properties. Internal consistency reliability using the Cronbach's alpha coefficient for the subscales used in this study ranged from a low $\alpha$ = 0.56 for bladder management to a high $\alpha$ = 0.82 for physical activity.

For the purpose of this study, two modifications to the LCHRA were implemented. The LCHRA is designed to be used on a computer directly interacting with the subject. For this study it was not financially viable to travel to the subjects to allow them to interact with a computer, thus the questions were administered over the telephone. The use of the telephone was not anticipated to alter the validity of the LCHRA. Skinner (1993) observed in the validation of the CLA that data collected on alcohol and cigarette use were not significantly different when collected using three different methods: computer, human interviewer, and self-administered written questionnaire. Additionally, the questionnaire was slightly modified to allow for retrospective data collection, in addition to the mainly cross-sectional data collection for which the questionnaire was originally designed. At the end of sections not originally designed to collect retrospective data, subjects were asked to report how for long their behaviour had occurred and any changes in that behaviour. A sensitivity question was added at the end of the questionnaire to estimate potential misclassification. The selected sections of the LCHRA and the coding scheme for the lifestyle risk variables is located in Appendix D.

(i) Physical Activity

Physical activity was evaluated on a 27 point scale based on frequency, intensity, and duration of exercise. Passive exercise, such as stretching performed by a physiotherapist, was not included. The scale exhibits an internal consistency reliability of $\alpha = 0.82$ (McColl & Skinner, 1992).

(ii) Body Mass Index

Body mass index (BMI), weight in kilograms divided by the squared height in meters (weight [kg]/ height [$m^2$]), is an indicator of fatness of individuals (Kushner, 1993). BMI has a low correlation with height thus allows comparison of body weight in people of varying heights (Williamson, 1993). BMI is a widely accepted measure of fatness for epidemiological studies and predicts morbidity and mortality in many populations (Hodge & Zimmet, 1994). As suggested by Noreau and Shephard (1992), because of a decrease in muscle and bone mass following SCI the ideal BMI for the SCI population is probably lower than the general population, although specific SCI norms have yet to be established. Normal population norms will be used for this study based on the Health and Welfare Canada (1988) publication Canadian Guidelines for Healthy Weights to establish obese or non-obese status. Subjects that experienced their injury in adulthood were asked to report their pre-injury height. Subjects injured prior to adulthood or having a congenital injury were asked to estimate their height.

(iii) Cigarette Use

The LCHRA captures several parameters of cigarette use; daily consumption, duration of use, time since quitting, and total years smoking. Average lifetime

consumption was calculated based on the aforementioned data. Subjects who smoked six months or less in their lifetime were categorized as nonsmokers. Neither pipe nor cigar smoking was assessed.

(iv) Alcohol Consumption

Total monthly alcohol consumption was estimated by the summation of four questions about monthly consumption. Frequency of excessive alcohol consumption over a one month period was estimated with the indicator of risk being number of days 4 drinks or more were consumed (McColl & Skinner, 1992). A standard drink was considered as: one twelve ounce bottle of regular beer, one five ounce glass of wine, or a one and a half ounce shot of liquor.

(v) Bladder Management

The goal of bladder management is to ensure filling and emptying of the bladder at periodic intervals to decrease risk of bladder infection. Preventive activities are dependent on the method of bladder management: indwelling catheter, intermittent catheterization, external drainage, diaper/pad, or tapping/straining. Attentiveness to self care was assessed based on adherence to techniques associated with each bladder management approach, as well as general attentiveness questions

4.4.3 Demographic And Injury Related Variables

Demographic and injury related variables, present in the Bawden SCI database, were included in the data analysis to investigate and control for confounding. Age, age

at injury, duration of disability, and lesion level have been shown to be associated with lifestyle health risks and morbidity outcomes in the SCI population (Cardus et al, 1992; Geisler et al, 1983; McColl & Skinner, 1992; Whiteneck et al, 1992).

Table 4.1 Study variables

| VARIABLE | DEFINITION | CODING |
|---|---|---|
| ID | Subject Identification Number | nominal |
| CARDIODS | Cardiovascular Morbidity | 0 - no morbidity, 1 - morbidity |
| RESPIRDS | Respiratory Morbidity | 0 - no morbidity, 1 - morbidity |
| UTDS | Urinary Tract Morbidity | 0 - no morbidity, 1 - morbidity |
| PHYSACT | Physical Activity | 1 - 27 |
| BMI | Body Mass Index | 0 - non obese, 1 - obese |
| CIGSDAY | Cigarettes Smoked per Day | continuous |
| CIGSLIFE | Cigarettes Smoked in Lifetime | continuous |
| CIGDUR | Duration of Cigarette Use | continuous |
| TMQUIT | Time Since Quit Using Cigarettes | continuous |
| ALCHMTH | Monthly Alcohol Consumption | continuous |
| ALCHEXC | Frequency of Excessive Alcohol Use | 0 - 30 |
| BLADSCOR | Bladder Self Care | 1 - 100 |
| GENDER | Gender | 1 - male, 2 - female |
| LEVEL | Level of Lesion | 1 - quadriplegic, 2 - paraplegic |
| COMPLETE | Completeness of Lesion | 1 - complete, 2 - incomplete |
| CAUSE | Cause of Injury | 1 - traumatic, 2 - non traumatic |
| AGE | Age at Interview | continuous |
| AGEINJ | Age at Injury | continuous |
| DURDIS | Duration of Disability | continuous |

4.5.0 Data Management And Analyses

Data collected through the telephone interviews were recorded by hand then entered into SPSS version 6.1 (SPSS Inc., 1996). Procedures available in SPSS 6.1 were used for the majority of the statistical analyses. Because SPSS 6.1 does not provided 95 percent confidence intervals for odds ratios, confidence intervals were calculated using Quattro Pro For Windows. According to David Nichols, Senior Support Statistician SPSS Inc. (personal communication, November 11, 1996), the degrees of freedom and significance levels associated with the -2 log likelihood and goodness of fit tests for the logistic regression procedure were removed from version 6.1 because they were incorrect. The Hosmer-Lemeshow goodness of fit test was obtained from the SPSS website and run in the syntax window.

(i) Descriptive Statistics

Descriptive statistics, including measures of central tendency and graphical representations, were used to describe the study variables, evaluate the need for data transformation, and determine the presence of outliers.

(ii) Univariate Analyses

The univariate analyses were undertaken to assess the relationships between the outcome and independent variables. Variables entered for selection into the logistic regression modeling were selected through the univariate analyses. Student's *t* tests were used to assess the associations between the morbidity outcomes and continuous predictor variables. Chi squared tests were used to assess the associations

between the morbidity outcomes and categorical predictor variables. When expected cell frequency was less than five the Fisher's exact test was used as the chi squared test is considered to be somewhat inaccurate under those conditions (Rosner, 1990).

As suggested by Hosmer and Lemeshow (1989), a selection criteria of $p < 0.25$ was used to select variables to enter into the logistic regression models. According to Mickey and Greenland (1989), traditional levels, such as 0.05 can fail to identify variables of known importance, while levels greater than 0.25 can include variables of questionable importance. Additionally, a more lenient selection $p$ value will include variable that may be weakly associated with the outcome, yet become an important predictor when taken together (Hosmer & Lemeshow, 1989). Because the univariate analyses is being used in an exploratory fashion to select variables for the logistic regression modeling, an increase in type I errors due to multiple comparisons is not a concern.

(iii) Logistic Regression

Based on the significant associations determined through the univariate analyses, predictor variables significantly associated with cardiovascular, respiratory, and urinary tract morbidity were utilized in logistic regression modeling. Theoretically relevant variables that were not significant in the univariate analyses were not selected for entry into the models. This decision was based on the relatively small sample size which, according to Hosmer & Lemeshow (1989), could produce numerically unstable multivariate models when nonsignificant yet scientifically relevant variables are included.

Variables were entered into three separate models (cardiovascular, respiratory, and urinary tract morbidity) in the forward stepwise method based on the probability of the likelihood ratio statistic. The stepwise approach was chosen as the sequential fashion of model building allows for the examination of a collection of models that may not have been examined otherwise (Hosmer & Lemeshow, 1989). Categorical predictor variables were transformed into sets of deviation contrasts where each category of the variable except the reference category was compared to the overall effect. An alpha level of 0.15 was chosen to determine entrance into the model as suggested by Hosmer and Lemeshow (1989) when using the stepwise method. The larger alpha level provides some assurance that the stepwise method will select variables with coefficients different from zero. An alpha level of 0.20 was selected to determine whether a variable should be removed from the model during the stepwise method (Hosmer & Lemeshow, 1989).

Given that the outcomes of interest in this study are not rare, odds ratios may over estimate the actual risk. Therefore, the probability of the morbidity outcomes were calculated for individuals with a specific set of risk factor values (Kelsey et al, 1996). Risk ratios, a comparison of probabilities of developing the morbid conditions, were then estimated.

Based on the literature one interaction was examined: smoking by alcohol consumption. The effect of the interaction was assessed through the likelihood ratio method, where the model without the interaction is compared to the model including the interaction and the difference in the -2 log likelihood function value is assessed for a significant contribution to the model using an approximate chi squared distribution. A significance level of $p = 0.05$ was chosen.

Model fit was assessed through the Hosmer-Lemeshow goodness of fit test which provides a single, easily interpretable value which summarized the agreement of observed and fitted values (Hosmer & Lemeshow, 1989). The null hypothesis is that the data are generated from the specified model (David Nichols, personal communication, 96/11/12). A $p$ value of 0.05 was chosen.

Diagnostic methods were used to identify points for which the models did not fit well and points that exerted a strong influence on the coefficient estimates. Normal probability plots of the deviances were utilized to assess general fit of the models. Plots of the standardized residuals, residuals divided by an estimate of the standard deviations, were also used to assess model fit. Leverage values, the relative influence of each observation on the model's fit, and DfBeta values, the change in the coefficients when a case is deleted from the model, were plotted to detect observations that exert a strong influence on the coefficient estimates (Norusis & SPSS Inc., 1994).

# 5.0 RESULTS

## 5.1.0 Characteristics Of The Study Population

Ninety-seven subjects were interviewed. The remainder of the 140 subjects from the database were either deceased (20), refused to participate (10), lost to follow-up (12), or ineligible (1), as indicated in Table 5.1. The ineligible subject exhibited poor health status which prevented participation in the study. Aggressive attempts were undertaken to contact all subjects believed to be alive. Subjects reported as lost to follow-up could not be located through any of the following means: Kingston General Hospital records; national CD ROM telephone directories; nor, next of kin. Two proxy interviews, in which the subjects themselves did not provide the information, were conducted as one subject did not speak English and another subject exhibited aphasia following a stroke. Two interviews were conducted in person due to the subjects' limited telephone access: one subject was living in a chronic care institution, St. Mary's of the Lake Hospital, and the other subject was temporarily in an acute care institution, Kingston General Hospital. Time to complete the interview ranged from 20 to 60 minutes. Locations of the subjects at the time of interview spanned the country from Victoria, British Columbia to Truro, Nova Scotia.

Table 5.1 Subject recruitment

| STATUS | N | % |
|---|---|---|
| Interviewed | 97 | 69.3 |
| Deceased | 20 | 14.3 |
| Lost to Follow up | 12 | 8.6 |
| Refused | 10 | 7.1 |
| Ineligible | 1 | 0.7 |
| TOTAL | 140 | 100 |

The study population was comprised of 87 (89.7%) males and 10 (10.3%) females, with an average age at the time of the interview of 47.5 years (s.d. ± 4.5). Slightly more than half of the subjects had paraplegia (57%) and the majority of the injuries were traumatic in nature (87%). Sixty-four percent of the injuries were incomplete. The mean age at the time of injury was 31.7 years (s.d. ± 16.5) with the mean duration of disability being 15.9 years (s.d. ± 10.1). The characteristics of this population are representative of the Canadian SCI population as a whole (Canadian Paraplegic Association, 1996). Descriptive information is summarized in Table 5.2.

Table 5.2 Characteristics of subjects interviewed

| CHARACTERISTIC | N (97) | % |
|---|---|---|
| GENDER | | |
| Male | 87 | 90 |
| Female | 10 | 10 |
| AGE | | |
| 18-24 | 2 | 2 |
| 25-34 | 15 | 15 |
| 35-44 | 30 | 31 |
| 45-54 | 21 | 22 |
| 55-64 | 11 | 11 |
| 65+ | 18 | 19 |
| mean | 47.5 | s.d. ± 4.5 |
| INJURY | | |
| quadriplegic | 41 | 42 |
| paraplegic | 55 | 57 |
| undetermined | 1 | 1 |
| complete | 32 | 33 |
| incomplete | 62 | 64 |
| undetermined | 3 | 3 |
| traumatic | 84 | 87 |
| non-traumatic | 13 | 13 |
| AGE AT INJURY | | |
| birth | 4 | 4 |
| 0 - 17 | 8 | 8 |
| 18 - 24 | 28 | 29 |
| 25 - 34 | 23 | 24 |
| 35 - 44 | 14 | 14 |
| 45 - 54 | 11 | 11 |
| 55+ | 9 | 9 |
| mean | 31.67 | s.d. ± 16.4 |
| DURATION OF DISABILITY | | |
| 1 - 10 | 34 | 35 |
| 11 - 20 | 33 | 34 |
| 21 - 30 | 23 | 24 |
| 31 - 40 | 5 | 5 |
| 41+ | 2 | 2 |
| mean | 15.9 | s.d. ± 10.1 |

Those subjects who refused to participate, as well as those subjects who were lost to follow-up, did not exhibit significantly different demographic and injury related characteristics from the 97 subjects who were interviewed. Those subjects who were deceased experienced their injuries at a significantly older age than the subjects who were interviewed, but the deceased were similar on all other characteristics. Given that the outcomes being studied in this research are common causes of death in the SCI population, it is highly likely that the twenty deceased members of this cohort died of cardiovascular, respiratory, or urinary tract disease. The lack of lifestyle and outcome data from these subjects could lead to an underestimation of risk. Table 5.3 presents the characteristics of the subjects not interviewed.

Table 5.3 Characteristics of subjects not interviewed

| CHARACTERISTIC | REFUSED | LOST | DECEASED |
|---|---|---|---|
| Number | 10 | 12 | 20 |
| Mean age | 45.30 | 46.17 | -- |
| Mean age at injury | 29.20 | 29.92 | 46.80* |
| Mean duration of disability | 16.00 | 16.10 | -- |
| Male | 9 | 11 | 18 |
| Female | 1 | 1 | 2 |
| Complete | 6 | 6 | 11 |
| Incomplete | 4 | 6 | 9 |
| Traumatic | 10 | 12 | 18 |
| Non-traumatic | 0 | 0 | 2 |
| Quadriplegic | 4 | 7 | 11 |
| Paraplegic | 6 | 5 | 7 |
| Undetermined | 0 | 0 | 2 |

* $t = -3.38$, $p = .001$

## 5.2.0 Descriptive Analyses

### 5.2.1 Morbidity Outcomes

The morbidity outcome questionnaire revealed 13 (13.4%) subjects who reported cardiovascular morbidity, 50 (51.5%) subjects who reported respiratory morbidity, and 67 (69.1%) subjects who reported urinary tract morbidity. According to a clinician in the Kingston area (personal communication; K. Smith, July 23, 1997), actual prevalence of urinary tract morbidity in this population is thought to be higher. This potential underestimation of urinary tract morbidity prevalence should be considered when interpreting the urinary tract model presented in this study.

### 5.2.2 Power Calculation and Sample Size Revisited

As significantly more subjects were successfully contacted than projected from Harley's (1994) work with this population, revisiting Hsieh's (1989) sample size tables projects smaller odds ratios which can be detected. For cardiovascular morbidity, with an event prevalence of 0.13, an odds ratio of approximately 2.4 was expected to be detected. For respiratory morbidity, with an event prevalence of 0.52, an odds ratio of 1.7 was expected to be detected. And for urinary tract morbidity, with an event prevalence of 0.69, an extrapolated odds ratio of 1.5 was expected to be detected.

### 5.2.3 Lifestyle Risk Factors

Summary data for the lifestyle variables are presented in Table 5.5

(i) Physical Activity

Twenty-three subjects (24%) reported doing no physical activity beyond daily living activities. The 74 (76%) active subjects had a mean score of 9.17 (s.d. $\pm$ 6.96)

out of 27 on the physical activity scale based on frequency, duration, and intensity of exercise. In comparison with work done by McColl & Skinner (1992) using this instrument with a similar population, the subjects in the present study are significantly less active ($t$ = 2.286, $p < .05$). McColl & Skinner (1992) reported a mean physical activity score of 11.50 (s.d. $\pm$ 6.37).

(ii) Body Mass Index

The mean BMI for the population was 25.75 (s.d. $\pm$5.08) with a range from 17.85 to 43.67. Standards for the Body Mass Index (weight in kg/ [height in m]$^2$), as utilized in the LCHRA, suggests that 32 percent of the study population is obese. BMI distribution is presented in Table 5.4. Because health risks do not increase linearly with BMI this variable was treated categorically. Two, three, and four category coding of BMI were examined with the dichotomous coding being more highly associated with the morbidity outcomes. Those subjects with BMI under 27 were categorized as non-obese and those subjects with BMI equal to or greater than 27 were categorized as obese.

Table 5.4 Body mass index distribution

| CATEGORY | RANGE | N | % |
|---|---|---|---|
| Underweight | BMI < 20 | 7 | 7.2 |
| Acceptable Weight | BMI 20 - 24.9 | 40 | 41.2 |
| Possibly Overweight | BMI 25 - 26.9 | 19 | 19.6 |
| Obese | BMI $\geq$ 27 | 31 | 32.0 |

(iii) Cigarette Smoking

Twenty-seven subjects (27.8%) reported never smoking, 40 (41.2%) subjects reported being past smokers, and 30 (31.0%) subjects reported being current smokers. Those who had smoked in the past quit smoking an average of 14.5 (s.d. ± 11.0) years ago. For both past and present smokers, the usual daily consumption of cigarettes averaged 17.7 (s.d. ± 14.8), the duration of cigarette use averaged 19.9 (s.d. ± 13.8) years, and lifetime cigarette consumption averaged 135 060 (s.d. ± 133 120) cigarettes.

(iv) Alcohol Consumption

Twenty-five subjects (26%) reported having consumed no alcohol in the past year. For the 72 (74%) subjects that reported consuming alcohol in the past year, the average monthly consumption ranged from one to 233 drinks with an average of 29.8 drinks (s.d. ± 42.5). Twenty-five subjects (26%) exhibited excessive drinking behaviour, defined as more than 4 drinks a day. Frequency of excess alcohol consumption ranged from one day per month to 30 days per month. The frequency of excessive alcohol consumption among this group occurred an average of 5.7 (s.d. ± 6.9) days per month.

(v) Bladder Self Care

Seventy subjects (72%) reported the use of bladder management techniques for near-normal or neurogenic bladders. Attentiveness to bladder self care ranged from 11% to 100% of ideal care, with a mean score of 78% (s.d. ± 20.5).

Table 5.5 Lifestyle risk factor summary

| RISK FACTOR (N = 97) | MEAN | S.D. | RANGE |
|---|---|---|---|
| Physical activity (score out of 27) | 9.170 | ± 6.96 | 0 - 26 |
| Body mass index | 25.75 | ± 5.08 | 17.9 - 43.7 |
| Cigarettes smoked per day | 17.71 | ± 14.82 | 1 - 82 |
| Lifetime cigarette consumption | 135 060 | ± 133 120 | 60 - 587 194 |
| Duration of cigarette use (years) | 19.89 | ± 13.77 | 1 - 67 |
| Time since quit smoking (years) | 14.46 | ± 11.01 | 0.5 - 38 |
| Monthly alcohol consumption (drinks) | 29.85 | ± 42.48 | 1 - 233 |
| Excessive alcohol consumption (days/mth) | 5.76 | ± 6.86 | 1 - 30 |
| Bladder self care (% compliance) | 77.53 | ± 17.40 | 11 - 100 |

## 5.3.0 Univariate Analyses

### 5.3.1 Cardiovascular Morbidity

Of the 16 independent variables studied, seven were found to be significantly associated with cardiovascular morbidity at the $p < 0.25$ level using the univariate methods described previously: duration of cigarette use, age, monthly alcohol consumption, bladder self care, frequency of excessive alcohol use, body mass index, and a complete lesion. Association details are presented in Table 5.6.

Table 5.6 Significant univariate associations for cardiovascular morbidity

| | No morbidity grp mean ($n_1 = 84$) | Morbidity grp mean ($n_2 = 13$) | *t* | *p* |
|---|---|---|---|---|
| Duration of cigarette use | 12.9 | 13.7 | -2.55 | 0.012 |
| Age at interview | 46.1 | 56.6 | -2.51 | 0.014 |
| Monthly alcohol consumption | 24.0 | 10.1 | 2.15 | 0.038 |
| Bladder care | 76.3 | 87.4 | -2.02 | 0.054 |
| Excessive alcohol consumption | 1.62 | 0.62 | 1.55 | 0.127 |

| Body mass index | No morbidity | Morbidity | $\chi^2$ | *p* |
|---|---|---|---|---|
| Non obese | 59 | 7 | 1.32 | 0.249 |
| Obese | 25 | 6 | | |

| Completeness of lesion | No morbidity | Morbidity | *Fisher's* | *p* |
|---|---|---|---|---|
| Incomplete | 52 | 10 | -- | 0.091 |
| Complete | 31 | 1 | | |

5.3.2 Respiratory Morbidity

Through the univariate analyses, cigarettes smoked per day, time since quit smoking, and level of lesion were found to be positively associated at the $p < 0.25$ level with respiratory morbidity. Details are presented in Table 5.7.

Table 5.7 Significant univariate associations for respiratory morbidity

| | No morbidity grp mean ($n_1 = 47$) | Morbidity grp mean ($n_2 = 50$) | $t$ | $p$ |
|---|---|---|---|---|
| Cigarettes smoked per day | 9.43 | 15.94 | -2.23 | 0.028 |
| Time since quite smoking | 4.21 | 7.61 | -1.68 | 0.095 |

| Level of lesion | | No morbidity | Morbidity | $\chi^2$ | $p$ |
|---|---|---|---|---|---|
| | quadriplegia | 15 | 26 | 4.425 | 0.035 |
| | paraplegia | 32 | 23 | | |

5.3.3 Urinary Tract Morbidity

Lifetime cigarette consumption, physical activity, duration of cigarette use, monthly alcohol consumption, duration of disability, cigarettes smoked per day, frequency of excess alcohol use, complete lesion, and cause of injury were found in the univariate analyses to be significantly associated with urinary tract morbidity at the $p < 0.25$ level. Association details are presented in Table 5.8.

Table 5.8 Significant univariate associations for urinary tract morbidity

| | No morbidity grp mean ($n_1 = 30$) | Morbidity grp mean ($n_2 = 67$) | *t* | *p* |
|---|---|---|---|---|
| Lifetime cigarette consumption | 62404 | 113165 | -2.13 | 0.036 |
| Physical activity | 7.2 | 10.1 | -1.92 | 0.058 |
| Duration of cigarette use | 10.3 | 16.2 | -1.84 | 0.069 |
| Monthly alcohol consumption | 34.3 | 16.7 | 1.74 | 0.090 |
| Duration of disability | 13.5 | 17.0 | -1.58 | 0.118 |
| Cigarettes smoked per day | 9.8 | 14.1 | -1.33 | 0.188 |
| Excessive alcohol consumption | 2.5 | 1.0 | 1.33 | 0.191 |

| Completeness of lesion | No morbidity | Morbidity | $\chi^2$ | *p* |
|---|---|---|---|---|
| complete | 7 | 25 | 1.50 | 0.221 |
| incomplete | 21 | 41 | | |

| Cause of injury | No morbidity | Morbidity | *Fisher's* | *p* |
|---|---|---|---|---|
| traumatic | 29 | 55 | -- | 0.059 |
| non traumatic | 1 | 12 | | |

5.4.0 Multivariate Analyses

5.4.1 Cardiovascular Morbidity Model

Seven variables identified as being significant in the univariate analyses were tested for entrance into the cardiovascular morbidity model using the forward stepwise method. Of these seven variables, two were found to be positively associated with risk of cardiovascular morbidity: age and duration of cigarette use. Table 5.9 contains details about the cardiovascular model main effects.

Table 5.9 Cardiovascular model main effects

| | B | se (B) | *p* | OR | 95% CI |
|---|---|---|---|---|---|
| CONSTANT | -4.2420 | 1.1928 | 0.0004 | --- | --- |
| Age | 0.0360 | 0.0227 | 0.1127 | 1.0367 | 0.9915, 1.0838 |
| Duration of cigarette use | 0.0300 | 0.0202 | 0.1380 | 1.0305 | 0.9905, 1.0721 |
| Hosmer - Lemeshow Goodness of Fit Test<br>Chi-Squared DF Significance<br>7.42 8 0.49 | | | | | |

While age and duration of cigarette use entered into the model, the associations did not react significance as indicated by the large p-values and the confidence intervals including the value one. Hosmer and Lemeshow's goodness of fit statistic indicates that the observed data do not differ significantly from values predicted by the model. Plotted diagnostics (Appendix E) indicate the model exhibits only moderate adequacy. The normal probability plot shows that the deviances do not cluster about a straight line indicating that the distribution of the residuals is not normal. Plot of the

standardized residuals and leverage values against case number show several cases for which the model does not fit well. Plots of DfBeta values, change in the coefficients when a case is deleted from the model, reveal several cases which have a moderate impact on the estimation of the coefficients. After examining the outlying cases, a conservative approach was taken and no cases were removed.

As indicated by the univariate analyses and the above model, age and duration of cigarette use are positively associated with cardiovascular morbidity in this population, yet no conclusions can be drawn from this model due to the lack of significance.

### 5.4.2 Respiratory Morbidity Model

Three variables identified as being significant in the univariate analyses were tested for entrance into the respiratory morbidity model using the forward stepwise method. Of these three variables, two were found to be positively associated with risk of respiratory morbidity: number of cigarettes smoked per day and level of lesion. Table 5.10 contains details about the main effects in the model.

Table 5.10 Respiratory model main effects

| | B | se (B) | *p* | OR | 95% CI |
|---|---|---|---|---|---|
| CONSTANT | -0.3993 | 0.2980 | 0.1802 | --- | --- |
| Quadriplegia | 0.5243 | 0.2237 | 0.0191 | 1.6893 | 1.0896, 2.6189 |
| Cigarettes smoked per day | 0.0423 | 0.0182 | 0.0198 | 1.0432 | 1.0066, 1.0811 |
| Hosmer - Lemeshow Goodness of Fit Test<br>Chi-Squared DF Significance<br>4.805 8 0.7781 | | | | | |

Two variations of the smoking by alcohol consumption interaction were examined: cigarettes smoked per day by monthly alcohol consumption and cigarettes smoked per day by frequency of excessive alcohol consumption. These interactions were pursued based on Sherrill and colleagues' (1990) suggestion that alcohol and smoking interact to create a detrimental synergistic effect on lung function. Neither interaction significantly improved the model fit at the 0.05 level. Table 5.11 contains details about the interactions.

Table 5.11 Interactions for the respiratory model

| Interaction | -2 Log Likelihood | $L_0$-$L_1$ | *df* | *p* |
|---|---|---|---|---|
| Main Effects Only | 121.770 | -- | -- | -- |
| Cigarettes smoked per day X Excessive alcohol consumption | 118.507 | 3.263 | 1 | 0.075 |
| Cigarettes smoked per day X Monthly alcohol consumption | 120.548 | 1.222 | 1 | 0.300 |

Hosmer and Lemeshow's goodness of fit statistic indicates that the observed data do not differ significantly from values predicted by the main effects model. The 95 percent confidence intervals for all variables in the model do not include the value one suggesting that the true risk is significantly different from one. Plotted diagnostics (Appendix E) indicate the model exhibits moderate adequacy. The normal probability plot reveals the deviances clustering somewhat about a straight line indicating that the distribution of the residuals is close to normal. Plots of the standardized residuals and leverage values against case number indicate two fairly distinct clusters of residuals. The Dfbeta plots reveal several cases with substantial impact on the estimation of the coefficients. After examining the outlying cases none were removed.

In summary, the respiratory model indicates that level of lesion and number of cigarettes smoked per day are significant predictors of respiratory morbidity. The probability of experiencing respiratory morbidity for non-smoking subjects with quadriplegia was 0.53 compared to 0.40 for non-smoking subjects with paraplegia. The associated risk ratio of 1.33 indicates that subjects with quadriplegia have a 33 percent increase in risk over subjects with paraplegia. The probability of experiencing respiratory morbidity for subjects with paraplegia smoking one pack of cigarettes per day (25 cigarettes) was 0.66 compared to 0.40 for non-smoking subjects with paraplegia. The associated risk ratio of 1.65 indicates that subjects with paraplegia smoking one pack of cigarettes per day have a 65 percent increase in risk of respiratory morbidity compared to non-smoking subjects with paraplegia.

### 5.4.3 Urinary Tract Morbidity Model

Nine variables identified as being significant in the univariate analyses were tested for entrance into the model using the forward stepwise method. Five variables were found to be significantly associated with risk of urinary tract morbidity: complete lesion, physical activity, cigarettes smoked per day, monthly alcohol consumption, and traumatic injury. Table 5.12 contains details about the model main effects.

Table 5.12 Urinary tract model main effects

| | B | se (B) | *p* | OR | 95% CI |
|---|---|---|---|---|---|
| Constant | 0.8047 | 0.6739 | 0.2324 | --- | --- |
| Complete lesion | 0.5965 | 0.2910 | 0.0404 | 1.8158 | 1.0265, 3.2119 |
| Physical activity | 0.1225 | 0.0439 | 0.0053 | 1.1303 | 1.0371, 1.2319 |
| Cigarettes smoked per day | 0.0449 | 0.0216 | 0.0380 | 1.0459 | 1.0026, 1.0912 |
| Monthly alcohol consumption | -0.0145 | 0.0063 | 0.0221 | 0.9856 | 0.9735, 0.9978 |
| Traumatic injury | -1.1199 | 0.5674 | 0.0484 | 0.3263 | 0.1073, 0.9922 |
| Hosmer - Lemeshow Goodness of Fit Test<br>Chi-Squared DF Significance<br>7.644 8 0.4689 | | | | | |

Hosmer and Lemeshow's goodness of fit statistic indicates that the observed data do not differ significantly from values predicted by the model. For all variables in the model the 95 percent confidence intervals do not include the value one, suggesting that the true risk associated with the variable is significantly different from one and did not occur by chance. Plotted diagnostics (Appendix E) indicate the model exhibits moderate adequacy. The normal probability plot reveals the deviances clustering somewhat about a straight line indicating that the distribution of the residuals is close to normal. Plots of the standardized residuals and leverage values against case number show some cases for which the model does not fit well. The Dfbeta plots reveal several cases with substantial impact on the estimation of the coefficients. After examining the outlying cases none were removed.

In summary, the urinary tract model indicates that a complete lesion, number of cigarettes smoked per day, and physical activity are positively associated with urinary tract morbidity. For those subjects with a complete lesion (with mean values for physical activity, cigarettes smoked per day, monthly alcohol consumption, and a traumatic injury) the probability of experiencing urinary tract morbidity was 0.85 compared to 0.76 for subjects with an incomplete lesion. The associated risk ratio of 1.12 indicates that subjects with a complete lesion had a 12 percent increase in risk over subjects with an incomplete lesion. For those subjects who smoked 25 cigarettes per day (with an incomplete lesion, mean values for physical activity and monthly alcohol consumption, and a traumatic injury) the probability of experiencing urinary tract morbidity was 0.81 compared to 0.59 for non-smoking subjects. The associated risk ratio of 1.37 indicates that subjects who smoked one pack of cigarettes per day had a 37 percent increase in risk over non-smoking subjects. For subjects with the average score on the physical activity questionnaire, 9 out of a possible 27 (33%), (with an incomplete lesion, mean values for cigarettes smoked per day and monthly alcohol consumption, and a traumatic injury) the probability of experiencing urinary tract morbidity was 0.76 compared to 0.91 for those subjects scoring 18 (67%). The associated risk ratio of 1.20 indicates that those subjects who scored higher, 18 compared to nine, on the physical activity scale were at greater risk, 20 percent, for urinary tract morbidity.

The urinary tract model indicated that monthly alcohol consumption and traumatic injury are negatively associated urinary tract morbidity. For subjects who consumed the average number of alcoholic beverages per month, 30 drinks, (with an incomplete lesion, mean physical activity and cigarettes smoked per day, and a traumatic injury) probability of urinary tract morbidity was 0.76 compared to 0.83 for

subjects who reported drinking no alcohol. The associated risk ratio of 1.09 indicates that non-drinkers were at nine percent greater risk than subjects consuming 30 alcoholic drinks per month. For those subjects who suffered a traumatic injury (with an incomplete lesion, mean values for physical activity, cigarettes smoked per day and monthly alcohol consumption) probability of urinary tract morbidity was 0.76 compared to 0.91 for subjects who suffered a non-traumatic injury. The associated risk ratio of 1.20 indicates that subjects who suffered a non-traumatic injury had a 20 percent greater risk of urinary tract morbidity than subjects who suffered a traumatic injury.

## 5.5.0 Summary Of Results

Objective 1:

Two variables were positively associated with cardiovascular morbidity, age and duration of cigarette use, yet neither variable reached significance in the logistic regression modeling.

Objective 2:

Two variables were positively associated with respiratory morbidity: level of lesion and number of cigarettes smoked per day.

Objective 3:

Three variables were positively associated with urinary tract morbidity: completeness of lesion, physical activity, and number of cigarettes smoked per day. Two variables, monthly alcohol consumption and traumatic injury, were negatively associated with urinary tract morbidity.

# 6.0 DISCUSSION

## 6.1.0 Cardiovascular Morbidity

Of the risk factors studied, age and duration of cigarette smoking entered into the cardiovascular model, yet these variables were not significant at the 0.05 level. Duration of cigarette use was not addressed by either Cardus and colleagues (1992) nor Krum and colleagues (1992) in their multivariate approach to cardiovascular disease in SCI populations. Cardus and colleagues (1992) recorded only the presence or absence of cigarette smoking then entered those data along with other risk factors into a computer program derived from the Framingham study to predict the overall probability of developing cardiovascular disease. Krum and colleagues (1992) assessed cigarette consumption through cigarettes smoked per day then obtained a cardiac risk factor score derived from logistic regression coefficients from the Multiple Risk Factor Intervention Trial (MRFIT), a study conducted with the general population in 1982. The coefficient derived by Krum and colleagues for cigarettes smoked per day was 0.227, just slightly below the greatest risk factor, age, with a coefficient of 0.288. The use of coefficients derived from the general population assumes that the inherent risk of smoking is the same in the SCI population. Because the effect of SCI on blood lipids is not yet clear this assumption may be inaccurate. Specific SCI risk coefficients need to be produced to accurately predict risk in this unique population.

Physical activity was not a significant predictor of cardiovascular morbidity in this study. Research to date on physical activity and cardiovascular disease in the SCI population has focused on lipid profiles. Jannsen (1994) observed that the number of hours of sports participation accounted for only a small percentage of variance in lipid

profiles. Another study (Hooker & Wells, 1989) observed significant improvements in lipid profiles only for those participants who trained at seventy to eighty percent of maximal heart rate. The association between exercise and lipid profiles in the SCI population remains somewhat unclear. Physical activity data are best collected under controlled conditions where participants perform exercise under the watchful eye of the researchers to determine if the activity is being conducted at the appropriate intensity, for the appropriate duration. Self-report of physical activity may allow for too many generalizations in a field of research where precision is paramount.

Body mass index was not a significant predictor of cardiovascular morbidity in this study. Of the thirteen subjects reporting cardiovascular morbidity, six were obese. Maki and colleagues (1995), after studying the relationship between anthropometric measurements and serum lipid profiles in a SCI population, concluded that BMI is significantly related to serum lipid parameters, yet abdominal circumference or abdominal circumference divided by height is more strongly related. While BMI has been proven useful in identifying individuals at risk for cardiovascular disease in the general population (Jakicic et al, 1993), concern has been expressed (Nuhlicek et al, 1988) that body composition changes secondary to long term paralysis make interpretation difficult.

Alcohol consumption was not found to be a significant predictor of cardiovascular morbidity in this study. The results in the literature pertaining to the general population clearly point to excessive alcohol consumption as a risk of cardiovascular disease. Given the evidence that the SCI population may have lipid profiles that exacerbate the risk of cardiovascular disease one would expect their risk to be equal or greater than the general population leading to the conclusion that an

association may have been present in this study yet undetected. To date, there have been no studies published assessing this relationship in the SCI population.

When all known risk factors for cardiovascular disease are considered together, they explain only forty percent of the cardiovascular disease that occurs (Syme, 1996). Physical inactivity, obesity, and excessive alcohol consumption may account for a small share of this forty percent. This study may not have had the statistical power to detect these associations. Syme (1996) suggests that social issues including poverty, poor housing, unemployment, and low education be studied to determine what accounts for sixty percent of the variance in cardiovascular disease. Recently the bacterial theory has emerged suggesting that a virus, chlamydia pneumoniae, lodges itself in the wall of the coronary artery causing the immune system to produce plaque that gradually narrows blood vessels eventually blocking blood flow to the heart (Ramirez, 1996).

### 6.2.0 Respiratory Morbidity

Quadriplegia was found to be positively associated with respiratory morbidity. Persons with quadriplegia are at greater risk of respiratory morbidity due to an impaired ability to clear the respiratory tract of secretions by coughing. Retention of respiratory tract secretions can lead to infection. Injuries above the C-3 spinal cord level produce almost total respiratory muscle paralysis leaving the patient unable to cough and respire. Mid and lower cervical spinal cord injuries, C-3 to C-8, leave the patient with limited expiratory function and patients with lesions from C-3 to C-5 have significantly compromised inspiration (Mansel & Norman, 1990). Of the 41 quadriplegics in this study, level of lesion ranged from C3 to C7, with 53 percent of the cases of respiratory disease being reported by subjects with quadriplegia. For patients with impaired ability to clear the respiratory tract by coughing attentive bronchial hygiene is a necessity,

including deep breathing maneuvers, assisted coughing, and chest percussion (Mansel & Norman, 1990).

Cigarettes smoked per day was also positively associated with respiratory morbidity. For both past and present smokers in this study, 70 subjects, the number of cigarettes smoked per day ranged from one to 82 cigarettes per day, averaging 17.71 cigarettes per day. McColl and Skinner's sample reported a mean 20.7 cigarettes per day for both past and present smokers. Twenty-seven subjects (27.8%) reported never smoking in comparison to 23.2 percent in Spungen and colleagues' group of male veterans (1995) and 34.6 percent in McColl & Skinners sample (1992). According to Spungen and colleagues (1995) the proportion of those in the general population that have never smoked is 49.9 percent. Seventy-six percent of the subjects with quadriplegia in the present study were past or current smokers smoking a range from one to 63 cigarettes per day, averaging 15.13. Seventy percent of the subjects with paraplegia were past or current smokers, ranging from one to 82 cigarettes per day, averaging 19.77. Sherrill and colleagues' (1990) suggestion that alcohol and smoking interact to create a detrimental synergistic effect on lung function were not confirmed in this study. The interaction between alcohol consumption and smoking was not significantly associated with risk of respiratory morbidity.

The results from this study confirm the major risk factors for respiratory problems in the SCI population to be smoking and level of lesion. To date there have been few published studies taking a lifestyle related multivariate approach to address respiratory morbidity in a SCI population. Almenoff and colleagues (1995) did assess the effect of level of lesion, completeness of injury, and smoking on pulmonary function concluding that level of lesion and pulmonary function are inversely related.

Additionally, Almenoff and colleagues observed decreased pulmonary function in complete high quadriplegics versus incomplete high quadriplegics. The authors observed significantly decreased pulmonary function at all levels of lesion except high quadriplegics which the authors caution may be the result of significantly impaired pulmonary function as a consequence of the high level of injury and/or a small number of high quadriplegic subjects in the study.

The SCI population inherently suffers from respiratory problems secondary to their injury. These results suggest, in accordance with previous work, that major efforts and resources need to be committed to smoking cessation programs to decrease the possible exacerbation of respiratory problems, as well as the implementation and maintenance of appropriate respiratory hygiene procedures.

### 6.3.0 Urinary Tract Morbidity

Completeness of lesion was found to be the strongest predictor of urinary tract morbidity in the study population. Complete lesion is a term used when there is an absence of sensory and motor function in the lowest sacral segment (Waters et al, 1991). Lack of innervation to the bladder, a neurogenic bladder, leads to urine retention or incontinence. Retention can cause urine reflux and eventual renal failure. Intermittent catheterization has become the most popular method of bladder control for the flaccid bladder or spastic sphincter. In turn, intermittent catheterization can introduce infection from external sources if hygienic procedures are not rigidly followed. Stone formation is a somewhat common complication of the neurogenic bladder, caused by urinary stasis and recurrent urinary tract infections. These finding confirm previous work by Morita and colleagues (1994), DeVivo and colleagues (1984) and

Fam and colleagues (1978) that those with complete lesions have a greater incidence of urinary tract complications.

Unexpectedly, physical activity was positively associated with increased urinary tract morbidity. This result is in contrast to previous work indicating that individuals with paraplegia involved in athletic competition have a lower incidence of urinary tract infections (Stotts, 1986; Curtis et al, 1986). Additionally, it has been noted that individuals with a higher level of cardiorespiratory fitness have decreased incidence of urinary tract infection (Hjeltnes & Jansen, 1990), although in a larger study no significant association was found between fitness, exercise, and the prevalence of secondary impairments (Noreau et al, 1993). Noreau and Shepard (1995) point out that these discrepancies could possibly be accounted for by the type of physical activity considered (athletic versus leisure) and methods used to document secondary impairments. In the current study it is suspected that there is a variable confounding this relationship. Quite possibly those subjects with chronic urinary tract problems are so burdened by their poor state of health that they are more conscious of the role of physical fitness in health and hence have increased their physical activity. Or it could simply be that the subjects over estimated their level of physical activity.

Cigarette smoking was positively associated with urinary tract morbidity. Research in the general population suggests that cigarette smoking is significantly associated with bladder cancer (Akdas et al, 1990; Smart, 1990; Shirai, 1993). Yet, the vast majority of urinary tract morbidity reported in this study was chronic urinary tract infections. To date there are no known reports in the literature regarding the association between cigarette smoking and urinary tract infections in the SCI population.

Similarly, there are no known reports in the literature regarding the association between alcohol and urinary tract morbidity in the SCI population. The results of the current study suggest that alcohol may exhibit a mild protective effect against urinary tract infections. There may be several reasons why alcohol exhibits a protective effect; alcohol produces a diuretic effect yielding a flushing of the bladder, or it may be an increase in volume passing through the urinary tract. It has also been speculated that alcohol produces a hostile environment for bacteria in the bladder inhibiting their growth (Anonymous, 1992).

While completeness of lesion was found to be a significant risk factor for urinary tract morbidity, level of lesion was not found to be a significant risk in contrast to previous work (Anson & Gray, 1993; Morita et al, 1994). Anson & Gray observed that subjects with injuries at the T12 level had significantly fewer urinary tract problems than those with injuries at a higher level. Cervical cord injured patients are at greater risk for urinary morbidity because they have a greater chance of having higher vesicle pressure (Morita et al, 1994). Level of lesion was treated as a dichotomous variable in this study which may account for the lack of association.

While time since injury was not found to be to be significantly associated with urinary tract morbidity in this study, the association probably explains the significant negative relationship between traumatic injury and urinary tract morbidity. Those subjects injured traumatically had their injury an average of 15 years (s.d. $\pm$ 8) prior to the interview while subjects with a non-traumatic injury were injured an average of 23 years (s.d. $\pm$1 8) prior to the interview. Time since injury very often indicates era of rehabilitation and associated bladder management methods. Those subjects who had an indwelling catheter are at greater risk of urinary tract complications. Additionally,

those subjects who have had their injury longer have undergone more episodes of intermittent catheterization exposing the urinary tract to bacteria. This result confirms Morita and colleagues' (1994) finding that time since injury is positively associated with urinary tract morbidity.

Surprisingly, scores on the bladder management questionnaire were not significantly associated with increased risk of urinary tract morbidity. The aim of the questionnaire was to determine compliance with specific hygienic procedures associated with the various types of bladder management; indwelling catheter, intermittent catheterization, and condom drainage. As well, general bladder management issues such as regular emptying and monitoring of urine quantity and quality were addressed. These results suggest that compliance with suggested routines associated with bladder care do not have a profound impact upon urinary tract morbidity. However, use of prophylactic antibiotics may be a confounding factor in the relationship between bladder self care and urinary tract morbidity. Additionally, it must be taken into consideration that the bladder management questionnaire was not empirically validated.

Advances in urinary tract management over the past few decades have decreased mortality, yet urinary tract complications continue to be a major health problem for the SCI population. Although the greatest risk factor for urinary tract morbidity cannot be changed, completeness of lesion, the risk associated with cigarette smoking can be addressed. At this point it would not be appropriate to provide recommendations regarding the possible protective affect of alcohol or to suggest physical activity guidelines based on these results. Further research needs to be undertaken to clarify the role of physical activity and alcohol consumption in urinary tract morbidity in the spinal cord injured population.

### 6.4.0 Study Limitations and Strengths

As with any study, these results must be viewed in light of a number of limitations. An inherent drawback of the cross-sectional design is the issue of temporality. It can be difficult to determine whether exposure preceded or resulted from morbidity. Efforts were made to minimize this limitation by collecting retrospective exposure data over a wide time frame, plus collecting dates of diagnosis and onset of symptoms.

Misclassification of morbidity status may have occurred, particularly since the cardiovascular and respiratory morbidity instruments were originally developed for the non-SCI population. The urinary tract morbidity instrument, while developed specifically for the SCI population, has not undergone empirical validation and may have underestimated the prevalence of urinary tract morbidity. Non-differential misclassification biases measures of association towards the null hypothesis, leading to an underestimation of the true association. If non-differential misclassification has occurred, associations observed probably are not spurious ones.

Reporting of lifestyle exposure history was subject to recall bias. Those subjects who experienced the morbidity outcomes of interest might have overestimated their exposure history, or conversely, subjects may have minimized exposure reports to appear more acceptable to the investigator leading to differential misclassification. In an attempt to determine systematic under reporting, subjects were asked if they felt uncomfortable answering any of the exposure questions and if so, which sections. Only six subjects (6.2%) reported feeling uncomfortable answering lifestyle exposure questions. The tobacco and alcohol sections were cited three times, bladder management twice, and one subject cited the morbidity section.

To alleviate volunteer bias, aggressive efforts were undertaken to interview the entire population. Only ten subjects refused to participate. Comparisons between responders and non-responders were performed to assess the representativeness of the sample. Those subjects who refused to participate, as well as those subjects who were lost to follow-up, did not exhibit significantly different demographic and injury related characteristics from the 97 subjects who were interviewed. Deceased members of the population experienced their injuries at a significantly older age, but were similar on all other characteristics. This study population was demographically similar to the Canadian SCI population as a whole allowing for generalizability of the study findings.

It is acknowledged that very large numbers of subjects are needed to adequately assess the role of lifestyle risks, and thus small and moderate associations may have gone undetected. Large studies are needed to uncover the detailed associations between lifestyle risks and chronic disease in the SCI population

### 6.5.0 Clinical Implications

Following a SCI a person's life is in great turmoil. It is a period when depression and anger can lead to the establishment of negative life long behaviours. A window of opportunity exists while the patient is undergoing initial rehabilitation in a health care setting to provide lifestyle information and counseling. This information should outline how physiological alterations and mobility impairments following a SCI may place them at greater risk for chronic diseases and how specific lifestyle strategies may be employed to minimize this risk. A program such as this may involve a variety of health care professionals including a dietitian, physical and occupational therapists, as well as nursing and medical staff. Systematic evaluations of these programs would need to be established to determine and improve program efficacy.

# 7.0 SUMMARY AND CONCLUSIONS

This study was designed to quantify the associations between three top causes of mortality and lifestyle risk factors in an adult SCI population. Morbidity and lifestyle data were collected from 97 participants through telephone interviews. A multivariate analytical approach was used to quantify these associations. The conclusions drawn from the preceding results and discussions are as follows:

1. While positively associated with cardiovascular morbidity, age and duration of cigarette use did not reach significance in the logistic regression modeling. A larger number of subjects is necessary to adequately evaluate these associations;

2. Subjects with quadriplegia had a significantly increased risk of respiratory morbidity, as did subjects who smoked cigarettes. Appropriate respiratory hygiene procedures should be implemented and maintained for those persons with quadriplegia;

3. A complete lesion, cigarette smoking, and physical activity were positively associated with risk of urinary tract morbidity. Traumatic injury and alcohol consumption were negatively associated with risk of urinary tract morbidity. Further research is needed to clarify the associations between physical activity and alcohol consumption with urinary tract morbidity in the SCI population;

4. Cigarette smoking, positively associated with each morbidity outcome in this study, is the main threat to the health of the SCI population in Canada. Smoking

prevention and cessation programs need to be specifically targeted towards the SCI population.

# REFERENCES


Akdas, A., Kirkali, Z., & Bilir, N. (1990). Epidemiological case-control study on the etiology of bladder cancer in Turkey. European Urology, 17(1), 23-26.

Almenoff, P.L., Spungen, A.M., Lesser, M., & Bauman, W.A. (1995). Pulmonary function survey in spinal cord injury: Influences of smoking and level and completeness of injury. Lung, 173, 297-306.

Anonymous (1993). The prevention and management of urinary tract infections among people with spinal cord injuries. Spinal Cord Injury Nursing, 10(2), 49-61.

Anson, C & Gray, M. (1993). Secondary complications after spinal cord injury. Urologic Nursing, 13, 107-112.

Bauman, W.A., Spungen, A.M., Raza, M., Rothstein, J., Zhang, R.L., Zhong, Y.G., Tsuruta, M., Shahidi, R., Person, R.N. Jr., Wany, J. et al (1992). Coronary artery disease: metabolic risk factors and latent disease in individuals with paraplegia. Mount Sinai Journal of Medicine, 59(2), 163-8.

Beaty, T.H., Menkes, H.A., Cohen, P.H., & Newill, C.A. (1984). Factors associated with longitudinal change in pulmonary function. American Review of Respiratory Disease, 129, 660-667.

Bennett, C.J., Young, M.N., Adkins, R.H., & Diaz, F. (1995). Comparison of bladder management complication outcomes in female spinal cord injury patients. Journal of Urology, 153(5), 1458-1460.

Biering-Sorensen, M., Norup, P.W., Jacobsen, E., & Beiring-Sorensen, F. (1995). Treatment of sleep apnoea in spinal cord injured patients. Paraplegia, 33(5), 271-273.

Bjomtorp, P. (1995). Regional patterns of fat distribution. Annals of Internal Medicine, 103, 994-995.

Brodkin, C.A., Barnhart, S., Anderson, G., Checkoway, H., Omenn, G.S, & Rosenstock, L. (1993). Correlation between respiratory symptoms and pulmonary function in asbestos-exposed workers. American Review of Respiratory Disease, 148, 32-37.

Broeker, B., Klein, F., & Hackler, R. (1981). Cancer of the bladder in spinal cord injury patients. Journal of Urology, 125, 196-197.

Cairns, V., Keil, U., Kleinbaum, D., Doering, A., & Stieber, J. (1984). Alcohol consumption as a risk factor for high blood pressure. Munich Blood Pressure Study. Hypertension, 6, 142-131.

Canadian Paraplegic Association (1996). Annual Report. Toronto: CPA.

Cardenas, D. D. & Hooton, T.M. (1995). Urinary tract infections in persons with spinal cord injury. Archives of Physical Medicine and Rehabilitation, 76(3), 272-280.

Cardus, D., Ribas-Cardus, F., & McTaggart, W.G. (1992). Coronary risk in spinal cord injury: Assessment following a multivariate approach. Archives of Physical Medicine and Rehabilitation, 73, 930-933.

Cardus, D., Ribas-Cardus, F., & McTaggart, W.G. (1992). Lipid profiles in spinal cord injury. Paraplegia, 30, 775-782.

Chai, T., Chung, A.K., Belville, W.D., & Faerber, G.J. (1995). Compliance and complications of clean intermittent catheterization in the spinal cord injured patient. Paraplegia, 33(3), 161-163.

Cook, D.G., Shaper, A.G., & MacFarlene, P.W. (1989). Using the WHO (Rose) angina questionnaire in cardiovascular epidemiology. International Journal of Epidemiology, 18(3), 607-613.

Cunnane, S.C. (1993). Childhood origins of lifestyle-related risk factors for coronary heart disease in adulthood. Nutrition & Health, 9(2), 107-115.

Curtis, K.A., McClanahan, S. & Hall, K.M. (1986). Health, vocational and functional status in spinal cord injured athletes and nonathletes. Archives of Physical Medicine and Rehabilitation, 67, 862-865.

Dearwater, S., Laporte, R., Robertson, R., Brenes, G., Adams, L., & Becker, D. (1986). Activity in spinal cord injured patients: An epidemiological analysis of metabolic parameters. Medicine and Science in Sports and Exercise, 18, 541-544.

DeVivo, M.J., Black, K.J., & Stover, S.L. (1993). Causes of death during the first twelve years after spinal cord injury. Archives of Physical Medicine & Rehabilitation, 7 (3), 248-254.

DeVivo, M.J., Fine, P.R., Cutter, G.R., and Maetz, H.M. (1984). The risk of renal-calculi in spinal cord injury patients. Journal of Urology, 131, 857-860.

DeVivo, M.J., Kartus, P.L., Stover, S.L., Rut, R.D., & Fine, P.R. (1989). Cause of death for patients with spinal cord injuries. Archives of Internal Medicine, 149(8), 1761-1766.

Dodge, R.R., & Burrows, B. (1980). The prevalence and incidence of asthma and asthma-like symptoms in a general population sample. American Review of Respiratory Disease, 122, 567-575.

Fam, B.A., Rossier, A. B., Blunt, K., Gabilondo, F. B., Sarkarati, M., Sathi, J., et al (1978). Experience in the urologic management of 120 early spinal cord injury patient. Journal of Urology, 119, 485-487.

Farzan, S. (1985). A Concise Handbook of Respiratory Diseases (2nd ed). Virginia: Reston.

Ferguson, R. & Morrissey, E. (1993). Risk factors for end-stage renal disease among minorities. Transplantation Proceedings, 25(4), 2415-2420.

Ferris, B.G. (1978). Epidemiology standardization project. American Review of Respiratory Disease, 118(6), 1-120.

Flavell, H., Marshall, R., Thornton, A.T., Clements, P.L., Antic, R., & McEvoy, D. (1992). Hypoxia episodes during sleep in high tetraplegia. Archives of Physical Medicine and Rehabilitation, 73, 623-627.

Frick N. M. & Bruno, R.L. (1986). Post-polio sequelae: Physiological and psychological overviews. Rehabilitation Literature, 47, 106-111.

Frisbie, J. H. & Brown, R. (1994). Waist and neck enlargement after quadriplegia. Journal of the American Paraplegia Society, 17(4), 177-178.

Garber C.E., Carleton, R.A., & Heller, G.V. (1992). Comparison of "Rose Questionnaire Angina" to exercise thallium scintigraphy: different findings in males and females. Journal of Clinical Epidemiology, 45(7), 715-720.

Gausch, P.A., Linder, S.H., Williams, T., & Ryan, S. (1991). A functional classification of respiratory compromise in spinal cord injury. Spinal Cord Injury Nursing, 8(1), 4-10.

Geisler, W.O., Jousse, A.T., Wynne-Jones, M., & Breithaupt, D. (1983). Survival in traumatic spinal cord injury. Paraplegia, 21, 364-373.

Green, D., Twardowski, P., Wei, R., & Rademaker, A.W. (1994). Fatal pulmonary embolism in spinal cord injury. Chest, 105(3), 853-855.

Gronbaek, M., Deis, A., Sorensen, T.I., Becker, U., Schnohr, P. & Jensen, G. (1995). Mortality associated with moderate intakes of wine, beer, or spirits. British Medical Journal, 310(6988), 1165-1169.

Grundy, S.M., Bilheimer, D., Blackburn, H. et al (1982). Rationale of the diet-heart statement of American Heart Association. Report of the nutrition committee. Circulation, 65, 839A.

Hackler, R.H. (1977). A 25-year prospective mortality study in the spinal cord injured patient: comparison with the long-term living paraplegic. Journal of Urology, 117(4), 486-488.

Harley, A.M. (1994). Aging in the Community With a Spinal Cord Injury: A Look at Health Status, Functional Independence, and Quality of Life. Unpublished report.

Health and Welfare Canada (1988). Canadian Guidelines for Healthy Weights. Ottawa: Health and Welfare Canada.

Heinemann, A., Keen, M., Donoghue, R., & Scholl, S. (1988). Alcohol use by persons with recent spinal cord injuries. Archives of Physical Medicine and Rehabilitation, 69, 619-624.

Heldenberg, D., Rubinstein, A., Levtov, O., Werbin, B., & Tamir, I. (1981). Serum lipids and lipoprotein concentrations in young quadriplegic patients. Atherosclerosis, 39, 163-167.

Helsing, K.J., Constock, G. W., Speizer, F.E., Ferris, B.G., Lebowitz, M.D., Tockman, M.S., & Burrows, B. (1979). Comparison of three standardized questionnaires on respiratory symptoms. American Review of Respiratory Disease, 120, 1221-1231.

Herruzo, C., Leturia, A., Vizcaino, A., Fernandez, A., & Calero, J. (1994). Analytic epidemiology of clinical urinary tract infection in spinal cord injury. European Journal of Epidemiology, 10(1), 23-27.

Higgins, M. (1991). Risk factors associated with chronic obstructive lung disease. Annals of the New York Academy of Sciences, 624, 7-17.

Higgins, M., Kannel, W.B., Garrison, R., Pinsky, J., & Stokes, J. (1987). Hazards of obesity. The Framingham Experience. Acta Medica Scandinavica (Suppl), 723, 23-26.

Hjeltnes, N., & Jansen, T. (1990). Physical endurance capacity, functional status and medical complications in spinal cord injured subjects with long-standing lesions. Paraplegia, 28, 428-432.

Hodge, A. M. & Zimmet, P. Z. (1994). The epidemiology of obesity. Baillieres Clinical Endocrinology and Metabolism, 8(3), 577-599.

Hooker, S.P. & Wells, C.L. (1989). Effects of low and moderate intensity training in spinal cord injured person. Medicine in Science, Sports, and Exercise, 21, 18-22.

Hosmer, D.W. & Lemeshow, S. (1989). Applied Logistic Regression. New York: Wiley.

Hsieh, F.Y. (1989). Sample size tables for logistic regression. Statistics in Medicine, 8, 795-802.

Imai, K., Kadowaki, T., Aizawa, Y., & Fukutomi, K. (1994). Morbidity rates of complications in persons with spinal cord injury according to the site of injury and with special reference to hypertension. Paraplegia, 32(4), 246-252.

Jaakkola, M.S., Ernst, P., Jaakkola, J.J., Nganga, L.W., & Becklake, M.R. (1991). Effect of cigarette smoking on evolution of ventilatory lung function in young adults. An eight-year longitudinal study. Thorax, 46, 907-913.

Jaakkola, M.S., Jaakkola, J.J., Ernst, P., & Becklake, M.R. (1993). Respiratory symptoms in young adults should not be overlooked. American Review of Respiratory Review, 147, 359-366.

Jakicic, J.M., Donnelly, J. E., Jawad, A.F., Jacobsen, D.J., Gunderson, S.C., & Pascale, R. (1993). Association between lipids and different measures of body fat distribution: effects of BMI and age. International Journal of Obesity, 17, 131-137.

Jannssen, T.W. (1994). Physical strain and physical capacity in men with spinal cord injures [dissertation]. Amsterdam: Vrije University.

Kannel, W.B. (1992). Epidemiology of cardiovascular disease in the elderly: An assessment of risk factors. Cardiovascular Clinics, 22(2), 9-22.

Kannel, W.B., McGee, D.L., & Castelli, W.P. (1984). Latest perspective on cigarette smoking and cardiovascular disease: The Framingham Study. Journal of Cardiac Rehabilitation, 4, 267-277.

Kannel, W.B., Wilson, P.W.F., Blair, S.N. (1985). Epidemiologic assessment of the role of physical activity and fitness in development of cardiovascular disease. American Heart Journal, 109, 876-885.

Kelsy, J., Whittemore, A., Evans, A., & Thompson, W.D. (1996). Methods in Observational Epidemiology 2nd Edition. New York, Oxford University Press.

Kirubakaran, V., Kumar, V., Powell, B., Tyler, A., & Arnatas, P. (1986). Survey of alcohol and drug misuse in spinal cord injured veterans. Journal of studies on Alcohol, 47, 223-227.

Komura, T., Yamasaki, M., Muraki, S., & Seki, K. (1994). Characteristics of the health conditions of old patients with spinal cord injury. Journal of Human Ergology, 23(2), 151-157.

Krum, H., Howes, L. G., Brown, D. J., Ungar, G., Moore, P., McNeil, J.J., & Louis, W. J. (1992). Risk factors for cardiovascular disease in chronic spinal cord injury patient. Paraplegia, 30, 381-388.

Kushner, R. F. (1993). Body weight and mortality. Nutrition Review, 51(5), 127-136.

Lalonde, M. (1974). A New Perspective on the Health of Canadians. Ottawa: Health and Welfare Canada.

Lammertse, D.P. & Yarkony, G.M. (1991). Rehabilitation in spinal cord disorders. 4. Outcomes and issues of aging after spinal cord injury. Archives of Physical Medicine and Rehabilitation, 72 (Suppl.), 309-311.

Lanig, I. (1993). The genitourinary system. In Whiteneck, G.G., Charlifue, S.W., Gerhart, K.A., Lammertse, D.P., Manley, R.R., Mentor, S., & Seedroff, K.R. (Eds.). Aging with Spinal Cord injury (105-116). New York: Demos.

Le C.T. & Price, M. (1982). Survival from spinal cord injury. Journal of Chronic Diseases, 35, 487-492.

Lebowitz, M.D. (1977). Smoking habits and changes in smoking habits as they relate to chronic conditions and respiratory symptoms. American Journal of Epidemiology, 105, 534-543.

Levi, R., Hulting, C., & Seiger, A. (1995). The Stockholm Spinal Cord Injury Study. 3. Health-related issues of the Swedish annual level-of-living survey in SCI subjects and controls. Paraplegia, 33(12), 726-730.

Lucas, R.W. , Mullin, P.J., Luna, C.B.X., & McInroy, D.C. (1977). Psychiatrists and a computer as interrogators of patients with alcohol-related illness: A comparison. British Journal of Psychiatry, 131, 160-167.

Ma, K.W., Greene, E.L., & Raij, L. (1992). Cardiovascular risk factors in chronic renal failure and hemodialysis populations. American Journal of Kidney Diseases, 19(6), 505-513.

Maki, K.C., Briones, E.R., Langbein, W.E., Inman-Felton, A., Nemchausky, B., Welch, M., & Burton, J. (1995). Associations between serum lipids and indicators of adiposity in men with spinal cord injury. Paraplegia, 33 (2), 102-109.

Mansel, J.K. & Norman, J.R. (1990). Respiratory complication and management of spinal cord injuries. Chest, 6, 1446 - 1452.

Mason, C.M., & Nelson, S. (1992). Normal host defenses and impairments associated with the delayed resolution of pneumonia. Seminars in Respiratory Infections, 7(4), 243-255.

McColl, M.A. & Skinner, H. (1992). Computerized Health Risk Assessment in a Spinal Cord Injured Population. Unpublished report.

Menter, R. (1993). Issues of aging with spinal cord injury. In Whiteneck, G.G., Charlifue, S.W., Gerhart, K.A., Lammertse, D.P., Manley, R.R., Mentor, S., & Seedroff, K.R. (eds.). Aging with Spinal Cord injury (pp. 1-8). New York: Demos.

Mickey, J. & Greenland, S. (1989). A study of the impact of confounder selection criteria on effect estimation. American Journal of Epidemiology, 129, 125-137.

Morita, H., Sazawa, A., Kanno, T., & Koyanagi, T. (1994). Long term urinary prognosis of cervical cord injury patients. Paraplegia, 32(1), 30-35.

Noreau, L. & Shepard, R.J. (1995). Spinal cord injury, exercise, and quality of life. Sports Medicine, 20 (4), 226-250.

Noreau, L., Shepard, R.J., Simard C. , Pare, G., & Pomerleau, P. (1993). Relationship of impairment and functional ability to habitual activity and fitness following spinal cord injury. International Journal of Rehabilitation Research, 16, 265-275.

Norusis, M.J. & SPSS Inc. (1994). SPSS Advanced Statistics 6.1. SPSS: Chicago.

Nuhlicek, D.N. (1988). Body composition of patients with spinal cord injury. European Journal of Clinical Nutrition, 42, 765-773.

Ontario Secretariat for Disabled Persons (1983). Alcohol and drug abuse among disabled persons: Report on preliminary findings. Toronto: Government of Ontario.

Perkash, I. (1993). Long-term urologic management of the patient with spinal cord injury. Urologic Clinics of North America, 20(3), 423-434.

Ramirez, J.A. (1996). Isolation of chlamydia pneumoniae from the coronary artery of a patient with coronary atherosclerosis. Annals of Internal Medicine, 125(12), 979-982.

Rose, G., McCartney, P., & Reid, D.D. (1977). Self-administration of a questionnaire on chest pain and intermittent claudication. British Journal of preventive and Social Medicine, 31, 42-48.

Rosner, B. (1990). Fundamentals of Biostatistics. PWS-Kent: Boston.

Samsa, G., Patrick, C., & Feussner, J. (1993). Long-term survival of veteran with traumatic spinal cord injury. Archives of Neurology, 50(9), 909-14.

Senthilselvan, A., Chen, Y., & Dosman, J.A. (1993). Predictors of asthma and wheezing in adults. American Review of Respiratory Disease, 148, 667-670.

Sherrill, D.L., Lebowitz, M.D., Burrows, B. (1990). Epidemiology of chronic obstructive pulmonary disease. Clinics in Chest Medicine, 11(3), 375-387.

Shirai, T. (1993). Etiology of bladder cancer. Seminars in Urology,11(3), 113-126.

Skinner, H.A. (1993). Early identification of addictive behaviours using a computerized life-style assessment. In Baer, J.S., Marlett, G.A., & McMahon, R.J. (eds.). Addictive Behaviours Across the Lifespan: Prevention, Treatment and Policy Issues. California: Sage.

Skinner, H.A., Allen, B.A., McIntosh, M.C., & Palmer, W.H. (1985). Lifestyle assessment: Applying microcomputers in family practice. British Medical journal, 290. 212-214.

Smart, C.R. (1990). Bladder cancer survival statistics. Journal of Occupational Medicine, 32(9), 926-928.

SPSS Inc.(1996). SPSS for Windows (version 6.1.4) [computer software]. SPSS: Chicago

Spungen, A.M., Lesser, M., Almenoff, P.L., & Bauman, W.A. (1995). Prevalence of cigarette smoking in a group of male veterans with chronic spinal cord injury. Military Medicine, 160(6), 308-311.

Star, A.M. & Osterman, A.L. (1988). Sleep apnea syndrome after spinal cord injury. Spine, 13(1), 116-117.

Statistics Canada (1995). Household Facilities and Equipment. Ottawa: Statistics Canada.

Stonehill, W.H., Dmochowski, R.R., Patterson, A.L., & Cox, C.E. (1996). Risk factors for bladder tumors in spinal cord injury patients. Journal of Urology, 155(4), 1248-1250.

Stotts, K. (1986). Health maintenance: Paraplegic athletes and non-athletes. Archives of Physical Medicine and Rehabilitation, 67, 109-114.

Stover, S.L. (1994). 1993 Donald Munro Memorial Lecture of the American Paraplegic Society. Spinal cord injury: Knowns and unknowns. Journal of the American Paraplegic Society, 17(1), 1-6.

Sweeney, T., & Foote, J. (1982). Treatment of drug and alcohol abuse in spinal cord injured veterans. International Journal of Addictions, 17, 897-904.

Syme, S.L. (1996). Rethinking disease: Where do we go from here? Annals of Epidemiology, 6(5), 463-468.

Tanagho, E. A. & McAninch, J. W. (1992). Smith's General Urology (13th ed). Connecticut: Appleton & Lange.

Vaziri, N. D., Gordon, S., & Nikakhtar, B. (1982). Lipid abnormalities in chronic renal failure associated with spinal cord injury. Paraplegia, 20, 183-189.

Walker, W. A., Evans, B.J., Pate, J.W., Weiman, D.S., and Riddle, J.C. (1996). Coronary operations in patients with spinal cord injury. Annals of Thoracic Surgery, 61, 789-794.

Waters, R.L., Adkins, R.H., and Yakura, J.S. (1991). Definition of complete spinal cord injury. Paraplegia, 9, 573-81.

Welborn, T.A., & Wearne, K. Coronary heart disease incidence and cardiovascular mortality in Busselton with reference to glucose and insulin concentration. Diabetes Care, 2, 154-160.

Whiteneck, G., Charlifue, S., Frankel, H.L, Fraser, M.H, Gardner, B.P., Gerhart, K.A., Krishnan, K.R., Menter, R.R, Nuseibeh, I., & Silver, J.R. (1992). Mortality, morbidity, and psychosocial outcomes of persons spinal cord injured more than 20 years ago. Paraplegia, 30(9), 617-630.

Williamson, D. F. (1993). Descriptive epidemiology of body weight and weight change in U.S. adults. Annals of Internal Medicine, 119(7), 646-649.

Wilmot, C., & Hall, K. (1993). The respiratory system. In Whiteneck, G.G., Charlifue, S.W., Gerhart, K.A., Lammertse, D.P., Manley, R.R., Mentor, S., & Seedroff, K.R. (eds.). Aging with Spinal Cord injury. New York: Demos.

Wilson, P.W., Garrison, R.J., Castelli, W.P., Feinleib, M., McNamara, P.M., & Kannel, W.B. (1980). Prevalence of coronary heart disease in the Framingham Offspring Study: Role of lipoprotein cholesterols. American Journal of Cardiology, 46, 649-654.

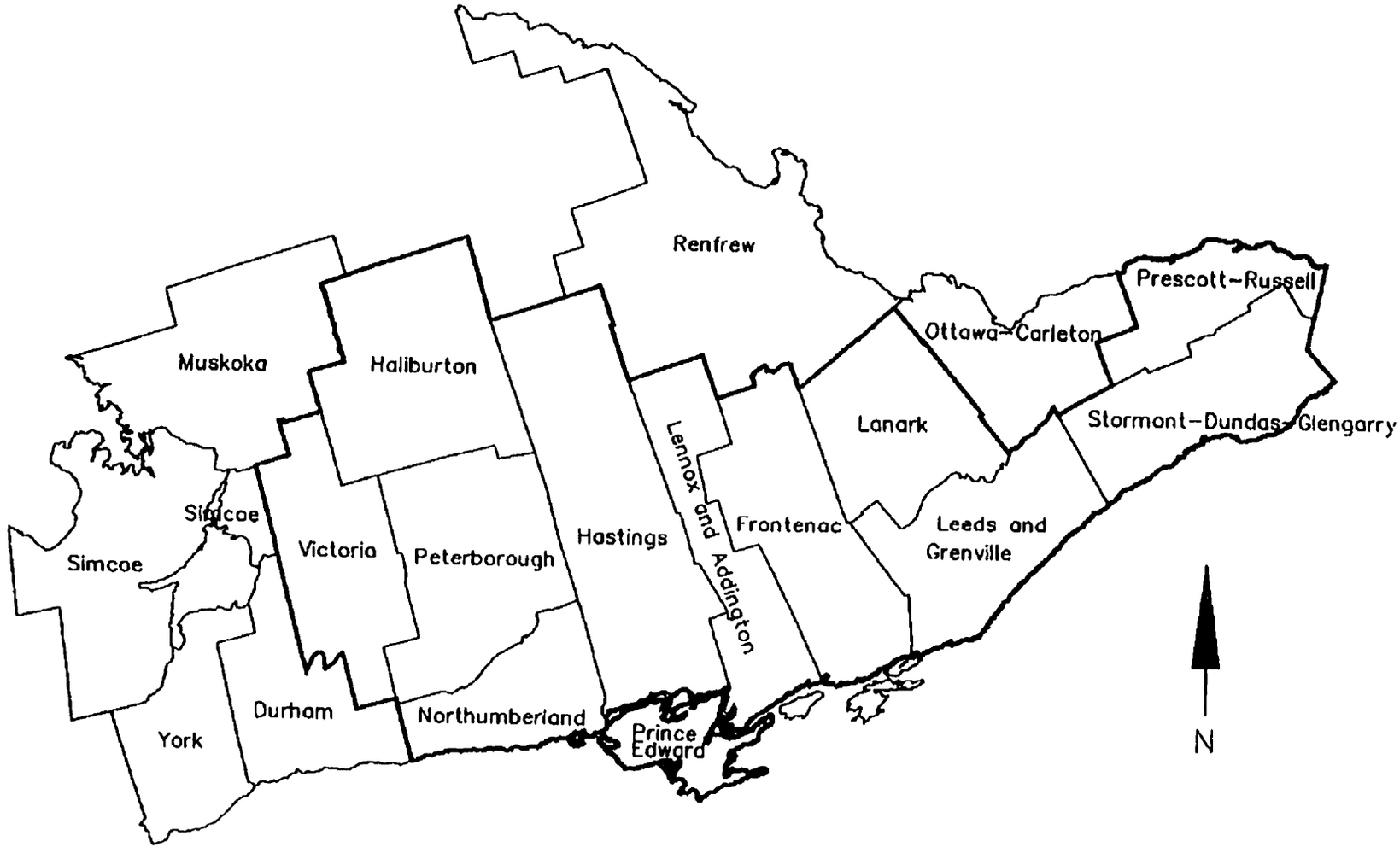
Yekutiel, M., Brooks, M.E., Ohry, A., Yarom, J., & Carel, R. (1989). The prevalence of hypertension, ischemic heart disease and diabetes in traumatic spinal cord injured patients and amputees, Paraplegia, 27, 58-62.

Yokoyama, O., Hasegawa, T., Ishiura, Y., Ohkawa, M., Sugiyama, Y., & Izumida, S. (1996). Morphological and functional factors predicting bladder deterioration after spinal cord injury. Journal of Urology, 155(1), 271-274.

Young, M. E., Rintala, D. H., Rossi, C. D., Hart, K. A., & Fuhrer, M. J. (1995). Alcohol and marijuana use in a community-based sample of persons with spinal cord injury. Archives of Physical Medicine and Rehabilitation, 76, 525-532.

APPENDIX A. BAWDEN REHABILITATION UNIT CATCHMENT AREA

# Bawden Rehabilitation Unit Catchment Area



# APPENDIX B. INFORMATION SHEET & CONSENT FORM

## INFORMATION SHEET

**TITLE OF PROJECT:**

EFFECTS OF LIFESTYLE RISKS ON THREE MAJOR DISEASE OUTCOMES IN SPINAL CORD INJURED ADULTS

**INVESTIGATOR:**
Diane Davies
Graduate Student, Queen's University, Dept. of Community Health and Epidemiology
(613) 545-6000 ext. 7890

A study is currently under way, through the Rehabilitation Unit at KGH, to follow-up on all spinal cord injured patients who received their rehabilitation at Bawden, and to try to understand the effects of lifestyle risk factors on their health. Through this study we hope to assess the effects of obesity, physical activity, cigarette use, alcohol consumption, and bladder management on heart, lung, and urinary tract disease so that appropriate health promotion and disease prevention programs can be implemented during the rehabilitation phase following a spinal cord injury.

We would be very pleased if you would participate in this study. Your participation would involve a single interview, conducted over the phone, at a time that is convenient for you. The interview lasts about 40 minutes, and involves a number of questions about conditions you may have or have had, plus questions about your lifestyle.

Your participation is strictly voluntary. You are free to decide not to participate, with no implications for present or future associations with KGH or individuals there. Your decision to participate, as well as any information you give the interviewer, would be treated with the utmost confidence. Your name or other identifying information will not appear anywhere on the questionnaire. Further, your responses will never be used in isolation, but rather, they will only be used in combination with the information of the other participants.

To the best of our knowledge, there are no risks involved in participating in this study. The benefit to you lies in your knowledge that you would be contributing to a better understanding of lifestyle risks in the spinal cord injured population.

If you have any questions or concerns about the study, you may call myself, Diane Davies, at 545-6000 ext. 7890, or my advisors Dr. McColl at 545-6110, or Dr. Durance at 546-6012.

## CONSENT FORM

**TITLE OF PROJECT:**

EFFECTS OF LIFESTYLE RISKS ON THREE MAJOR DISEASE OUTCOMES IN SPINAL CORD INJURED ADULTS

**INVESTIGATOR:**
Diane Davies
Graduate Student, Queen's University, Department of Community Health and Epidemiology
(613) 545-6000 ext. 7890

The study has been explained to me and my questions have been answered to my satisfaction. I understand that to the best of the researchers' knowledge, there are no risks involved in participating in this study. The benefit to me lies only in my knowledge that I would be contributing to a better understanding of the effects of lifestyle riskS in the spinal cord injured population. I have been furnished with a copy of the information sheet and consent form for my own records. I agree to participate in the study.

NOTE: Please return in the provided self-addressed stamped envelope

Signed

_____ Date: _____

Witness

_____ Date: _____

I have carefully explained to the participant the nature of the above research study. I certify that to the best of my knowledge, he/she understands the nature of the study and the demands, benefits and risks involved.

Investigator

_____ Date: _____
Diane Davies

# APPENDIX C. MORBIDITY QUESTIONNAIRE AND CODING

## MORBIDITY QUESTIONNAIRE

**All questions refer to post SCI period.**

***CARDIOVASCULAR MORBIDITY***
(Adapted from Rose et al, 1977)

**PART A**

(1) Have you ever had any pain or discomfort in your chest?
☐Yes ☐No (Go to part C)

If uses electric chair go to 7.

(2) Do you get this pain or discomfort when you walk or wheel uphill or hurry?
☐Yes ☐No (Go to part B)

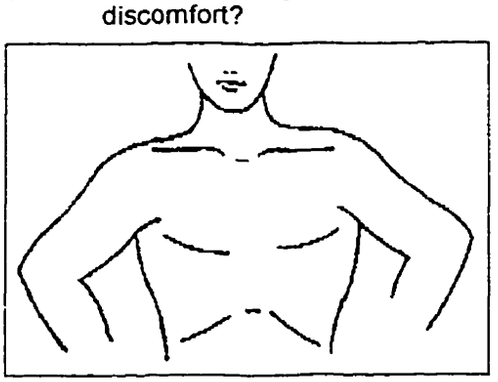
(3) Do you get it when you walk or wheel at an ordinary pace on level ground?
☐Yes ☐No

(4) When you get any pain or discomfort in your chest what do you do?
☐Stop
☐Slow down
☐Continue at the same pace

(5) Does it go away when you are still?
☐Yes ☐No

(6) How soon?
☐10 minutes or less
☐More than 10 minutes

(7) Where do you get this pain or discomfort?



**PART B**

(1) Have you ever had a severe pain across the front of your chest lasting for half an hour or more?
☐Yes ☐No

**PART C**

(1) Have you ever been diagnosed by a doctor as having any form of heart disease?
☐Yes ☐No

IF *YES* TO QUESTION 1:

(2) What type of heart disease did you have / do you have?

_____

_____

(3) When were you first diagnosed?

_____/_____/_____
year month day

***RESPIRATORY MORBIDITY***
(Adapted from Ferris, 1978)

**PART A**

(1) Do you usually have a cough? (Count a cough with first smoke or on first going out-of-door. Exclude clearing of throat.)
☐Yes ☐No

(2) Do you usually cough at all on getting up or first thing in the morning?
☐Yes ☐No

IF *NO* TO 1 & 2, SKIP TO PART B.

(3) Do you usually cough like this on most days for 3 consecutive months or more during the year?
☐Yes ☐No

(4) For how many years have you had this cough?
_____ years

**PART B**

(1) Do you usually bring up phlegm from your chest? (Count phlegm with the first smoke or on first going out-of-doors. Exclude phlegm from the nose. Count swallowed phlegm.)
☐Yes ☐No

(2) Do you usually bring up phlegm at all on getting up, or first thing in the morning?
☐Yes ☐No

IF *NO* TO 1 & 2, SKIP TO PART C.

(3) Do you bring up phlegm like this on most days for 3 consecutive months or more during the year?
☐Yes ☐No

(4) For how many years have you had trouble with phlegm?
_____ years

**PART C**

(1) Have you had periods or episodes of (increased*) cough and phlegm lasting for 3 months or more for two consecutive years?
* for persons who usually have cough and / or phlegm
☐Yes ☐No

IF *YES* TO QUESTION 1:

(2) For how long have you had at least 1 such episode per year?
_____ years

**PART D**

(1) Does your chest ever sound wheezy or whistling:

When you have a cold?
☐Yes ☐No

Occasionally apart from colds?
☐Yes ☐No

Most days or nights
☐Yes ☐No

**PART E**

(1) Have you been diagnosed by a doctor as having had any of the following illnesses:

Pneumonia?
☐Yes ☐No
date of diagnosis
_____/_____/_____
year month day

Chronic bronchitis?
☐Yes ☐No
date of diagnosis
_____/_____/_____
year month day

Emphysema?
☐Yes ☐No
date of diagnosis
_____/_____/_____
year month day

Asthma?
☐Yes ☐No
date of diagnosis
_____/_____/_____
year month day

Sleep Apnea?
☐Yes ☐No
date of diagnosis
_____/_____/_____
year month day

Other?
☐Yes ☐No

_____

date of diagnosis
_____/_____/_____
year month day

## *URINARY TRACT MORBIDITY*

**PART A**

(1) What best describes your bladder function?
☐Normal function
☐Near normal function
☐Neurogenic

(2) Approximately how many symptomatic urinary tract infections that require antibiotics or a change in your antibiotics have you had over the past year? (symptoms include: decreased appetite, fever, decreased energy, and change in odour of urine)
☐None
☐One - Two
☐Three -Four
☐Five - Six
☐Seven or more

(3) Do you take antibiotics daily to prevent bladder infections?
☐Yes ☐No

(4) Do you attend regular bladder / kidney check-ups?
☐Yes ☐No

(5) Have you been told by your urologist to come back yearly or more than once per year?
☐Yes ☐No

(6) Have you ever had bladder/kidney surgery or lithotripsy?
☐Yes ☐No

(7) Have you been diagnosed by a doctor as having diabetes?
☐Yes ☐No

IF YES TO QUESTION 7:

(8) What type of diabetes?
☐insulin ☐non insulin

(9) When were you diagnosed?
_____/_____/_____
year month day

**PART B**

(1) Have you been diagnosed by a doctor as having any form of urinary tract disease? (stones, scarring, obstructive uropathy, pouches on bladder, or dilated ureters)
☐Yes ☐No

IF *YES* TO QUESTION 1:

(2) What type of urinary tract disease did you have/do you have?

_____

(3) When were you diagnosed?
_____/_____/_____
year month day

## Definitions of Positive Morbidity Classification

**Cardiovascular Morbidity**
(Adapted from Rose et al, 1977)

An individual will be classified as a 'case' of cardiovascular morbidity if:

Part A -'yes' to questions 1 and 2, 'stop' or 'slow down' to 4, 'yes' to 5, '10 minutes or less' to 6, site must include either sternum (any level) or left anterior chest left arm, or;

Part B -'yes' to question 1, or;

Part C - forms of ischaemic heart disease reported by subject as diagnosed by a physician.

**Respiratory Morbidity**
(Adapted from Ferris, 1978)

An individual will be classified as a 'case' of respiratory morbidity if:

Part A - 'yes' to 1 or 2 , and 'yes' to 3 may indicate respiratory tract infections (Farzan, 1985), or;

Part B - 'yes' to 1 or 2 , and 'yes' to 3 may indicate respiratory tract infections (Farzan, 1985), or;

Part C - 'yes' may indicate chronic bronchitis (Farzan, 1985), or;

Part D - wheezing or whistling, apart from colds, may indicate asthma, acute bronchitis, and other causes of bronchial narrowing (Farzan, 1985), or:

Part E - chronic respiratory diseases, as listed, reported by subject as diagnosed by a physician.

**Urinary Tract Morbidity**

An individual will be classified as a 'case' of urinary tract morbidity if:

Part A - > 2 symptomatic infections per year (Tanagho & McAninch,1992), or daily antibiotics, or surgery, or;

Part B - urinary tract disease as reported by subject as diagnosed by a physician

# APPENDIX D. HEALTH RISK ASSESSMENT AND CODING

## HEALTH RISK ASSESSMENT

(Adapted from McColl & Skinner 1992)

**PHYSICAL ACTIVITY**

1. How many times per week do you exercise for at least 15 minutes? (Do NOT include exercise resulting from daily living. e.g. transfers, wheeling)
   - [a] Daily
   - [b] 5 - 6 times per week
   - [c] 3 - 4 times per week
   - [d] 1 - 2 times per week
   - [e] Less than once a week
   - [f] Never

2. How often do you exercise so that your breathing rate increases and you begin to sweat? (Do NOT include exercise from daily living. e.g. transfers, wheeling)
   - [a] Daily
   - [b] 5 - 6 times per week
   - [c] 3 - 4 times per week
   - [d] 1 - 2 times per week
   - [e] Less than once a week
   - [f] Never

3. How often do you do stretching and flexibility exercises?
   - [a] Daily
   - [b] 5 - 6 times per week
   - [c] 3 - 4 times per week
   - [d] 1 - 2 times per week
   - [e] Less than once a week
   - [f] Never

4. What is the total number of minutes a week that you do VIGOROUS physical exercise? e.g. wheelchair sports, swimming, universal gym, nautilus, stationary bicycling

   _____ minutes

5. What is the total number of minutes a week that you do MODERATE physical exercise? e.g. table tennis, strength sports (weightlifting), arm exercises WITH weights / resistance (arm bike, pulleys)

   _____ minutes

6. What is the total number of minutes a week that you do LIGHT physical exercise? e.g. light training program, arm exercises WITHOUT weights / resistance

   _____ minutes

7. Would you describe your current level of physical activity as representative of your activity level since one year following your SCI?
   - [a] Yes
   - [b] No, I have been more active in the past
   - [c] No, I have been less active in the past

8. For how long has your activity level been like this?

_____ years

**BODY MASS INDEX**

1. How tall were you before your injury?

_____ cm / inches

2. How much do you weigh?

_____ kg / lb.

3 Would you describe your current weight as being representative of your weight since one year following your SCI?

[a] Yes
[b] No, I have weighed more in the past
[c] No, I have weighed less in the past

4. For how long has your weight been like this?

_____ years

**CIGARETTE USE**

1. Have you ever smoked cigarettes?
☐ Yes ☐ No **If No, go to Alcohol Use**

2. Do you smoke cigarettes now? (this means daily or occasionally)
☐ Yes ☐ No **If No, go to 9**

3. For how many years, in total, have you smoked over your lifetime? (round up to the nearest year; if 6 months or less, enter zero).
_____ years

4. For how many years, in total, have you smoked on a DAILY basis? (round up to the nearest year; if 6 months or less, enter zero).

_____ years

5. How many cigarettes do you smoke on the days when you smoke?

_____ cigarettes

6. How many days in a usual week do you smoke cigarettes?

_____ days

7. Have you ever quit smoking for six months or more?
☐ Yes ☐ No **If No, go to alcohol consumption**

8. For how many years did you quit smoking completely?

_____ years **Go to alcohol consumption**

9. For how many years, in total, have you smoked over your lifetime? (round up to the nearest year; if 6 months or less, enter zero).

_____ years

10. For how many years did you smoke on a DAILY basis? (round up to the nearest year; if 6 months or less, enter zero)

_____ years

11. How many years ago did you smoke on a DAILY basis? (round up to the nearest year; if 6 months or less, enter zero)

_____ years

12. How many cigarettes did you smoke on the days when you smoked?

_____ cigarettes

13. How many days in a usual week did you smoke cigarettes?

_____ days

14. How many years ago did you quit smoking completely? (round up to the nearest year; if 6 months or less, enter zero)

_____ years

**ALCOHOL USE**

1. Have you had at least one alcoholic beverage in the last year?
Examples include: wine, beer, liquor (e.g. vodka, scotch, brandy)
[a] Yes
[b] No **If No, go to 7**

2. On how many days in the PAST MONTH (4 weeks) did you have 9 or more drinks?
One drink equals: a bottle / can of beer
a 1 1/2 oz. shot of scotch, vodka, etc.
a small (5 oz) glass of wine

_____ days

3. On how many of the REMAINING DAYS in the PAST MONTH (4 weeks) did you have 5 - 8 drinks?

_____ days

4. On how many of the REMAINING DAYS in the PAST MONTH (4 weeks) have you had 3 - 4 drinks?

_____ days

5. On how many of the REMAINING DAYS in the PAST MONTH (4 weeks) did you have 1-2 drinks?

_____ days

6. Would you describe the last month as a typical month of alcohol consumption since one year following your SCI?
   [a] Yes
   [b] No, I usually drink more.
   [c] No, I usually drink less.

7. For how long has your alcohol consumption been like this?

_____ years

**BLADDER MANAGEMENT**

1a. Do you have an internal/indwelling catheter (e.g. Foley catheter)?
   [a] Yes
   [b] No **If No, go to 2a**

1b. Do you consistently have your indwelling catheter changed every month?
   [a] No
   [b] Sometimes
   [c] Often
   [d] Always or almost always

1c. Do you use soap and water to clean around the catheter area?
   [a] Less than once per day
   [b] Once per day

2a. Do you use intermittent catheterization?
   [a] Regularly
   [b] Occasionally
   [c] Never **If No, go to 3a**

2b. Do you do your own intermittent catheterizations (I.C.s)?
   [a] Always or almost always
   [b] Often
   [c] Sometimes
   [d] No

2c. When having an I.C. done, are steps taken to ensure cleanliness?
e.g. good hand washing, careful cleansing of the genital area, etc.
   [a] Always or almost always
   [b] Often
   [c] Sometimes
   [d] No

2d. Do you use soap and water to clean around the catheter area?
   [a] Less than once per day
   [b] Once per day
   [c] Twice per day

3a. Do you use an external drainage device (e.g. condom drainage)?
[a] Regularly
[b] Occasionally
[c] Never **If No, go to 4**

3b. How often is the condom for your condom drainage replaced?
[a] Less than every two days
[b] Every two days
[c] Once per day
[d] Twice per day
[e] After every I.C.

3c. When changing from a leg bag to a night bad ( or vice versa) do you take strict precautions to ensure cleanliness and/or sterility?
e.g. replace the drainage tubing wipe connections with alcohol
[a] No
[b] Sometimes
[c] Often
[d] Always or almost always

3d. Do you clean and soak your leg bag at night (and your night/closed system bag in the day)?
[a] No or rarely
[b] Sometimes
[c] Often
[d] Always or almost always

3e. How frequently do you check your leg bag to ensure proper drainage?
[a] At least every 2 hours
[b] Every two - four hours
[c] Two - three times per day

4. Do you use a diaper/pad in your bladder management?
[a] Regularly
[b] Occasionally
[c] Never

5. Do you use tapping, straining, or crede in your bladder management routine?
[a] Regularly
[b] Occasionally
[c] Never

6. Is emptying of your bladder done on a closely monitored, consistent basis (e.g. same times of the day)?
[a] No
[b] Sometimes
[c] Often
[d] Always or almost always
[e] N/A _____

7. Do you closely monitor the quality and quantity of urine released?
e.g. cloudy versus clear, too much / too little
[a] No
[b] Sometimes
[c] Often
[d] Always of almost always

8. Would you describe your current level of bladder management as being representative of your bladder management since one year following your SCI?
   [a] Yes
   [b] No, I have had better bladder management in the past
   [c] No, I have had worse bladder management in the past

9. For how long has your bladder management been like this?

   _____ years

**SENSITIVITY**

1. Have you felt uncomfortable answering any of these questions?
   ☐ Yes ☐ No

2. If yes, which sections?
   [a] Physical Exercise
   [b] Obesity using BMI
   [c] Tobacco use
   [d] Alcohol consumption
   [e] Bladder Management

**Lifestyle Risk Exposure Variables and Coding**
(Adapted from McColl & Skinner, 1992)

## Physical Activity

| | | | |
|---|---|---|---|
| PHYSACT | addition of questions 1 - 6 with score out of 27 | | |
| | frequency (questions 1-3) | 0 | never |
| | | 5 | daily |
| | duration (questions 4-6) | 0 | 0 |
| | | 1 | <30 mins |
| | | 2 | 30 - 60 mins |
| | | 3 | 61 - 90 mins |
| | | 4 | > 90 mins |

## Obesity Using BMI

| | | |
|---|---|---|
| OBESITY | (weight in kg/ (height in m)$^2$) | |
| | Non obese | BMI < 27 |
| | Obese | BMI ≥ 27 |

## Cigarette Use

| | |
|---|---|
| CIGSDAY | cigarettes smoked in a usual day |
| CIGSLIFE | estimate of total lifetime cigarette consumption |
| CIGDUR | duration of cigarette use |
| TMQUIT | time since quitting |
| DURSMOK | total years smoking |

## Alcohol Consumption

| | |
|---|---|
| ALCHMTH | monthly alcohol consumption, addition of questions 2 - 5 |
| ALCHEXC | frequency of excess alcohol consumption in a month (>4 drinks per day) |

## Bladder Management

| | |
|---|---|
| BLADSCOR | percent compliance with particular procedures associated with each management approach |

# APPENDIX E. LOGISTIC REGRESSION DIAGNOSTICS

Cardiovascular Model Diagnostics

Figure E1 Normal probability plot of the deviances

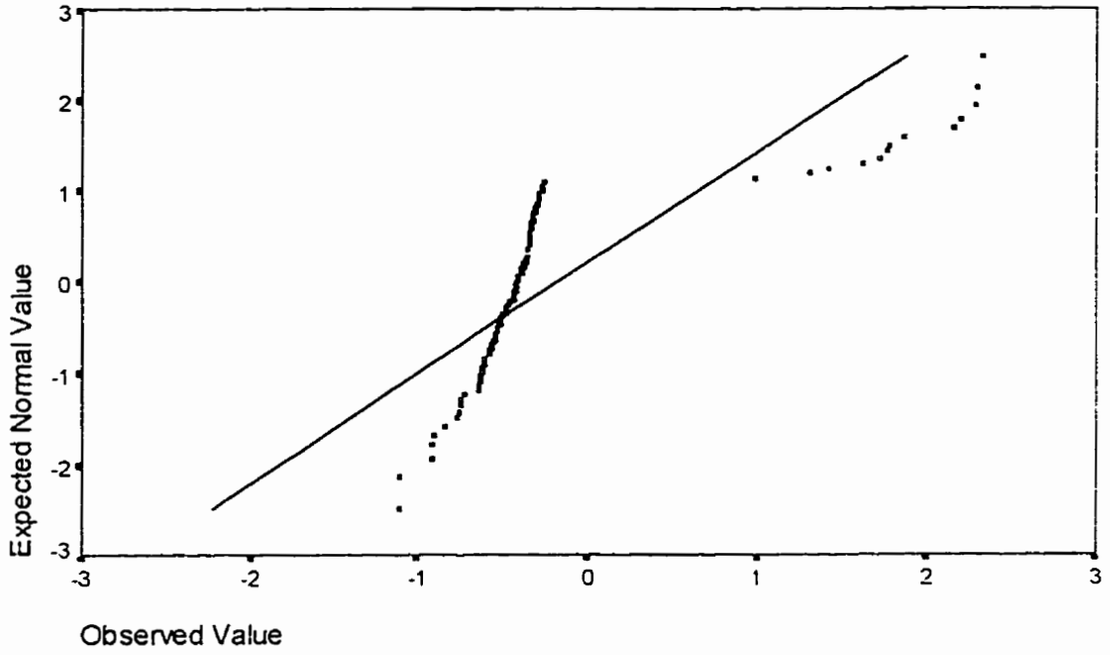



Figure E2 Plot of standardized residual with subject ID

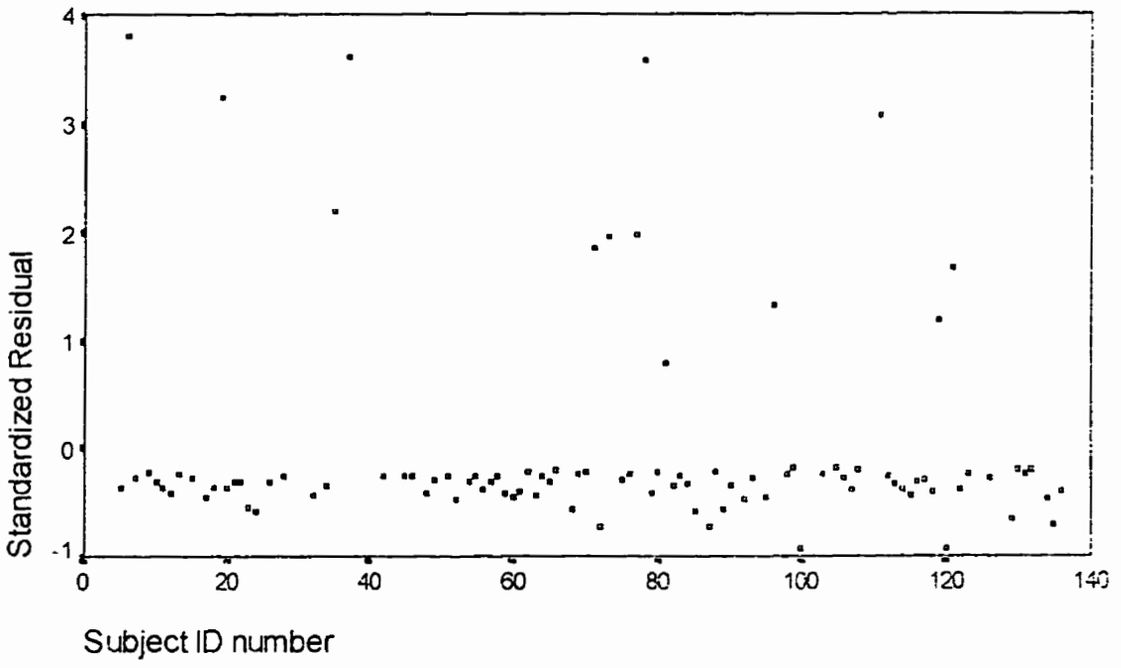


Figure E3 Plot of leverage with subject ID

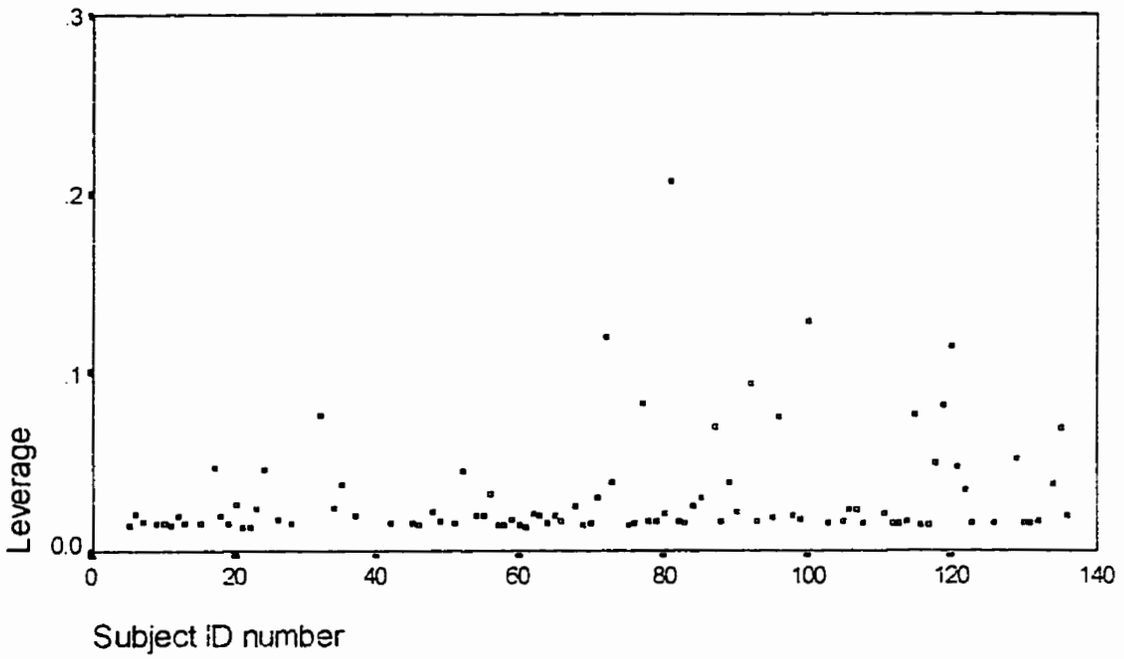



Figure E4 Plot of change in CIGDUR coefficient with subject ID

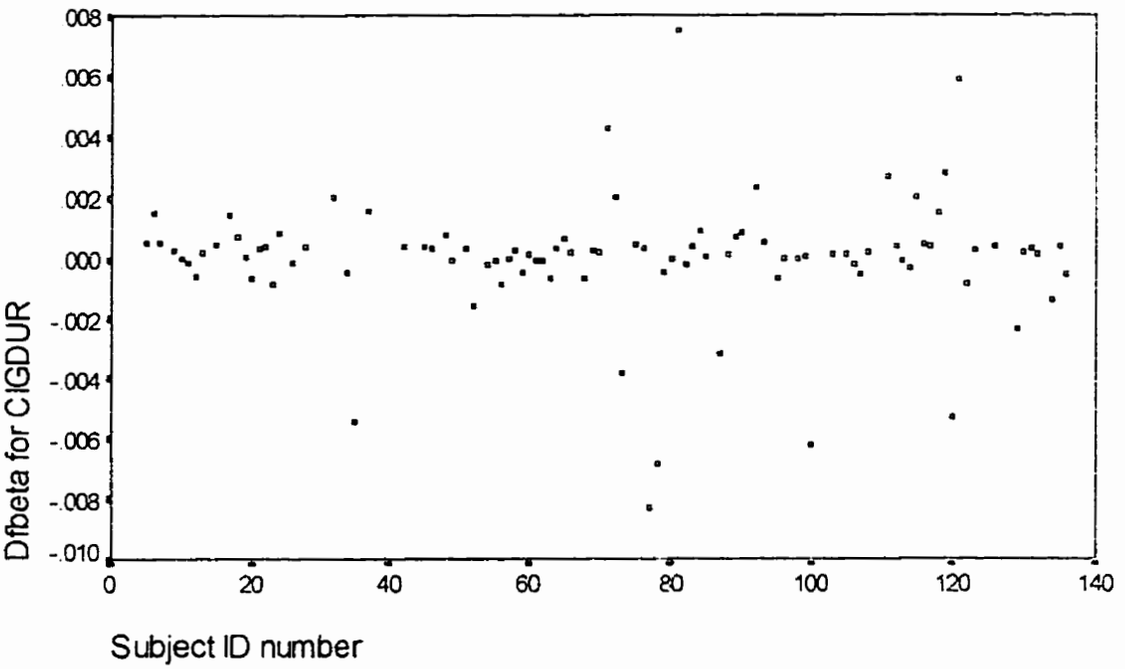


Figure E5 Plot of change in AGE coefficient with subject ID

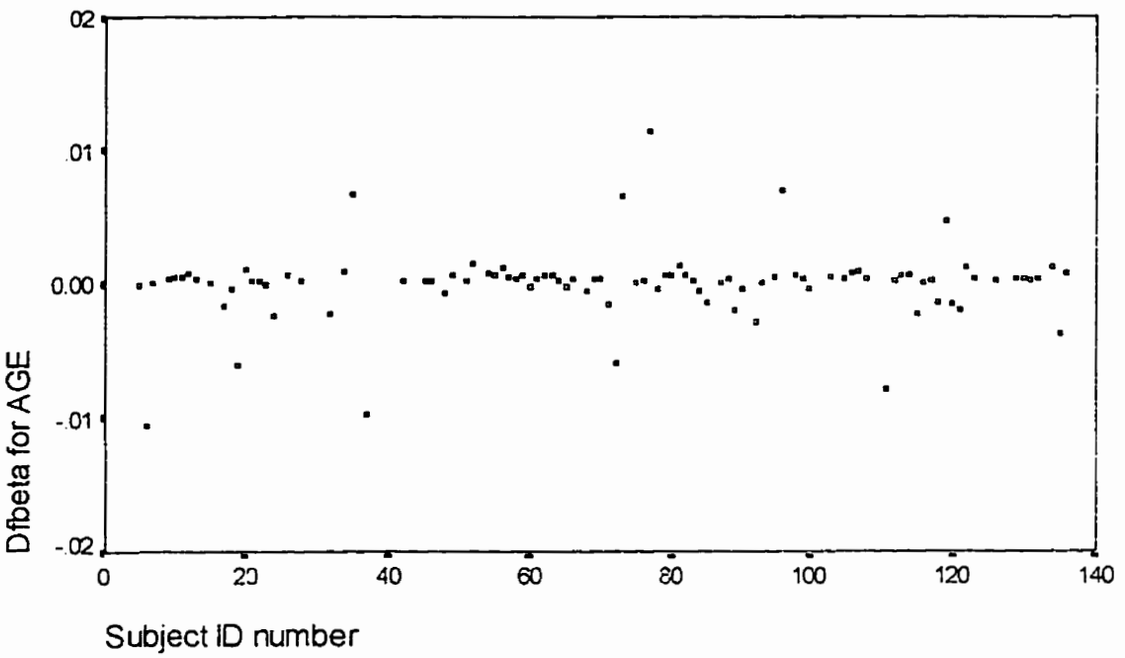


Figure E6 Normal probability plot of the deviances

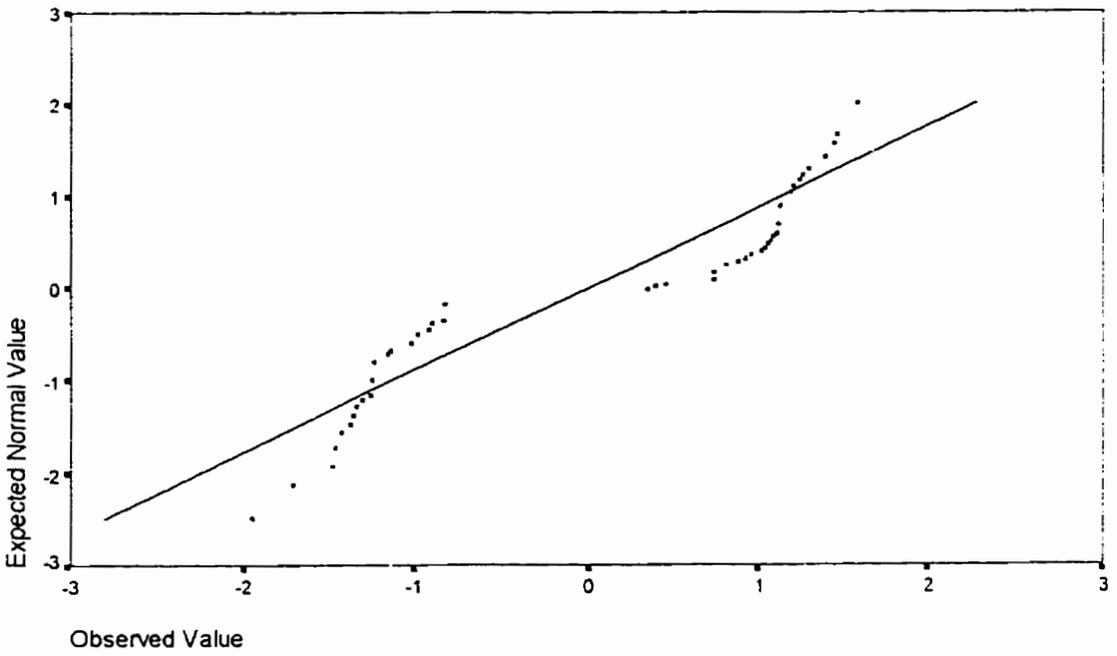



Figure E7 Plot of standardized residual with subject ID

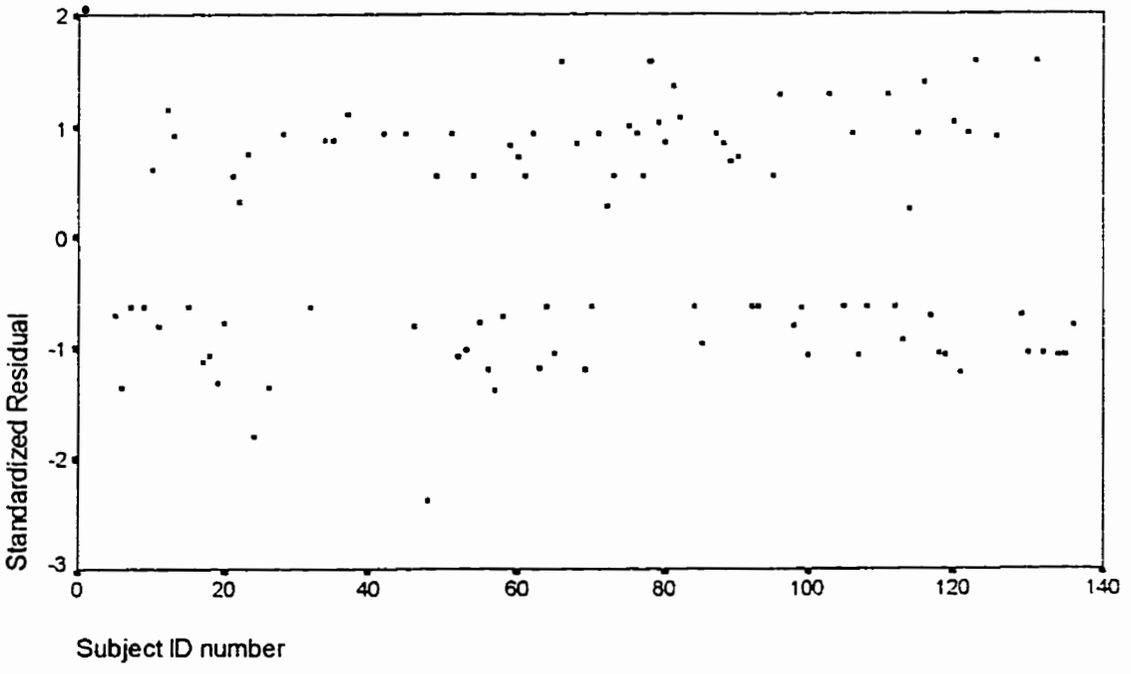


Figure E8 Plot of leverage with subject ID

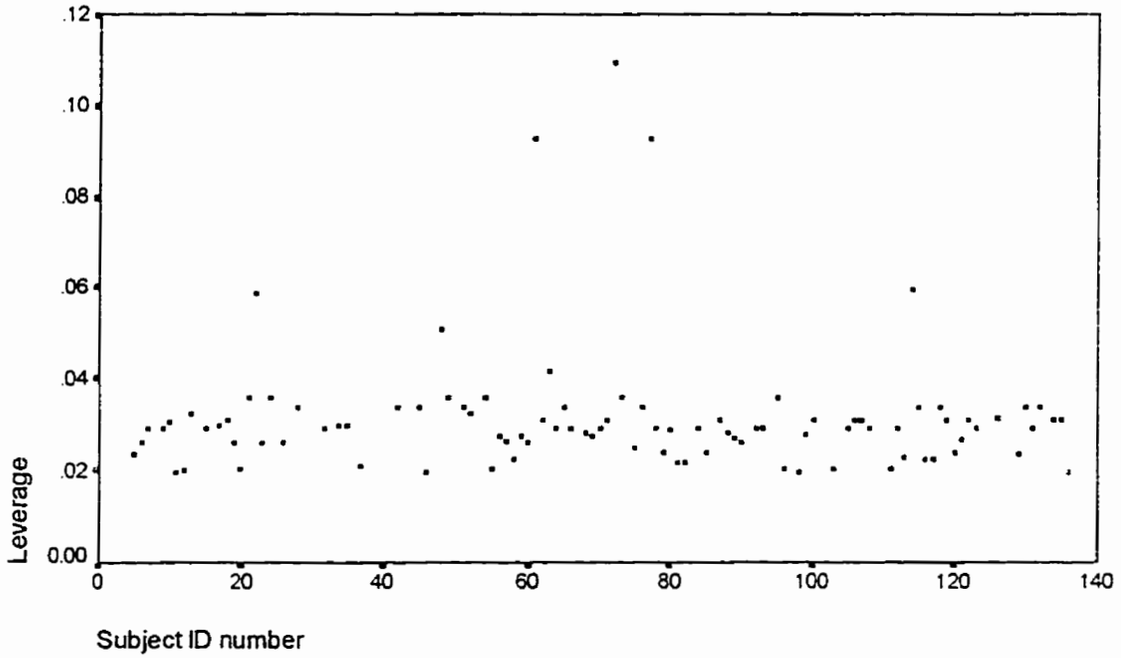



Figure E9 Plot of change in CIGSDAY coefficient with subject ID

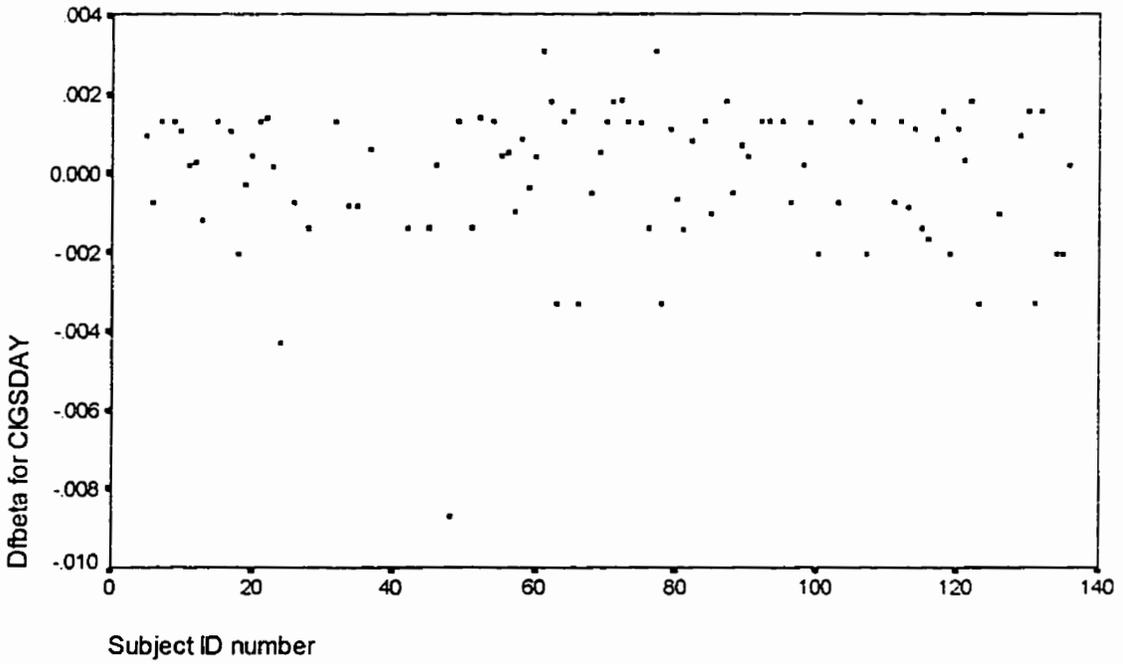


Figure E10 Plot of change in LEVEL coefficient with subject ID

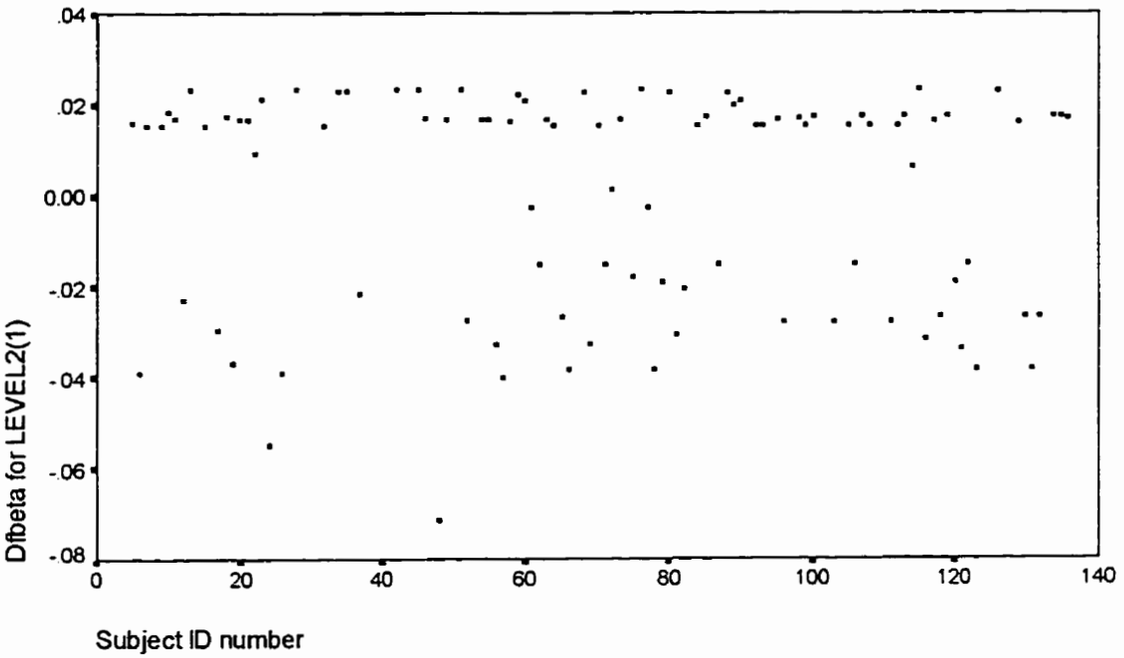


Figure E11 Normal probability plot of the deviances

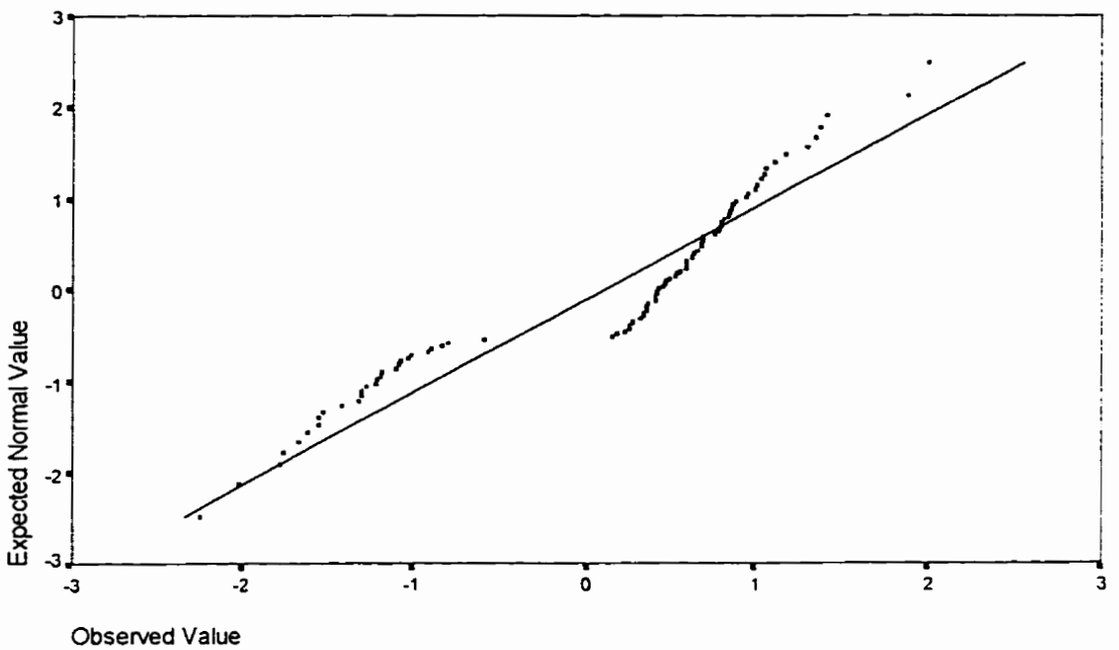



Figure E12 Plot of standardized residual with subject ID

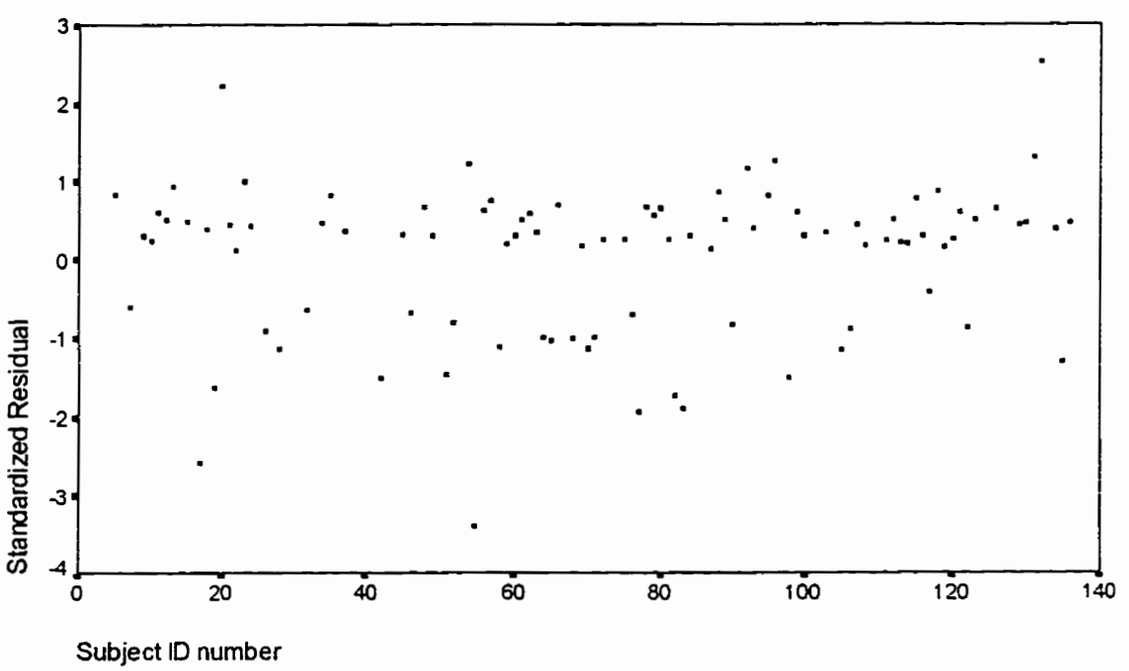


Figure E13 Plot of leverage with subject ID

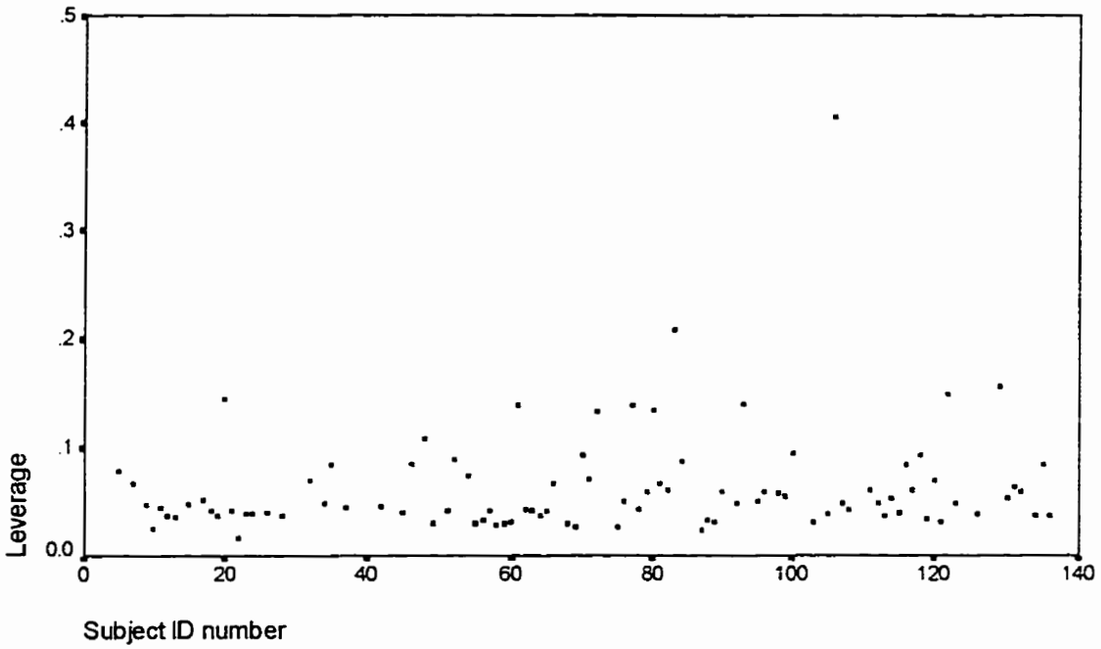



Figure E14 Plot of change in PHYSACT coefficient with subject ID

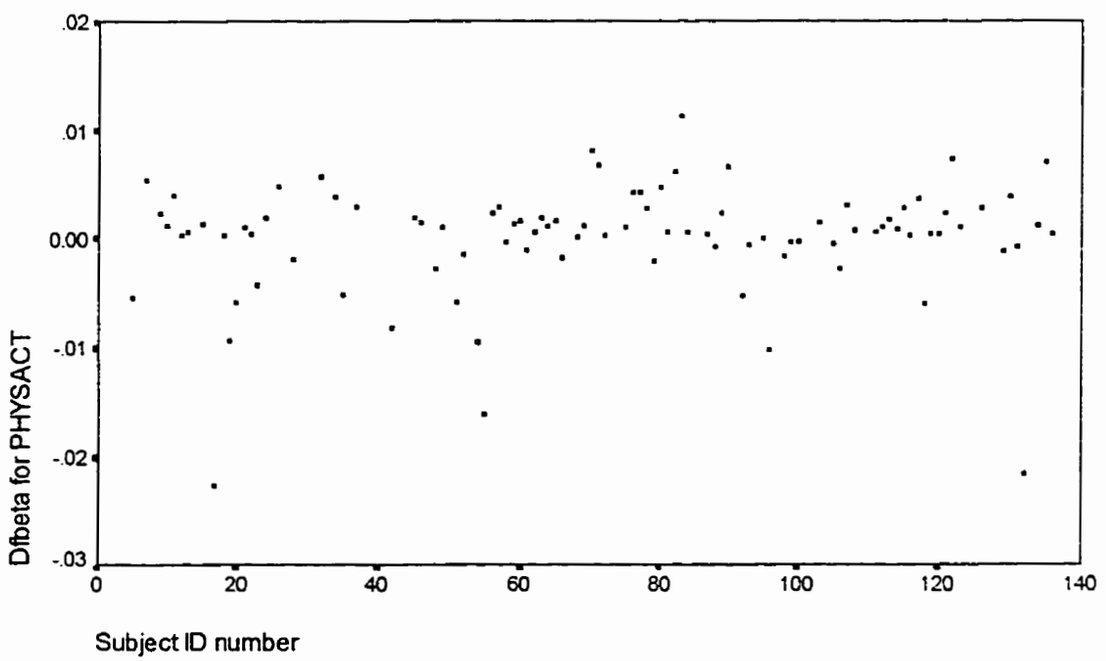


Figure E15 Plot of change in ALCHMTH coefficient with subject ID

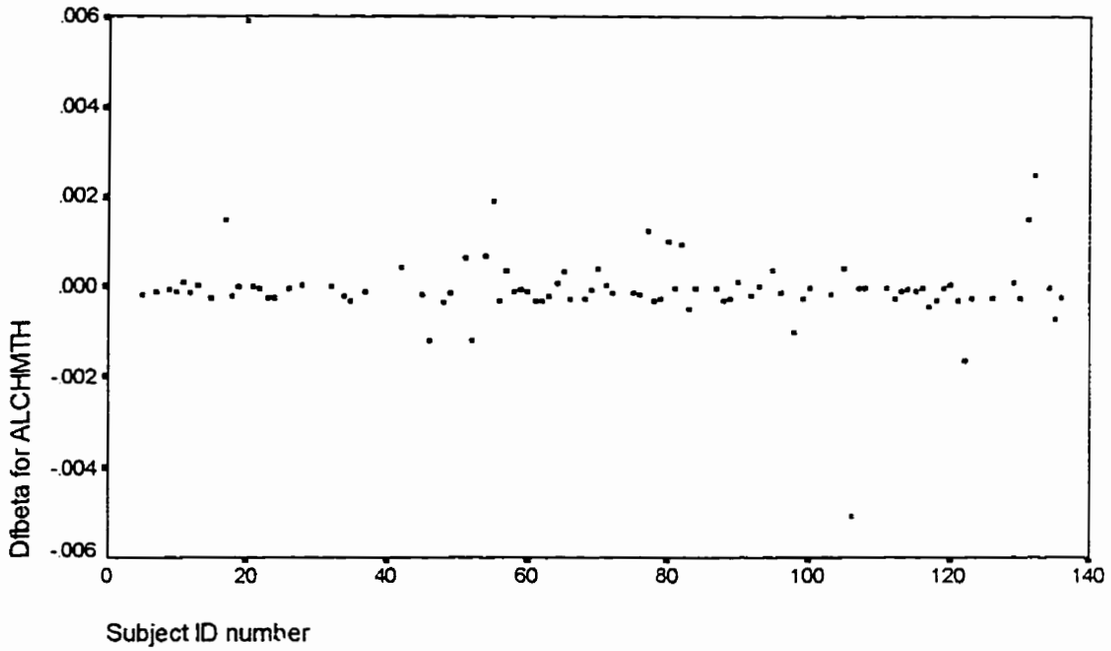



Figure E16 Plot of change in CIGSDAY coefficient with subject ID

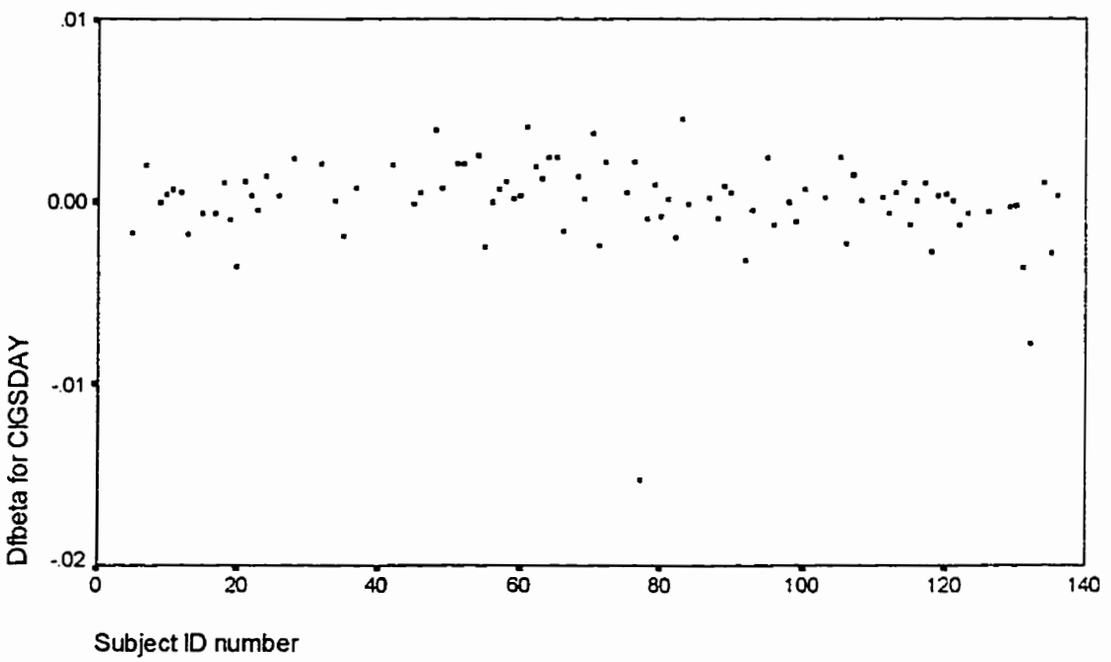


Figure E17 Plot of change in COMPLETE coefficient with subject ID

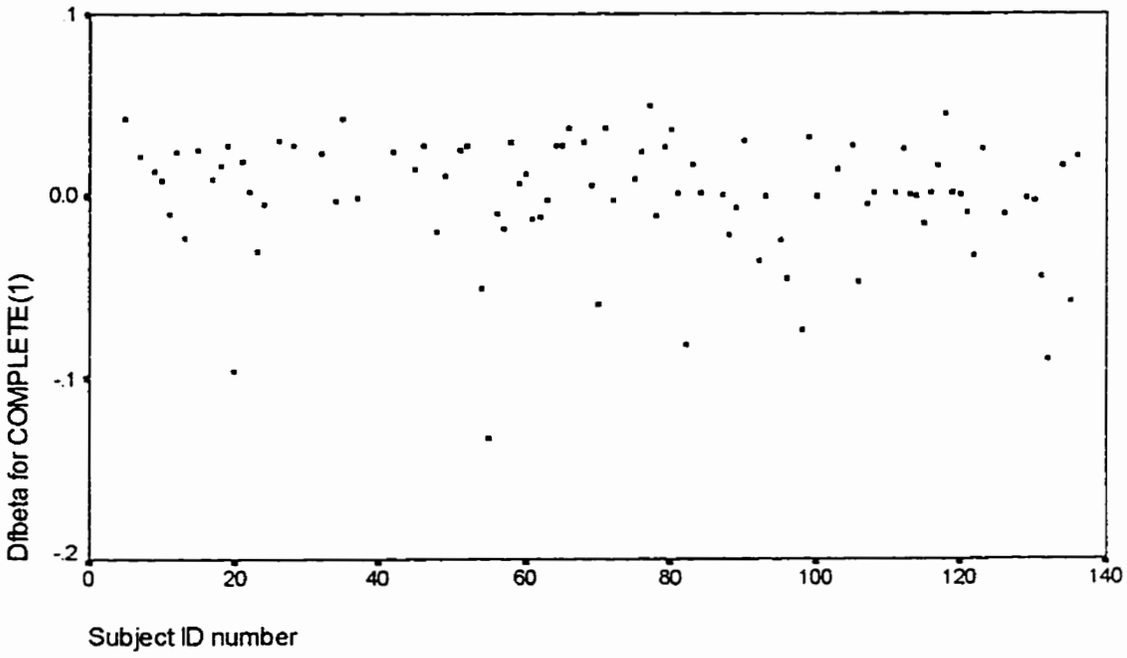



Figure F18 Plot of change in CAUSE coefficient with subject ID