USE OF MICRO-DATA TO DETERMINE EFFECTIVE INDICATORS OF FEE-FOR-SERVICE GENERAL PRACTITIONER UTILIZATION IN NEWFOUNDLAND

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NEWFOUNDLAND

by

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Abstract

In Newfoundland and Labrador health care resources are currently distributed to Regional Health Authorities (RHAs) largely according to their previous expenditure levels. It is suggested that this historical distribution may not be the most equitable way to distribute resources because these allocation levels may not be indicative of needs of the population living in the area. As such, some communities do not receive an adequate share of resources, resulting in a violation of the concept of *vertical equity.*

The primary objective of this research is to determine which population characteristics (demographic and health) are the best indicators of FFS GP utilization. To do this, multiple linear regression was used to estimate the dollar value of GP resources consumed based on the demographic and health characteristic information of the population. Data were collected from: the Medical Care Plan (MCP) administration data for the years 1996-2004, the 1995 Newfoundland Panel on Health and Medical Care – Adult Health Survey (AHS), and the 2001 Canadian Community Health Survey (CCHS).

It is recommended that, as a minimum, age and gender variables be used as the main predictors for GP resource utilization. However, it is also recommended that the number of chronic conditions and self assessed health status be used to compensate for all other variables outside of age and gender demographics. The health practices and socioeconomic indicators as measured in this study did not hold strong statistical significance and showed unexpected and inconsistent resource allocation values.

These results could be used as part of a capitation formula which would assign funding to communities based on expected future need and thus result in a fairer allocation of scarce resources

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CHAPTER 1

Introduction

In Newfoundland and Labrador a large proportion of health care resources are distributed to its four Regional Health Authorities (RHAs) according to previous expenditure levels. A similar strategy is used in the majority of provinces throughout Canada where essentially a historical global budget is used to allocate health care resources to its provincial health regions (Hurley, 2004). Hurley states that "regardless of the official process…funding de facto becomes historical funding with minor annual updates: in most cases this year's plan is last year's plan slightly twigged to reflect updated information (though never in a direction that would reduce funding)" (p.36). Allocation based on historical spending does not take into account the fact that there may be unmet need within some populations. Unmet need is defined as the difference between health care expected and health care delivered, reflecting a shortcoming in the allocation of funding (Rice & Smith, 2001a). Structural changes to the population, through out-migration and the increasing urbanization of the Newfoundland and Labrador population may leave some communities with smaller, older populations. Population needs-based allocation strategies are commonly investigated in the search for equity across health care sectors (Frohlich & Carriere, 1997; Hutchison, Torrance-Rynard, Hurley, Birch, Eyles & Walter, 2003; Eyles & Birch, 1993) and almost all provinces have declared the intent to develop such a strategy (Hurley, 2004).

Population needs-based allocation strategies serve to link the health needs of a population with the amount of health care resources allocated to them (Frohlich & Carriere, 1997). In the creation of these strategies, it is important to determine which population characteristics are effective indicators of health care resource consumption. This research study will correlate micro-level population characteristics (demographic and health indicators) of Newfoundland and Labrador[1] to the dollar value of fee-for-service (FFS) General Practitioner (GP) funds expended. Doing this will determine which characteristics are significantly associated with GP resource consumption.

Determining population characteristics that are correlated with GP resource consumption is an important preliminary step in the eventual creation of a needs-based allocation formula. Measuring the occurrence of these significant demographics and health indicators in each RHA will give an indication to the GP funding required in each authority. It is proposed that this will increase the equity in which health care funding is distributed across the province (Hutchison et al., 2003). Although this research may contribute to the conception of such a formula, creation itself lies beyond the scope of this thesis.

To avoid ambiguity of the term *equity*, for the purpose of this research, it will refer to equity in the distribution health care resources. The definitions of horizontal and vertical equity are used to further elaborate. *Horizontal equity* is when those with the same need for care have access to the same level of health resources. *Vertical equity* is when those with different needs for care have access to appropriately different levels of health resources (Morris, Sutton, Gravelle, 2003).

Prior utilization of health care resources has been deemed to be the best predictor of current period utilization (Hurley, Hutchison, Buckley & Woodward, 2004). Rice and

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[1] In practice, the analysis will largely be restricted to residents of Newfoundland since most Labradorians receive their GP services from salaried doctors and as such are not included in this analysis. Labradorians receiving GP services from fee for service doctors are included in the analysis where data is available.

Smith (2001a) state that an effective method to determine a good needs factor is to measure if the variable affects actual health care expenditures in a statistically significant way. Birch and Abelson showed an association between greater need and greater use, but call for further research in the area (Asada & Kephart, 2007). It should be noted however, that health care use does equate with need, but rather is a function of both need and non-need factors of a population (Rice and Smith, 2001a). This idea is further elaborated in the literature review chapter of this thesis.

Culyer & Wagstaff (1992) define *need* as the amount of expenditure required to reduce a person's capability to benefit from health care to zero. If a capacity to benefit is zero, then need is zero. Culyer & Wagstaff explain some difficulties of identifying *need* with 'ill health', meaning the sicker that a person is, the more health care they will require to get better. The first being, if the person is terminally ill and there is no cure for the sickness, the person will have a high need for care, but no amount of care will cure them. Secondly, if a person is receiving an expensive form of treatment for their illness and a new equally effective treatment is created for half the cost, then the person still has the same need but requires significantly less resource dollars. Culyer & Wagstaff's definition of *need* does not match with our use of the term. In our research the individual's capacity to benefit from is irrelevant because regardless if the treatment cures them, they are still using these health care dollars and are therefore included in our analysis.

Several Canadian provinces, including Alberta, Ontario, and Manitoba, have been working towards creating distribution formulas for their provincial allocation (Alberta Health and Wellness, 2004; Hutchison et al., 2003; Shanahan & Gousseau, 1997). Birch and Chambers (1993) used the 49 counties of Ontario to theoretically distribute health care resources geographically. They used the age and sex composition of each county to create a per capita distribution formula. It is known that males and females have different average expenditures of health care services throughout most stages of life (Birch & Chambers, 1993). Once this adjustment has been made, the premature standardized mortality rate (SMR) is used to capture the general health of the population. Birch and Chambers (1993) define SMR as the "deaths of all people aged 64 years or less in Ontario" (p.609). Only deaths in the nonelderly population are used because the authors feel that this is a better proxy for relative need for care than using all age groups. SMR is used in an effort to compensate for the differing health risks of the population in each county.

Birch and Chambers (1993) report that the needs-based approach to health care resource distribution is an improvement over historical use-based approaches. The implementation of a population-needs-for-health-care approach can improve the equitable and fair distribution of health care resources.

Alberta's Ministry of Health and Wellness has also adopted a population needs-based approach for distributing its health care resources (Alberta Health and Wellness, 2004). Using population characteristics such as age, sex, and socioeconomic information, Alberta Health and Wellness distributes resources accordingly to regional health authorities (RHA). Similar to Newfoundland and Labrador, the provincial government of Alberta once used historical funding levels to distribute resources (Alberta Health and Wellness, 2004). Beginning in 1997/1998 however, Alberta adopted a population-based approach. The demographics and health characteristics of those living in each RHA were measured and used to determine the level of funding allocated to each area. The characteristics measured included age, gender and SES (Alberta Health and Wellness, 2004). These categories are used as a proxy for relative need of health care resources. The approximate health care consumption of each age, gender and socioeconomic category was estimated using historical health care expenditure data of each group (Alberta Health and Wellness, 2004). Also, because population-based funding is so strongly linked to patient location, the amount of import-export activity between RHAs was taken into consideration (Hindle, 2002; Culyer & Wagstaff, 1992). An activity is considered 'import-export' when the region that a patient receives health care service is different from the region of their residence (Alberta Health and Wellness, 2004).

The Manitoba Centre for Health Policy (MCHP) developed a computable equity based resource allocation framework with their own modifications (Mustard & Derksen, 1997). Age and health profiles were the key determinant used by the MCHP. But in order to integrate population characteristics outside of age and gender they used a blend of variables. While premature mortality, social and economic characteristics, infant mortality and diabetes prevalence proved to be good indicators, from a government policy making standpoint it was thought to be beneficial to drop the latter two. It was thought that instead of diabetes prevalence working as a proxy for chronic condition burden on a community, it would just emphasize one disease in a population (Mustard & Derksen, 1997). The authors were also concerned that an RHA may emphasize diabetes screening in order to increase the apparent prevalence, resulting in a higher need score. Infant mortality also came into question due to the instability of this measure in some RHAs. Communities with much smaller populations may show a skewed infant mortality rate compared to the larger populations due to the instability of calculations based on smaller populations and rarity of infant mortality (Mustard & Derksen, 1997). Therefore it was concluded that a blended measure of premature mortality and social and economic characteristics is the best indicator of health care need outside of age and gender.

Our research study will include several variables similar to those used across the country as well as some novel measures. Our variables include age, gender, socioeconomic indicators (yearly income and level of education), health indicators (number of chronic conditions, self-assessed health status) and lifestyle choices (smoking, drinking, exercise habits). We are using health survey information from the 1995 Newfoundland Panel on Health and Medical Care – Adult Health Survey (for simplicity we will call AHS), the 2001 Canadian Community Health Survey (CCHS) as well as Medical Care Plan (MCP) administration data. This unique combination of health survey data and empirical health care utilization data allows us to link a variety of personal behaviours and characteristics to their actual MCP expenditure. To determine which of these hypothesised proxies are effective measures of population need, these individuals are correlated to their actual MCP use of FFS GP resources. By observing the effective indicators of need in an RHA, policy makers will be able to estimate which health authorities will have a higher relative need per capita for GP resources than others. The primary objective of this research is to determine which population characteristics (demographic and health) are the best indicators of FFS GP utilization.

The remainder of this thesis is organized as follows: Chapter 2 will review relevant literature from the field of needs-based allocation research; Chapter 3 will describe the data and methodology used in the study; Chapter 4 will discuss the study results; and Chapter 5 will discuss how the results fit with the broader literature, describe the study limitations and identify the implications that this study may have on policy making.

CHAPTER 2

Literature Review

Beginning in the late 1970s population needs-based formulas were first practiced in England when health care resources were distributed based on weighted populations by hospital bed numbers and caseloads (Eyles, Birch, Chambers, Hurley, & Hutchison, 1991). Increasingly, more governments are using population data in order to guide the allocation of health care funding (Mustard & Derksen, 1997; Alberta Health and Wellness, 2004; Peacock & Smith, 1995). This chapter examines relevant literature to determine the health characteristics and demographics used by other researchers to predict resource utilization. Reviewing the existing research provides us with evidence to base our decision on which needs-indicators would be best suited for our study.

This chapter will offer a conceptual overview of needs-based allocation, review key Canadian research and provide an overview of allocation strategies used and studied internationally.

2.1 Conceptual Overview of Needs-Based Allocation.

2.1.1 Regionalization

In order to increase the equity in which health care resources are deployed throughout a provincial population, the province is divided into several geographic regions. This regionalization allows researchers to measure the population characteristics of each area and compare differences between them (Hurley, 2004). By doing this it actively engages policy makers and allows them to consider the varying populations which they are servicing. Regionalization has been largely proven to be an effective primary step in increasing the efficiency and equity in which resources are allocated (Hurley, 2004). There are some limitations with regionalization. Rice and Smith (2001a) discuss the effect that supplier induced demand may have on geographic regions. They state that an area with better access to health care may induce its citizens to increase their use. On the other hand, citizens in an area with poor access to care may exhibit supplier reduced demand. A further discussion of health care supply and demand will follow.

2.1.2 Capitation

Capitation methods attempt to distribute health resources across regions in direct proportion to the relative need of each (Bedard, Dorland, Gregory, Roberts et al., 2000). To determine the appropriate level of funding, capitation payments are determined for every individual of the region (Smith, Rice, Car-Hill, 2001). The simplest form of this would be to divide the total health care budget equally between all people in the region. This however would be naïve because it assumes all members of a region will use the same amount of health care dollars. Rice and Smith (2001b) state that three fundamental choices must be made:

1. Determine the amount of global funds to be distributed (this is mainly a political decision and is beyond the scope of this research)
2. Determine the population characteristics to be considered to guide allocation
3. Determine the weights to assign to the population characteristics.

Determining predictors of health care use can be thought of in terms of non-need (supply) and need (demand). Supply factors such as waiting times, distance, capacity, availability or even policy decisions are all factors that affect health care use, but cannot be directly attributed to health care need (Gravelle et al, 2003; Hakkinen & Jarvelin, 2004). Needs factors are those that are statistically significant and explain actual spending patterns (Rice & Smith, 2001b). Some examples of needs factors are age, sex, and self-assessed health status. Hurley et al (2004) states that some variables are not quite as easily divided into need and non-need. He adds that not all non-need variables are even supply related, such as the historical regional budget or the ability to speak English (in this case the dominant language). Socioeconomic status (SES) for example, may capture both need and non-need factors through their effect on true need, attitudes on perceived need, and preferences on the type of care. SES is also associated with how and when patients make contact with the health system (Asada & Kepart, 2007). Asada and Kephart suggest that lower SES is associated with contacting physicians at a later stage of disease than those with higher SES. They do note however, that one would expect that if this was the case that we should also see higher visitation to hospitals and specialists, but this is not the case. Further research is needed into the complexities of SES and health care use in order to disaggregate the reasons for these findings. Rice and Smith (2001b) use the terms *legitimate* factors to describe needs factors and *illegitimate* factors to describe non-need factors. They discuss that in the extreme, if enough explanatory variables were included in an empirical model of health care use, that the end would result would be to simply duplicate the spending patterns, defeating the purpose of capitation. Instead Rice and Smith recommend that for the purpose of developing general capitation levels, that illegitimate (or non-need) factors be excluded from the analysis if at all possible. In this study we did not determine the effects of non-need factors on FFS GP use.

It would also be beneficial to avoid those needs factors that are open to manipulation or 'gameability' (Bedard et al 2000; Smith, Rice & Carr-Hill, 2001; Rice &

Smith, 2001b). For example several studies have shown that prior utilization is a good predictor of current utilization (Rice & Smith, 2001b). However, this may be left out of capitation strategies because of its vulnerability to manipulation by providers. In an effort to receive more health care funding, providers may potentially over provide to their population, falsify diagnoses, or engage in other deceptive activity in an effort to increase utilization and receive a higher level of future funding. For this reason it is preferred to select factors that are universally collected and are more difficult for potential manipulation, such as age and gender.

2.1.3 Population characteristics

The discussion of the variables in this section is meant to highlight several of the commonly used capitation factors. A further discussion of these factors is included in the *Key Studies* and *Overview of International Approaches* sections.

According to the literature, age and gender are the most widely used and accepted predictors of health resource utilization (Hutchison, Hurley, Reid, Dorland, Birch, Giacomini & Pizzoferrato, 1999; Hurley, 2004). These two variables are used in some capacity in virtually all needs-based formulas (Mustard & Derksen, 1997; Roos, Fransoo, Bogdanovic, Friesen, Frohlich, Carriere, Patton & Wall, 1996; Hindle, 2002). With the exception of the time between child birth and infancy, the older a person is the more likely they will need health services. Similarly, women of child bearing age will consume more health resources than a male of the same age (Birch & Chambers, 1993). These facts are well documented and therefore make age and gender very strong predictors of relative health care need (Hutchison, et al., 2003). Hutchison, Hurley, Reid, et al. (1999) recommend age and gender as integral variables in any needs-based allocation formulas.

However, they believe that policy makers and health researchers should collaborate to include other variables in order to get a more complete adjustment for relative health care need.

Socioeconomic status is another well documented determinant of health (Hindle, 2002; Frohlich & Carriere, 1997). Annual income, level of education and employment status are all factors shown to affect health status. We assume that those of worse health will likely use a higher amount of health care resources. For example, a community with a low average income, low education, or low employment rate will likely show a higher need for health care than a community with higher levels. However, there is conflicting research on the relationship between income, education and health care use. Asada and Kephart (2007) discuss some of these inconsistencies. They note in their literature review that people of a lower SES will use more health care services than those of a higher SES, confirming the strong association between SES and health. However, they also discuss the Ontario research linking health survey data (the National Population Health Survey) to administration data that concluded that there is no statistically significant relationship between income and GP use. Asada and Kephart conclude in their own research that people with lower income were less likely to contact a GP than those with higher income. However, once the initial contact was made, those with lower income were more likely to have a higher volume of visits. They also conclude that education is not significantly associated with GP initial contact, but lower education was associated with a higher frequency of GP visits. Birch, Eyles, and Newbold (1993) also report that income and education yields no effect on the GP contact or volume of visits, with the exception of healthy people of lower education having a higher volume of use than healthy people of higher education. It is evident from these studies that a more comprehensive set of variables is needed beyond age, sex, and SES in order to capture the comprehensive nature of health care need. It is for this reason that we investigate indicators of health such as self assessed health status and the presence of chronic conditions.

Self assessed health status has been shown to be a reliable indicator of actual health (Hutchison et al., 2003). Using self assessed health of a population could potentially be a good measure of population need (Birch, Eyles Newbold, 1993; Eyles & Birch, 1993). It is however, open to manipulation by the individuals reporting their health status. Populations that deliberately report being sicker than they actually are would receive more funding than a region that reports their true health status.

Although the use of mortality ratios in needs-based allocation has been criticized, it has still been widely used (Morris, Sutton & Gravelle, 2003; Bedard et al., 2000; Birch, Eyles & Newbold, 1995; Smith & Rice, 2004; Hutchison, Hurley, Birch, Lomas, Walter, Eyles, & Stratford-Devai, 2000). In order to capture population need outside of age and gender, researchers often use premature death as a measurement to account for health care need. Calculating the mortality rate of people of a regional health authority between the ages of 0 to 64 (or 0 to 74) and then comparing it to the provincial rate yields a standardized mortality ratio (SMR). This ratio describes whether the people in this area tend to die earlier than the people in the rest of the province. Death could be from any number of reasons, such as poor air quality, local industry, or living conditions (Morris et al., 2003). The link between need for health care and mortality data however, has been widely debated (Bedard et al, 2000; Smith Rice, 2004). SMR is commonly used in research concerning relative need where a capitation model is functioning under a fixed budget, rather than investigating absolute need. All other variables being equal, regions with a higher SMR as compared to the reference population will be allocated a higher relative level of resources. The functionality of such a variable in needs-based allocation has not been thoroughly defined (Bedard et al, 2000). For example, if a region has a SMR that is 10% higher than the provincial SMR, exactly how much more resources should be given to this region? Bedard and colleagues state that, to their knowledge all previous work has used an ad hoc approach to determining the relationship between mortality and health care need and there has yet to be a consensus on the appropriate relationship. Hutchison et al (2000) concluded that his use of all age SMR did not perform any better than the use of simply age and gender. In this research we take the perspective of investigating individual level characteristics for determining good indicators of GP use. SMR is measured at the population level and is therefore not appropriate for this study. It is also important to note that the use of SMRs does not account for the trend for individuals to live longer albeit with a number of chronic conditions that require routine and regular GP visits.

The formulas in which researchers use these variables may differ greatly. Some investigators combine variables to create new ones, such as the Standardized Health Ratio or the Socio-Economic Risk Index, discussed later in this chapter. No matter how the variables are used the search continues for the best combination of factors to measure population need.

Once population characteristics are selected for use in the capitation, they must then be weighted in order to compensate for the level of impact they have on health care use. Selection and weighting is often done through regression analysis measuring the relationship between the need factor and health care use (Smith & Rice, 2001). The most effective way to do this is through the use of individual data. However, this level of data is often unavailable and instead aggregate data is used to measure need at the regional level (Rice & Smith). Hurley uses an example of his previous work in which he determined that need is high among both the elderly population and the population that lives alone, which is available from regional level data. However, through individual level data he was easily able to determine that need is particularly high among the elderly that live alone, something which he was unable to determine with regional data. Smith, Rice and Carr-Hill note the severe limitations in dealing with small area aggregate data in their 2001 paper *Capitation funding in the public sector*. They recommend the use of a capitation formula based on individual level data collected through a survey designed for the specific purpose of capitation funding. Once capitation payments have been set, these values are then applied to the citizens of the population. Summing the capitation payments for the individuals of a population will yield the health care funding 'needed' by this group. As shown by Gravelle et al. (2003) and Hurley et al. (2004), often models will include adjustments for non-need variables as well.

It is evident that the process of needs based allocation, is a complex and continuously evolving field. "The methods used should be able to accommodate serious data limitations, to distinguish between legitimate and illegitimate sources of variation in utilization, and to offer results that are statistically robust and readily implemented as a capitation formula" (Rice & Smith, 2001b, p. 98).

2.2 Key Studies

In Canada there has been extensive research on the topic of population needs-based health care allocation. Researchers in several provinces have been investigating this strategy in an effort to improve the equity with which they distribute resources. This section will highlight key studies that helped to guide our methodology and analysis.

2.2.1 Centre for Health Economics and Policy Analysis.

At the Centre for Health Economics and Policy Analysis (CHEPA) at McMaster University, one of its main goals is to analyze and evaluate the effectiveness of resource allocation initiatives and to determine their efficiency and equity for the area it is serving.

Created in 1988, CHEPA is an internationally recognized centre that has been dedicated to research and knowledge transfer in the areas of health economics and policy analysis (CHEPA, 2005). From its inception, this organization has engaged decision makers in an effort to create the most feasible and equitable strategy for health care resource distribution. CHEPA has published several documents regarding population needs-based allocation strategies, which constitutes a large portion of the Canadian research in this area.

Under the Ontario health care policy reform of 1991, health care funding was distributed according to previous allocations rather than the population's need for service (Eyles, Birch, Chambers, Hurley Hutchison, 1991; Birch & Chambers, 1993). This was seen as an inequitable method of resource allocation, and a search for a more equitable method of resource management was needed. Eyles et al. (1991) set out with a goal to create a population needs-based methodology for Ontario in order to achieve a more equitable and fair distribution of health care resources.

Eyles et al. report in 1991 that the Ontario Ministry of Health introduced the idea of dividing the province into several Comprehensive Health Organizations (CHOs). CHOs were defined as "non-profit corporation[s] which assume responsibility for providing or purchasing the delivery of a full range of vertically integrated health and related services to a defined population" (Eyles et al. 1991, p. 490). The full range of health services they describe includes primary, secondary, and tertiary health care services. Each CHO would be paid a certain amount per person living in their area. Eyles et al. created capitation rates for each health service program in a CHO. When summed they create a global capitation rate for the CHO (see equation 1). In order to compensate for the needs of the individuals living in the CHO, three adjustments were made to the initial per capita distribution (Eyles et al., 1991).

Equation 1

$$S_1 + S_2 + S_3 + \ldots S_n = GCR$$

Where S_1 = health care service 1, S_2 = health care service 2, S_3 = health care service 3 and GCR = global capitation rate for the CHO

First, an allowance was made for the age and gender differences in health care needs (Eyles et al., 1991). The provincial average use of each health care program by age and gender was calculated and applied to the study population. This produces a population baseline level of need that determines the percentage of the provincial utilization of the program. This percentage is used to calculate the amount of the baseline share of the budget allocated to this CHO. Dividing the dollar amount of the budget allocated to the CHO by the study population size yields the per capita amount (Eyles et al., 1991).

Secondly, the SMR of the CHO is calculated in order to represent the health care need of a population not attributed to age and gender (Shanahan, Steinbach, Burchill, Friesen & Black, 1997). Because of the small sample size, the SMR was calculated using ten years mortality experience. Furthermore, it was based on ages from 0-64, as this is a better proxy for premature morbidity than using all ages. The SMR calculated for the CHO was used to estimate the index of need for each service program provided. This is used to calculate the percentage of the total provincial program used by the area, and then to calculate the capitation rate (Eyles et al., 1991).

The third and final adjustment is made to account for the variation in cost of providing health care to different groups of people. For example, hospitals serving a smaller population may not have the same opportunities to increase bed occupancy rates as larger urban hospitals. For appropriate service programs, a relative cost factor is applied to the needs-adjusted capitation rate.

Birch and Chambers (1993) used the 49 Ontario counties and divided the province into separate zones much like the CHOs described by Eyles et al. (1991). Based upon the population demographics of each of these zones, resources were allocated to different counties. Birch and Chambers (1993) use the age and sex data of each county to adjust their formula. The age and sex adjusted shares are then adjusted a second time for the different health risks of each population. For example, the population of community A may be at a higher risk of respiratory infection because of lifestyle and environmental factors than the population of community B. Community A may therefore require more health care resources than community B, despite the comparable age and sex details of the populations. The SMRs of each county were used as a proxy for the relative need for health care.

Birch and Chambers (1993) report that there are currently no mechanisms in place to systematically direct resources to populations with the greatest need. They ascertain that the needs-based approach to health care resource distribution is an improvement over the current historical use-based approach. The implementation of a population needs for health care approach can improve the equitable distribution of health care resources.

Hutchison, Hurley, Birch, Lomas, Walter, Eyles and Stratford-Devai (2000) developed alternative needs-based capitation formulas for the enrolled (or 'rostered')[2] primary care population of Ontario. Their goal was to compare the current capitation formula (age/sex data) to alternative formulas that use self assessed health status, socioeconomic characteristics or mortality data, in order to determine which method best reflects the population's relative need for health care.

The reference standard formula was based on age, sex, self-assessed health status and health status-specific utilization of primary medical services for Ontario (Hutchison et al, 2000). Data for the age, sex, and health status cells were based on fee-for-service expenditures for general practitioner services (provided by the Ontario Ministry of Health) and individual health data from the Ontario Health Survey (OHS). Equation 2 shows how the needs-adjusted share (NAS) was calculated. This reference standard was then used in the socioeconomic capitation formula.

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[2] A rostered population is registered with their local primary care unit. This unit tracks each person in their serviced population and records their demographics and health characteristic information.

Equation 2

$$\hat{NAS}_{i,j,h} = \hat{AS}_{i,j} \times \frac{\text{Proportion of physician contacts within cell i, j for individuals within i, j with health state h}}{\text{Proportion of population within cell i, j made up by individuals with health state h}}$$

Where: i = sex [male, female],
j = age, and
h = health status [excellent, very good, good, fair, poor]
(Hutchison et al., 2000)

And:

$$\text{age-sex adjusted share} = \hat{AS}_{i,j} = \frac{\text{Proportion of provincial expenditure accounted for by cell i, j}}{\text{Proportion of provincial population accounted for by cell i, j}}$$

In order to develop the socioeconomic formula, first Hutchison et al. (2000) evaluated a relationship between socioeconomic characteristics and health status. To do this they created an ordered logistic probability model using data from the OHS. Logistic probability models measure the strength of a relationship that connects two variables (Armitage & Colton, 2005). The coefficients determined in the logit model were used to estimate the probability that a person of a certain age, sex, and socioeconomic characteristic is in each of the five possible health status categories. The probabilities are then multiplied by the reference standard needs-adjusted share to yield a needs-adjusted share for each individual.

The mortality based formula used the SMRs at the census enumeration area (125-375 households) and census tract (5,000 – 8,000 population) levels over a ten year period.

The SMR of each area/tract was then multiplied by the provincial expenditures for GPs in each age/sex cell to calculate the capitation rate[3].

Hutchison et al. (2000) conclude that the age and sex formula did not reflect the relative health care needs of the practice populations. Nor did they find that any of the alternative methods of funding distribution generated payments that coincided more closely with the reference standard formula. Hutchison et al. asserts that this is a reflection of the "imperfect correspondence between socioeconomic characteristics and small area SMRs on the one hand and individual health status on the other" (Hutchison et al., 2000, p. 14). The authors suggest that this may reflect the fact that rostered family practice populations are not a random sample from the overall population they are representing. Capitation payments based on socioeconomic characteristics tend to be lower than the expected cost based on the reference standard. Hutchison et al. attribute this to the possibility that people of higher SES may choose capitation-funded practices over fee-for-service. Similarly, the capitation funded practices may try to retain or attract a wealthier demographic. Due to the small number of practices included in their study, these findings can only be viewed as suggestive (Hutchison et al.). The authors argue that, although their findings refute using socioeconomic characteristics as a proxy for relative health care needs, there is a need for further research in the area.

Newbold, Eyles, Birch, and Spencer (1998) created a population needs based formula using mortality and non-mortality based proxies of health care. Ontario was divided into 47 geographic zones called Public Health Units (PHUs), used to distribute health care funding in the province. Newbold et al. use three indicators of population

[3] A detailed description for all formulas is available upon request.

health as a proxy for the relative need of health care in each of these PHUs. They calculate a Standardized Health Ratio (SHR), Standardized Socioeconomic Indicator (SEI), and Standardized Mortality Ratio (SMR). The SHR, SEI, and SMR indicate each PHU's level of self reported health, SES, and mortality rates compared to the province as a whole. The data used in the analysis was taken from the 1990 Ontario Health Survey.

Calculation of Standardized Health Ratio (SHR)

There are three stages involved in the calculation of SHR.

1. Calculate population rates of self-reported health for each of the age groups (12-19, 20-44, 45-64, 65+) and sex (male, female) categories. Self reported health status was split into 2 categories, "unhealthy" and "healthy".
2. Apply the calculated provincial rates of unhealthy individuals per age/sex category to the age/sex distribution of each PHU's population. This generates an "expected" number of unhealthy people for each PHU, assuming that each PHU has the same age/sex distribution of the two health levels.
3. Calculate the ratio of unhealthy individuals in each PHU based on their self reported health survey responses to the "expected" number of unhealthy individuals calculated in step 2. This gives us the SHR.

A score of greater than one indicates that the population of this region have lower levels of self reported health than expected, while a score of less than one indicates the population has higher levels of self reported health.

Calculation of Standardized Socioeconomic Indicator (SEI)

The SEI is an indicator of the SES of a PHU based on significantly correlated socioeconomic and socio-demographic characteristics to self reported health. Newbold et al. (1998) uses the SEI in order to integrate the broader determinants of health into the calculation of the population's need for health care in each PHU.

There are three stages involved in the calculation of SEI. These are:

1. Estimate an equation for the probability of reporting health as healthy or unhealthy at the provincial level using a logit model and a set of explanatory variables (create a dummy variable of 0 if healthy, or 1 if unhealthy). Variables found to be statistically significant include sex, age, marital status, smoking and drinking habits, employment status, income, household ownership, and education.

2. Using the estimated coefficients, calculate the relative odds of being unhealthy for each variable.

3. a) multiply the relative odds for each level of the significant variables to the number of individuals in each level of the units.

   b) sum the weighted PHU populations to reflect the additive nature of the estimated equation.

   c) divide by the actual population in each zone (see Equation 3).

Equation 3

$$SEI = \frac{[(P_{ia} * RO_a) + (P_{ib} * RO_b) \ldots]}{P_i}$$

Where: P_i = population of unit *i*
P_{ia} = population of unit *i* with characteristic *a*
RO_a = relative odds of being unhealthy for those in the provincial population with characteristic *a*

An SEI score greater than one indicates that the population of the unit has lower levels of economic status compared to the province as a whole. A score less than one indicates higher levels of economic status.

Calculation of Standardized Mortality Ratio (SMR)

The SMRs in this study are calculated based on vital statistics for Ontario for the population aged 0-64 years. This is assuming that deaths in this age range represent premature mortality.

An SMR score greater than one indicates that the PHU has higher mortality levels than expected given the age/sex distribution of the population. Scores less than one indicate lower mortality levels.

Newbold et al. (1998) acknowledges the fact that to improve horizontal and vertical equity in health care funding, resources should be distributed according to population need. To measure population need throughout the province, Newbold et al. measured the SHR, SEI and the SMR of each PHU based on the age/sex distribution of each unit. The authors propose that these indicators may be used in order to determine which PHU has a greater need for health care resources over other PHUs.

Although these calculations yield an indication of the relative health care need of each unit, it does not provide a method to determine how to adjust the level of funding based on these measures. These formulas may indicate to us which PHU should theoretically be allocated more funding than others based on need, but the issue of how much of the province's resources should be allocated to each PHU remains uncertain.

2.2.2 Alberta Health and Wellness.

The Alberta Ministry of Health and Wellness has adopted a population needs-based approach for distributing its health care resources. In September of 2004, it created a manual which describes in detail its strategy for provincial health care allocation using age, sex, and socioeconomic information (Alberta Health and Wellness, 2004).

In the past, the provincial government of Alberta allocated health care resources based primarily on previous funding levels (Alberta Health and Wellness, 2004). Beginning in 1997/1998 however, Alberta adopted a population-based approach to improve the equity in resource allocation. The province was geographically divided into nine regional health authorities (RHAs). The people living in each RHA were divided into demographic categories based on twenty age groups, two gender and four SES groups (Alberta Health and Wellness).

Age groups are categorized starting with "less than one year old", and proceed in five year intervals, up to the final category of "90 plus". The gender categories are male and female. The socioeconomic groups are: subsidy under age 65 (those with subsidized health care premiums), aboriginal (Treaty Status) under age 65, welfare (those receiving social assistance during the year) under age 65, and regular[4] (the majority of Albertans) of all ages. These categories are used as a proxy for relative need of health care resources (Alberta Health and Wellness, 2004). For example, a senior citizen will tend to have a higher relative health care need than a teenager. Similarly, a 30 year old male in the social assistance group will tend to have a higher health care need than a 30 year old male

[4] A 'regular' Albertan in this study is defined as any person that is not aboriginal, receiving social assistance, or have subsidized health care premiums

in the regular group (Alberta Health and Wellness). The approximate health care consumption of each category was estimated using historical health care expenditure data for each group.

RHA patient activity data were collected from five sectors: acute hospital inpatient care, hospital based ambulatory care, continuing care, home care, and community lab (Alberta Health and Wellness, 2004). Acute hospital inpatient care data were collected from hospital inpatient data separations from the Canadian Institute for Health Information (CIHI) Inpatient Morbidity file. Ambulatory care data were collected via the Ambulatory Care Classification System (ACCS) where all acute care facilities in the province report ambulatory care visits. Continuing care activity data were obtained from the Resident Classification System (RCS). The RCS classifies each continuing care resident using annual evaluations. Residents are then placed into one of seven categories (A to G scale) representing increasing need for resources for care. Home Care data were collected from the Home Care Information System, where all RHAs file a standardized monthly report on all clients. Community lab data take into account the lab tests completed for non-hospital patient lab tests ordered by physician offices. These data were collected from RHAs through a special data request.

Population demographic information was collected primarily from the Alberta Health Care Insurance Plan (AHCIP) Population Registry file. This file was derived from the Stakeholder Registry System, which was designed primarily for AHCIP billing purposes. The Registry file contains data for all residents that are eligible for Health Care Insurance coverage (Alberta Health and Wellness). Information included in the file includes: resident address, gender, date of birth, and some socioeconomic information.

The remainder of socioeconomic data was collected from Alberta Family and Social Services (Alberta Health and Wellness).

Once data were collected, all patient activities are converted into RHA expenditure. CIHI then calculates and attaches Resource Intensity Weights (RIWs) to all of the acute hospital inpatient data. RIWs are derived from Canadian cost records. Hospital based ambulatory care is weighted according to ACCS relative values from historical cost information. Home care costs are measured using actual reported costs. The provincial average cost rates are calculated by adding all provider costs for all regions and dividing by the number of providers. Community lab is a program that keeps track of the non-hospital and community patient lab tests taken by physicians in all nine Alberta health authorities. It calculates relative rates that were based on service coding from Capital Health, an academic health region servicing Edmonton and area (Alberta Health and Wellness, 2004; Capital Health, 2006). Once data has been weighted, it is then scaled in order to coincide with the Alberta health care budget (Alberta Health and Wellness).

RHA patient activity data collected are not entirely inclusive of all patient activity in the province. Similarly, weights assigned to each RHA collection sector do not account for 100% of the actual costs of health care expenditure (Alberta Health and Wellness, 2004). To compensate for these deficiencies, the weighted sectors are scaled so that they equal their total expected yearly expenditure. Summing all of the scaled weighted sectors equals the total health care budget. The total expected annual expenditure was determined from historical expenditure and funding available.

The next step in aligning the weighted sectors with population need is to assign the scaled expenditures to the 124 demographic groups. The Personal Health Numbers[5] (PHNs) of each individual in a RHA are used to link patient activity expenditures to the Alberta Health Care Registry file to determine which demographic group they belong. PHNs are scrambled so that the identity of each individual is unknown (Alberta Health and Wellness, 2004). The expected health care expenditure for all members of each demographic group are summed and divided by the total number of people in that group. This gives the group provincial average per capita rate for each demographic. The capitation rates for each group are then assigned to populations of the RHAs (Alberta Health and Wellness, 2004).

The postal code of each individual is used to determine which RHA they will be assigned. The capitation rate for each demographic group is multiplied by the number of people in that demographic in the RHA. Summing the rates of all groups of a region will determine the level of yearly health care funding provided to that authority. Since each RHA consists of varying numbers of each group, a different overall per capita funding will occur for each region (Alberta Health and Wellness, 2004). Health protection, promotion and prevention (PPP) activity data are difficult to measure and was therefore determined by a modified population formula.

To distribute PPP resources, a PPP funding pool was split into three age group categories. Proportions were based on the judgement of Alberta Health and Wellness personnel involved in the programs. Age 0-19 received 62%, 20-64 received 26%, and

[5] PHNs are a unique number given to Albertans that they present each time they receive publicly funded health care. PHNs can be used to track a person's history or health care use.

ages 65+ received 12% of the funding. Socioeconomic groups where then weighted as follows: Regular 1, Subsidy 2, Aboriginal 5, Welfare 5. The funding was then distributed to the RHAs based on each region's proportion of the weighted populations (Alberta Health and Wellness, 2004).

Because population-based funding is so strongly linked to patient location, patient activity between regions must be taken into account. An activity is considered import-export when the region of service differs from the region of residence (Alberta Health and Wellness, 2004). The value of import-export activity is deducted from the exporting region and is then added to the importing (servicing) region. Summed net import-export adjustments will equal zero throughout the province however, the net change in funding in RHAs may not. The net change in export dominated regions will be negative while the net change in importing regions will be positive. The import-export variable is vital in ensuring that the regions that are servicing other RHA's residents are being compensated for the higher amount of patients treated (Alberta Health and Wellness).

2.2.3 Manitoba Centre for Health Policy.

The Manitoba Centre for Health Policy (MCHP) is a branch of the University of Manitoba's Department of Community Health Sciences, Faculty of Medicine (Shananhan & Gousseau, 1997). MCHP is active in health research and evaluation of health policy in the province. It is interested in using the "Manitoba health data base to describe and explain patterns of care and profiles of health and illness" (Roos, Fransoo, Bogdanovic, Friesen, Frohlich, Carriere, Patton, & Wall, 1996, p. ii)

In 1997 at the request of Manitoba Health[6], the MCHP developed a framework for the allocation of health care resources to the province's twelve Regional Health Associations (RHAs) (Mustard & Derksen, 1997). The goal of this framework was to distribute resources to all RHAs based on a population needs-based formula.

Age and health profiles were the key determinant used by the MCHP (Mustard & Derksen, 1997). "Populations with a higher proportion of older individuals will have a greater requirement for health care services than populations with younger age structures" (Mustard and Derksen, 1997, p.1). However, two communities with the same age structure may have very different health resource utilization. For this reason, health profiles of individuals will be taken into account in order to increase the equity with which resources are allocated across RHAs.

The first step was to define 6 service categories from Manitoba Health that group similar health care services. The six groups created were:

- Institutional Acute Care services
- Institutional Long Term Care services
- Home-Based Continuing Care services
- Health Promotion and Disease Prevention services
- Medical services
- Pharmacare benefits

These categories were measured by the dollar amount spent for every five year age group, separated by gender. An average value was then calculated for each

[6] Manitoba's provincial government department of health.

age/gender group (Mustard & Derksen, 1997). By calculating the number of people in each age/gender category living in a RHA and summing all of their average uses of each health care service, a total dollar amount of health services used in that health association was derived (see equation 4) (Mustard & Derksen).

Equation 4

$$\beta Avg_{A/G}X = \frac{\text{Total dollar amount used in age/gender group X}}{\text{Total number of people in age/gender group X}}$$

Where: $\beta Avg_{A/G}X$ is the average dollar amount used of health service β in five year interval age/gender group X

$$\beta_{TOT} = N_A * \beta Avg_{A/G}A + N_B * \beta Avg_{A/G}B + N_C * \beta Avg_{A/G}C + \ldots + N_n * \beta Avg_{A/G}N$$

Where: β_{TOT} is the total value of dollars spent in service β
N_A is the number of people in age/gender group A
N_B is the number of people in age/gender group B
N_C is the number of people in age/gender group C
N_n is the number of people in age/gender group N

$$RHA_{TOT} = \beta_{TOT} + \gamma_{TOT} + \delta_{TOT} + \ldots + \theta_{TOT}$$

Where: RHA_{TOT} is the total dollar value of health services used in the RHA
β_{TOT} is the total value of dollars spent in health service β
γ_{TOT} is the total value of dollars spent in health service γ
δ_{TOT} is the total value of dollars spent in health service δ
θ_{TOT} is the total value of dollars spent in health service θ

In order to capture health care need of each RHA outside of age and gender, other variables were added. Among those considered were premature mortality, infant mortality, social and economic characteristics and diabetes prevalence (Mustard & Derksen, 1997). Premature mortality was defined as the number of deaths of people under the age 75 per 1000 people. Infant mortality was defined as the number of deaths occurring to live-born infants per 10,000 that die within the first 365 days of life. The social and economic characteristics of a community were measured using six categories:

- the mean value of owner-occupied dwellings
- the proportion of the population aged 25-34 with a high school diploma
- the proportion of households with children aged 0-14 that were headed by a female single parent
- the proportion of women aged 15 years of age or older in the labour force
- the unemployment rate among persons aged 15-24
- the unemployment rate among persons aged 45-54 (Mustard & Derksen, 1997).

Using administrative health care records, diabetes prevalence was measured in people between the ages of 20 and 79 as a measure of the prevalence of chronic conditions in the community (Mustard & Derksen). A case of diabetes was defined as the occurrence of two or more visits to a physician within three years that showed a diagnosis of diabetes. Body mass index[7] (BMI) and self-reported disability were also considered, however due to a lack of population data at the time, both variables were excluded (Mustard & Derksen).

Instead of using just one of these variables to compensate for health care need outside of age and gender it was thought to be more effective to combine several of them (Mustard & Derksen, 1997). As noted earlier, while premature mortality, social and economic characteristics, infant mortality and diabetes prevalence proved to be good indicators, from a policy standpoint it was thought to be beneficial to drop the latter two.

[7] BMI is calculated by the dividing the weight of an individual (kg) by the square of their height (m). It is used to generally classify people's body type into 'underweight', 'ideal weight', 'overweight' and 'obese' and 'morbidly obese'.

Instead of diabetes prevalence working as a proxy for chronic condition burden on a community, concern was displayed this would just emphasize one disease in a population. Another concern was that an RHA may put an emphasis on diabetes screening in order to increase the apparent prevalence, resulting in a higher need score (Mustard & Derksen). Infant mortality also came into question due to the instability of this measure in some RHAs. Communities with much smaller populations may show a skewed infant mortality rate compared to the larger populations due to the instability of calculations based on smaller populations and rarity of infant mortality (Mustard & Derksen). Therefore it was concluded that a blended measure of premature mortality and social and economic characteristics are the best indicators of health care need outside of age and gender (Mustard & Derksen).

In another study carried out by MCHP, Roos, Fransoo, Bogdanovic, Friesen, Frohlich, Carriere, Patton, and Wall (1996) investigated the distribution of generalist physicians throughout the province. Manitoba was divided into 54 different Physician Service Areas (PSAs) based on actual physician use patterns of residents. Visit rates were determined by measuring office visits, house calls, emergency room visits, and walk in clinics visits. Inpatient visits were excluded because they were more likely to be conducted by a specialist.

In order to measure the need for care in each PSA, each area's actual visit rate was compared to its 'needed' visit rate (Roos et al., 1996). Actual visit rates were tracked using claims that are routinely filed by salaried and fee-for-service physicians. Need for physician visits was determined using regression analysis on Manitoba residents. Predictions were based on regression analysis that measured the magnitude of the relationship between variables. The variables used to gauge population need were age, gender, socio-economic status and health status. Roos et al. created a Socio-Economic Risk Index (SERI) using census data regarding unemployment rates, high rates of single female parent families, low housing values, and low participation in labour force by women (Frohlich & Carriere, 1997). Regressions were run on these variables and actual 1993/1994 visit rates providing an estimate for physician contact in each area. This primary regression was then adjusted using premature mortality rates (death before age 74) for each area. Areas with premature mortality rates over 3.6 deaths per 1000 residents were deemed to be in poorer health and therefore the need for physician visits increased (Roos et al.). Conversely, areas whose residents were deemed to be healthier than average had their need values decreased. The final estimate created by this formula includes age, gender, socio-economic status and health status and is expressed by the average number of physician visits needed per resident per year (Roos et al.).

2.2.4 Overview of international approaches.

Rice and Smith (1999) administered a survey to 19 developed countries to catalogue the strategies used to distribute health funding. It was commissioned in February 1999 as part of a fundamental review by United Kingdom Ministers of their own needs-based strategy. The report was informed by published literature and contacts in both the political and academic settings of each country (Rice & Smith). Rice and Smith (2001b) also published an international progress report of their findings. This overview of international approaches pools information from both of these sources. This overview is not meant to give detailed information on the specific equations and calculations used by each country, but to provide some insight into the population characteristics and general strategies used.

There is considerable variation in the methods by which funds are allocated in the developed countries. Each country however, is broken down in multiple smaller areas or groups in order to facilitate the dispersion of health care funding. Whether this is by insurance pools, local governments, administrative boards, or sickness funds, each one of these groups sets a budget that is meant to be both prospective and fair in nature (Rice & Smith, 2001b).

All countries in this review use some form of capitation strategy. It is not whether or not the countries decide to set capitations, but how they are set (Rice & Smith, 2001b). Spain for example uses the simplest capitation possible by distributing health funding equally per capita. Israel, Germany, and Switzerland use risk-adjusted data based on the demographics such as age and sex. Four broad types of health care systems put these capitation methods to use. The four systems and the countries that use them are:

1. *Competitive insurance markets*: Belgium, the Netherlands, Germany, Israel, Switzerland.
2. *Captive employment-based insurance*: France, Japan.
3. *Centralized public sector*: Australia (New South Wales), Canada (Alberta), Italy, New Zealand, United Kingdom (England, Scotland, Wales, Northern Ireland).
4. *Devolved public sector*: Denmark, Finland, Norway, Spain, Sweden.

Competitive insurance markets offer the population a choice of insurance options. These are generally highly regulated with a minimum mandatory level of care offered, premiums unrelated to health status, and require that everyone must be accepted for coverage.

In captive employment-based insurance systems, workers and their dependents are placed into a sickness insurance fund depending on the sector in which they are employed. Again this must be highly regulated in order to avoid having sectors with sicker, poorer members being charged higher premiums than other funds.

The centralized public sector system is normally funded through general taxation. They function on the main objective that all citizens should enjoy equal and equitable access to care based on their need, not on characteristics such as income, employment, or area of residence.

Devolved public sector systems rely on using the lower levels of government, from national or state to the more local levels. Some, or potentially all, of the health system is then funded by localized taxes. However this may cause problems due to the varying levels of need between each area. Areas with higher need for care would have to tax appropriately higher in order to cover the higher costs. For those countries that employ a devolved public sector, this is unacceptable. Instead there is a level of intergovernmental transfer based on risk-adjusted capitation payments in order to standardize the level of taxes as well as the level of care (Rice & Smith, 2001b).

The next step is defining which risk adjusted capitation factors are used. Almost all countries used empirical data combined with the analysis of existing patterns of health care use. The exceptions to this are Spain (no risk adjustment), Norway (empirical results are moderated by political judgment), and Italy and Scotland (where SMRs are used as the risk adjuster without linking to utilization. A hybrid system of using both individual and aggregate data was the most common (Australia, Canada (Alberta), Denmark, England, Finland, Italy, the Netherlands, New Zealand, Northern Ireland, Norway, Scotland, and Wales). The use of individual data alone was the second most popular approach among these countries (France, Israel, Japan, Sweden, and Switzerland). Only Belgium used aggregate data alone. In general, systems that work in a competitive market tend to use simpler adjustment schemes.

The public sector systems tend to incorporate more variables, attempting to link social and demographic variables to health care use. The selection of risk adjustment variables seems to rely more on the availability of data rather than the evidence supporting their use (Rice & Smith, 2001b). It is important to note that although countries are using these variables, they are not necessarily strong determinants of the allocation of funds. Smith and Rice break the variables down into seven broad categories:

1. *Demography*: Only Spain does not take age and gender into account.
2. *Ethnicity*: Several schemes take ethnicity into account by treating it much like a third category of demography. New South Wales and New Zealand break ethnicity into three categories, whereas in Alberta just one aboriginal identifier category is used.
3. *Employment/disability status*: The Netherlands, New Zealand, Alberta, and Northern Ireland categorize employment/disability into categories such as: employed, permanently sick, temporarily unable to work, unemployed, or pensioner (Rice & Smith, 2001b). An advantage of this is that these are normally updated and universally recorded. The main disadvantage is that these are not

recorded for the purpose of health care allocation and are susceptible to errors in recording or manipulation.

4. *Geographical location*: Place of residence may have a strong influence on variations of need that are not captured by other factors. Furthermore, it may capture variations of utilization related to the level of need as well as differences in the supply of health care and policy.
5. *Mortality*: Crude and standardized mortality rates are used in New South Wales, Belgium, Wales, Scotland, Northern Ireland, Italy, New Zealand, and Norway. Mortality is generally universally recorded and verifiable, however their link to need for care is debatable (Rice & Smith, 2001b).
6. *Morbidity*: Morbidity is an individual characteristic closely related to health care need but may also be susceptible to gaming by providers (the diagnoses of more chronic diseases in an area would lead to more funding being allocated there). Access to reliable and valid morbidity data is also a problem in many countries. Belgium, Finland, and the Netherlands measure morbidity through levels of disability. Northern Ireland includes a measure for low birth weight that is both universally and consistently recorded. Israel is the only system that excludes patients of certain diagnoses from their capitation scheme.
7. *Social Factors*: The use of social factors stems more from the availability of data more so than a direct link to health care needs. This data is generally collected through national census and therefore generally reliable and universally collected. This data however becomes dated quickly and at best provides an indirect link to health care need (Rice & Smith, 2001b). New South Wales, Belgium, the

Netherlands, Sweden, Alberta, New Zealand, Northern Ireland, Norway, and Finland all incorporate some form of social measure. Examples include, homelessness, education, unemployment, welfare status, marital status, family structure, housing quality/tenure, social class, cohabitation, and income.

Rice and Smith (1999) state that it is important to note that the shift to risk adjusted schemes has been a slow and cautious process in most countries. The move away from historical spending is impeded by heavily dampening needs adjusted allocations in order to avoid large fluctuations in budgets. In most instances, such as in Alberta, governments guarantee that no spending will be cut in any regions, instead needs based allocation will simply guide future spending. The Norwegians and Dutch go as far as including weights and 'safety nets' into their capitation schemes in order to avoid dramatic shifts in spending year to year (Smith & Rice, 2001b).

2.3 Conclusion

Needs-based health care allocation has been a widely researched field over the past two decades. Throughout Canada and the rest of the world, policy makers have been taking steps in order to increase the equity in which they distribute health care resources (Hutchison et al., 1997; Mustard & Derksen, 1997; Alberta Health and Wellness, 2004, Smith & Rice, 2001b). It is their goal to ensure that all people of the population receive equitable and fair access to health services.

When reviewing the literature several predictor variables are used frequently. Used in various combinations, age, gender, measurements of health (self assessed health status), and socio-economic indicators (unemployment, housing, income) are viewed as some of the best indicators of need. Researchers and policy makers collaborate to use these variables in order to link the health care needs of the population to the amount of resources they receive. It should be noted "that even the most sophisticated formulae cannot capture all the factors that bear on a region's need for health care resources" (Hurley, 2004, p. 37) and we must continue to investigate the impact that individual characteristics may have on health care need.

This thesis focuses on individual level data collected from national and provincial health surveys, as well as from health care administration records. The use of health survey data is valuable in the creation of needs-based formulae, especially when linked to health care utilization data (Hurley, 2004). By using this data at the micro-level we can explore the interactions of the selected needs-factors. Smith, Rice and Carr-Hill (2001) recommended the use of a capitation formula based on individual level data collected through a survey designed for the specific purpose of capitation funding. Since such a survey is not available in Newfoundland and Labrador, we have chosen to use provincial and national health survey data that has been linked with actual medical care expenditures.

Guided by the evidence in this review, we will test the relationship between needs factors and their effect on health care utilization. Although there has been research into the use of micro-data and their link to health care use, we feel that our research is unique in that it combines data across two MCP linked health surveys, as well as using the MCP administrative database. We hope that the use of combined empirical and survey data will help add to the growing literature base of needs based allocation and perhaps be considered in the development of a capitation strategy in Newfoundland and Labrador.

CHAPTER 3

Data and Methodology

The three databases used in this study are: the Medical Care Plan (MCP) administration data for the years 1996-2004, the 1995 Newfoundland Panel on Health and Medical Care – Adult Health Survey (AHS), and the 2001 Canadian Community Health Survey (CCHS).

Manipulation of the CCHS, AHS and MCP administration databases comprised a considerable portion of this study's methodology. Therefore a description of each database is first given to provide the context for discussing the design and analysis. The study design section describes the manipulation of the survey and administration data prior to the data for analysis. The data analysis section describes the methodology used to determine which population characteristics are useful in determining predictors of FFS GP use.

3.1 Databases

MCP administration data were used to obtain information on the value of insured GP services consumed and the age and gender profile of the patient. With the exception of military personnel and RCMP officers, Canadian citizens living in Newfoundland and Labrador are assigned an MCP number that fee-for-service physicians record at each visit. The physician uses this number in order to bill for the services they provide to the patient. Fee codes are used by physicians in order to record details of the patient visit. These codes outline the type of procedure performed, type of doctor performing the procedure (general practitioner (GP), specialist, surgeon), where the visit took place (office, home, hospital), and the dollar value of the visit[8]. The scope of this study extends only to GP funding and therefore the MCP data used relates to FFS GPs only.

Historical MCP data analyses show that not all residents will visit a GP in a one year period. In an effort to obtain MCP data on the greatest proportion of the provincial population, nine years of MCP data were used, ranging from 1996-2004, inclusive. Therefore, if an individual did not consume any MCP resources in a certain year, they will likely appear in the database in one of the other eight years. Once they have been recorded at least one time, it is possible to retroactively assign them a value of 'zero resources consumed' for previous and subsequent years that they are not recorded. If an individual does not appear in the database at all over the nine year observation there are four reasons likely for this: 1. They are being serviced by a salaried physician in which case there is no MCP claim associated with their GP visits; 2. They are now seeing a specialist, in which case will not be included in the GP utilization database; 3. They have moved out of province, or 4. They have died. This issue is discussed in further detail in the MCP portion of the *Study Design*. It is also possible that an individual may remain healthy over the nine year period and never visited a GP. We assume that this is unlikely and would be a very small percentage of the population.

Two health survey databases were used in this study to obtain information regarding health characteristics and demographic information of the population.

The 1995 AHS was administered randomly by telephone to 11,789 participants over the age of 17 from the island of Newfoundland (Segovia, J., Edwards, A. C., &

[8] The dollar value of the fee codes are determined through negotiations between the Newfoundland and Labrador Medical Association, representing doctors, and the provincial government represented by the Health Boards Association, the Department of Health and Community Services, and Treasury Board.

Bartlett, R.F., 1996). Labrador was omitted from the survey because "of its dispersed population, large proportion of native peoples, "company" towns (mining, power generation, armed forces), and a health system that differs from that on the island part of the province; it would have required a separate study with a specific design and methodology" (Segovia et al., 1996, p.2).

In addition to age and gender data, this survey provides information on people's lifestyle choices (e.g. alcohol consumption, smoking habits, amount of daily exercise), frequency of preventative check ups (e.g. blood pressure, prostate specific antigen test, pap smears), self assessed health status, level of education, annual income, and employment status. These variables help to refine our model and encompass determinants of health service utilization outside of age and sex.

The 2001 Canadian Community Health Survey (CCHS) was developed by Statistics Canada to provide population information on health status, health care utilization and determinants of health of Canadians across the country (Statistics Canada, 2008). The sample size collected in Newfoundland and Labrador was 3,734.

It is important to note that the 1995 AHS and the 2001 CCHS are samples of the general population, and are not all FFS GP users. On both surveys participants are asked for consent to link their MCP number to the data they provided on the survey. Pending a 'yes' response, participants' MCP numbers are used to track their health care utilization information and attach it to their health survey data. With this information it is possible to link the health information collected from these surveys to the value of their health resources consumed. A further discussion of the linkage is provided in the study design.

3.2 Study Design

This section will discuss the procedures used in order to prepare the three databases for analysis.

3.2.1 Medical Care Plan data.

It is important to the note the context of FFS GPs versus salaried GPs in Newfoundland. The majority of physicians in Newfoundland and Labrador (72%) receive FFS payments, especially in more densely populated or urban areas (Department of Health and Community Services Annual Physician Supply Report, 2006). Physicians in rural Newfoundland however, are primarily paid by salary. The reason for this is that the population in rural Newfoundland is much more dispersed and the physicians will not see as many patients as urban GPs (Hunt, n.d.). Furthermore, rural GPs lose more clinic time due to travel between sites. They are required to travel more in order to help with emergencies or to travel to satellite clinics. They also require more time to confer with colleagues due to the larger scope of their practice (Hunt, n.d.). Rural general practitioners are unable to refer many of their patients to specialists because of the travel requirements and emergent nature of their illnesses. It is impractical for many patients to see specialists as often due to the distance they must travel. Therefore the GPs must treat more complex cases.

Each patient visit to a FFS GP contains the individual's MCP number and the corresponding fee code for the service rendered. MCP numbers contain a string of twelve digits that include information on the year of birth, date of birth (on the Julian calendar), and gender of the individual. For example, using the fictional MCP number 99 945 012 3

456. The third, fourth, and fifth numbers in the code, 945, are the last three digits of the individual's year of birth. Therefore this person was born in the year 1945. The sixth, seventh, and eighth numbers, 012, is this person's day of birth on the Julian calendar. This person was born on the 12th day of the Julian calendar year, January 12th. The ninth number in the MCP code shows the gender of the individual. A value of 0 to 4 signifies male, 5 to 9 signifies female. In this example the ninth number is 3, therefore indicating that this hypothetical individual is male.

Fee-for-service GPs record a fee code for each visit depending on the service provided. Only one fee code may be claimed per patient visit. Therefore, if a patient visits a doctor with multiple conditions the GP is generally only permitted to bill for one service. The fee-code assigned to this patient visit will not accurately describe all services provided by the physician. This will not bias our results as it is constant over all utilization data.

Each fee code has a corresponding dollar value and the physician is paid this amount per code (see Table 1) (Government of Newfoundland and Labrador: MCP Newsletter, 2005). The FFS payment is an average cost of a procedure. The fee paid to the GP considers that some visits for the same service may be very short while others could take longer. Fee code values change over time. Therefore, for the purpose of this study all values used are based on the 2005 code rates[9]. Using this information it is possible to sum each individual's fee codes for a given year, yielding a total dollar amount of GP resources consumed. The MCP database contains data for each

[9] The value for three codes in the study could not be determined. They were assigned the most common value of $25.74, the fee payable for a general office visit.

individual's use of a fee-for-service (FFS) physician service from 1996 to 2004. Each observation is an individual's cumulative GP use from January to December of a given year.

Table 1

2005 General Practitioner Fee Code Values – Newfoundland and Labrador

Fee Code	**Value**	**Description**
Office Visits		
101010	$50.00	Consultation
111010	$50.00	Pre-dental general assessment
112010	$50.00	General assessment
114010	$35.00	General reassessment
121010	$25.74	Partial assessment
122010	$25.74	Visit for well baby-care
124010	$25.74*	
125010	$30.00	Partial assessment for a patient 65 years or older
131010	$40.00	Psychotherapy : individual per 1/2 hr
132010	$15.00	Psychotherapy: group per member, per hour
136010	$25.00	Psychotherapy: family therapy per 1/2 hour per family
143010	$25.74*	
181010	$30.00	Detention per 1/4 hour
Home Visits		
210010	$50.00	Nursing home general assessment
246010	$50.00	a) Elective any hour of any day b) non-elective 8am-6pm Mon-Sat
248010	$75.00	Non-elective between 8am and midnight on Sunday or Statutory Holiday
249010	$75.00	Non-elective 6pm to midnight
250010	$125.00	Non-elective from midnight to 8am
251010	$75.00	Emergency visit with sacrifice of office hours
252010	$25.00	Extra patient seen during home visit
281010	$30.00	Detention per 1/4 hour
282010	$25.74*	

*No fee code provided, therefore assigned a value of $25.74.

If a person does not appear in the MCP database for a given year but appear in any of the other eight years of observation, they are given a GP dollar amount consumed of zero year(s) they are missing. If an individual does not appear in the database over the nine year observation, it is likely that they are: being serviced by a salaried physician (in which case there is no MCP claim associated with their GP visits), they have moved out of province, they have died, or are very healthy and have not visited a GP. In order to account for these situations, a list of lapsed MCP numbers was provided by the Department of Health and Community Services, and these observations were purged from the files in the years of, and following their lapse date. However, it appears that a significant number of MCP numbers that should be deleted are not. This became evident when looking at older members of the database who were showing a significant decline in utilization over time. To remedy this, for those in the 80 plus age group with no physician visits, we determined the last year that they went to a GP and then dropped them from the analysis for the subsequent years. We are assuming that people who are in this age group and not seeing a GP are likely seeing a specialist or have died. Making this assumption corrected the GP utilization drop off in the higher age groups and demonstrated a trend that was consistent through time (increasing GP utilization as individuals get older) and with established national patterns.

3.2.2 Newfoundland Panel on Health and Medical Care - Adult Health Survey

The AHS asks participants to provide consent to allow their survey data to be linked to MCP utilization data. Of the 11,789 AHS participants, 2,559 (21.7%) did not consent to linking their MCP data with their survey data and were therefore dropped from our analysis leaving us with a sample size of 9,230.

Two data files were provided for the 1995 AHS. The 1995 AHS data file contains participant health survey information and the MCP-AHS link file contains health care utilization information. The MCP-AHS link file is a database containing MCP utilization data for each visit to a GP by the participants of the AHS between April 1, 1994 and March 31, 1995. In order to link participants' survey data to their MCP utilization we merged the 1995 AHS data file with the MCP-AHS link file. In both the link file and the health data file participants are separated into households ('hh' variable) and by each person in the households ('subj' variable). A unique identifier was given to participants by combining their household number and their subject number. This variable was named 'person id'. By relating this corresponding id between the link file and the health data file made it possible to create the bridge between each person's AHS data and their MCP GP utilization data. Using coinciding unique identifiers to link the two files we combined them to give a master file containing each person's health survey information and the corresponding value of GP resources consumed that year. Several variables were selected from the survey database and used to predict the value of GP services. Although the AHS provides only one year of MCP linked information, yielding a smaller number of observations than the CCHS, we feel it is important to include it in all regressions in order to give us a point of comparison. Furthermore, its inclusion in the regressions has no effect on the CCHS or MCP results.

The AHS was done through random sampling, therefore no design weights were created in this survey.

3.2.3 Canadian Community Health Survey.

Due to privacy and security issues surrounding the CCHS we sought the services of the Newfoundland and Labrador Center for Health Information[10] (NLCHI) to carry out the data file linking between the 2001 CCHS and its associated MCP utilization data ranging from 1995-2004. The output file from NLCHI was a de-identified link file containing information on participants' health survey information collected in 2001 and their corresponding MCP utilization from 1995-2004[11].

Of the 3,734 CCHS respondents in Newfoundland and Labrador, 745 were dropped from our analysis due to the fact they did not record a GP visit from 1995-2004. We are assuming that these people are: seeing a specialist, visiting a salaried physician, have moved out of the province, have died, or are very healthy. We are assuming that those who are very healthy and not visited a FFS GP in this time period constitute a small portion of this group and should not significantly bias our results.

Sample weights were provided with the CCHS database and were used in the analysis in order to produce unbiased population estimates.

Using variables from the MCP administration database, the AHS, and the CCHS and their linked MCP information it is now possible to determine how their population

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[10] NLCHI is a government established organization, responsible for providing quality health information and ensuring integrity, confidentiality, and privacy of health research (Newfoundland and Labrador Centre for Health Information, 2004).

[11] The MCP utilization data used in the CCHS link is a unique database and should not be confused with the MCP administration data described in section 3.2.1. The linkage between the CCHS and the MCP database was conducted by NLCHI to capture the same utilization information as used in the AHS and the MCP data files.

demographics and health characteristics are associated with FFS GP resource consumption.

3.3 Data Analysis

Multiple linear regression estimates the expected value of a dependent variable given the values of several independent variables (Armitage & Colton, 2005). In this study, multiple linear regression is used to measure the actual dollar value of FFS GP resources per year (dependant variable) given the value of the demographic and health characteristics of the population (independent variables) selected from our databases. Several variables describing the population demographics, health indicators, lifestyle choices, and socioeconomic status were chosen to correlate with the value of GP resources they consumed per year. This section describes how this multiple linear regression analysis was carried out in the MCP administration database, the AHS, and the CCHS.

3.3.1 MCP administration database.

The MCP administration database contains information on two demographic variables, age and gender. The age variable starts from 'Age 0-4' and continued in five year increments up to 'Age 80+'. This was combined with the male or female gender variable to allow for an age/gender analysis of FFS GP utilization.

The MCP dataset contains aggregate data from 1996 to 2004 consisting of 3,112,813 observations. Each observation represents an individual's cumulative GP use from January to December of a given year[12].

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[12] These observations are not independent of one another. In some cases, individuals of the data sample provide several observations and are therefore highly correlated. The same applies to the AHS and CCHS.

The independent variables in our MCP database are age and gender for the FFS GP patients from 1996 to 2004. The regression equation for the MCP database is outlined in Equation 7. In an effort to get more detailed information on trends over time, the age/gender regression was run on all nine years together as well as for each year separately. The output for each regression contains the beta values, t-statistics and adjusted R^2. The beta value for each male age/gender interaction represents the mean dollar amount that a male patient in that category used in one year. The beta value for each of the female age/gender interactions represents the difference in the mean dollar amount used by a female compared to a male patient in one year. A positive coefficient on the interaction terms represents the additional amount of GP resources a female in that age range would be expected to use each year compared to a man. A negative coefficient represents the additional amount of GP resources a male in that age range would be expected to use each year.

The t-statistic represents the statistical significance of the result. If the t-statistic is above 1.96 or below -1.96, then we can be 95% confident that the result is significant. The adjusted R^2 represents the explanatory power that the independent variables have on the linear regression.

The explanatory power increases only when the newly added independent variables improve the model more than would be expected by chance (Armitage & Colton, 2005). The possible values of the adjusted R^2 range from 0 to 1. The greater the value, the more explanatory power the model has. In order to provide predicted value of utilization for each age group, the regressions were run without a constant term.

Equation 7

Y (predicted utilization) = (β_1Age 0-4) + (β_2Age 5-9) + (β_3Age 10-14) + (β_4Age 15-19) + (β_5Age 20-24) + (β_6Age 25-29) + (β_7Age 30-34) + (β_8Age 35-39) + (β_9Age 40-44) + (β_{10}Age 45-49) + (β_{11}Age 50-54) + (β_{12}Age 55-59) + (β_{13}Age 60-64) +(β_{14}Age 65-69) + (β_{15}Age 70-74) + (β_{16}Age 75-79) + (β_{17} Age 80 plus) + (β_{18}Age 0-4 Female) + (β_{19}Age 5-9 Female) + (β_{20}Age Female 10-14) + (β_{21}Age 15-19 Female) + (β_{22}Age 20-24 Female) + (β_{23}Age 25-29 Female) + (β_{24}Age 30-34 Female) + (β_{25}Age 35-39 Female) + (β_{26}Age 40-44 Female) + (β_{27}Age 45-49 Female) + (β_{28}Age 50-54 Female) + (β_{29}Age 55-59 Female) + (β_{30}Age 60-64 Female) + (β_{31}Age 65-69 Female) + (β_{32}Age 70-74 Female) + (β_{33}Age 75-79 Female) + (β_{34} Age 80 plus Female)

Table 2

MCP Variables

Variable	**Categories**
Age	00-04, 05-09, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80 plus
Gender	Male, Female

3.3.2 *Newfoundland Panel on Health and Medical Care - Adult Health Survey.*

Multiple linear regression models were estimated using the AHS to determine the relationship between health characteristics and the value of FFS GP resources consumed. The AHS regression equation is displayed in Equation 8. The dependant variable is the actual dollar amount of FFS GP resources used in that year. The AHS-MCP data is over a 12 month period.

Similar to the MCP data analysis, first the relationship between age and gender and the value of FFS GP resources consumed were measured. Then for each subsequent regression an additional independent variable was added until the final analysis included: age, gender, number of chronic conditions, body mass index, health practices (cigarette smoking habits, alcohol consumption and physical activity), socioeconomic indicators (yearly income and level of education) and self assessed health status. Since there were no participants included in the AHS below the age of 17, the age intervals commenced at 'Age 15-19' and increased in 5 year increments up to 'Age 80+'. Even though 15 and 16 year olds were excluded from the survey, for consistency all groups were in five year intervals, and thus this age group was named 'Age 15-19'. The income category 'missing values' compensates for all participants of the AHS that did not submit their yearly salary information. The AHS considers the following as chronic conditions if they are present for three months or more:

> anemia, allergy (of any kind), arthritis (rheumatism), asthma, cancer, Cerebral Palsy, diabetes, dysmennorrhea, ear infection, emphysema, epilepsy, heart disease, hemorrhoids, high blood pressure, kidney disease (stones etc.), mental illness, missing arm(s) or leg(s), missing finger(s) or toe(s), paralysis of any kind, prostate disease, recurring backaches, recurring headaches, stomach ulcer, thyroid trouble or goiter, tuberculosis.

The AHS dataset contains 9,230 observations collected between April 1, 1994 and March 31, 1995. Each observation is the cumulative GP use of each AHS respondent in the twelve month period. Table 3 contains all the independent variables and their categories used in the AHS regressions.

Equation 8[13]

$$Y\ (\text{predicted utilization}) = (\beta_1 \text{Age 15-19}) + (\beta_2 \text{Age 20-24}) + (\beta_3 \text{Age 25-29}) + (\beta_4 \text{Age 30-34}) + (\beta_5 \text{Age 35-39}) + (\beta_6 \text{Age 40-44}) + (\beta_7 \text{Age 45-49}) + (\beta_8 \text{Age 50-54}) + (\beta_9 \text{Age 55-59}) + (\beta_{10} \text{Age 60-64}) + (\beta_{11} \text{Age 65-69}) + (\beta_{12} \text{Age 70-74}) + (\beta_{13} \text{Age 75-79}) + (\beta_{14} \text{ Age 80 plus}) + (\beta_{15} \text{Age 15-19 Female}) + (\beta_{16} \text{Age 20-24 Female}) + (\beta_{17} \text{Age 25-29 Female}) + (\beta_{18} \text{Age 30-34 Female}) + (\beta_{19} \text{Age 35-39 Female}) + (\beta_{20} \text{Age 40-44 Female}) + (\beta_{21} \text{Age 45-49 Female}) + (\beta_{22} \text{Age 50-54 Female}) + (\beta_{23} \text{Age 55-59 Female}) + (\beta_{24} \text{Age 60-64 Female}) + (\beta_{25} \text{Age 65-69 Female}) + (\beta_{26} \text{Age 70-74 Female}) + (\beta_{27} \text{Age 75-79 Female}) + (\beta_{28} \text{ Age 80 plus Female}) + (\beta_{29} \text{CC1}) + (\beta_{30} \text{CC2}) + (\beta_{31} \text{CC3plus}) + (\beta_{32} \text{Ed1}) + (\beta_{33} \text{Ed2}) + (\beta_{34} \text{Ed3}) + (\beta_{35} \text{Ed4}) + (\beta_{36} \text{Ed5}) + (\beta_{37} \text{Inc1}) + (\beta_{38} \text{Inc2}) + (\beta_{39} \text{Inc3}) + (\beta_{40} \text{Inc4}) + (\beta_{41} \text{Inc5}) + (\beta_{42} \text{Inc6}) + (\beta_{43} \text{Inc7}) + (\beta_{44} \text{BMI1}) + (\beta_{45} \text{BMI2}) + (\beta_{46} \text{BMI3}) + (\beta_{47} \text{Smk1}) + (\beta_{48} \text{Smk2}) + (\beta_{49} \text{Smk3}) + (\beta_{50} \text{Drnk1}) + (\beta_{51} \text{Drnk2}) + (\beta_{52} \text{Exer1}) + (\beta_{53} \text{HS1}) + (\beta_{54} \text{HS2}) + (\beta_{55} \text{HS3})$$

Reference Categories: CC0, Ed0, Inc0, BMI0, Smk0, Drnk0, Exer0, HS0

Where: CC [0 – patients with zero chronic conditions; 1 - patients with one chronic condition; 2 - patients with two chronic conditions; 3 plus - patients with three or more chronic conditions]
Ed [0 – high school education; 1 - education less than high school; 2 - high school education with a trade; 3 - no high school with a trade; 4 - University no degree; 5 - University with degree]
Inc [0 – income of $40,000-$50,000; 1 – income of $0-10,000; 2 – income of $10,000-20,000; 3 – income of $20,000-30,000; 4 – income of $30,000-40,000; 5 – income of $50,000-60,000; 6 – income of $60,000-80,000, 7 - Income missing values]

[13] In the Results chapter that follows, the variables are entered in stages to show the incremental explanatory power achieved by adding health practice, status and socio-economic factors to the core age-gender models.

BMI [0 – BMI of 20-26 (ok weight); 1 - BMI Less than 20 (underweight); 2 - BMI of 27-29 (overweight); 3 - BMI 30 plus (obese)]
Smk [0 – non-smoker;1- smokes 1-9/day; 2- smokes 10-19/day; 3 - smokes 20 plus/day]
Drnk [0 – non-drinker; 1 - 1-2 drinks/day, 2 - 3 plus drinks/day; reference category = non-drinker]
Exer [0 - Moderate-Very Active; 1 – Sedentary]
HS [Self assessed health status 0 – Good; 1- Excellent; 2 – Fair; 3 – Poor; reference category = Good]

Table 3

AHS Variables

Variable	**Categories**
Age	15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80 plus
Gender	Male, Female
Number of Chronic Conditions	0, 1, 2, 3 plus
Level of Education	Less than high school, High school, High school with a trade, No high school with trade, University no degree, University with degree
Income	$0-10,000, $10,000-20,000, $20,000-30,000, $30,000-40,000, $40,000-50,000, $50,000-60,000, $60,000-80,000, Income missing values
Body Mass Index	Less than 20 (underweight), 20-26 (ok weight), 27-29 (overweight), 30 plus (obese)
Smoking	Non-smoker, 1-9/day, 10-19/day, 20 plus/day
Drinking	Non-drinker, 1-2/day, 3 plus/day
Exercise Health Practice	Sedentary, Moderate-Very Active
Self Assessed Health Status	Excellent, Good, Fair, Poor

3.3.3 Canadian Community Health Survey.

The Canadian Community Health Survey analysis was very similar to the AHS analysis. For comparison purposes, all variables were created as similar as possible to the AHS variables.

The CCHS often provided more detailed information than the AHS, but could not always be manipulated to directly match. The CCHS contains two more age variables than the AHS for both males and females, AGE 5-9 and AGE 10-14. The CCHS contains a 'missing value' variable for participants that did not submit this information. Physical activity was measured using different methods between the two surveys. The CCHS categories represent the frequency per month that people are active for longer than 15 minutes. The AHS in contrast, describes whether the person is very active, moderately active, active, or sedentary. Both however, show a continuum of physical activity levels. The AHS database did not provide adequate information to create an income category from \$60,000-\$70,000 and \$70,000-\$80,000. Instead these two categories are grouped together to create \$60,000-\$80,000. The education categories created for the AHS that could not be matched directly with the CCHS were: no high school with trade, university no degree, university with degree. The education categories contained in the CCHS and not in the AHS are: some university, college diploma, university certification less than a bachelor, bachelor degree, and higher than bachelor degree. The CCHS education categories go into more detail but unfortunately could not be combined to directly match the AHS. The body mass index and income variables both contain categories for 'missing values'. This permits inclusion of participants that did not submit body mass index and income information.

The CCHS defines chronic conditions as long-term conditions diagnosed by a health professional that are expected to last, or have lasted longer than 6 months. Chronic conditions measured in the CCHS are:

> allergies (of any kind), asthma, fibromyalgia, arthritis/rheumatism, back problems, high blood pressure, migraine headaches, chronic bronchitis, emphysema/chronic obstructive pulmonary disease, diabetes, epilepsy, heart disease, heart attack, angina, congestive heart failure, cancer, stomach/intestinal ulcers, suffering from effects of a stroke, urinary incontinence, bowel disorders (Crohn's Disease/colitis), Alzheimer's/dementia, cataracts, glaucoma, thyroid condition, Parkinson's, multiple sclerosis, chronic fatigue syndrome, multiple chemical sensitivities[14].

The CCHS regression equation is displayed in Equation 9.

The CCHS dataset contains data from 1995 to 2004 containing 29,809 observations. Each observation is one individual's cumulative GP use from January to December of a given year. CCHS variables are listed in Table 4.

The dependant variable is the actual dollar amount of FFS GP resources used per year, measured using the fee code valuations taken from the 2005 fee schedule.

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[14] Chronic conditions contained in the AHS that are not in the CCHS: anemia, Cerebral Palsy, dysmennorrhea, ear infection, hemorrhoids, kidney disease, mental illness, missing arm(s) or leg(s), missing finger(s) or toe(s), paralysis of any kind, prostate disease, recurring headaches, tuberculosis.

Chronic conditions contained in the CCHS that are not contained in the CCHS: fibromyalgia, migraine headaches, chronic bronchitis, heart attack, angina, congestive heart failure, suffering from effects of a stroke, urinary incontinence, bowel disorders, Alzheimer's/dementia, cataracts, glaucoma, Parkinson's, multiple sclerosis, chronic fatigue syndrome, multiple chemical sensitivities.

Equation 9

$$Y \text{ (predicted utilization)} = (\beta_1 \text{Age 5-9}) + (\beta_2 \text{Age 10-14}) + (\beta_3 \text{Age 15-19}) + (\beta_4 \text{Age 20-24}) + (\beta_5 \text{Age 25-29}) + (\beta_6 \text{Age 30-34}) + (\beta_7 \text{Age 35-39}) + (\beta_8 \text{Age 40-44}) + (\beta_9 \text{Age 45-49}) + (\beta_{10} \text{Age 50-54}) + (\beta_{11} \text{Age 55-59}) + (\beta_{12} \text{Age 60-64}) + (\beta_{13} \text{Age 65-69}) + (\beta_{14} \text{Age 70-74}) + (\beta_{15} \text{Age 75-79}) + (\beta_{16} \text{Age 80 plus}) + (\beta_{17} \text{Age 5-9 Female}) + (\beta_{18} \text{Age 10-14 Female}) + (\beta_{19} \text{Age 15-19 Female}) + (\beta_{20} \text{Age 20-24 Female}) + (\beta_{21} \text{Age 25-29 Female}) + (\beta_{22} \text{Age 30-34 Female}) + (\beta_{23} \text{Age 35-39 Female}) + (\beta_{24} \text{Age 40-44 Female}) + (\beta_{25} \text{Age 45-49 Female}) + (\beta_{26} \text{Age 50-54 Female}) + (\beta_{27} \text{Age 55-59 Female}) + (\beta_{28} \text{Age 60-64 Female}) + (\beta_{29} \text{Age 65-69 Female}) + (\beta_{30} \text{Age 70-74 Female}) + (\beta_{31} \text{Age 75-79 Female}) + (\beta_{32} \text{ Age 80 plus Female}) + (\beta_{33} \text{CC1}) + (\beta_{34} \text{CC2}) + (\beta_{35} \text{CC3plus}) + (\beta_{36} \text{Ed1}) + (\beta_{37} \text{Ed2}) + (\beta_{38} \text{Ed3}) + (\beta_{39} \text{Ed4}) + (\beta_{40} \text{Ed5}) + (\beta_{41} \text{Inc1}) + (\beta_{42} \text{Inc2}) + (\beta_{43} \text{Inc3}) + (\beta_{44} \text{Inc4}) + (\beta_{45} \text{Inc5}) + (\beta_{46} \text{Inc6}) + (\beta_{47} \text{Inc7}) + (\beta_{48} \text{Inc8}) + (\beta_{49} \text{BMI1}) + (\beta_{50} \text{BMI2}) + (\beta_{51} \text{BMI3}) + (\beta_{52} \text{BMI4}) + (\beta_{53} \text{Smk1}) + (\beta_{54} \text{Smk2}) + (\beta_{55} \text{Smk3}) + (\beta_{56} \text{Drnk1}) + (\beta_{57} \text{Drnk2}) + (\beta_{58} \text{Exer1}) + (\beta_{59} \text{Exer2}) + (\beta_{60} \text{Exer3}) + (\beta_{61} \text{HS1}) + (\beta_{62} \text{HS2}) + (\beta_{63} \text{HS3})$$

Reference Categories: CC0, Ed0, Inc0, BMI0, Smk0, Drnk0, Exer0, HS0

Where: CC [0 – zero chronic conditions; 1 - patients with one chronic condition; 2 - patients with two chronic conditions; 3 plus - patients with three or more chronic conditions]
Ed [0 – high school education; 1 - education less than high school; 2 – trade diploma; 3 – some university; 4 – bachelor degree; 5 – bachelor degree plus]
Inc [0 – income of $40,000-50,000; 1 – income of $0-10,000; 2 – income of $10,000-20,000; 3 – income of $20,000-30,000; 4 – income of $30,000-40,000; 5 – income of $50,000-60,000; 6 – income of $60,000-70,000; 7 - $70,000-80,000, 8 - Income missing values;]
BMI [0 – BMI of 20-26 (ok weight); 1 - BMI Less than 20 (underweight); 2 - BMI of 27-29 (overweight); 3 - BMI 30 plus (obese); 4 – BMI missing values]

Smk [0 – non-smoker; 1 - smokes 1-9/day; 2- smokes 10-19/day; 3 - smokes 20 plus/day]
Drnk [0 – non-drinker; 1 - 1-2 drinks/day, 2 - 3 plus drinks/day]
Exer [monthly frequency of physical activity > 15 minutes: 0 – 0/month; 1- 1-10/month; 2 - 11-20/month; 3 - 21-30/month, 4 - 31 plus/month]
HS [Self assessed health status: 0 – Good; 1- Excellent; 2 – Fair; 3 – Poor]

Table 4

CCHS Variables

Variable	**Categories**
Age	05-09, 10-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, 80 plus
Gender	Male, Female
Number of Chronic Conditions	0, 1, 2, 3 plus
Level of Education	Less than high school, High school, Trade diploma, Some university, Bachelor degree, Bachelor plus
Income	\$0-10,000, \$10,000-20,000, \$20,000-30,000, \$30,000-40,000, \$40,000-50,000, \$50,000-60,000, \$60,000-70,000 \$70,000-80,000, Income missing values
Body Mass Index	Less than 20 (underweight), 20-26 (ok weight), 27-29 (overweight), 30 plus (obese), BMI missing values
Smoking	Non-smoker, 1-9/day, 10-19/day, 20 plus/day
Drinking	Non-drinker, 1-2/day, 3 plus/day
Monthly frequency of Physical Activity > 15 minutes	0, 1-10, 11-20, 21-30, 31 plus
Self Assessed Health Status	Excellent, Good, Fair Poor

The regression analyses for the MCP, AHS, and CCHS are used in order to compare statistical outcomes between three independent databases and increase the scientific rigor. Comparing the regression results from three databases, rather than using just one (or even two) allows us to more confidently determine which needs factors are effective predictors of GP resource consumption. These findings are a key preliminary step in the creation of a needs-based allocation formula. It will then be possible to measure the occurrence of the statistically significant predictor characteristics of the individuals in the RHAs. Then by summing the predicted GP dollar value consumed of each person in the region population, it will be possible to calculate a prospective value of GP resource usage per RHA. This gives a needs-based prediction of the relative need of resources by region. Measuring the occurrence of these characteristics in each RHA and determining value of GP resource utilization per health authority is beyond the scope of this research.

SPSS statistical software was used to carry out the Ordinary Least Squares (OLS) analysis.

CHAPTER 4

Results

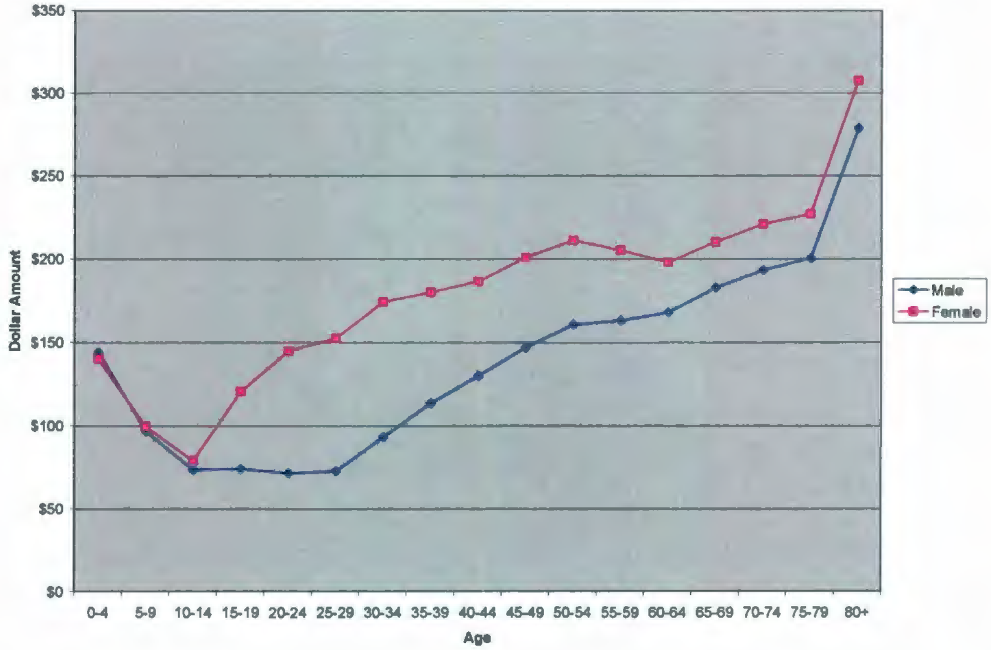
The research findings are presented in the order in which the need-factors were added to the regression. We begin with a relatively simple model of age and gender and progress to include chronic conditions, BMI, health practices, socioeconomic status indicators, and self assessed health status. A description of the results from the MCP, CCHS, and AHS analyses are reported along with a comparison between datasets.

4.1 Age and Gender

4.1.1 MCP.

The Medical Care Plan administration database contains over three million observations collected from 1996 to 2004; each case representing the annual FFS GP use in dollars spent. This database is not representative of the general population, but represents only the population that is serviced by FFS GPs in Newfoundland and Labrador. Multiple linear regression was used to measure the relationship between age and gender and the value of FFS GP resources used by each age/gender group. Figure 1 illustrates the dollar value of GP resources consumed by each age/gender group. This figure shows a distinct difference between each age/gender profile. The male and female values are very similar from ages 0 to 14. There is a steep decline in dollars used from birth to the beginning of adolescence. When females enter the child bearing years a vast difference is evident when compared to the male groups of the same age. Around the ages of 50-54 where women are beyond child bearing years, the difference between male and female values becomes less pronounced.

Figure 1. MCP administration data dollar amount of general practitioner resources consumed by age and gender



Male utilization patterns remain relatively constant between the ages of 10 and 29 where they then enter a linear increase in FFS GP resources used into the 75-79 age group. The 80 plus age group for both genders shows a pronounced increase from 75-79. The males increase from $200.32 in the 75-79 group to $278.40 in the 80 plus group. Females increase from $226.85 in the 75-79 group to $307.25 in the 80 plus group. That is a difference of $78.08 and $80.40 for men and women respectively.

In order to gain additional information on this result, the MCP data set was analyzed per individual year of administration data. Figure 2 illustrates the male and Figure 3 illustrates the female MCP values separated by year from 1996 to 2004. It is evident from these figures that age group 75-79 begins to decline over time, especially for males. Over the nine years of observation GP utilization from 75-79 decreases over $100 for both males and females. Age 80 plus however, remains within about $50 for males from 1996 to 2004 and therefore causes a larger spike over time at the end of the graph. As described in the methodology section of this paper, for those in the 80 plus age group with no physician visits, we determined the last year that they went to a GP and then dropped them from the analysis for the subsequent years. We are assuming that people who are in this age group and not seeing a GP have likely moved out of the province, are seeing a specialist or salary paid physician, or have died. This strategy was not implemented for the 75-79 group and may be the reason for the larger discrepancies between it and the 80 plus group over time.

Figure 2. Male MCP administration data per year

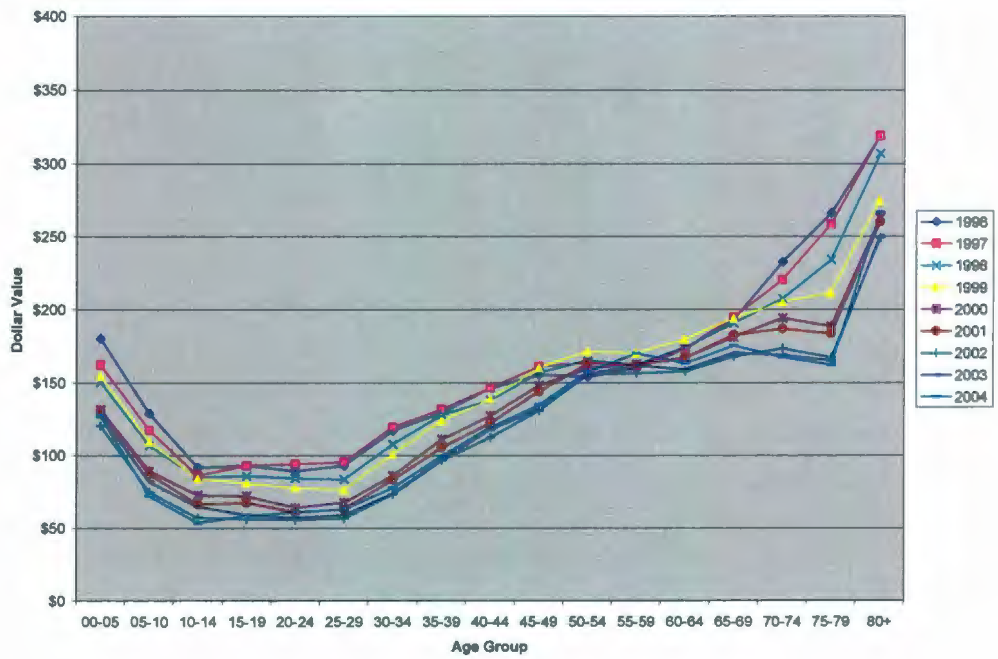
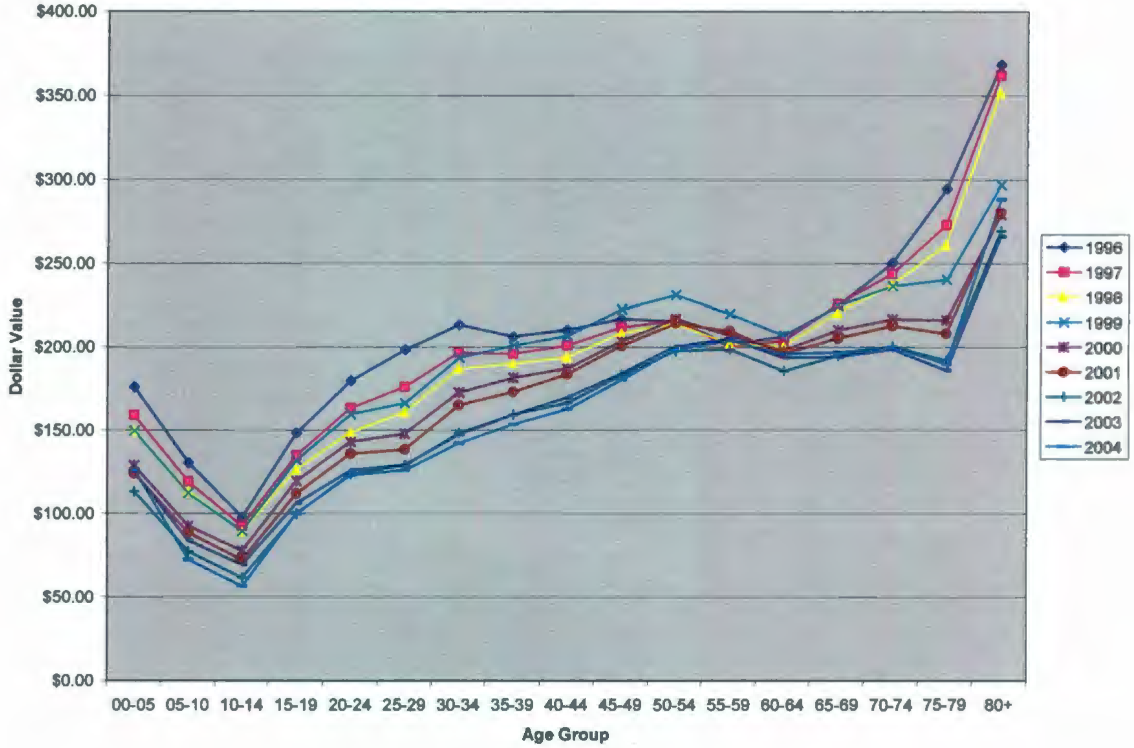


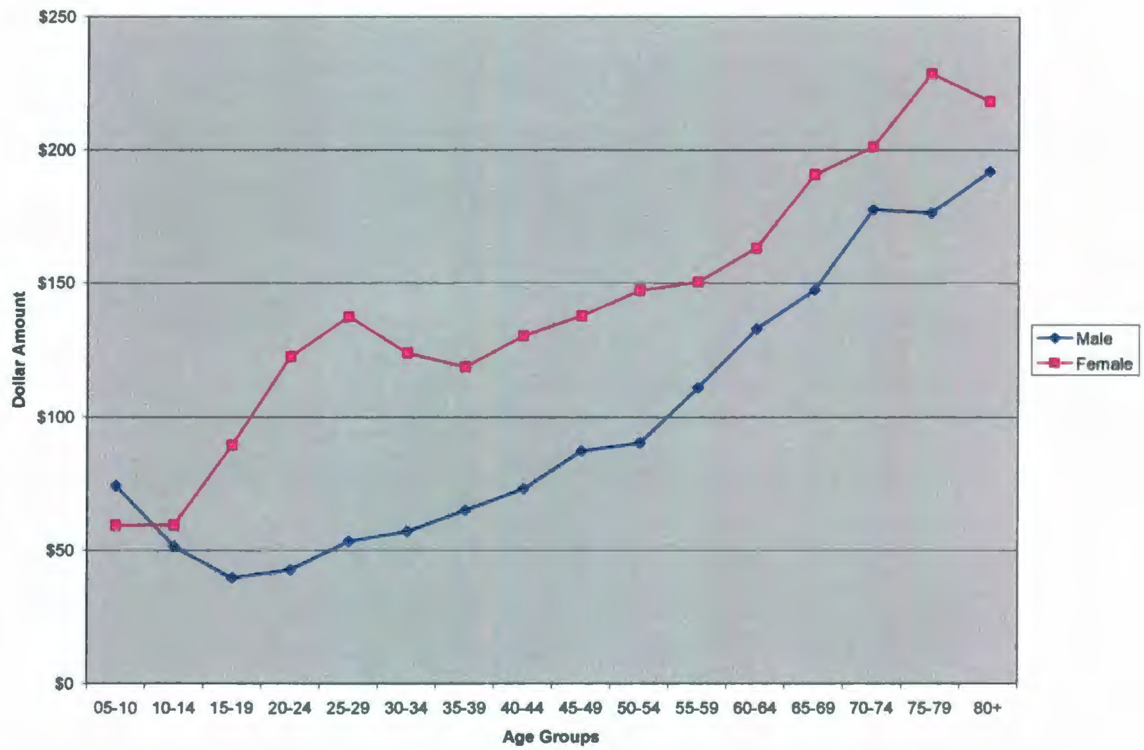
Figure 3. Female MCP administration data per year



4.1.2 CCHS.

The age/gender profile of the CCHS data, illustrated in Figure 4, shows a similar pattern to the MCP with the females consuming a consistently higher value of GP resources throughout their child-bearing years. Note that the starting age group is 5-10 as data were not available for earlier ages. The female group shows an unexpected spike at 75-79.

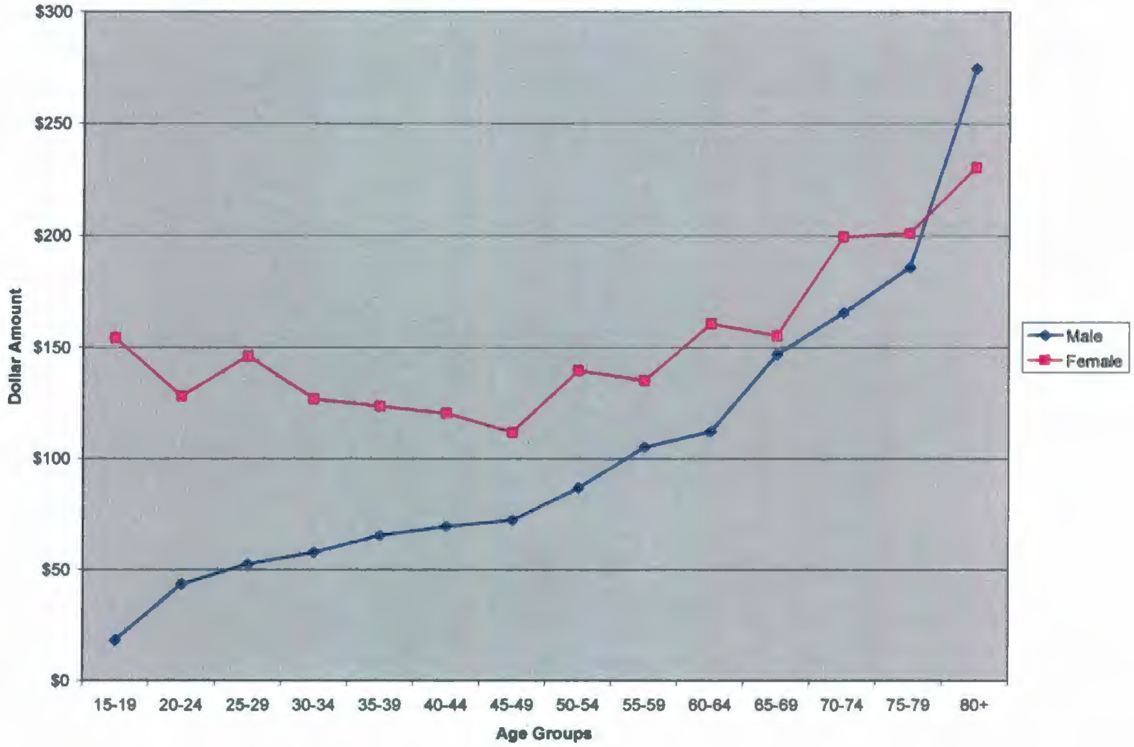
Figure 4. CCHS respondents MCP utilization of GP resources by age and gender



4.1.3 AHS.

The Newfoundland Panel on Health and Medical Care - Adult Health Survey analysis shows a consistent pattern with the MCP and CCHS regressions. Figure 5 shows the age/gender GP resource consumption of the participants of the survey. Note the starting age group is 15-19. Female utilization remains consistently higher than males throughout child-bearing years and then eventually converges in post child-bearing years.

Figure 5. AHS respondents GP resource utilization by age and gender



4.1.4 *MCP, CCHS, and AHS comparison.*

Table 5 summarizes the MCP, CCHS and AHS age/gender regressions. All models are run without constants to facilitate easier interpretation of the results. The beta value is the dollar amount of general practitioner resources used per group. To determine the dollar amount for males, simply use the beta value from their age group. The coefficient for the female groups is the difference in means for the females versus the males in the same age group. To determine the annual dollar value of GP resources used for females, the beta value from their corresponding male age group must be added to the beta value from the female age group. For example, according to the MCP administration database, a 21 year old male would be expected to consume $71.48, whereas a 21 year old female would be expected to consume \$144.71 (\$71.48 + \$73.23). The 't-stat' is the statistical significance of the reported beta value. A blank cell on the table depicts a category not available from the dataset. The n value (number of observations) represents the number of person years included in the regression analysis. The adjusted R^2 is the explanatory power of the independent variables in the regression.

Table 5

Age, Gender Regressions

	Variables	MCP		CCHS		AHS	
		Beta value	**T-stat**	**Beta value**	**T-stat**	**Beta value**	**T-stat**
Mean Betas For Males	Male AGE 0-4	$144.07**	208.59				
	Male AGE 5-9	$96.93**	147.49	$74.17**	7.83		
	Male AGE 10-14	$73.56**	114.22	$51.43**	10.07		
	Male AGE 15-19	$74.10**	114.34	$39.68**	8.16	$18.02	0.37
	Male AGE 20-24	$71.48**	109.48	$42.81**	7.12	$43.28**	6.22
	Male AGE 25-29	$72.81**	111.30	$53.39**	9.23	$52.27**	7.12
	Male AGE 30-34	$93.35**	143.25	$57.05**	11.16	$57.58**	8.19
	Male AGE 35-39	$113.73**	177.86	$65.02**	13.65	$65.07**	9.63
	Male AGE 40-44	$129.84**	206.33	$73.05**	15.47	$69.19**	10.73
	Male AGE 45-49	$146.92**	234.11	$87.33**	18.71	$71.90**	10.64
	Male AGE 50-54	$160.63**	250.90	$90.32**	19.35	$86.44**	10.44
	Male AGE 55-59	$162.95**	238.30	$111.01**	20.93	$105.07**	11.30
	Male AGE 60-64	$167.84**	226.23	$132.87**	20.96	$112.19**	11.23
	Male AGE 65-69	$182.74**	231.74	$147.41**	21.05	$146.88**	13.27
	Male AGE 70-74	$193.32**	229.64	$177.27**	22.93	$165.39**	14.17
	Male AGE 75-79	$200.32**	217.99	$176.14**	19.91	$185.95**	12.40
	Male AGE 80+	$278.40**	279.13	$191.71**	18.39	$274.52**	14.87
Difference In Mean For Females Versus Males	Female AGE 0-4	-$4.11**	-4.14				
	Female AGE 5-9	$2.52**	2.68	-$14.83	-1.10		
	Female AGE 10-14	$5.40**	5.91	$7.97	1.12		
	Female AGE 15-19	$46.35**	52.29	$49.79**	7.54	$136.05*	2.09
	Female AGE 20-24	$73.23**	83.92	$79.72**	10.07	$84.63**	8.70
	Female AGE 25-29	$79.41**	91.01	$84.05**	11.15	$93.71**	9.38
	Female AGE 30-34	$80.78**	92.87	$66.82**	9.92	$69.16**	7.29
	Female AGE 35-39	$66.12**	76.96	$53.68**	8.46	$58.44**	6.36
	Female AGE 40-44	$56.59**	66.25	$57.23**	9.09	$51.12**	5.76
	Female AGE 45-49	$53.79**	62.51	$50.40**	7.93	$39.82**	4.27
	Female AGE 50-54	$50.39**	56.75	$56.90**	8.83	$53.02**	4.63
	Female AGE 55-59	$42.10**	43.90	$39.37**	5.50	$29.84*	2.27
	Female AGE 60-64	$30.04**	28.74	$30.14**	3.61	$48.16**	3.39
	Female AGE 65-69	$27.27**	24.68	$43.25**	4.80	$8.11	0.54
	Female AGE 70-74	$27.39**	23.52	$23.73*	2.42	$34.02*	2.09
	Female AGE 75-79	$26.53**	21.29	$52.30**	4.55	$15.13	0.77
	Female AGE 80+	$28.85**	23.16	$26.28*	1.99	-$44.14	-1.93
** = Significance at 1%		n =	3,112,813	n =	29,809	n =	9,230
* = Significance at 5%		Adj R^2 =	0.391	Adj R^2 =	0.359	Adj R^2 =	0.383

Figure 6 and Figure 7 illustrate the dollar amount the male groups and the female groups consume in each dataset, respectively. The CCHS and the AHS overlap for much of both of the figures. The MCP database values are higher than the health survey values on Figures 6 and 7. Figure 8 and figure 9 however, illustrate the *relative* value of FFS GP resources consumed by age/gender. The relative value is calculated by first determining the average amount of GP resources used per person by all people in a dataset, regardless of age and gender. Each age group beta value is then divided by this amount to give a value relative to the mean. As illustrated by Figures 8 and 9, the relative values bring all three of datasets closer together and eliminates the gap between MCP and the two health surveys. The underlying relative values are displayed in Table 6. This allows us to compare trends in GP use, rather than simply the absolute dollar amount.

Figure 6. MCP, CCHS, AHS male dollar value of GP resources consumed

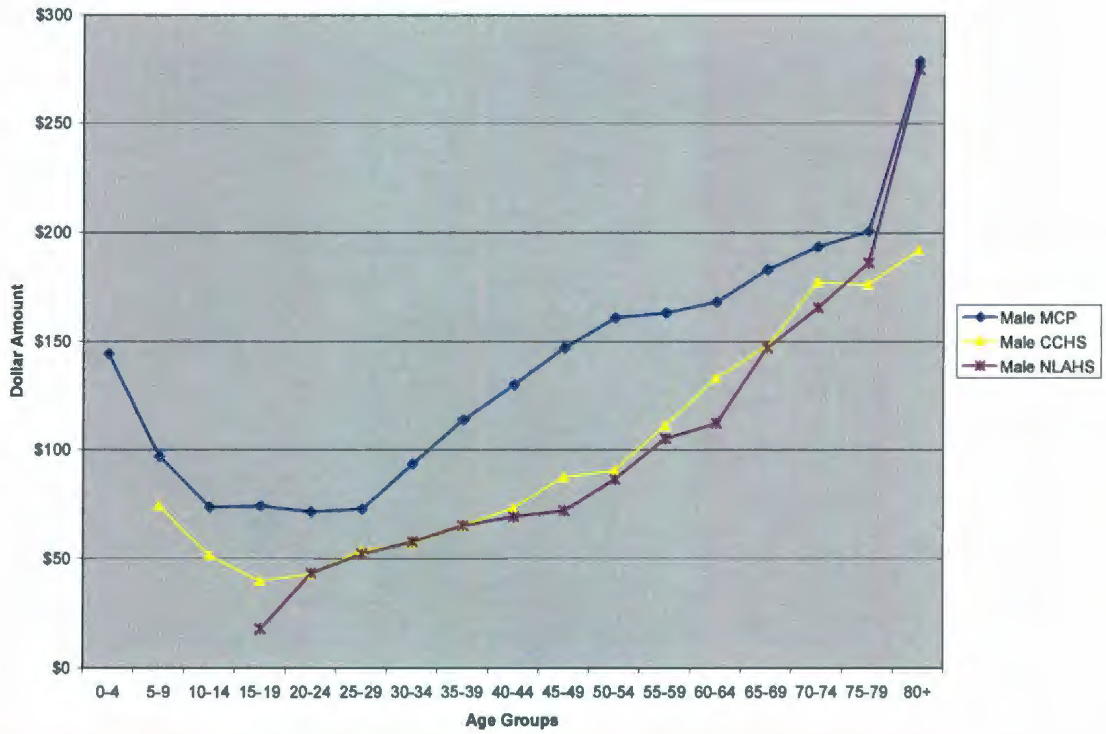


Figure 7. MCP, CCHS, AHS female dollar value of GP resources consumed

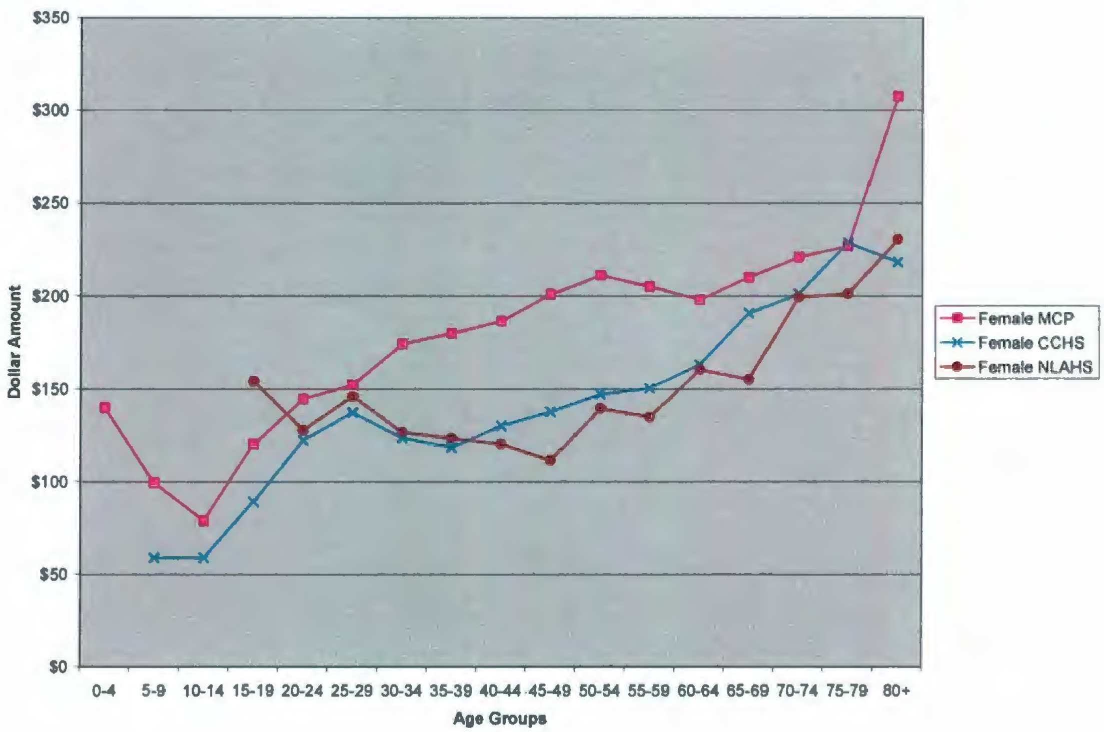


Figure 8. Male relative value of GP resources consumed by dataset

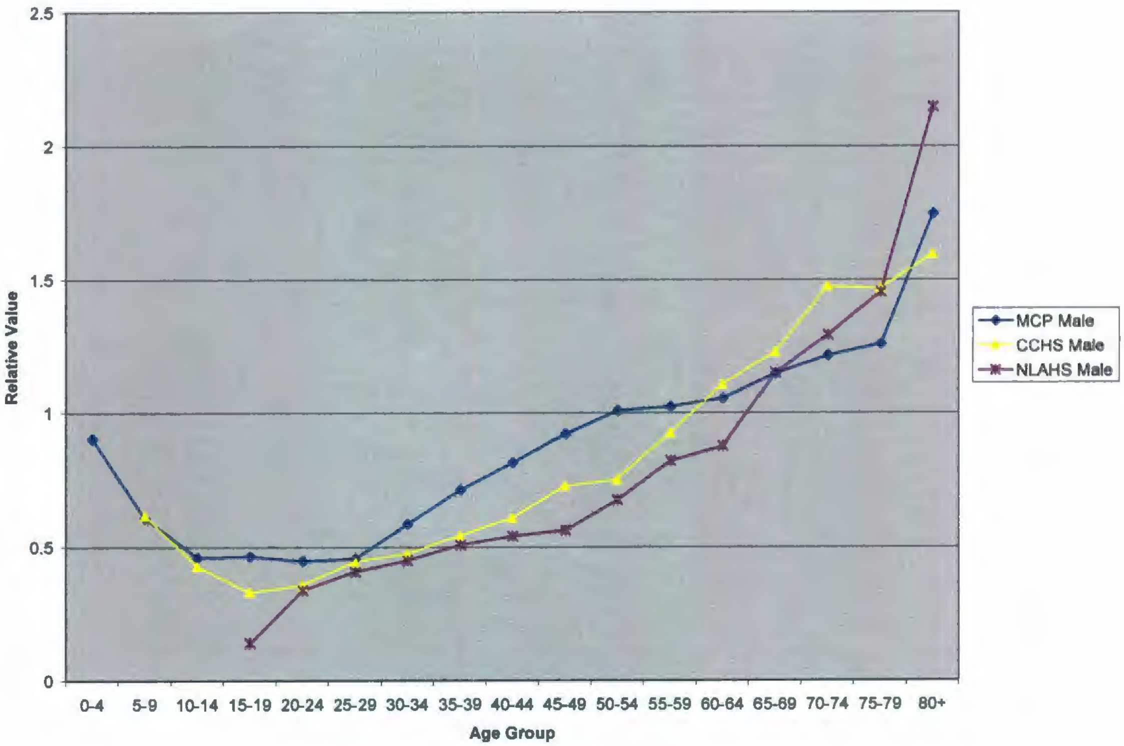


Figure 9. Female relative value of GP resources consumed by dataset

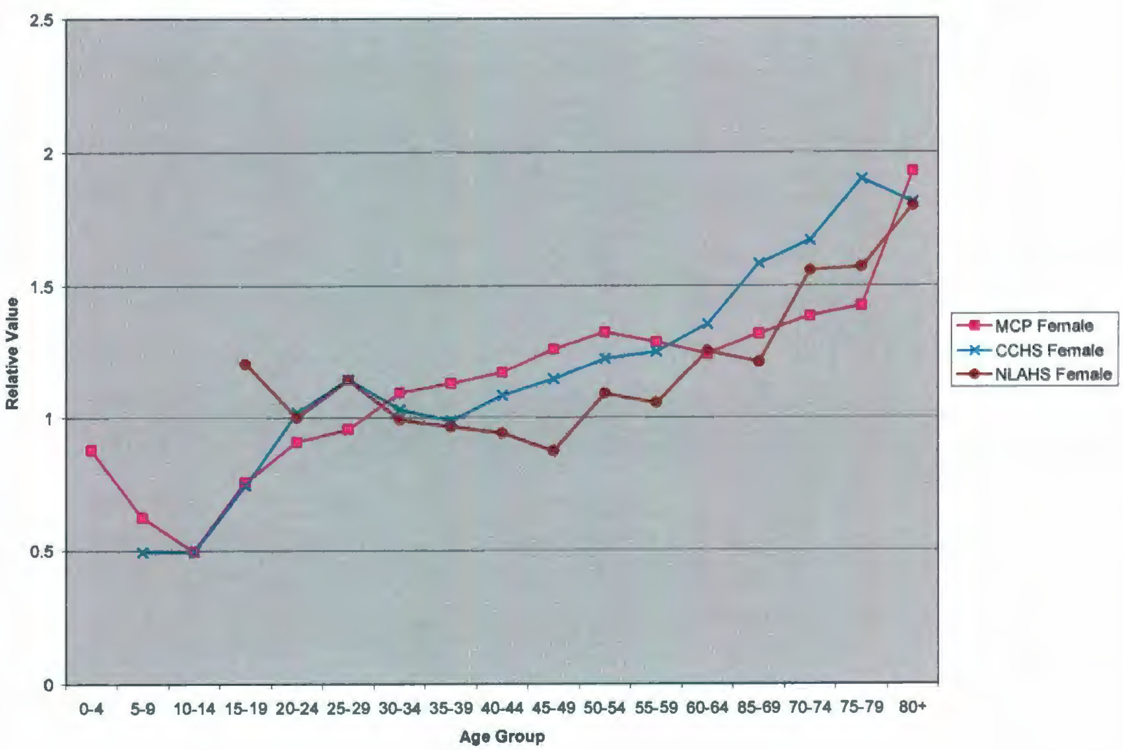


Table 6

Relative Values of GP Resources Consumed

Variables	MCP		CCHS		AHS	
	Male	Female	Male	Female	Male	Female
AGE 0-4	0.904	0.878				
AGE 5-9	0.608	0.624	0.617	0.494		
AGE 10-14	0.462	0.495	0.428	0.494		
AGE 15-19	0.465	0.756	0.330	0.744	0.141	1.203
AGE 20-24	0.448	0.908	0.356	1.019	0.338	0.999
AGE 25-29	0.457	0.955	0.444	1.143	0.408	1.140
AGE 30-34	0.586	1.093	0.474	1.030	0.450	0.990
AGE 35-39	0.714	1.129	0.541	0.987	0.508	0.965
AGE 40-44	0.815	1.170	0.607	1.083	0.540	0.940
AGE 45-49	0.922	1.259	0.726	1.145	0.562	0.873
AGE 50-54	1.008	1.324	0.751	1.224	0.675	1.089
AGE 55-59	1.022	1.287	0.923	1.251	0.821	1.054
AGE 60-64	1.053	1.242	1.105	1.356	0.876	1.253
AGE 65-69	1.147	1.318	1.226	1.585	1.147	1.211
AGE 70-74	1.213	1.385	1.474	1.671	1.292	1.558
AGE 75-79	1.257	1.423	1.465	1.900	1.453	1.571
AGE 80+	1.747	1.928	1.594	1.813	2.144	1.800

4.2 Age, Gender and Number of Chronic Conditions

The MCP administration dataset includes only information on age and gender and will therefore be excluded from the remaining results. Table 7 reports the beta values and t-statistics for the CCHS and AHS age, gender and number of chronic conditions regression. Calculating the value of GP resources used is similar across all of the regressions. New variables are entered into the model as sets of dummy variables with an omitted reference category (as identified in Chapter 3). Since the main objective is to use these results for prediction, we can simply use the age variable to predict the utilization values for males with reference category characteristics. If a male has one, two, or three or more chronic conditions, the beta value from the corresponding chronic condition variable will be added to the appropriate age category. In each table the column furthest on the left describes the variables included for each category. Below is a step by step example for a 30 year old female with two chronic conditions using the CCHS analysis:

1. Select the appropriate age category (30-34) = $38.88
2. Select the female category of the proper age (30-34) = $56.37
3. Select the proper number of chronic conditions (2 chronic conditions) = $42.40
4. Add all three beta values together (38.88 + 56.37 + 42.40) = $137.65

If this individual had zero chronic conditions, the value added in Step 3 would equal because Step 1 includes those with zero chronic conditions.

Table 7

Age, Gender, Number of Chronic Conditions (CC) Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With Zero CC	Male AGE 5-9	58.59**	6.26		
	Male AGE 10-14	36.45**	7.16		
	Male AGE 15-19	25.33**	5.23	-8.63	-0.18
	Male AGE 20-24	28.08**	4.71	21.87**	3.12
	Male AGE 25-29	36.06**	6.27	26.29**	3.54
	Male AGE 30-34	38.88**	7.61	30.89**	4.35
	Male AGE 35-39	46.57**	9.75	34.90**	5.03
	Male AGE 40-44	52.85**	11.10	36.62**	5.50
	Male AGE 45-49	61.50**	12.94	33.08**	4.72
	Male AGE 50-54	60.03**	12.56	45.02**	5.32
	Male AGE 55-59	77.18**	14.29	52.67**	5.57
	Male AGE 60-64	91.44**	14.22	57.55**	5.68
	Male AGE 65-69	102.39**	14.43	85.66**	7.65
	Male AGE 70-74	132.24**	16.97	96.87**	8.21
	Male AGE 75-79	127.20**	14.35	110.02**	7.35
	Male AGE 80+	144.13**	13.89	206.57**	11.35
Difference In Mean For Females Versus Males With Zero CC	Female AGE 5-9	-13.46	-1.01		
	Female AGE 10-14	6.32	0.90		
	Female AGE 15-19	44.94**	6.92	101.44	1.61
	Female AGE 20-24	71.99**	9.25	67.85**	7.18
	Female AGE 25-29	75.50**	10.19	84.46**	8.72
	Female AGE 30-34	56.37**	8.51	54.10**	5.88
	Female AGE 35-39	42.03**	6.73	47.01**	5.28
	Female AGE 40-44	43.65**	7.05	39.35**	4.57
	Female AGE 45-49	37.49**	6.00	32.81**	3.63
	Female AGE 50-54	43.56**	6.87	36.28**	3.26
	Female AGE 55-59	25.30**	3.60	24.70	1.94
	Female AGE 60-64	20.88*	2.54	38.38**	2.79
	Female AGE 65-69	35.03**	3.96	1.58	0.11
	Female AGE 70-74	14.42	1.50	27.61	1.75
	Female AGE 75-79	47.25**	4.18	17.54	0.92
	Female AGE 80+	15.01	1.16	-50.70*	-2.29
Difference in mean for having a CC versus Zero CC	1 Chronic Condition	20.84**	8.62	23.91**	5.64
	2 Chronic Conditions	42.40**	15.46	42.58**	9.08
	3 plus Chronic Conditions	93.40**	32.61	104.34**	23.69
		n =	29,809	n =	9,230
		Adj R^2 =	0.382	Adj R^2 =	0.421

** = Significance at 1%

* = Significance at 5%

As illustrated in Figure 10 and Figure 11, the results show that when the number of chronic conditions increases, the consumption of GP resources becomes proportionally higher. For the CCHS $20.84, $42.40, $93.40 will be added for one, two and three plus chronic conditions respectively in comparison with those with zero chronic conditions. In the AHS $23.91, $42.58, and $104.34 will be added for one, two and three plus chronic conditions. Figure 10 and Figure 11 show how the male and female GP utilization pattern evolves with the addition of more chronic conditions. A pronounced leap in the trend is noticed at the three plus chronic conditions.

Figure 10. CCHS respondents relative utilization of GP resources according to age, gender and number of chronic conditions.

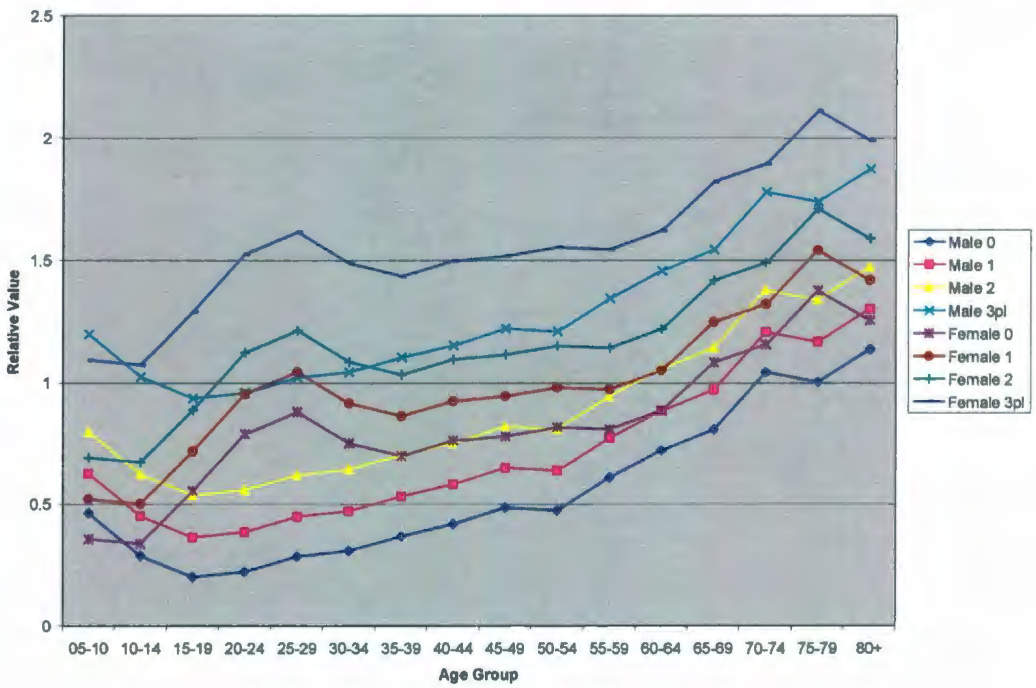
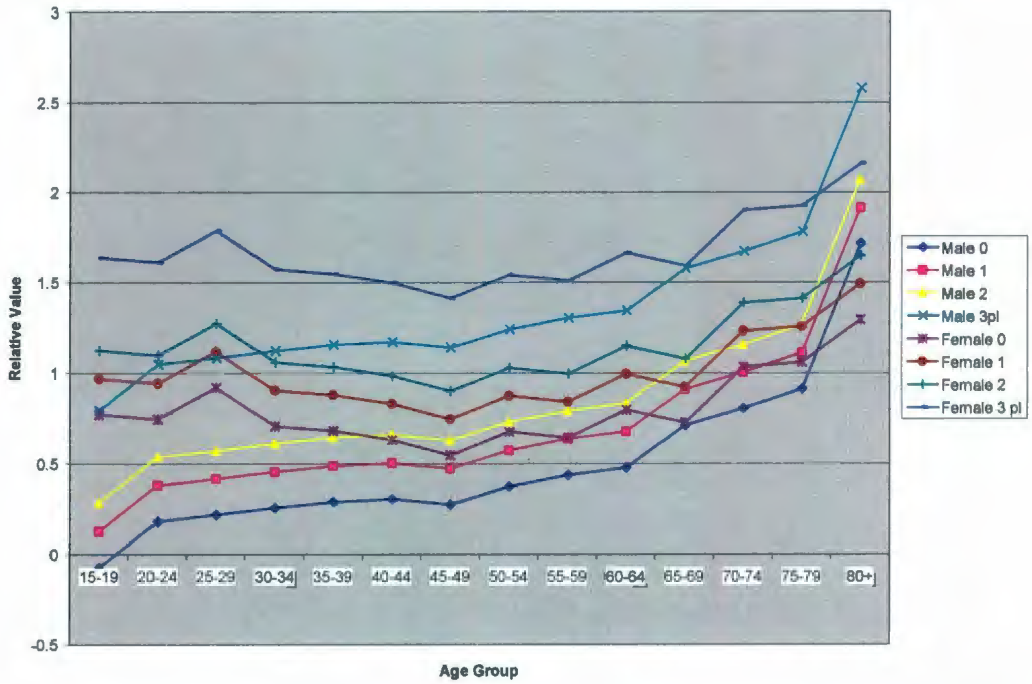


Figure 11. AHS respondents relative utilization of GP resources according to age, gender and number of chronic conditions



The explanatory power increases from 0.359 in the CCHS age and gender regression to 0.382 with the addition of number of chronic conditions to the regression. For the AHS the explanatory power increases from 0.383 to 0.421. Therefore, by adding the number of chronic conditions into the regression we strengthen the explanatory power by 0.023 and 0.038 in the CCHS and the AHS, respectively.

Figure 12 and Figure 13 show the comparison of the relative values of the CCHS and the AHS separated by gender. As illustrated, the relative values of each age/gender profile are very similar between the two data sets with the zero to two chronic conditions close together and the three plus chronic conditions substantially higher, reflecting the cumulative impact of multiple chronic conditions on need for GP services.

Figure 12. CCHS and AHS male comparison of relative GP resource utilization according to age and number of chronic conditions

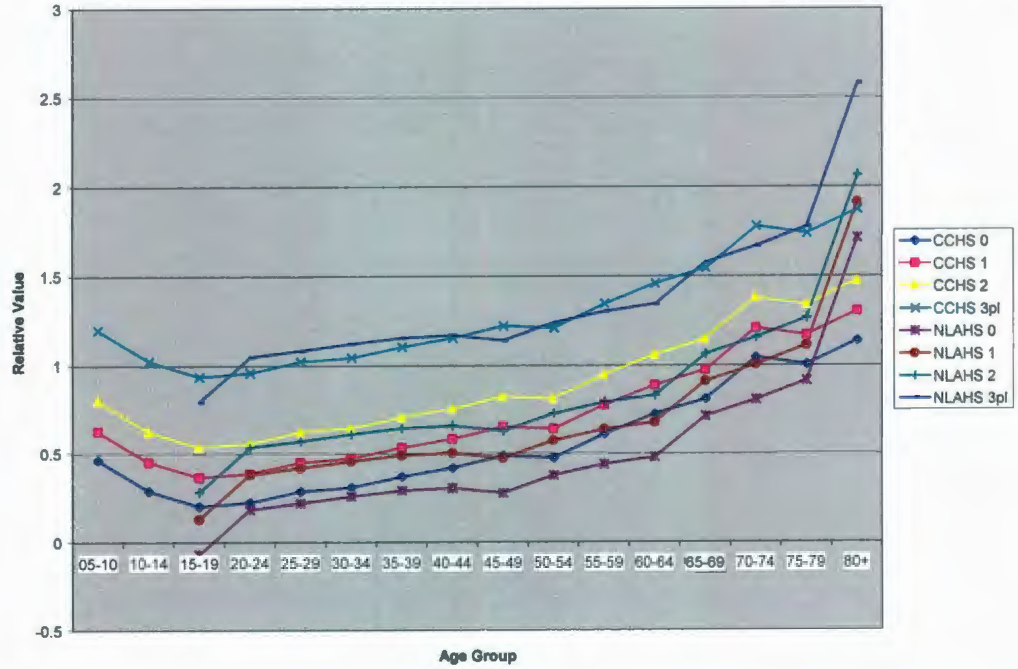
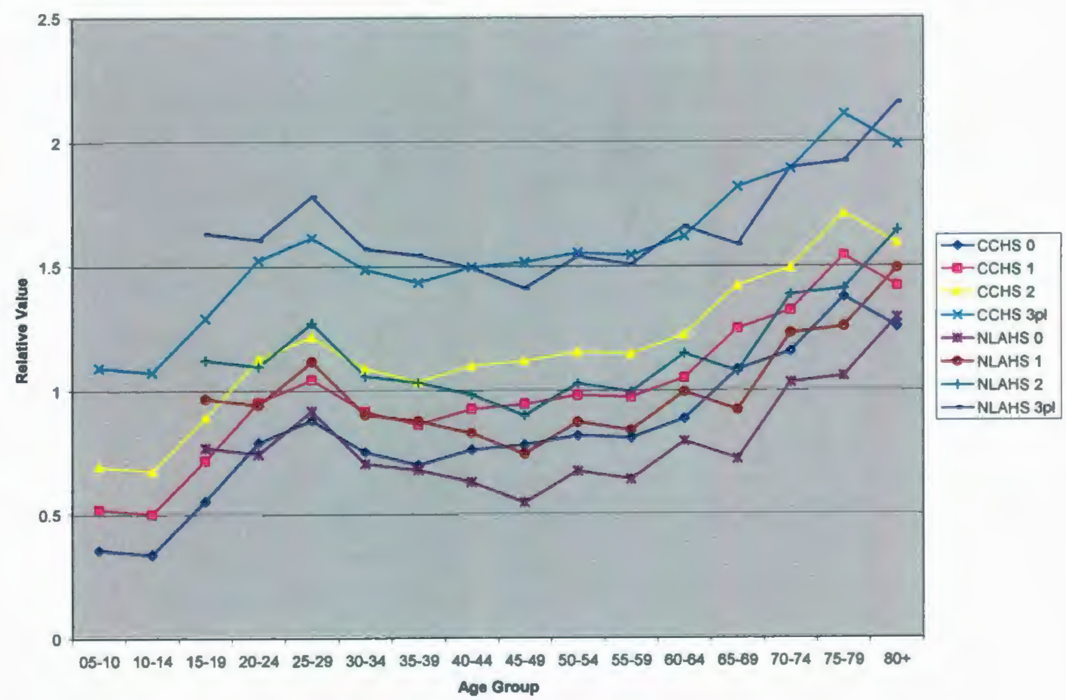


Figure 13. CCHS and AHS female comparison of relative GP resource utilization according to age and number of chronic conditions



4.3 Age, Gender, Number of Chronic Conditions, and Body Mass Index

The addition of body mass index into the regressions did not substantially affect the pre-existing beta-values (age, gender and number of chronic conditions). Table 8 shows the regression summary for the age, gender, number of chronic conditions and body mass index. The 'ok weight' variable was excluded as the reference category and as such the included BMI coefficients should be interpreted as the difference in observed utilization for that BMI classification. The explanatory power for both the CCHS and the AHS increased by 0.001, to 0.383 and 0.422 respectively.

Table 8

Age, Gender, Number of Chronic Conditions and Body Mass Index Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With Zero CC & 'OK Weight'	Male AGE 5-9	58.65**	5.75		
	Male AGE 10-14	36.44**	5.63		
	Male AGE 15-19	24.31**	4.18	-8.45	-0.18
	Male AGE 20-24	24.15**	3.95	22.21**	3.13
	Male AGE 25-29	30.89**	5.26	26.75**	3.55
	Male AGE 30-34	34.25**	6.55	31.30**	4.34
	Male AGE 35-39	42.57**	8.67	35.49**	4.99
	Male AGE 40-44	48.81**	9.92	37.34**	5.42
	Male AGE 45-49	56.80**	11.53	33.72**	4.69
	Male AGE 50-54	54.98**	11.15	45.85**	5.34
	Male AGE 55-59	72.44**	13.15	53.64**	5.61
	Male AGE 60-64	88.51**	13.27	58.87**	5.76
	Male AGE 65-69	101.72**	12.82	86.53**	7.67
	Male AGE 70-74	132.27**	15.08	97.38**	8.20
	Male AGE 75-79	127.24**	13.07	110.69**	7.38
	Male AGE 80+	144.20**	12.96	207.32**	11.39
Difference In Mean For Females Versus Males	Female AGE 5-9	-13.48	-1.01		
	Female AGE 10-14	6.12	0.88		
	Female AGE 15-19	43.59**	6.72	98.00	1.55
	Female AGE 20-24	69.85**	8.97	65.96**	6.94
	Female AGE 25-29	73.72**	9.93	83.27**	8.58
	Female AGE 30-34	54.64**	8.23	52.96**	5.74

	Female AGE 35-39	40.77^{**}	6.52	46.19^{**}	5.17
	Female AGE 40-44	43.02^{**}	6.94	38.04^{**}	4.40
	Female AGE 45-49	37.63^{**}	6.02	31.99^{**}	3.53
	Female AGE 50-54	44.01^{**}	6.94	35.30^{**}	3.17
	Female AGE 55-59	25.38^{**}	3.61	23.60	1.85
	Female AGE 60-64	20.60^{*}	2.51	36.12^{**}	2.63
	Female AGE 65-69	35.18^{**}	3.98	0.78	0.05
	Female AGE 70-74	14.47	1.5	26.85	1.70
	Female AGE 75-79	47.29^{**}	4.19	16.74	0.88
	Female AGE 80+	15.02	1.16	-52.55^{*}	-2.37
Difference in Mean for Having a CC Versus Zero CC	1 Chronic Condition	21.46^{**}	8.88	23.76^{**}	5.60
	2 Chronic Conditions	42.53^{**}	15.51	42.09^{**}	8.97
	3 pl Chronic Conditions	93.47^{**}	32.5	103.78^{**}	23.49
Difference in Mean for Not Having 'OK Weight'	Underweight	42.12^{**}	7.52	8.64	1.17
	Overweight	10.53^{**}	3.61	-8.30^{*}	-2.07
	Obese	3.29	1.15	8.82^{*}	2.10
	BMI missing value	-0.25	-0.06		
		n =	29,809	n =	9,230
		Adj R^2 =	0.383	Adj R^2 =	0.422

** = Significance at 1%
* = Significance at 5%

For the CCHS values, people classified as 'underweight', 'overweight' and 'obese' would be allocated an additional \$42.53, \$10.53, \$3.28, respectively. In the AHS they would be allocated \$8.64 for 'underweight', and \$8.83 if in the 'obese' group. An interesting observation is that according to the AHS a person in the 'overweight' group would be allocated \$8.30 less than someone classified as 'ok weight'. It should be noted however that all three AHS BMI categories do not achieve statistical significance at the 99% level. Only the 'overweight' and 'obese' categories are significant at the 95% level. Given that the gains in explanatory power using BMI are weak and the effects are inconsistent across the database, it would not appear that BMI is a particularly strong predictor of utilization after controlling for chronic conditions, age and gender. However the effects are significant and as such we will include the BMI measures in subsequent utilization estimations.

4.4 Age, Gender, Number of Chronic Conditions, Body Mass Index, and Health Practices

The term 'health practices' incorporates the number of cigarettes smoked per day, the number of alcoholic beverages consumed per day, and the participant's level of physical activity.

In the health practice models, the variables indicating no tobacco or alcohol consumption and no physical activity are left out as the reference variables. The results are not what one might expect. One would hypothesize that the more a person smokes or drinks alcohol, the more GP resources they would use. Conversely, one could assume that the more a person exercises the less GP resources they would require. Table 9 shows that the data does not reflect such assumptions in this regression, however the statistical significance of each value should be considered. A person that smokes 1-9 cigarettes per day would use an additional $17.18 annually of GP resources than a non-smoker according to the CCHS. However, someone that smokes 10-19 cigarettes per day or 20 plus will actually use $2.28 and $7.60 less than a non-smoker. For the CCHS respondents that drink alcohol, according to the data, a person that drinks 1 to 2 drinks a day will consume $8.30 less than a non-drinker and a person that drinks 3 or more per day will consume $23.35 less. Although some studies show health benefits from low to moderate levels of alcohol consumption, such as reduced risk of heart disease, alcohol consumption is strongly linked to hypertension, stroke, and other vascular disease (Puddy & Beilin, 2006). Therefore we would still expect a deleterious health effect for those drinking 3 or more alcoholic beverages per day, however this does not appear to translate into greater GP resource utilization. One possible explanation of this effect is that individuals with high levels of alcohol and tobacco consumption place less value in their health and as such are less likely to seek medical care when they are unwell.

Table 9

Age, Gender, Number of Chronic Conditions, Body Mass Index, Health Practices Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With: Zero CC, OK Weight, Non-smoker, Non-drinker, No Exercise	Male AGE 5-9	73.41**	7.02		
	Male AGE 10-14	52.56**	7.57		
	Male AGE 15-19	42.15**	6.63	19.85	0.42
	Male AGE 20-24	42.98**	6.50	49.28**	5.51
	Male AGE 25-29	49.33**	7.76	53.25**	5.74
	Male AGE 30-34	53.39**	9.19	58.51**	6.44
	Male AGE 35-39	61.90**	11.27	62.27**	6.91
	Male AGE 40-44	67.91**	12.43	63.83**	7.26
	Male AGE 45-49	75.31**	13.85	59.52**	6.62
	Male AGE 50-54	72.97**	13.46	70.92**	7.03
	Male AGE 55-59	89.68**	15.10	78.07**	7.18
	Male AGE 60-64	105.44**	14.97	81.89**	7.20
	Male AGE 65-69	118.79**	14.40	108.25**	8.81
	Male AGE 70-74	148.02**	16.42	115.19**	9.09
	Male AGE 75-79	142.06**	14.32	127.22**	8.21
	Male AGE 80+	159.63**	14.15	221.20**	11.90
Difference In Mean For Females Versus Males	Female AGE 5-9	-13.57	-1.02		
	Female AGE 10-14	6.10	0.88		
	Female AGE 15-19	42.52**	6.54	93.84	1.49
	Female AGE 20-24	67.83**	8.68	62.67**	6.57
	Female AGE 25-29	71.96**	9.67	76.88**	7.87
	Female AGE 30-34	51.91**	7.79	46.50**	4.99
	Female AGE 35-39	37.69**	6.00	39.15**	4.33
	Female AGE 40-44	40.23**	6.46	30.06**	3.42
	Female AGE 45-49	34.57**	5.50	23.41*	2.54
	Female AGE 50-54	39.98**	6.27	26.17*	2.32
	Female AGE 55-59	21.15**	3.00	12.81	0.99
	Female AGE 60-64	16.11*	1.96	26.27	1.89
	Female AGE 65-69	29.88**	3.38	-8.81	-0.60
	Female AGE 70-74	9.66	1.00	18.63	1.17
	Female AGE 75-79	42.75**	3.79	7.68	0.40
	Female AGE 80+	7.32	0.57	-61.17**	-2.75

Difference in Mean for Having a CC versus Zero CC	1 Chronic Condition	20.99**	8.68	23.56**	5.57
	2 Chronic Conditions	42.18**	15.38	41.40**	8.83
	3 pl Chronic Conditions	91.99**	31.9	101.95**	23.00
Difference in Mean for Not Having 'OK Weight'	Underweight	41.93**	7.48	6.71	0.90
	Overweight	10.11**	3.45	-8.84*	-2.21
	Obese	2.09	0.73	7.21	1.71
	BMI missing value	-2.98	-0.73		
Difference in Mean Versus Non-smoker, Non-drinker, No exercise	Smoke 1-9	17.18**	3.71	0.05	0.01
	Smoke 10-19	-2.28	-0.70	6.80	1.28
	Smoke 20 plus	-7.61*	-2.41	0.55	0.12
	1-2 Drinks	-8.30**	-3.37	-3.65	-0.82
	3 plus Drinks	-23.35**	-4.33	-13.58**	-2.81
	Phys Act > 15min/mth 1-10	-13.27**	-4.66		
	Phys Act > 15min/mth 11-20	-23.23**	-7.40		
	Phys Act > 15min/mth 21-30	-14.11**	-4.32		
	Phys Act > 15min/mth 31 pl	-11.36**	-3.79		
	At least moderately active			-17.88**	-4.54
		n =	29,809	n =	9,230
		Adj R^2 =	0.385	Adj R^2 =	0.424

** = Significance at 1%
* = Significance at 5%

For physical exercise, we would assume that those who exercise more would use less GP resources. The CCHS results show that those who exercise more than 15 minutes per month use less GP resources than a person that does not exercise. This however, is not a linear decrease in utilization. A person that exercises for more than 15 minutes 11 to 20 times per month requires the least amount of GP resources ($23.23 less than someone that doesn't exercise), while 21-30 times and 31 plus require $14.11 less and $11.36 less than a non-exerciser.

The AHS smoking and drinking results also proved to be inconsistent with expectations. Smoking 1-9, 10-19, and 20 plus cigarettes increased GP use only slightly ($0.05, $6.80 and $0.55 respectively). Harrison, Feehan, Edwards and Segovia (2003) however, also used the AHS and discovered that both current and former smokers strongly show higher hospital and physician utilization rates. Harrison et al. measured hospital and physician use by the number of visits to a hospital (along with the length of stay), the number of visits to a FFS GP and the number of visits to a specialist. A possible reason for the discrepancy between our results and the Harrison et al.'s study is that when a smoker becomes ill, they are often referred to a specialist (such as oncologists, pulmonary specialists etcetera) or maybe hospitalized. Because our study only encompasses GP visits we do not measure the increased number of visits to a hospital or specialist. Therefore we do not record this increase in health care use. It should also be noted that 'years smoked' was not included in this study. It is possible that former smokers will use more health care resources compared to those that have never smoked.

Continuing with the AHS, a drinker of 1-2 drinks and 3 or more drinks per day will use \$3.65 \$13.58 less than a non-drinker. The physical activity measure however, was consistent with what one would expect. It showed that someone living at least a moderately active lifestyle will use \$17.88 less than a person in the sedentary category. Data was not available for the AHS for the number of times a participant exercised for longer than 15 minutes per month.

Again, the lack of significance associated with these anomalies in both datasets should be considered. The CCHS smoking group of 10-19 cigarettes was not statistically significant. In the AHS all of the smoking categories and the category 'drinks 1-2' did not achieve statistical significance at 95%. Therefore the beta values of these statistically insignificant results are not considered to be accurate predictions.

The explanatory power for the CCHS increased from 0.383 to 0.385 and the AHS increased from 0.422 to 0.424, suggesting that health practices has a limited effect on predicted utilization after controlling for age, gender, chronic conditions and BMI. However since some of the categories are statistically significant, we will include these measures in subsequent estimations.

4.5 Age, Gender, Number of Chronic Conditions, Body Mass Index, Health Practices, and Socioeconomic Status

Socioeconomic status (SES) variables included in these regressions are based on income and level of education. The variables indicating an income between $40,000 and $50,000 and having a high school education were excluded as the reference category. Table 10 shows the results for all variable groups.

Table 10

Age, Gender, Number of Chronic Conditions, Body Mass Index, Health Practices, Socioeconomic Status Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With: Zero CC, OK Weight, Non-smoker, Non-drinker, No Exercise, $40-50,000, High School Education	Male AGE 5-9	70.13^{**}	6.30		
	Male AGE 10-14	49.30^{**}	6.26		
	Male AGE 15-19	38.82^{**}	5.34	16.06	0.34
	Male AGE 20-24	39.38^{**}	5.28	48.63^{**}	4.49
	Male AGE 25-29	44.57^{**}	6.09	52.75^{**}	4.77
	Male AGE 30-34	47.83^{**}	7.00	57.73^{**}	5.25
	Male AGE 35-39	56.29^{**}	8.65	61.13^{**}	5.70
	Male AGE 40-44	62.78^{**}	9.72	62.79^{**}	5.91
	Male AGE 45-49	70.85^{**}	10.89	57.32^{**}	5.27
	Male AGE 50-54	68.59^{**}	10.47	68.78^{**}	5.84
	Male AGE 55-59	85.20^{**}	12.23	74.78^{**}	6.01
	Male AGE 60-64	101.40^{**}	12.81	78.98^{**}	6.06
	Male AGE 65-69	114.45^{**}	12.62	105.02^{**}	7.49
	Male AGE 70-74	142.62^{**}	14.58	111.92^{**}	7.81
	Male AGE 75-79	136.04^{**}	12.81	123.51^{**}	7.30
	Male AGE 80+	153.25^{**}	12.85	213.35^{**}	10.74
Difference In Mean For Females Versus Males	Female AGE 5-9	-13.39	-1.01		
	Female AGE 10-14	5.52	0.79		
	Female AGE 15-19	41.14^{**}	6.33	85.84	1.36
	Female AGE 20-24	66.16^{**}	8.46	63.37^{**}	6.64
	Female AGE 25-29	72.03^{**}	9.67	77.71^{**}	7.95
	Female AGE 30-34	52.67^{**}	7.89	45.34^{**}	4.87
	Female AGE 35-39	38.09^{**}	6.06	37.94^{**}	4.20
	Female AGE 40-44	39.81^{**}	6.39	28.98^{**}	3.30
	Female AGE 45-49	33.64^{**}	5.34	22.86^{*}	2.48
	Female AGE 50-54	39.20^{**}	6.13	25.16^{*}	2.24
	Female AGE 55-59	20.10^{**}	2.84	14.08	1.09
	Female AGE 60-64	14.66	1.78	25.91	1.87
	Female AGE 65-69	27.94^{**}	3.16	-10.18	-0.69
	Female AGE 70-74	7.80	0.81	16.11	1.01
	Female AGE 75-79	41.42^{**}	3.67	3.74	0.20
	Female AGE 80+	6.99	0.54	-61.79^{**}	-2.78
Difference in Mean For Having a CC Versus Zero CC	1 Chronic Condition	20.48^{**}	8.45	23.50^{**}	5.56
	2 Chronic Conditions	41.56^{**}	15.09	41.08^{**}	8.77
	3 pl Chronic Conditions	91.38^{**}	31.54	100.84^{**}	22.69
Difference in	Underweight	41.26^{**}	7.34	6.24	0.84

Mean for Not Having 'OK Weight'	Overweight	9.53**	3.24	-9.18*	-2.29
	Obese	1.97	0.68	6.31	1.49
	BMI missing value	-2.12	-0.51		
Difference in Mean Versus Non-Smoker, Non-drinker, No Exercise	Smoke 1-9	15.61**	3.36	-1.72	-0.26
	Smoke 10-19	-3.88	-1.17	3.33	0.62
	Smoke 20 plus	-8.30**	-2.59	-1.93	-0.41
	1-2 Drinks	-7.93**	-3.17	-2.22	-0.49
	3 plus Drinks	-22.55**	-4.16	-13.03**	-2.69
	Phys Act > 15min/mth 1-10	-12.94**	-4.52		
	Phys Act > 15min/mth 11-20	-23.57**	-7.47		
	Phys Act > 15min/mth 21-30	-14.34**	-4.37		
	Phys Act > 15min/mth 31 pl	-11.26**	-3.73		
	At least moderately active			-17.31**	-4.39
Difference in Mean Versus $40-50,000, High School Education	Income $0-10,000	24.85**	4.92	2.93**	3.74
	Income $10,000-20,000	10.05**	2.62	3.95	0.60
	Income $20,000-30,000	7.13	1.85	-3.61	-0.55
	Income $30,000-40,000	-4.75	-1.23	-4.47	-0.69
	Income $50,000-60,000	-6.40	1.44	8.02	1.19
	Income $60,000-70,000	14.84**	3.07		
	Income $60,000-80,000			5.48	0.75
	Income $70,000-80,000	-2.74	-0.52		
	Income $80,000 plus	15.35**	3.60	3.16	0.40
	Income missing values	3.41	0.78	38.50**	2.63
	Less than high school	-2.11	-0.70	1.49	0.30
	No high school with trade			1.58	0.31
	Some post-secondary	-1.22	-0.27		
	Trade diploma	5.28	1.58	13.95	1.48
	College diploma	2.90	0.72		
	University with no degree			-10.79	-1.69
	University cert < bachelor	-25.09**	-3.46		
	Bachelor degree	-0.86	-0.18		
	Higher than bachelor degree	-5.92	-0.89		
	University degree			-12.71	-1.95
		n =	29,809	n =	9,230
		Adj R^2 =	0.387	Adj R^2 =	0.426

** = Significance at 1%
* = Significance at 5%

In both the CCHS and AHS, participants with an income below $10,000 showed the highest GP use. Otherwise, the income categories do not show any pattern of GP consumption and yield inconsistent results between the two surveys. Five of the nine CCHS income categories and 6 of the 8 AHS categories were not statistically significant at a 95% level of confidence. Given the strong association with SES and health, we would expect that as income increases, GP use would decrease. Our results did not show this association. The lack of statistical significance and lack of a utilization pattern are consistent with much of the literature in this area however. Asada and Kephart (2007) review the inconsistent findings of several studies. They note research confirming the negative relationship between SES and health care use, as well as studies contradicting this. Furthermore, they note several studies that do not find a statistically significant relationship between income and health care use. They interpret that this is because these variables reflect both need and non-need. The adjusted effects reflect mostly non-need.

The education categories also do not show a consistent pattern with GP utilization values. The CCHS shows that people with a university certification lower than a bachelor's level designation will consume $25.09 less than a person with a high school education. A person with a trades diploma uses the most in both surveys, using $5.27 more than a high school graduate in the CCHS and $13.95 more in the AHS, perhaps reflecting work in more dangerous and physically demanding occupations. In the AHS a person with a university degree consumes the least at $12.71 less than a high school graduate.

Statistical significance was again lacking in many of the categories. In the CCHS analysis only 5 out of 16 categories proved to be statistically significant (at 95%) for the income and education groups. In the AHS only 2 of the 13 income and education groups were statistically significant at the 95% confidence level.

The addition of socio-economic variables increased the explanatory power of both models increased by 0.002, suggesting that socio-economic factors have limited incremental explanatory power as compared to the earlier measures. Similar to the BMI measures, some of the coefficients are significant and the education measures behave in a manner that is largely consistent with the determinants of health literature[15]. As such, these variables will be included in subsequent iterations of the model.

4.6 Age, Gender, Number of Chronic Conditions, Body Mass Index, Health Practices, Socioeconomic Status, and Self Assessed Health Status

Next, we incorporated variables on individual's self reported health status. The variable indicating 'good' health was omitted from the regression to act as the reference category. For both data sets the predicted value of GP resources used increases by a large amount for poorer self assessed health levels versus "good health". CCHS respondents that ranked their health as 'excellent' required \$5.81 less than a person of 'good' health. Respondents of 'fair' health consume \$39.01 more than a person of good health while a person of 'poor' health consumes \$62.94 more per year.

The AHS shows a similar trend. A person of excellent health uses \$5.68 less than a person of 'good' health. A person of fair health requires \$22.19 more and a person of poor health requires \$114.81 more than a person of good health.

The statistical significance for self assessed health status was much stronger than the previous two analyses. Only the excellent health group of the AHS proved to be insignificant at the 95% confidence level suggesting that those with excellent health do not use significantly less GP services as compared to those with 'good' health.

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[15] An F-test was conducted on the AHS education variables to test for joint significance. The F-statistic demonstrated that while none of the individual education variables were significant at 95% confidence, collectively they were significant at this level. For this reason, as well as for consistency and also to avoid unnecessary omitted variable bias, the education variables were included in subsequent analyses using the AHS.

The explanatory power of the CCHS and the AHS increased 0.005 and 0.008 respectively when comparing the adjusted r-square values reported in Tables 10 and 11, respectively.

Table 11

Age, Gender, Number of Chronic Conditions, Body Mass Index, Health Practices, Socioeconomic Status, Self Assessed Health Status Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With: Zero CC, OK Weight, Non-smoker, Non-drinker, No Exercise, $40-50,000, High School, Good Health	Male AGE 5-9	69.86**	6.26		
	Male AGE 10-14	48.08**	6.07		
	Male AGE 15-19	37.03**	5.06	10.13	0.22
	Male AGE 20-24	37.32**	4.96	45.47**	4.20
	Male AGE 25-29	42.79**	5.80	50.32**	4.55
	Male AGE 30-34	44.96**	6.51	54.45**	4.94
	Male AGE 35-39	52.27**	7.92	58.65**	5.46
	Male AGE 40-44	58.42**	8.92	58.01**	5.45
	Male AGE 45-49	66.05**	10.02	52.67**	4.83
	Male AGE 50-54	62.74**	9.46	63.57**	5.39
	Male AGE 55-59	77.32**	10.96	67.71**	5.43
	Male AGE 60-64	92.14**	11.53	71.51**	5.47
	Male AGE 65-69	106.27**	11.66	97.84**	6.96
	Male AGE 70-74	134.20**	13.67	105.46**	7.37
	Male AGE 75-79	125.49**	11.77	119.23**	7.06
	Male AGE 80+	144.02**	12.06	209.61**	10.59
Difference In Mean For Females Versus Males	Female AGE 5-9	-15.15	-1.15		
	Female AGE 10-14	4.46	0.64		
	Female AGE 15-19	40.80**	6.30	94.97	1.52
	Female AGE 20-24	66.53**	8.54	65.54**	6.91
	Female AGE 25-29	72.19**	9.73	79.12**	8.16
	Female AGE 30-34	54.50**	8.19	48.17**	5.21
	Female AGE 35-39	40.89**	6.53	39.13**	4.36
	Female AGE 40-44	41.75**	6.73	31.42**	3.60
	Female AGE 45-49	35.40**	5.65	25.62**	2.80
	Female AGE 50-54	43.36**	6.80	27.11*	2.43
	Female AGE 55-59	26.55**	3.77	19.59	1.53
	Female AGE 60-64	20.16**	2.46	32.41*	2.35
	Female AGE 65-69	31.70**	3.59	-4.22	-0.29
	Female AGE 70-74	11.28	1.18	17.51	1.11
	Female AGE 75-79	46.40**	4.13	8.41	0.44
	Female AGE 80+	9.15	0.71	-59.13**	-2.68
Difference in	1 Chronic Condition	19.04**	7.84	21.47**	5.09

Mean For Having a CC Versus Zero CC	2 Chronic Conditions	35.21**	12.56	37.07**	7.85
	3 pl Chronic Conditions	77.11**	25.23	87.23**	18.63
Difference in Mean for Not Having 'OK Weight'	Underweight	40.02**	7.14	3.23	0.44
	Overweight	9.66**	3.29	-9.84*	-2.47
	Obese	1.27	0.44	4.42	1.05
	BMI missing value	-0.64	-0.15		
Difference in Mean Versus Non-Smoker, Non-drinker, No Exercise	Smoke 1-9	13.32**	2.88	-2.85	-0.43
	Smoke 10-19	-3.05	-0.92	2.68	0.50
	Smoke 20 plus	-10.76**	-3.35	-3.47	-0.74
	1-2 Drinks	-6.51**	-2.60	-1.24	-0.28
	3 plus Drinks	-22.40**	-4.15	-13.20**	-2.74
	Phys Act > 15min/mth 1-10	-8.44**	-2.93		
	Phys Act > 15min/mth 11-20	-19.48**	-6.16		
	Phys Act > 15min/mth 21-30	-9.93**	-3.02		
	Phys Act > 15min/mth 31 pl	-4.97**	-1.64		
	At least moderately active			-11.00**	-2.78
Difference in Mean Versus $40-50,000, High School Education	Income $0-10,000	19.06**	3.78	28.32**	3.24
	Income $10,000-20,000	7.37	1.92	1.25	0.19
	Income $20,000-30,000	5.66	1.47	-4.98	-0.76
	Income $30,000-40,000	-5.15	-1.33	-4.93	-0.77
	Income $50,000-60,000	-4.84	-1.09	7.26	1.08
	Income $60,000-70,000	15.15**	3.15		
	Income $60,000-80,000			4.95	0.68
	Income $70,000-80,000	-1.08	-0.21		
	Income $80,000 plus	16.31**	3.85	3.92	0.50
	Income missing values	3.43	0.78	37.37**	2.57
	Less than high school	-4.31	-1.43	-1.16	-0.24
	No high school with trade			2.53	0.51
	Some post-secondary	-0.76	-0.17		
	Trade diploma	5.34	1.61	14.52	1.55
	College diploma	2.44	0.61		
	University with no degree			-9.83	-1.55
	University cert < bachelor	-21.27**	-2.95		
	Bachelor degree	0.22	0.04		
	Higher than bachelor degree	-4.44	-0.67		
	University degree			-11.11	-1.72
Difference in Mean Versus Good Health	Excellent health	-5.81*	-2.38	-5.68	-1.44
	Fair health	39.01**	11.79	22.19**	5.05
	Poor health	62.94**	11.77	114.81**	11.14
		n =	29,809	n =	9,230
		Adj R^2 =	0.392	Adj R^2 =	0.434

** = Significance at 1%
* = Significance at 5%

Overall, while we can see that self assessed health status does not make an appreciable difference to the overall explanatory power of the model, these measures do still make a significant contribution to our understanding of GP utilization practices, even after controlling for age, gender, chronic conditions, SES and health practices[16].

For the CCHS and MCP data (where repeat observations of the same individuals are used in the analysis) we replicated the regression analysis by clustering on the unique identifier. This resulted in an increase in the standard errors, but the coefficient values were unchanged and the t-statistics were qualitatively similar.

4.7 Robustness Checks

There are three concerns with respect to the analysis conducted to this point. The first concern is that Newfoundland and Labrador uses a large number of salaried physicians, for which there is no record of the GP visit in the MCP database. While we have deleted individuals in the MCP and CCHS database that had no visits over the entire data period it may be that certain geographic areas have seen their GP coverage change from being provided by a FFS GP to a salaried doctor. For those individuals it may be that they do show up in early years of the CCHS as having made GP visits, however under the care of a new physician, their visits cease to be recorded by MCP. In addition, individuals in the AHS may have consented to allow linkage to MCP data, but their visits are not recorded because there was no MCP claim corresponding to their visit. To address these concerns, the final specification was re-estimated in the CCHS for

[16] A likelihood ratio test was performed when adding each subsequent class of variables for both the CCHS and the NLAHS. In every case the reported p-value was less than .05, suggesting that collectively that class of variables does add information to the model.

individuals living in 'urban[17]' areas and for individuals in the AHS who were identified as living in the St. John's Community Health Board area. As discussed earlier, salaried doctors are much more likely to practice in rural and remote areas and by making these sample restrictions we are better able to include individuals who are likely visiting FFS GPs. The results of these estimations are presented in Appendix A.

The second concern is the use of an untransformed measure for utilization. Health utilization data is often highly skewed, which makes the estimation of OLS estimators potentially less efficient and possibly biased. The conventional way of dealing with this problem is through a transformation of the utilization measure into natural logarithms. However, this method was not utilized here because a sizeable number of individuals in the dataset do not have any utilization in many of the years and a logarthimic transformation can only be conducted on values greater than 0. However, to address this issue a tobit regression was estimated. Tobit estimation is used when a variable is censored at 0 with a large cluster of observations at this censored point. For each data set a tobit regression was estimated on the final full specification (i.e. incorporating all of the variables) and can be found in Appendix B.

The third major concern is that in the CCHS, the survey data is reported as at the time of survey (2001). The apart from gender and age, characteristics reported at 2001 were treated as invariant throughout the entire CCHS observation period (1995 through 2004). Of particular concern is the effect of chronic conditions and self-reported health status, which were significant predictors of utilization, but which we would expect to be

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[17] In the CCHS the first three characters of an individual's postcode were included. If the second character is a '0' this indicates that the individual resides in a rural community.

time-varying (and likely getting worse over time). To address this concern we conducted a separate estimation of the full model for only 2001 utilization for the CCHS (Appendix C).

With respect to these urban respondents, they are likely serviced by a FFS GP and therefore this analysis gives us a truer prediction model of utilization, but with a substantially smaller sample size. The explanatory power increased from 0.392 and 0.434 in the CCHS and AHS full population regressions to 0.534 and 0.521 in the urban only regressions. The number of observations (an individual's yearly utilization) was reduced to 12,142 for the CCHS and 2,830 for the AHS. The results proved to be qualitatively similar, however, some changes of statistical significance were noted. In eleven CCHS categories significance was lost (at 95% confidence) where previously it was significant in the total population regression. All four physical activity groups lost significance, as well as three of the female age groups, one in the drinking group (1-2 drinks), two income groups ($60-70,000 and $80,000 plus), and one self assessed health status (excellent). CCHS gained significance in five categories, 4 in the income categories, and one in the education categories (college). The AHS lost significance (95% confidence) in seven categories: three in the female age groups, and one in BMI (overweight), drinking behaviour (3 plus), physical activity (at least moderately active) and income categories (income missing values). The AHS gained significance in three categories, two of which were in the education groups, and one in smoking (smokes 20 plus).

There were ten CCHS categories that changed from a positive relationship to a negative relationship or vice versa. The largest changes were in the female age group 55-59 and in the BMI category 'underweight'. The 55-59 year old females went from adding

$26.55 in the full population regression to subtracting $4.68 in the urban only. This category also lost statistical significance. The underweight BMI category changed from adding $40.02 to subtracting $22.97, while maintaining its significance at 1%. The AHS had 5 categories change positive and negative relationships. Most dramatically the female age group 15-19 changed from adding $94.97 to subtracting $82.65 (although not statistically significant). The female 60-64 group changed from adding $32.41 to subtracting $18.01 (although not statistically significant). The variable for less than high school education went from subtracting $1.16 to adding $21.04.

The tobit regression requires a different interpretation since it should be estimated with a constant. In looking at the overall trend, it yielded a similar age-gender effect as the OLS regressions, demonstrating an increasing age-effect and the widest gap between males and females occurring during child-bearing years. All MCP variables remained statistically significant at 95% confidence. One variable (physical activity greater than 15 minutes 1-10 times per month) gained significance, where three variables (two income, one education) lost significance at 95%. In the AHS two variables changed from a positive to negative (smokes 10-19 and income $10,000-$20,000) and one changed from negative to positive (1-2 drinks). Eleven variables lost significance, ten being in the male age categories and one in the income missing values. Female age 55-59 gained significance at 95%.

In another check for robustness we compared the regressions of the CCHS in 2001 only with the CCHS 1995-2004 regression. The CCHS data was collected in 2001 and we used it link to their health utilization over a ten year period. We mainly wanted to compare the chronic conditions and self assessed health status values between these two sets of results. The trend of use for the chronic conditions of 2001 remained similar to that of the ten year regression. All variables remained statistically significant. The self-assessed health status patterns of predicted use also remained similar between both sets of results, however the 'excellent' health category lost its statistical significance. The full set of results can be seen in Appendix C.

A test of multicollinearity was run on all three datasets in order to measure the inter-correlation of the independent variables[18]. If a variable has a high correlation with another variable used in the linear regression, they are redundant (Armitage & Colton, 2005). This means that even though the independent variables have different names and numeric values they both are contributing to the beta value simultaneously. This could create a false model where several variables seem to correlate highly with the dependent variable however these variables are already being represented through another independent variable (Armitage & Colton, 2005). Our tests of multicolinearity did not show that any of the independent variables in any of the datasets approach the threshold (0.75) where we would conclude the variables are multicolinear and as such we are confident that the models are not compromised.

[18] Multicollinearity test results available upon request.

CHAPTER 5

Conclusion

This section discusses the results of the study, limitations and potential policy implications of the research.

5.1 Discussion

As supported by the literature, age and gender seem to be the best two predictors of GP resource utilization (Hutchison et al., 1999; Mustard & Derksen, 1997; Hindle 2002). When using these two variables in a regression the adjusted R^2 values are 0.359 and 0.383 in the CCHS and AHS respectively. When all ten categories of predictor variables are included, the adjusted R^2 increases to only 0.392 and 0.434, respectively. Age and gender are also very easy to measure and difficult to manipulate, making it a solid foundation on which to build an allocation formula (Hutchison et al., 2003).

Much of the increase in explanatory power is due to the addition of the 'number of chronic conditions' variable. When chronic conditions are included in the regression, the CCHS and AHS R^2 values increase to 0.382 and 0.421, respectively. Chronic conditions however, are more complicated to measure than age and gender and the limitations mentioned in the proceeding section must be considered. It also raises the issue of perverse incentives for providers that may over-diagnose, or over-report the occurrence of chronic conditions of their patients in order to gain a higher level of future funding.

The body mass index, health practices, and socioeconomic status variables did not prove to be particularly good predictors of utilization. All of these variables yielded inconsistent beta values that did not consistently follow predicted utilization patterns.

Similarly, the income and education variables showed inconsistent utilization patterns. For example, it is not practical to allocate less money to someone who smokes more, drinks more and exercises less. For many of these coefficients the t-statistics did not prove to be statistically significant and furthermore the results were inconsistent between the CCHS and the AHS. Asada and Kephart (2007) highlight literature that supports this inconsistent relationship between income, education and GP use. Birch, Eyles, and Newbold (1993) report that income and education yields no effect on the GP contact or volume of visits, with the exception of healthy people with lower education levels having a higher volume of use than healthy people of higher education. Hutchison, Hurley, Birch, Lomas, Walter, Eyles and Stratford-Devai (2000) also reported that their use of socioeconomic data did not improve their formulae any more than using only age and gender.

The socioeconomic status (SES) indicators (education and income) provide an interesting example of a variable that may include both need and non-need factors. If a regression includes only age, sex, and SES, SES is likely capturing both need and non-need factors. As we add more variables to the regression such as self assessed health and health practices these variables likely absorb some of the explanatory power of the SES on the needs indicators. Therefore the addition of more definite needs indicators will likely shift the SES to include more non-need (such as supply) than need. Supply factors may be due to geographic limitations such as proximity to a health care provider, which we have included in this study.

Similarly documented by Hutchison et al. (2003) and Hurley et al (2004), the self assessed health status variable proved to be a good indicator of GP utilization. It showed the next largest increase in explanatory power after the chronic conditions variable. The self assessed health beta values show a decrease in services consumed for someone of 'excellent' health, an increase for someone of 'fair' health, and a substantial increase for someone of 'poor' health (Hurley et al., 2004). However the 'gameability' of this variable comes into question as well. It is possible that respondents could report lower self assessed health levels in order to increase GP resource allocation to their RHA. Therefore, it would be beneficial to use more objective measure of health status such as the Health Utilities Index (HUI). HUI is a system that uses questionnaires to elicit patient reported health status information for its use in clinical trials (Horsman, Furlong, Feeny & Torrance, 2003). It evolved due to the need to develop standardized measure of health and its "measures have strong theoretical foundations, are valid, are reliable, and are well accepted by patients and professionals" (Horsman et al., 2003, page unknown).

5.2 Limitations

It is important to note, as described in Chapter 4, that the results of this study are based on MCP FFS utilization rates. Physicians in Newfoundland bill for their services in one of two ways: by salary, or by fee for service (FFS). Salaried physicians have a fixed yearly income and are paid regardless of the number of patients they see in the year. Fee for service physicians' income are based on the number of patients they service (Xu, 2001). The more patients that visit, the more services they bill for.

The majority of physicians in Newfoundland and Labrador (72%) receive FFS payments, especially in urban areas (Department of Health and Community Services Annual Physician Supply Report, 2006). Rural physicians in Newfoundland however, are primarily paid by salary. This is primarily because the population of rural Newfoundland is much more dispersed and the typically physicians will not see as many patients as urban GPs (Hunt, n.d.).

As such the results may not be generalizable to individuals living in rural areas and receiving their primary care from salaried doctors. However, we believe that with the corrections we have made to the data and robustness checks, these issues are of a minor concern. The limitation to generalization will be if individuals living in rural areas have fundamentally different patterns of health need. We would expect individuals living in these communities to largely have their need determined by the same factors that we observe as being significant and important for the individuals observed in our datasets.

If a person does not visit a physician in a year they will not show up in the database. This may cause problems because they are not given a value of 'zero GP resources consumed', they are just simply non existent in the database. It is for this reason that up to ten years of MCP data were used in the regressions. Assuming that if someone does not go to the doctor in one year, most will at least visit once in ten years. Once they have been recorded at least one time it is possible to track them back through the other nine years and put in the value of 'zero resources consumed'. If an individual does not show up in the ten year range they are likely being serviced by a salaried physician, have moved out of the province for a significant period of time, or are deceased. A list of lapsed MCP numbers was provided by the Department of Health and Community Services, and these observations were purged from our databases. For those 80 years old and over, we determined when their last visit to a GP was and then removed them. We are assuming that they are in now in specialist care, have moved out of province, or have died. In doing this the data followed a trend that was consistent through time (increasing GP utilization as individuals get older) and also with established national patterns. In the AHS however, we have only one year of GP utilization data. Therefore, we were unable to determine those with zero utilization that may now be deceased, out of province, or seeing a specialist. We assume they are healthy with no GP visits.

Despite these limitations with utilization data, we feel that we have taken the appropriate steps to yield the most robust results possible with these datasets.

The AHS sample does not include children and is therefore missing data from the ages of 0 to 17. This left a gap in data for this survey. However, the MCP administration data and the CCHS help to compensate for this shortcoming. The 2001 CCHS includes only participants age 12 and over. By using the ten years of CCHS linked MCP utilization data we can track the respondents back to 1995. Therefore we have access to information from when the youngest survey participants were 6 years old. The MCP administration data are not from a survey questionnaire but a record of all patient visits to FFS GPs in the province. Therefore people of all ages are included throughout all nine years. Because the MCP administration data contain over three million person-years and the CCHS has almost 30,000, these databases help to offset the age group shortcoming of the AHS. Furthermore, because the AHS was implemented on the island portion of Newfoundland and Labrador, the results of this prediction model cannot be generalized to Labrador. As stated by Segovia et al (1996), Labrador requires a specifically designed survey due to its large proportion of native peoples, industry towns, and a dispersed population.

There are several limitations surrounding the measured chronic conditions in the AHS and the CCHS. The list of chronic conditions measured in each survey are not identical. Although the relationship between chronic conditions and GP utilization is similar between the two data sets, their values are not directly comparable. The concern is that some chronic conditions that are considered major, such as diabetes or cancer, will require more GP care than minor chronic conditions such as mild allergies. The variable, 'number of chronic conditions' does not account for the severity of condition and inherently the amount of GP services required to manage the disease. If the lists do not have the same major and minor conditions in them, it makes it difficult to compare the dollar values. One list may include more conditions that demand higher GP use than the other list.

For the CCHS, chronic conditions were self-reported at the time of the survey in 2001, but was used to calculate average GP resource consumption from 1995-2004. It was not possible to investigate how the number of chronic conditions may have changed over time, therefore potentially decreasing the accuracy of this measurement. Hence the reason for running the '2001 only' regression mentioned in the *Robustness Checks* section.

The self-report of chronic conditions is also quite complex. What one may consider a chronic condition at one point in their life they may no longer consider it later in life. For example if an 18 year old suffers from mild asthma they may consider this a chronic condition. Hypothetically, once this 18 year old turns 70 and now has arthritis and diabetes, he/she may no longer consider their mild asthma a chronic condition when asked on a survey. Although Mustard and Derksen (1997) did not have success linking chronic condition prevalence to health care need, their research shows a strong correlation between the number of chronic conditions a person has and their level of GP utilization.

It is recommended in future analysis that only chronic conditions diagnosed by a health professional are included and only conditions that are considered major. Although the CCHS specifically states that the condition must be diagnosed by a health professional, the AHS simply asks "do you have any of the following chronic conditions?". The CCHS question wording would reduce the likelihood of any self-diagnosis. By including only major conditions, this would help to standardize the lists between health surveys as well as reduce the concern of under-reporting chronic conditions at an older age.

5.3 Conclusion

In summary, this study found that age and gender, number of chronic conditions and self assessed health status are good indicators of FFS GP utilization. The health practices and socioeconomic indicator regressions did not hold strong statistical significance and showed unexpected and impractical resource allocation values.

Our results for the age, gender, chronic conditions, self-assessed health status and SES variables proved to be largely consistent with current literature (Hutchison et al., 1999; Mustard & Derksen, 1997; Hindle, 2002; Birch, Eyles, and Newbold, 1993; Hutchison et al., 2003; Hurley et al, 2004; Asada & Kephart, 2007). To our knowledge, there has not been extensive research done on the effects of health practices (smoking, drinking, exercising), and body mass index on health care utilization. Our research did not produce any solid evidence supporting the use of such variables in capitation formulas. The effect of adding these variables to the regressions showed inconsistent trends in utilization between the data sets and also lacked statistical significance for many values.

Our research is unique in the fact that we used two health surveys and MCP utilization records to link micro data to GP use. Using two health surveys allowed us to compare between them and gauge the consistency of our results. The linkage of these individual specific variables such as BMI and health practices has not been greatly explored, especially over two surveys simultaneously. We feel that our methodology offers great potential to improve the field of needs based resource allocation. Through his own research, Hurley et al (2004) also support the use of health survey micro-data linked to health care use. He states that the potential of using micro-data exceeds the research using aggregate data at the population level.

Based on the results of this study we have determined that age and gender prove to be the best indicators of FFS GP use, considering the ease data is collection and low possibility of manipulation. As a strong supplement to these, the number of chronic conditions and self assessed health status also prove to be good indicators of FFS GP use, keeping in mind the 'gameability' of such variables.

The findings of this research are a useful first step in the creation of a needs-based allocation strategy. By determining which factors provide good indicators of health care need we can begin to determine the most effective way to collect this data so that it is both universally collected and difficult to manipulate. These findings provide a good starting point for the creation of a capitation survey for the province of Newfoundland and Labrador. The potential of such a survey could help to standardize the collection of useful data and increase the validity of its measures. Although not within the scope of this research, the next step would be to determine the weights to be given to each needs factor.

The political side of needs-based allocation also comes into play. The use of capitation payments can be a somewhat controversial issue when allocating dollars based on personal characteristics. For instance, allocating health care dollars based on the number of smokers (and how much they smoked), in a health region likely would not be a favourable political decision. As stated by Rice and Smith (2001b) capitation payments should promote an incentive for healthy behaviour rather than rewarding the unhealthy. The selection of variables that are not susceptible to manipulability is also important. The measure should be objective as possible and unethical activity, such as deliberately distorting data, should not result in an increase in health funding. Although this research provides the statistical information supporting the use of some variables as needs indicators, it is ultimately up to the policy makers to decide on the practical variables to use.

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Appendix A

Urban Regressions

Variable Description	Variables	CCHS		AHS	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With: Zero CC, OK Weight, Non-smoker, Non-drinker, No Exercise, $40-50,000, High School, Good Health	Male AGE 5-9	86.39**	5.30		
	Male AGE 10-14	50.37**	4.41		
	Male AGE 15-19	38.02**	3.72	47.78	0.70
	Male AGE 20-24	40.05**	3.99	56.19**	2.99
	Male AGE 25-29	37.00**	3.80	55.53**	2.98
	Male AGE 30-34	41.02**	4.37	68.95**	3.79
	Male AGE 35-39	51.42**	5.53	74.77**	4.13
	Male AGE 40-44	55.81**	5.93	73.42**	3.93
	Male AGE 45-49	71.10**	7.55	74.01**	4.01
	Male AGE 50-54	65.25**	6.92	86.47**	4.23
	Male AGE 55-59	98.52**	9.73	92.74**	4.33
	Male AGE 60-64	101.78**	8.54	98.18**	4.39
	Male AGE 65-69	137.87**	10.19	117.84**	4.83
	Male AGE 70-74	168.71**	12.30	105.82**	3.95
	Male AGE 75-79	146.93**	9.96	140.77**	4.55
	Male AGE 80+	170.50**	7.78	219.23**	5.06
Difference In Mean For Females Versus Males	Female AGE 5-9	-25.28	-1.26		
	Female AGE 10-14	-2.15	-0.21		
	Female AGE 15-19	33.84**	3.79	-82.65	-0.71
	Female AGE 20-24	68.06**	7.01	78.38**	5.04
	Female AGE 25-29	106.57**	11.45	96.69**	6.46
	Female AGE 30-34	91.25**	10.44	55.39**	3.85
	Female AGE 35-39	71.37**	8.28	54.21**	3.65
	Female AGE 40-44	54.79**	6.34	29.76*	1.98
	Female AGE 45-49	41.20**	4.85	32.71*	2.18
	Female AGE 50-54	46.42**	5.38	31.02	1.65
	Female AGE 55-59	-4.68	-0.47	9.15	0.44
	Female AGE 60-64	17.90	1.43	-18.01	-0.77
	Female AGE 65-69	5.38	0.40	-36.40	-1.39
	Female AGE 70-74	5.63	0.41	6.12	0.20
	Female AGE 75-79	64.43**	4.09	0.97	0.03
	Female AGE 80+	16.48	0.72	-32.64	-0.69
Difference in Mean For Having a CC Versus Zero CC	1 Chronic Condition	19.93**	5.91	22.75**	3.33
	2 Chronic Conditions	37.01**	9.62	25.86**	3.30
	3 pl Chronic Conditions	84.27**	19.81	91.41**	11.82
Difference in	Underweight	-22.97**	-3.23	3.45	0.31

Mean for Not Having 'OK Weight'	Overweight	14.41**	3.68	-1.85	-0.27
	Obese	5.28	1.28	2.31	0.30
	BMI missing value	-4.86	-0.84		
Difference in Mean Versus Non-Smoker, Non-drinker, No Exercise	Smoke 1-9	31.26**	5.09	-13.79	-1.22
	Smoke 10-19	1.26	0.29	-2.48	-0.28
	Smoke 20 plus	-18.82**	-4.07	-25.07**	-3.05
	1-2 Drinks	1.91	0.59	-4.49	-0.56
	3 plus Drinks	-21.97**	-3.09	-13.32	-1.55
	Phys Act > 15min/mth 1-10	-2.22	-0.51		
	Phys Act > 15min/mth 11-20	-5.43	-1.16		
	Phys Act > 15min/mth 21-30	-1.01	-0.22		
	Phys Act > 15min/mth 31 pl	0.61	0.14		
	At least moderately active			-11.05	-1.63
Difference in Mean Versus $40-50,000, High School Education	Income $0-10,000	18.82**	2.70	68.55**	4.56
	Income $10,000-20,000	15.08**	2.62	15.49	1.35
	Income $20,000-30,000	12.08*	2.10	-1.06	-0.09
	Income $30,000-40,000	-20.05**	-3.35	-3.48	-0.32
	Income $50,000-60,000	-13.26*	-2.08	-0.39	-0.04
	Income $60,000-70,000	5.13	0.80		
	Income $60,000-80,000			0.30	0.03
	Income $70,000-80,000	-6.85	-1.05		
	Income $80,000 plus	-3.22	-0.58	-5.92	-0.53
	Income missing values	-8.21	-1.41	9.38	0.48
	Less than high school	4.47	1.03	21.04	2.29
	No high school with trade			6.76	0.82
	Some post-secondary	1.33	0.24		
	Trade diploma	2.73	0.61	30.98	1.94
	College diploma	-10.48*	-2.02		
	University with no degree			-19.18*	-2.02
	University cert < bachelor	-28.18**	-3.13		
	Bachelor degree	-4.22	-0.73		
	Higher than bachelor degree	-7.50	-1.06		
	University degree			-22.46*	-2.42
Difference in Mean Versus Good Health	Excellent health	-5.57	-1.67	-6.40	-1.04
	Fair health	62.53**	13.25	23.62**	2.95
	Poor health	112.72**	14.20	98.80**	4.94
		n =	12,142	n =	2,830
		Adj R^2 =	0.534	Adj R^2 =	0.521

** = Significance at 1%

* = Significance at 5%

Appendix B

Tobit Regressions

Variables	MCP		CCHS		AHS	
	Beta Value	T-stat	Beta Value	T-stat	Beta value	T-stat
Male AGE 0-4						
Male AGE 5-9	-65.63**	-54.83				
Male AGE 10-14	-98.97**	-83.05	-43.75**	-3.09		
Male AGE 15-19	-101.59**	-84.84	-77.11**	-5.42		
Male AGE 20-24	-118.96**	-98.19	-85.95**	-5.48	40.44	0.63
Male AGE 25-29	-125.22**	-102.79	-61.33**	-3.91	41.46	0.65
Male AGE 30-34	-86.11**	-71.61	-55.36**	-3.63	47.37	0.74
Male AGE 35-39	-51.28**	-43.37	-43.79**	-2.92	57.79	0.91
Male AGE 40-44	-26.98**	-23.08	-28.49	-1.91	56.62	0.89
Male AGE 45-49	-3.70**	-3.18	-10.81	-0.73	55.07	0.86
Male AGE 50-54	15.02**	12.82	-15.47	-1.04	71.54	1.12
Male AGE 55-59	17.87**	14.78	6.82	0.45	80.86	1.26
Male AGE 60-64	23.21**	18.41	22.62	1.48	88.01	1.37
Male AGE 65-69	39.04**	29.97	47.38**	3.07	116.74	1.80
Male AGE 70-74	47.41**	35.00	83.37**	5.23	135.41*	2.09
Male AGE 75-79	49.16**	34.27	74.52**	4.42	154.85*	2.35
Male AGE 80+	157.01**	105.55	100.67**	5.54	249.95**	3.72
Female AGE 0-4	-4.56**	-3.70				
Female AGE 5-9	4.75**	3.98	-20.82	-1.17		
Female AGE 10-14	8.55**	7.31	16.04	1.69		
Female AGE 15-19	75.72**	67.34	89.39**	9.99	136.24	1.64
Female AGE 20-24	119.05**	106.52	127.88**	11.87	102.96**	8.21
Female AGE 25-29	125.81**	111.68	116.67**	11.64	124.76**	9.67
Female AGE 30-34	118.15**	107.01	90.16**	10.07	87.31**	7.09
Female AGE 35-39	93.35**	86.56	64.14**	7.61	64.43**	5.41
Female AGE 40-44	77.55**	72.77	61.41**	7.43	58.71**	5.09
Female AGE 45-49	71.27**	66.71	46.00**	5.57	44.50**	3.69
Female AGE 50-54	64.18**	58.43	60.48**	7.23	44.47**	3.05
Female AGE 55-59	53.82**	45.35	36.08**	3.92	32.73*	1.97
Female AGE 60-64	39.80**	30.76	32.12**	3.01	46.56**	2.61
Female AGE 65-69	35.68**	26.09	41.33**	3.62	5.06	0.27
Female AGE 70-74	36.67**	25.41	15.24	1.24	22.74	1.13
Female AGE 75-79	37.04**	23.88	52.84**	3.66	6.13	0.25
Female AGE 80+	29.47**	19.44	8.03	0.49	-63.57*	-2.28
1 Chronic Condition			33.44**	10.30	40.45**	7.17
2 Chronic Conditions			56.73**	15.31	66.59**	10.68
3 pl Chronic Conditions			102.87**	25.65	124.70**	20.26
Underweight			43.14**	5.87	5.48	0.58
Overweight			14.39**	3.70	-12.08*	-2.30
Obese			0.08	0.02	2.63	0.47
BMI missing value			-7.08	-1.28		
Smoke 1-9			19.45**	3.19	-3.16	-0.36
Smoke 10-19			-3.07	-0.70	-0.66	-0.09

Smoke 20 plus			-16.52**	-3.85	-9.95	-1.59
1-2 Drinks			-9.15**	-2.75	2.66	0.46
3 plus Drinks			-33.98**	-4.56	-12.96*	-2.06
Phys Act > 15min/mth 1-10			-5.43	-1.43		
Phys Act > 15min/mth 11-20			-22.12**	-5.27		
Phys Act > 15min/mth 21-30			-9.17*	-2.10		
Phys Act > 15min/mth 31 pl			-2.41	-0.60		
At least moderately active					-10.43*	-2.04
Income $0-10,000			11.74	1.76	29.49**	2.60
Income $10,000-20,000			2.84	0.56	-9.14	-1.06
Income $20,000-30,000			-0.81	-0.16	-14.31	-1.67
Income $30,000-40,000			-11.15*	-2.17	-10.70	-1.27
Income $50,000-60,000			-13.91*	-2.34	6.92	0.79
Income $60,000-70,000			20.21**	3.17		
Income $60,000-80,000					8.48	0.89
Income $70,000-80,000			0.28	0.04		
Income $80,000 plus			14.58**	2.58	8.34	0.82
Income missing values			5.49	0.94	36.54	1.93
Less than high school			-8.97*	-2.24	-8.97	-1.40
No high school with trade					7.54	1.15
Some post-secondary			-5.61	-0.94		
Trade diploma			5.70	1.30	21.71	1.77
College diploma			3.05	0.57		
University with no degree					-2.29	-0.28
University cert < bachelor			-34.58**	-3.56		
Bachelor degree			4.92	0.77		
Higher than bachelor degree			-0.82	-0.09		
University degree					-9.53	-1.13
Excellent health			-7.77*	-2.37	-9.94	-1.90
Fair health			41.60**	9.63	26.14**	4.59
Poor health			71.55**	10.39	122.73**	9.36
Constant	112.00	130.35	24.84	1.67	-71.08	-1.11
	n =	3,112,813	n =	29,809	n =	9,230

Appendix C

CCHS 2001 and CCHS 1995-2004 Regressions

Variable Description	Variables	CCHS 2001		CCHS 1995-2004	
		Beta value	T-stat	Beta value	T-stat
Mean Betas For Males With: Zero CC, OK Weight, Non-smoker, Non-drinker, No Exercise, $40-50,000, High School, Good Health	Male AGE 5-9	(dropped)		69.86**	6.26
	Male AGE 10-14	-29.71	-0.99	48.08**	6.07
	Male AGE 15-19	-45.35	-1.61	37.03**	5.06
	Male AGE 20-24	21.11	0.97	37.32**	4.96
	Male AGE 25-29	14.16	0.66	42.79**	5.80
	Male AGE 30-34	28.55	1.46	44.96**	6.51
	Male AGE 35-39	34.59	1.91	52.27**	7.92
	Male AGE 40-44	32.82	1.79	58.42**	8.92
	Male AGE 45-49	50.30**	2.70	66.05**	10.02
	Male AGE 50-54	44.10*	2.40	62.74**	9.46
	Male AGE 55-59	57.65**	3.04	77.32**	10.96
	Male AGE 60-64	80.53**	3.67	92.14**	11.53
	Male AGE 65-69	-15.80	-0.50	106.27**	11.66
	Male AGE 70-74	93.41**	2.87	134.20**	13.67
	Male AGE 75-79	41.99	1.21	125.49**	11.77
	Male AGE 80+	26.10	0.74	144.02**	12.06
Difference In Mean For Females Versus Males	Female AGE 5-9	(dropped)		-15.15	-1.15
	Female AGE 10-14	8.72	0.40	4.46	0.64
	Female AGE 15-19	51.76**	3.28	40.80**	6.30
	Female AGE 20-24	52.24*	2.23	66.53**	8.54
	Female AGE 25-29	56.94*	2.55	72.19**	9.73
	Female AGE 30-34	46.30*	2.45	54.50**	8.19
	Female AGE 35-39	31.01	1.80	40.89**	6.53
	Female AGE 40-44	42.53*	2.47	41.75**	6.73
	Female AGE 45-49	36.04*	2.03	35.40**	5.65
	Female AGE 50-54	57.23**	3.24	43.36**	6.80
	Female AGE 55-59	22.96	1.23	26.55**	3.77
	Female AGE 60-64	21.98	0.99	20.16**	2.46
	Female AGE 65-69	69.52**	2.85	31.70**	3.59
	Female AGE 70-74	-2.26	-0.09	11.28	1.18
	Female AGE 75-79	54.20	1.78	46.40**	4.13
	Female AGE 80+	22.30	0.72	9.15	0.71
Difference in Mean For Having a CC Versus Zero CC	1 Chronic Condition	24.50**	3.63	19.04**	7.84
	2 Chronic Conditions	45.59**	5.83	35.21**	12.56
	3 pl Chronic Conditions	80.94**	9.52	77.11**	25.23
Difference in	Underweight	4.54	0.29	40.02**	7.14

Mean for Not Having 'OK Weight'	Overweight	19.54*	2.39	9.66**	3.29
	Obese	14.23	1.76	1.27	0.44
	BMI missing value	60.04**	2.72	-0.64	-0.15
Difference in Mean Versus Non-Smoker, Non-drinker, No Exercise	Smoke 1-9	28.24*	2.18	13.32**	2.88
	Smoke 10-19	3.75	0.41	-3.05	-0.92
	Smoke 20 plus	-8.71	-0.97	-10.76**	-3.35
	1-2 Drinks	-4.41	-0.63	-6.51**	-2.60
	3 plus Drinks	-7.02	-0.47	-22.40**	-4.15
	Phys Act > 15min/mth 1-10	5.05	0.63	-8.44**	-2.93
	Phys Act > 15min/mth 11-20	-5.79	-0.66	-19.48**	-6.16
	Phys Act > 15min/mth 21-30	1.42	0.15	-9.93**	-3.02
	Phys Act > 15min/mth 31 pl	-5.53	-0.65	-4.97**	-1.64
Difference in Mean Versus $40-50,000, High School Education	Income $0-10,000	25.79	1.84	19.06**	3.78
	Income $10,000-20,000	15.44	1.44	7.37	1.92
	Income $20,000-30,000	19.55	1.82	5.66	1.47
	Income $30,000-40,000	1.05	0.10	-5.15	-1.33
	Income $50,000-60,000	-2.62	-0.21	-4.84	-1.09
	Income $60,000-70,000	19.89	1.48	15.15**	3.15
	Income $70,000-80,000	1.60	0.11	-1.08	-0.21
	Income $80,000 plus	12.82	1.08	16.31**	3.85
	Income missing values	11.15	0.91	3.43	0.78
	Less than high school	-5.60	-0.66	-4.31	-1.43
	Some post-secondary	7.88	0.63	-0.76	-0.17
	Trade diploma	0.85	0.09	5.34	1.61
	College diploma	4.76	0.42	2.44	0.61
	University cert < bachelor	-11.70	-0.58	-21.27**	-2.95
	Bachelor degree	-8.43	-0.63	0.22	0.04
	Higher than bachelor degree	-13.77	-0.74	-4.44	-0.67
Difference in Mean Versus Good Health	Excellent health	-0.76	-0.11	-5.81*	-2.38
	Fair health	43.89	4.77	39.01**	11.79
	Poor health	99.44	6.70	62.94**	11.77
** = Significance at 1%		n =	2,986	n =	29,809
* = Significance at 5%		Adj R^2 =	0.481	Adj R^2 =	0.392