Diabetes Prevalence and Associated Risk Factors among Canadians of South Asian Origin: Estimates from a National Survey

by

Gurjeet Sivia
B.Sc., University of Victoria, 1993

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STUDENT'S NAME: Gurjeet Sivia

DEGREE: MASTER OF PUBLIC HEALTH

THESIS TITLE: **DIABETES PREVALENCE AND ASSOCIATED RISK FACTORS AMONG CANADIANS OF SOUTH ASIAN ORIGIN: ESTIMATES FROM A NATIONAL SURVEY**

Chair of Defense: ______________________________

Dr. Tim Takaro
Associate Professor
Faculty of Health Sciences

Senior Supervisor: ______________________________

Dr. Michael Hayes
Professor
Faculty of Health Sciences

Supervisor: ______________________________

Dr. Michel Joffres
Professor
Faculty of Health Sciences

External: ______________________________

Dr. Kate Bassil
Assistant Professor
Faculty of Health Sciences

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ABSTRACT

International evidence suggests that prevalence of type 2 diabetes (T2D) is higher among people of South Asian origin, however, limited information exists about T2D in Canadians belonging to this ethnic group. This study estimates the prevalence of self-reported T2D and assesses its relationship with demographic, socioeconomic and lifestyle factors in South Asians using data from the 2003 Canadian Community Health Survey, Cycle 2.1. Canadians of South Asian origin were compared with following ethnic groups: Whites, Chinese and Aboriginals. Descriptive statistics and odds ratios were calculated. T2D prevalence varied by ethnicity with South Asians having one of the highest rates (8.0%). Independent of age, sex, household income, education, body mass index and physical activity, South Asians had higher odds (2.9) of T2D compared with Whites. T2D occurred at a younger age and at lower body mass in this ethnic group compared with Whites.

Keywords: type 2 diabetes; South Asians; ethnicity; prevalence; risk factors; health surveys

Subject Terms: Ethnic groups – Health and hygiene; Health – Cross-cultural studies; Minorities – Health and hygiene; Minorities – Medical care; Immigrants – Health and hygiene; Diabetes Mellitus -- Epidemiology

DEDICATION

To my wife, Awneet

my three children, Perveen, Simrin and Saajan

and my Bebeji

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1. INTRODUCTION

Diabetes mellitus (DM), one of the most prevalent and serious chronic health conditions, can lead to a multitude of complications such as heart disease, stroke, renal failure, amputation and blindness (Kumar and Houlden, 2005; Oldroyd, Banerjee, Heald and Cruickshank, 2005). It affects approximately 4.5% of Canadian adults 18 years of age and older (Millar and Young, 2003), with a large proportion of undetected and unmanaged cases (Davachi, Flynn and Edwards, 2005; Foroughi et al., 2005). The prevalence increases dramatically with age: approximately 12% of Canadians aged 65 and over are affected (Millar and Young, 2003). The number of people with diabetes and its associated complications is projected to increase substantially over the next 20 years, mainly attributable to the anticipated increases in the rates of obesity and inactivity as well as the aging of the Canadian population (King, Aubert and Herman, 1998).

Increasing evidence suggests that Canadians of South Asian origin face disproportionate levels of morbidity and mortality due to chronic diseases, especially from type 2 diabetes and cardiovascular disease compared to non-South Asians (Bhopal et al., 2002; Sriskantharajah and Kai, 2007). They are estimated to be at a much higher risk of developing type 2 diabetes than Canadians of European origin (Davachi et al., 2005; Davies et al., 1999; Kumar and Houlden, 2005; Lawton, 2006; Mohanty, Woolhandler, Himmelstein and Bor, 2005). Similar disparity in diabetes prevalence is seen in South Asians and in Whites from the United Kingdom (UK) and in other European countries with sizable populations belonging to this ethnic group (Cappuccio, Barbato and Sally, 2003; Jenum, Holme, Graff-Iversen and Birkeland, 2005; Lawton, 2006). Diabetes-related complications are also more frequent in this group and occur much earlier than in non-South Asians (Cappuccio, 1997). For example, diabetes is now considered a major contributing factor in the elevated cardiovascular disease among South Asians (Bhopal et al., 2002; Bush, Williams, Lean and Anderson, 2001; Sriskantharajah and Kai, 2007).

Studies have shown that both environmental and genetic factors play important roles in the increased incidence of diabetes in this group (O'Rahilly, 1997; Tziomalos, Weerasinghe, Mikhailidis and Seifalian, 2008). They tend to have higher abdominal adiposity and insulin resistance, two important correlates of diabetes in this group (Whhincup et al., 2002). The situation becomes even more serious given that knowledge of the risks associated with diagnosed and undiagnosed diabetes as well as its risk factors is poor among South Asians (Rankin and Bhopal, 2001; Stone, Pound and Pancholi, 2005). This is partially due to their underutilization of diabetes-related services resulting from two significant barriers: language challenges (Chowdhury, Grace and Kopelman, 2003; Davachi et al., 2005) and the lack of culturally sensitive services and programs (Kumar and Houlden, 2005). South Asians have lower rates of secondary service use and lower hospitalization rates from type 2 diabetes compared to Whites despite having higher prevalence of type 2 diabetes (Williams and Harding, 2004).

Within Canada, there is inadequate information about diabetes as it relates to ethnic/racial groups other than Aboriginal Canadians and Canadians of European ancestry and about the chronic complications of diabetes in ethnic groups such as South Asians. This is despite the fact that the burden of type 2 diabetes in the entire population as well as the population of South Asians is growing across Canada.

According to the 2001 Canadian Census, there were approximately 265,600 people of South Asian ethnicity residing in British Columbia and about 1.32 million in Canada. Identifying the unique risk factors is important in the development of tailored strategies for the identification, prevention and management of type 2 diabetes (Harris, 2001; Jenum et al., 2005; Sheth, Nair and Nargundkar, 1999) since South Asians represent a significant and growing population of Canada. The unique socio-cultural needs of the high-risk ethnic populations must be recognized and addressed, however, this cannot occur if cultural-specific information is lacking. To date, research addressing the extent of type 2 diabetes health issue and its associated risk factors in the South Asian population within Canada is very limited. This paper aims to address this information void by:

- estimating the prevalence of type 2 diabetes in Canadians of South Asian origin;
- exploring the influence of ethnicity, age, gender, income, education and lifestyle factors on the prevalence of type 2 diabetes;

- assessing how the prevalence of type 2 diabetes and its associated factors differ in Canadians of South Asian origin compared with Canadians of White, Chinese and Aboriginal ethnic origin.

2. BACKGROUND

Studies from around the globe suggest that people of South Asian ethnic origin are at higher risk of type 2 diabetes and other related chronic diseases such as cardiovascular and renal diseases irrespective of their religion, diet or socioeconomic status (Balarajan, Bulusu, Adelstein and Shukla, 1984). This scenario persists regardless of the country of choice for immigration among South Asians (Barnett et al., 2006). Literature suggests that some of the reasons for this excessive risk are genetic, environmental, behavioral, socioeconomic and differences in access to healthcare (Harris, 2001; Tziomalos et al., 2008). Studies also suggest that type 2 diabetes and its risk factors manifest differently in this group than in the host populations: it's occurring at a younger age and at a much lower body mass index (Yoon et al., 2006). This chapter provides information on why these differences occur and more specifically, a literature review of the epidemiology of type 2 diabetes in South Asians (both in the countries they have migrated to and in their ancestral countries), its risk factors and how cultural beliefs and barriers further increase the risk of type 2 diabetes in this ethnic group.

2.1. Epidemiology of type 2 diabetes in South Asians

Ethnic populations face disproportionate levels of morbidity and mortality due to chronic diseases, especially cardiovascular disease and type 2 diabetes

(Bhopal, 2002; Reddy and Yusuf, 1998). The prevalence of type 2 diabetes in South Asians is estimated to be 2 to 5 times higher than the White Europeans in UK and in other European countries (McKeigue, Shah and Marmot, 1991; O'Rahilly, 1997; Whhincup et al., 2002). Diabetes-related complications are also more frequent in this group and occur much earlier than in non-South Asians (Bhopal, 2002). This elevated risk of cardiovascular disease and diabetes among South Asians is seen across the globe, irrespective of the length of migration or the level of risk with the host population (see Table 1) (Cappuccio, 1997).

Table 1. Coronary heart disease mortality in South Asian populations overseas

Country	Years	Groups	Age	CHD Mortality Ratio
Singapore	1980-86	S.Asian vs Chinese	30-69	3.8
Fiji	1980	S.Asian vs Melanesian	40-59	3.0
Trinidad	1977-86	S.Asian vs African	35-69	2.4
South Africa	1985	S.Asian vs European	35-74	1.4
England	1979-83	S.Asian vs European	20-69	1.4

Source: (Cappuccio, 1997)

A study comparing Canadians of European, South Asian and Chinese origins showed that South Asians had significantly higher mortality rates from ischemic heart disease and diabetes than the other ethnic groups (Sheth et al., 1999). This study assessed 15 years of mortality data from 1979 to 1993 and quantified the increased risk of diabetes mortality to be 2- and 3-fold higher in South Asians compared to Canadians of European and Chinese origin. Another Canadian study using the same ethnic groupings recruited 985 participants from Hamilton, Toronto and Edmonton to assess cardiovascular risk and its associated risk factors including atherosclerosis (Anand et al., 2000). This study found higher rates of established diabetes and cardiovascular disease in the South Asian ethnic group compared with Canadians of European and Chinese origin despite lower carotid atherosclerosis in South Asians (Anand et al., 2000).

Some of the earliest studies assessing health differences of South Asian immigrants with the rest of the general population come from the UK (McKeigue et al., 1988) where they represent close to 4% (or about 2 million total) of the total population (Barnett et al., 2006). Majority of the UK studies have shown that the excess mortality seen in South Asians is mostly explained by the increased risk of cardiovascular disease and type 2 diabetes (Mather and Keen, 1985; Wilkinson et al., 1996).

A study based on death certificates investigating coronary heart disease (CHD) in England and Wales for the 1970 to 1972 period showed 20% higher rate of mortality for this disease among those born in South Asia (McKeigue et al., 1988). Follow-up to this study done on mortality data for the 1979 to 1983 period showed even higher rates of coronary heart disease mortality than the initial study (Balarajan, 1991). Another similar UK study by Chaturvedi and Fuller (1996) assessed the differences in cardiovascular mortality in those with non-insulin-dependent diabetes among South Asians, African-Americans and the rest of the population. Results from this study revealed that the all-cause and cardiovascular disease death rates were twice as high in South Asians and African Americans. Further, ischemic heart disease death rates were approximately three times higher in South Asians with diabetes than those born in England or Wales. Hughes, Raval and Raftery (1989) followed White and South Asian men over time to measure the relative rate and clinical course of first myocardial infarction and reported that the rate of infarction was nearly five-times higher in this group than the White population. Further, the rate was higher in all age groups and the infarction event occurred at a much younger age in South Asians (50.2 years) compared with the White group (55.5 years) (Hughes, Raval and Raftery, 1989). *The Health Survey for England 2004: Health of Ethnic Minorities,* by the Department of Health also showed that ischemic heart disease rates among South Asian men were 30-40% higher than in men in the general European population (Barnett et al., 2006).

The Singapore Cardiovascular Cohort Study, a longitudinal assessment of coronary heart disease and its traditional risk factors for Chinese, Malay and Asian Indian males, showed that Asian Indian men were at greatest risk of CHD compared with the other two ethnic groups (Lee et al., 2001). Another study showed that even though South Asians have higher rates of heart disease than the majority White populations, their wait times for coronary angiography are likely to be much longer (Williams and Harding, 2004).

While the majority of people represented in South Asian studies tend to be first generation immigrants, research evidence suggests that increased risk for coronary heart disease and diabetes is also seen in second-generation individuals (Barnett et al., 2006) with most of this risk occurring at younger ages (Balarajan, 1991; Chaturvedi and Fuller, 1996). Hughes, Raval and Raftery

(1989) reported a difference of nearly five years in the mean age for myocardial infarction among South Asian men versus the general UK population.

2.1.1. Higher prevalence of type 2 diabetes in South Asians

To date, Canadian studies addressing the prevalence of type 2 diabetes or its risk factors in Canadians of South Asian origin are limited. Two studies, discussed earlier in this section, on ischemic heart disease and cardiovascular disease mortality, morbidity and risk factors identified higher prevalence of type 2 diabetes in this ethnic group (Anand et al., 2000; Sheth et al., 1999). The Anand et al. (2000) study reported a prevalence of 6.2% among this group based on a small sample of diabetics. A recent study by Davachi, Flynn and Edwards (2005) explored the prevalence of type 2 diabetes risk factors and the development of a screening and awareness program aimed at Canadians of South Asian origin. This study addressed an important limitation of self-reported studies by directly measuring most anthropometric factors such as height, weight, waist circumference and blood glucose tests and concluded that a high level of risk factors associated with type 2 diabetes exist among South Asians.

Perez (2002) compared the health status and health behaviour of immigrants to Canada versus those born in Canada using data from the 2000/01 Canadian Community Health Survey (Cycle 2.1). He concluded that immigrants tend to be healthier than non-immigrants but this pattern reverses with time spent in Canada (Perez, 2002).

Studies from United States have reported higher rates of diabetes among South Asians. Jonnalagadda and Diwan (2005) reported diabetes of 18% in 226 Asian Indians aged 50 years and above with average immigration length of 25 years in the US. Similar prevalence of diabetes mellitus (18.3%) was reported by Venkataraman, Nanda and Baweka et al. (2004) in a study in the Atlanta metro area of Georgia. The mean age of the study population was 52.8 years and those with diabetes, 57.2 years. Co-morbidities such as myocardial infarction, hypertension, coronary artery interventions, history of dialysis, hypercholesterolemia and stroke also showed significant associations with diabetes (Baweja, Nanda, Parikh, Bhatia and Venkataraman, 2004). The generalizability of this study to the South Asian population may be weak given that the participants in this study were originally from one particular state in western India (Gujarat) and all affiliated with a certain religious sect and an international socio-spiritual organization (Venkataraman et al., 2004). Based on a national population health survey in the United States, Mohanty, Woolhandler, Himmelstein and Bor (2005) showed that Asian Indians have higher prevalence of diabetes than non-Hispanic Whites. However, the same survey did not show elevated risk of coronary heart disease or hypertension in South Indians compared to the non-Hispanic Whites.

Studies from United Kingdom have shown three to four fold higher prevalence rates of type 2 diabetes in South Asians compared with the general population (Chaturvedi and Fuller, 1996). The Southhall Diabetes Survey in West London was one of the first and largest house-to-house studies done to ascertain the difference in known prevalence of diabetes among this group and Europeans in a suburb with substantial immigrant population (Mather and Keen, 1985). This study found approximately a five-fold higher prevalence of diabetes in South Asians than in Europeans in the 40 to 64 years age group. At about the same time, these differences in diabetes prevalence were confirmed by the Coventry Study considered to be methodologically sound given its large sample size and the use of study participants from a wide range of ages (Simmons, Williams and Powell, 1989). This house-to-house survey in a low socioeconomic area with a high concentration of South Asians reported the adjusted diabetes prevalence for people aged 20 and over in South Asian men to be 11.2% and women 8.9% compared with White men at 2.8% and in women at 4.3%. Another study of low socioeconomic individuals in the 35 to 79 years age group in Manchester showed surprisingly high prevalence of diabetes among Europeans (20%) and even higher rates among Pakistanis (33%) (Riste, Khan and Cruickshank, 2001).

Table 2. Sample of published UK studies on prevalence of type 2 diabetes

				Diabetes Prevalence (%)			
Year	Setting	Size	Age Range	Europeans	S.Asians	African/ Caribbeans	Authors
1991	Coventry	9,903	20+	3.2-4.7	11.2-12.4	---	Simmons *et al.*
1991	Southall,	3,753	40-69	2.3-4.8	16.1-19.9	14.6	McKeigue *et*
1997	London	1,578	40-59	5-7	20-25	15-18	Cappuccio *et*
1998	Newcastle	1,504	25-74	7.1	21.4	---	Unwin *et al.*
2001	Manchester	981	35-79	8.1-22.7	15.7-48.1	15.7-29.5	Riste *et al.*

Source: (Foroughi et al., 2005)

McKeigue, Shah and Marmot (1991), in another large study conducted in West London about five years after the Coventry Study, reported the prevalence of diabetes to be 4.3 times higher in South Asians compared with the European group in the 40 years and older population. These authors also reported prevalence within the South Asian ethnic group as follows: Sikh (20%), Punjabi Hindu (19%), Gujarati Hindu (22%) and Muslim (19%). Cappuccio, Cook, Atkinson et al. (1997) also showed four-fold higher prevalence of diabetes in South Asians than Europeans in the 40-59 year age group.

The Health Survey for England 2004: Health of Ethnic Minorities, a recent survey by the Department of Health, reported that South Asian men and women were more likely to develop type 2 diabetes - nearly three times more than the general England population (Lovegrove, 2007). This survey provided data on another important aspect of ethnicity-based studies: differences in the prevalence of diabetes and ischemic heart disease as well as their determinants *within* this group in countries other than their ancestral homeland. For example, prevalence of type 2 diabetes was highest in Pakistanis (approximately 45% in women and 26% in men aged 55 years and above), followed by Indians (25% in men and 20% women) and Bangladeshis (30% in men and 13% in women). The prevalence of diabetes was substantially lower in the general population (Lovegrove, 2007). The pattern for the prevalence of ischemic heart disease or stroke was similar among the three South Asian groups but with Pakistani *men* having substantially higher rates, followed by the Indians and Bangladeshis (Lovegrove, 2007). Lovegrove (2007) correlated the increased risk of cardiovascular disease among those with type 2 diabetes to be two-to-four fold in men and three-to-five fold in women.

While there is ample evidence suggesting higher risk of type 2 diabetes in the South Asian ethnic group irrespective of the country they have immigrated to, the next section briefly reviews whether this higher prevalence of type 2 diabetes is also seen in the South Asian countries of India, Pakistan, Sri Lanka and Bangladesh.

2.2. Prevalence of type 2 diabetes in South Asia

Estimates suggest that the proportion of people with type 2 diabetes and its associated health effects have increased much faster, and in younger ages, in South Asia than any other areas of the globe (Yoon et al., 2006). According to the World Health Organization (WHO) estimates, there were approximately 40.8 million people aged 20 and older in South Asia with type 2 diabetes in 2000 and this number is projected to increase to 106.0 million people by 2030 (Wild, Roglic, Green, Sicree and King, 2004). Based on these projections, South Asia will experience the highest increase in prevalence and in the total number of people with diabetes. India, in particular, will continue to have the most number of people with type 2 diabetes in the world (Mohan, Sandeep, Deepa, Shah and Varghese, 2007; Yoon et al., 2006). The health consequences of diabetes become potentially alarming given South Asia's large population combined with higher prevalence of diabetes.

Throughout South Asia and India in particular, numerous population-based studies and surveys have been implemented to estimate the prevalence and correlates of diabetes mellitus. The studies summarized here show a level of heterogeneity in the results reported and this is likely due to differences in study design, especially in the diagnostic criteria used and the type of socioeconomic cluster being studied. Regardless of these methodological issues, the important thing to note is that collectively they all convey the same message: the prevalence of diabetes is increasing (rapidly) in all four South Asian countries.

2.2.1. India

One of the first systematic national studies conducted in India on the prevalence of type 2 diabetes in the early 1970's showed a prevalence of 2.1% in urban and 1.5% in the rural population for those aged 14 years and older (Mohan et al., 2007). Subsequent studies in the 1980's and 1990's demonstrated rapidly increasing trends in diabetes prevalence across all parts of India (Mohan et al., 2007). Given that most of these studies were regional and often with differing methodologies, a national survey in 2000 was conducted to assess the diabetes scenario in all regions of India (Ramachandran et al., 2001). The National Urban Diabetes Survey, which measured the prevalence of type 2 diabetes in six metropolitan areas of India for the 20 and older population, reported the total age-standardized prevalence to be 12.1% (Ramachandran et al., 2001). Regionally, the prevalence in southern India varied from 12.4% to 16.6%, was 11.7% in eastern India (Kolkatta), 11.6% in northern India (New Delhi) and 9.3% in western India (Mumbai) (Mohan et al., 2007).

One of the most wide ranging WHO investigations done on diabetes prevalence by King, Aubert and Herman (1998) estimated the prevalence and counts at the urban/rural level for countries across the globe at three time frames

(1995, 2000 and 2025) show the enormity of diabetes prevalence in South Asia (Table 3). These WHO projections used existing studies and/or survey data to model and predict current and future diabetes prevalence rates and counts for each country. According to their estimates and projections, India will undergo the highest rate of increase in the number of people with diabetes mellitus: from 19 million people in 1995 to 57 million in 2025 making India the country with the world's largest number of adults (age 20 and older) with diabetes. The corresponding prevalence rate is projected to increase from 3.8% in 1995 to 6.0% in 2025. As seen in Table 3, the majority of the increase in diabetes numbers will occur in urban populations.

Table 3. Estimated prevalence of diabetes and the number of people with diabetes in adults aged 20 years and over, South Asia, 1995, 2000 and 2025

		Number of people with diabetes		
Country	**Prevalence (%)**	**Rural**	**Urban**	**Total**
India				
1995	3.8	8,135,000	11,262,000	19,397,000
2000	4.0	9,086,000	13,793,000	22,878,000
2025	6.0	14,094,000	43,149,000	57,243,000
Bangladesh				
1995	2.2	856,000	429,000	1,285,000
2000	2.2	969,000	595,000	1,564,000
2025	3.1	1,652,000	2,381,000	4,032,000
Pakistan				
1995	6.7	2,159,000	2,179,000	4,338,000
2000	7.1	2,473,000	2,837,000	5,310,000
2025	8.7	4,229,000	10,294,000	14,523,000
Sri Lanka				
1995	2.5	171,000	104,000	275,000
2000	2.6	190,000	128,000	318,000
2025	3.5	243,000	374,000	617,000
World				
1995	4.0	171,000	104,000	135,286,000
2000	4.2	190,000	128,000	154,392,000
2025	5.4	243,000	374,000	299,974,000

Source: (King et al., 1998)

This WHO study was updated six years later by Wild, Roglic, Green, Sicree and King (2004) using newer data and different methods for estimating age-specific prevalence for the years 2000 and 2030 (Table 4). The prevalence estimates confirmed India as the country with the largest number of diabetics but the new prevalence of diabetes estimates for the year 2000 increased from 4.0% to 5.5% and the number of people with diabetes from about 23 million to approximately 32 million. The 2030 prevalence was estimated to be 8.0% and the total number of people with diabetes to be over 79 million compared with approximately 57 million in the first study.

Table 4. Estimated prevalence of diabetes and the number of people with diabetes in adults aged 20 years and over, South Asia, 2000 and 2030

		Number of people with diabetes		
Country	**Prevalence (%)**	**Rural**	**Urban**	**Total**
India				
2000	5.5	12,302,000	19,403,000	31,705,000
2030	8.0	21,124,000	58,317,000	79,441,000
Bangladesh				
2000	4.6	1,397,000	1,800,000	3,196,000
2030	7.7	2,670,000	8,470,000	11,140,000
Pakistan				
2000	7.7	2,403,000	2,814,000	5,217,000
2030	8.7	4,761,000	9,092,000	13,853,000
Sri Lanka				
2000	5.4	293,000	360,000	653,000
2030	9.0	422,000	1,114,000	1,537,000
World				
2000	4.6	---	---	171,228,000
2030	6.4	---	---	366,212,000

Source: (Wild et al., 2004)

These diabetes prevalence estimates are similar to the International Diabetes Federation estimates suggesting India's total number of people with diabetes to be close to 41 million in 2006 (Mohan et al., 2007). Another national survey (n= 18,363) done over a three year span (1999-2002) and including both urban and rural populations reported diabetes prevalence at 4.3% (urban = 5.6%, rural = 2.7%) (Sadikot et al., 2004).

The DECODA Study Group performed 11 studies in four Asian countries to assess age- and sex-specific diabetes prevalence and impaired glucose tolerance in the 30 and above population living in urban areas. This group reported higher prevalence of diabetes in India than in China, Japan and Singapore, with the age of onset of diabetes being much younger in respondents from India.

Regional differences in India

As these studies show, the prevalence of type 2 diabetes and the number of studies done on this disease vary greatly by region of the country and by the urban/rural focus. Consequently, most diabetes studies in India are regional and majority of these have been confined to the urban areas of southern India (Sadikot et al., 2004).

Regional rates show that the prevalence of diabetes appears to be lower in the northern half of the country (Mohan et al., 2007). Gupta et al (2003) reported age-standardized prevalence of 8.6% in urban population in western India. Other studies show a 6-10% prevalence rate of diabetes in the northwestern parts of India (Mohan et al., 2007).

Two studies conducted in the southern state of Kerala showed diabetes prevalence in the 9 to 16% range. In the earlier study, Kutty, Joseph and Soman

(1999) assessed the prevalence and management of type 2 diabetes in an urban housing settlement and found the overall prevalence in the 20 years and older population to be 16.3%. This study was seen as non-representative of the general Kerala state population given the small sample size, the homogeneity of the housing settlement, the relative socioeconomic status of participants (for example, most of the residents living in this particular settlement were well-off) and the proportion of the three main religions represented in this sample.

In a more recent study, Menon et al (2006) conducted a community-based cross-sectional survey in three randomly selected areas of South Central Kerala (in southern India) using a much larger sample size (n=3069). In this survey, the prevalence of *known* diabetes mellitus was 9% and the prevalence of *newly* diagnosed diabetes – derived from the respondents who agreed to a blood test – was 10.5%, meaning that over 50% of diabetes in this population was undetected. The authors noted concern about the extent of the undetected diabetic cases given that Kerala state has high literacy rates, has one of the best health standards in India, and has much higher rates of access and availability of primary health care centres.

Both of these studies have shown a higher prevalence of diabetes in Kerala than in other parts of India. A major component of this difference is likely that both of these studies included only urban (or mostly urban) populations which have higher prevalence rates of diabetes (Gupta et al., 2004; Ramachandran, Snehalatha, Latha, Vijay and Viswanathan, 1997). Another reason for this higher prevalence may be because the state of Kerala is more developed than the rest of India (Menon et al., 2006). For example, this small southern state has shown remarkable social and economic development in India within the last few decades. Compared to India as whole, Kerala has the highest literacy rates in India, much lower fertility and population growth rates, lower mortality rates, lower infectious disease and broader access to health care (Menon et al., 2006). Higher literacy rates have enabled Kerala to become a major information technology centre in India and have allowed many professionals to migrate to developed countries. These changes in socioeconomic status have led to the urbanization and westernization of its population with major shifts in diet and lifestyle changes (Menon et al., 2006).

The higher rates of diabetes mellitus in southern India are further supported by the Chennai Urban Rural Epidemiology Study (CURES) and three other epidemiologically similar studies which first reported diabetes prevalence in 1989 for the city of Chennai (formerly Madras) (Mohan et al., 2001). According to these studies, the prevalence of diabetes in Chennai – a metropolitan city on the south-eastern coast of India – for the 20 and older population was 8.3% in 1989 (Ramachandran et al., 1997). The prevalence increased to 11.6% in 1995 (Ramachandran et al., 1997), to 13.5% in 2000 and to 14.3% in 2004 as reported by the CURES (Mohan et al., 2007).

2.2.2. Pakistan

The Pakistan National Diabetes Survey is a main sources of diabetes prevalence estimates in Pakistan. Rolled out in four phases in four provinces during the mid-1990’s, this survey was conducted to establish prevalence of diabetes and glucose tolerance in both urban and rural settings for those aged 25 years and above (Shera, Jawad and Maqsood, 2007). According to this survey, the prevalence of type 2 diabetes in rural areas was 3.3% in men and 2.5% in women versus the urban areas where it was 6.0% in men and 3.5% in women (Shera et al., 2007).

These prevalence rates were much lower than the WHO's projected rate of 7.7% in 2000 and 8.7% in 2030 (Wild et al., 2004) and even the 1995 prevalence rate of 6.7% projected in the initial WHO estimates by King et al. (1998).

2.2.3. Sri Lanka

The WHO projections by Wild et al. (2004) showed Sri Lanka's diabetes prevalence rate to be similar to India. For example, Sri Lanka's diabetes prevalence for the 20 years and older population was projected to increase from 5.4% in 2000 to 8.0% in 2030 (Wild et al., 2004). Two other studies - the first in 1990 and a follow-up study in 2000 - of about 200 rural participants in the central province of Sri Lanka showed that the age-standardized diabetes prevalence increased from 2.5% in 1990 to 8.5% in 2000 (Illangasekera, Rambodagalla and Tennakoon, 2004). Wijewardene et al. (2005) conducted a much larger (n=6,047) cross-sectional study of Sri Lankan adults from four provinces to assess the prevalence of cardiovascular risk factors, diabetes and obesity. The prevalence of diabetes was estimated to be 14.2% in men and 13.5% in women.

2.2.4. Bangladesh

According to the WHO projections, Bangladesh's prevalence of diabetes for population aged 20 years and older was 4.6% in 2000 and 7.7% in 2030 (Wild et al., 2004). A lower prevalence in 1999 (2.3%) of type 2 diabetes was recorded by Hussain et al. (2006) in their study of rural individuals from a central area of Bangladesh. This same study was repeated five years later in 2004 by Rahim et al. (2007) to assess the temporal changes in type 2 diabetes prevalence. From 1999 to 2004, the prevalence of type 2 diabetes increased from 2.3% to 6.8%. The authors note that this area, just north of the capital city of Dhaka, continues to undergo rapid urbanization and can now be classified as semi-urban and that the increase in diabetes between 1999 and 2004 may be attributable to societal changes associated with this process (Rahim et al., 2007).

A study done by Sayeed, Banu, Khan and Hussain (1995) of suburban population in the mid 1990's showed the prevalence of type 2 diabetes to be 4.5% in the 30-65 year olds. The increase in diabetes prevalence in Bangladesh is further reinforced by two other urban studies showing prevalence of 7.9% in 1996 and 8.1% in 2002 (Rahim et al., 2007).

2.2.5. Urban/Rural differences in type 2 diabetes prevalence

Studies from South Asia suggest that the prevalence of type 2 diabetes is much higher in cities than in rural populations, suggesting the importance of risk factors associated with urban environment and lifestyle (Illangasekera et al., 2004; Mohan et al., 2001; Ramachandran et al., 1997).

Evidence from studies reviewed above suggests that majority were conducted on urban or semi-urban populations, however, numerous studies have reported urban to rural differences in the prevalence of type 2 diabetes. Overall, the prevalence of diabetes is considerably lower in rural habitats (Chow et al., 2006; Mohan et al., 2001; Ramachandran et al., 1997; Sadikot et al., 2004). The first systematic diabetes investigation in India in the early 1970's reported the prevalence at 1.5% in rural areas (Mohan et al., 2007). About three decades later, the Prevalence of Diabetes in India Study, reported the rural prevalence at 2.7% and the urban at 5.6% (Sadikot et al., 2004). Studies from other South Asian countries have shown similar differences in diabetes prevalence among rural and urban areas (Rahim et al., 2007; Shera et al., 2007).

Further, the WHO diabetes projections suggest that the total population aged 20 and older in the four South Asian countries with type 2 diabetes will increase from approximately 16.4 million to about 29.0 million by 2030 (Wild et al., 2004). And the corresponding increase in type 2 diabetes in the urban population will be from approximately 24.4 million in 2000 to about 77.0 million in 2030.

2.3. Risk factors associated with type 2 diabetes

Evidence suggests that the impact of classical risk factors associated with diabetes materialize differently and do not fully explain the increased risk in South Asians (Anand et al., 2000; Bhopal et al., 2002). For example, Patel et al. (2001) concluded that obesity was not strongly associated with the metabolic syndrome in this group but the waist-to-hip ratio was. Migration is also seen as a key determinant of increased risk of chronic disease in South Asians, especially since migration has not led to increased risk of chronic disease among other ethnic groups, for example, the Afro-Caribbean people (Khunti and Samani, 2004).

As outlined earlier, South Asians have a much higher risk of developing type 2 diabetes and cardiovascular disease. Research evidence on ethnic studies suggests that some ethnic groups – for example, South Asians and Hispanics - are predisposed to developing type 2 diabetes and cardiovascular disease at a much higher rate than the White Caucasian ethnic population (Abate and Chandalia, 2001; Simmons et al., 1989). This increased risk is seen in wherever the South Asians have immigrated to (for example, Europe, North America, Australia, or to other Asian countries such as Singapore) and is primarily attributed with higher insulin resistance and clustering of other metabolic factors referred to as the insulin resistance syndrome or the metabolic syndrome.

2.3.1. The Metabolic or Insulin Resistance Syndrome

The term *insulin resistance syndrome* was first coined by Reaven in 1988 to describe the clustering of certain risk factors associated with cardiovascular and other related diseases (Misra and Vikram, 2004). This syndrome, now more widely referred to as the *metabolic syndrome*, consists of insulin resistance, dyslipidemia, hypertension and obesity as the main risk factors and conveys a substantial risk for cardiovascular disease and type 2 diabetes (Lovegrove, 2007;

McKeigue, Pierpoint, Ferrie and Marmot, 1992; Tan, Chew and Tai, 2004). Prevalence of the individual risk factors as well as the clustering of the metabolic syndrome components is higher in South Asians (Barnett, 2005). UK studies have reported higher rates of abdominal obesity, glucose intolerance and hyperinsulemia in this group compared with the host White population (McKeigue et al., 1988; McKeigue et al., 1992; McKeigue et al., 1991). Up to 50% of South Asian adults are estimated to be insulin resistant (Misra and Vikram, 2004). They have higher concentrations of plasma triglycerides and lower concentrations of high-density lipoprotein cholesterol compared with Whites (Gupta et al., 2004; Tziomalos et al., 2008).

Studies from India have estimated the prevalence of metabolic syndrome to be in the 11 to 41% range, with higher prevalence rates seen in the urban areas (Gupta et al., 2003; Mohan et al., 2001).

Another unique aspect of the insulin resistance syndrome applicable to South Asians is that it manifests in this ethnic group at a much younger age (Misra and Vikram, 2007; Misra, Khurana, Vikram, Goel and Wasir, 2007). A study done by Dickenson, Colagiuri, Faramus, Petocz and Brand-Miller (2002) on young adults aged 18 to 35 years from five ethnic groups showed that South Asians had the highest level of insulin resistance. Whincup et al. (2002) demonstrated greater insulin resistance in South Asian children compared with White UK children even after adjusting for central obesity.

Insulin resistance

Insulin resistance is perceived to be the single most important component of the metabolic syndrome and the best predictor of type 2 diabetes among South Asians (Barnett et al., 2006). South Asians are known to have the highest insulin resistance among major ethnic groups (Abate and Chandalia, 2001). A large cohort investigation by McKeigue et al. (1988) showed a much higher level of insulin resistance in South Asian immigrants compared with the local White Caucasians with similar living conditions and social environments and with little or no excess obesity. A smaller US study comparing South Asian immigrants with Whites of European ancestry showed a higher level of insulin resistance in this group (Laws et al., 1994). Anand at al. (2000) reported the highest prevalence of insulin resistance among Canadians of South Asian origin compared with Canadians of European and Chinese origin.

Two important pre-diabetic clinical manifestations conferring higher risk of diabetes and cardiovascular are IGT (impaired glucose tolerance) and IFG (impaired fasting glucose). IGT, a condition of elevated blood glucose after a two-hour glucose overload and IFG, a condition of elevated glucose after fasting, are important markers seen in pre-diabetic patients and tend to have higher prevalence in South Asians (Anand et al., 2000; Gerstein et al., 2003; Mohan et al., 2007). Anand et al. (2003) found higher levels of fasting glucose concentrations in this group compared with Canadians of European and Chinese decent.

In turn, adiposity is considered a key correlate of insulin resistance with South Asians being more prone to higher percentages of body fat than other ethnic populations (Dudeja et al., 2001; Patel et al., 2001). This increased body fat is manifested through higher truncal or abdominal obesity and lower muscle mass (Barnett et al., 2006; Misra and Ganda, 2007).

Central obesity and WHR (waist to hip ratio)

Central obesity or abdominal obesity refers to the collection of body fat in the upper body (waist and trunk) instead of the hips and thighs. It is measured by the waist to hip ratio (WHR) and reflects a key factor in the distribution of body fat and body profiles in South Asians versus the White Caucasians (Forouhi and Sattar, 2006). As seen in Table 5, South Asians generally are shorter, have thinner limbs and lower muscle mass but tend to be centrally obese and have higher waist-to-hip ratio despite lower or average BMIs (Banerji, Faridi, Atluri, Chaiken and Lebovitz, 1999; Misra and Vikram, 2004). In an early and important study by McKeigue, Shaw and Marmot (1991), the authors concluded that central obesity in South Asians in the UK was strongly associated with insulin resistance even though they were no more obese than Europeans. In a more recent Canadian study, Anand, Ysuf and Vuksan (2000) showed that Canadians of South Asian origin were lighter than Europeans but heavier than the Chinese. South Asians and Europeans had a higher amount of abdominal adiposity compared with Chinese based on WHR. These findings are contradictory with American, Afro-Caribbean and European populations in which insulin resistance is associated with general obesity (McKeigue et al., 1991).

Abdominal obesity and a high proportion of body fat are associated with insulin resistance, type 2 diabetes (Patel et al., 2001; Yoon et al., 2006), atherosclerosis and heart disease and is inversely associated with physical activity and intake of carbohydrates and trans fatty lipids (Merchant et al., 2005).

Table 5. Body profile of South Asians and their association with insulin resistance

Shorter height
Lower BMI
Excess body fat*
Abdominal obesity*
High waist-to-hip ratio
Normal waist circumference
Higher intra-abdominal fat
High truncal subcutaneous fat*

*positive association with insulin resistance

Source: (Misra, Misra, Wijesuriya and Banerjee, 2007; Misra and Vikram, 2004)

Given the body type and lower BMIs of South Asians, the waist-to-hip ratio (WHR) is considered a better predictor of obesity in this group since it is more sensitive to the measurement of abdominal obesity (Misra, Wasir and Vikram, 2005). This line of reasoning argues that, especially for this group, obesity could be redefined as excess in body fat and not excess in body weight (Deurenberg-Yap, Schmidt, Staveren and Deurenberg, 2000).

Body Mass Index

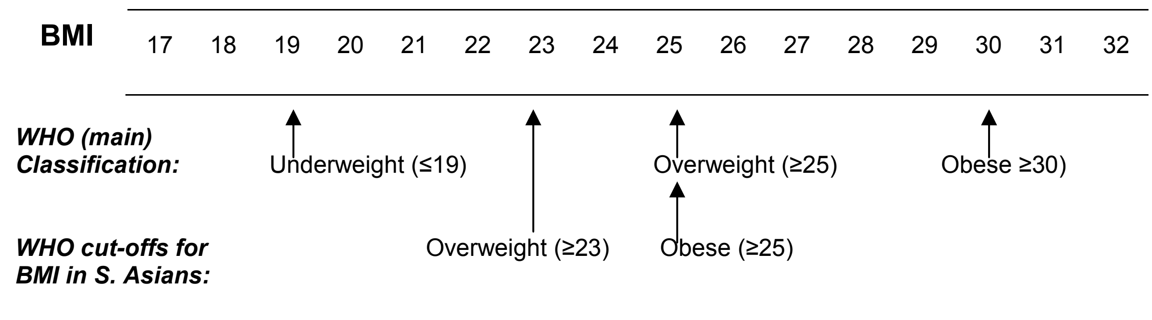
BMI generally, but body fat content specifically, are linearly associated with insulin resistance, type2 diabetes and cardiovascular disease (Dudeja et al., 2001). For example, the risk of type 2 diabetes is estimated to increase by 4.5% for every kilogram of weight gain (Abate and Chandalia, 2007).

Studies from India have reported the prevalence of obesity from 2% to 15% in urban areas and less than 6% in rural areas by using the current WHO definition of obesity (see Figure 1) (Misra and Vikram, 2004). Recent studies have suggested an increasing trend of obesity in children, adolescents and women in South Asia (Misra and Vikram, 2007; Misra et al., 2007).

Obesity rates in South Asian migrant populations are reported to be higher, but are still lower than obesity rates seen in local White Caucasians, Mexican-Americans and Blacks (Misra and Ganda, 2007). Studies have shown that compared with the White Caucasian groups, South Asians have a higher percentage of body fat at a lower BMI (Lovegrove, 2007; McKeigue et al., 1991), which is an important risk factor for insulin resistance (Barnett, 2005; Dickinson, Colagiuri, Faramus, Petocz and Brand-Miller, 2002). Consequently, the use of BMI in South Asians greatly underestimates the risk of diabetes and other diseases given that their BMI range is typically lower than Europeans (Barnett et al., 2006). For example, an individual of European ancestry with a BMI of 30 or higher is estimated to have similar morbidities as a person of South Asian origin with BMI of 27.5 or higher (Barnett et al., 2006).

The traditional BMI cut-off values based on the WHO criteria primarily originated from studies of European populations (Dudeja et al., 2001; Lovegrove, 2007), however, a growing body of evidence questions the applicability of these cut-offs to non-European population groups. Studies have suggested that due to certain genetic and environmental characteristics associated with the South Asian ethnic group, the risk of chronic disease in this ethnic group becomes more evident at lower BMI values (Lovegrove, 2007; Misra et al., 2005). Consequently, the WHO Expert Consultation (2004) revised the BMI cut-offs points for classifying overweight from the current BMI level of ≥25 to ≥23 and obesity from the current BMI level of ≥30 to ≥25 in South Asians (see Figure 1).

Figure 1. BMI cut-offs (kg/m2) for the risk assessment of South Asian ethnic populations based on WHO criteria



Source: (Lovegrove, 2007)

These lower BMI cut-offs more accurately reflect the body type of South Asians which is leaner in body mass but higher in body fat, as discussed above. For example, in Caucasian men, a BMI of 30 kg/m2 corresponds to 25% body fat (Dudeja et al., 2001) whereas in South Asian men, a BMI of 24.5 kg/m2 corresponds to 33% body fat (Banerji et al., 1999).

2.3.2. Metabolic syndrome and type 2 diabetes

The earlier international studies assessing variations in prevalence of and/or mortality from diabetes and cardiovascular disease among people of South Asian originally suggested environmental factors (for example, diet and physical activity) instead of genetic factors as the primary factors associated with these diseases (Cappuccio, 1997). Currently, the collective evidence from ethnic-based studies suggests a combination of both environmental and genetic factors are at play. However, most of the literature on South Asians points to obesity and sedentary lifestyle, which in turn are directly influenced by physical activity, diet, urbanization and factors associated with the broader socioeconomic status.

Diet

Diet, consisting of higher and faulty fat intake, higher carbohydrate but lower protein intake, is considered a major factor in South Asians' increased susceptibility to diabetes, cardiovascular disease and other associated diseases (Das, 2002a; Das, 2002b; Raheja, Bhoraskar and Narang, 1996). An association between higher carbohydrate intake and hyperinsulinemia in South Asians has been reported (Abate and Chandalia, 2007; Sevak, McKeigue and Marmot, 1994). A higher dietary fat intake is associated with insulin resistance and obesity (Lip, Malik, Luscombe, McCarry and Beevers, 1995; Misra, 2002; Raheja et al., 1996). Reduced fibre consumption and increase in the consumption of refined carbohydrates are associated with increased risk of developing type 2 diabetes (Abate and Chandalia, 2007).

Traditionally, South Asians had higher carbohydrate intake, both in their home countries (about 60-67% of energy intake) and in countries of migration (Misra and Vikram, 2004; Raheja et al., 1996; Sevak et al., 1994). A recent Canadian study compared the consumption of carbohydrates and HDL cholesterol levels in four population groups and concluded that South Asians consumed the most carbohydrates, followed by Europeans, Aboriginals and

Chinese, and that higher carbohydrate consumption was associated with lower HDL cholesterol levels (Merchant et al., 2007).

Further, dietary fat intake tends to increase in migrant South Asians and this higher intake, especially of animal fat, is attributable to the westernization of diets and the nutrition transition (Misra, 2002; Misra and Ganda, 2007). Lip et al. (1995) compared the food purchasing habits of Whites, Blacks and South Asians in England and concluded that South Asians purchased the highest quantity of fatty foods compared with the other two groups. They also observed frying as a common food preparation method compared with grilling or poaching in Whites and Blacks. Consequently, a significant proportion of the fat consumed by South Asians comes from cooking fat which lacks the longer chain fatty acids (Bedi, Singh, Syed, Aryafar and Arora, 2006; Tziomalos et al., 2008) needed for normal insulin action (Raheja et al., 1996). Others have suggested a higher intake of fat as a proportion of total energy among this group compared with Whites (Lip et al., 1995). In UK, South Asian children are known to consume fewer fruits and vegetables than White children (Whhincup et al., 2002).

The higher consumption of carbohydrates is attributable to the fact that the majority of South Asians are vegetarian (Misra and Vikram, 2004). Evidence suggests that South Asian vegetarians have higher BMI, higher body fat, increased truncal obesity and lower consumption of fibre compared with White vegetarians (Misra and Vikram, 2004).

Physical activity

Physical activity is associated with reduced complications and mortality from type 2 diabetes (Boulé, Haddad, Kenny, Wells and Sigal, 2001; Hayes et al., 2002). In addition, levels of physical activity are inversely related with waist circumference, BMI and insulin resistance in South Asians (Hayes et al., 2002).

Studies have shown that physical activity levels are significantly lower in South Asians compared with other ethnic groups (Lawton, 2006; Sriskantharajah and Kai, 2007; Williams, 1994). Poorer physical fitness levels are seen even in South Asian children. A UK study of 9-year old children showed that children from the Indian subcontinent had poorer physical activity levels compared to White and Afro-Caribbean children (Bettiol, Rona and Chinn, 1999). South Asian women are especially prone to reduced physical activity (Sriskantharajah and Kai, 2007). Issues such as migration, unfamiliarity of surroundings and norms such as gender roles, religious modesty, mixed-gender activity, job participation levels among females and language difficulties are considered possible contributing factors (Eyler, 2002; Jenum et al., 2005). Barriers such as lack of time, existing health issues, motivation, weather and lack of facilities tend to be common among all ethnic groups, however, the level and capacity to overcome these constraints differ for South Asians (Eyler, 1998).

A study assessing physical activity of South Asian women diagnosed with coronary heart disease and diabetes found that women expressed lack of knowledge about their conditions and were uncertain about the benefits of exercise to their illness and the type of activity most suitable for their conditions

(Sriskantharajah and Kai, 2007). In the same study, motivation for exercise and physical activity among women varied by age: improving body image and appearance motivated younger women while being mobile and active motivated older women. Thus, engagement in physical activity was often not for the purposes of disease management (Siriwardena, 2004) – an important concept for care providers to understand when developing care plans. In addition, being overweight is culturally seen as a sign of wealth, elevated social standings and being healthy (Greenhalgh, Chowdhury and Wood, 2005; Lear, 2004).

For women, exercising in public places is viewed as culturally inappropriate, especially if it involves displaying their bodies, such as in community swimming pools or if the sessions constitute mixed-gender activities (Siriwardena, 2004; Stone et al., 2005). Thus, South Asian women will often indicate preference for women-only sessions and other culturally appropriate programs in their communities (Harris, 2001; Lawton, 2006).

Genetic factors

While environmental conditions (economic, social and lifestyle) are considered to play a major role in the development of chronic diseases such as type 2 diabetes, data from migrant studies suggests a strong interaction between genetic and environmental factors (Misra and Ganda, 2007). This is especially true in the development of type 2 diabetes in South Asians given that they are believed to have an increased susceptibility to insulin resistance and central obesity, especially if combined with western-style living (Barnett et al., 2006; Misra and Ganda, 2007).

Neonatal studies have suggested that South Asian babies are born smaller but are much fatter than Caucasian babies and this phenotype tends to be present in childhood and could signal the adult body shape of South Asians as described earlier (Mohan et al., 2007). A retrospective study in Southern India reported that the risk of coronary heart disease was associated with their size at birth such that people with low birth weight and small head circumference were at higher risk of coronary heart disease later in life (Stein and Fall, 1996).

The ‘thrifty phenotype’ is another hypothesis which suggests that given South Asians socio-economic status, babies tend to face under-nutrition in fetal and infant spans followed by over-nutrition in later years which predisposes individuals to chronic diseases such as diabetes (Forouhi and Sattar, 2006). A recent investigation demonstrated that low birth weight babies with increased over-nutrition in later years were associated with greater prevalence of insulin resistance (Yajnik et al., 2002).

The familial aggregation of type 2 diabetes tends to be much higher in this group. Results from one UK study show that 45 percent of South Asians had a first degree relative with diabetes versus 36 percent for Europeans (Radha and Mohan, 2007). The same study showed that about 10 percent of South Asians had both parents with diabetes compared with only one percent for Europeans. Data about the offsprings where both parents have type 2 diabetes show that about 55 to 60 percent South Asian offspring had diabetes or impaired glucose tolerance – a proportion much higher than parents who were European (Radha and Mohan, 2007).

2.3.3. Ethno-cultural barriers and beliefs associated with type 2 diabetes

Besides the traditional environmental and genetic factors, cultural and social factors play a significant role in the development and management of type 2 diabetes. Cultural practices and attitudes towards two health-promoting activities - physical activity and diet – have been highlighted in previous pages. Factors such as language, cultural values attached to health and wellbeing, as well as stereotypes and attitudes about ethnic minorities held by care providers all determine people's ability to access and utilize health interventions (Huff and Kline, 1999).

Health beliefs of South Asians

How South Asians view health and diagnosis of a disease is often contradictory to established views held by modern medicine. Reaction to a disease diagnosis, even if not life threatening, is that of helplessness and resignation, accepted as the will of God (Kumar and Houlden, 2005; Rhodes, 2003; Stone et al., 2005). Causes of illness are often attributed to such things as genetics and the colder climate and rarely to personal factors (Lawton, 2006). Illness and physical weakness is seen as part of aging with diseases such as diabetes further weakening the body, especially among the elderly (Huff and Kline, 1999; Lawton, 2006; Williams and Harding, 2004). These physical changes are perceived as signals that the body requires rest which can further lead to reduced physical activity levels among South Asian clients (Lawton, 2006).

Support acquisition, both emotional and therapeutic, is often guarded and is mostly through lay family members and relatives (Rhodes, 2003). Family involvement in care plans and in other health-related decisions is culturally appropriate with patients often being accompanied by one or more family members to clinics and other primary care settings (Nunez and Robertson, 2006). This is contradictory to the modern medical culture favouring individualistic relationship between client and care provider (Nunez and Robertson, 2006). Thus, care providers and other sources of written information play a smaller role in knowledge acquisition about health conditions and medical services due to language difficulties (Stone et al., 2005). This cultural practice is contradictory to a widely held view of South Asians placing high regard for information received from a health professional (Stone et al., 2005). This contradiction may simply be due to the fact that the information provided by practitioners may not be in their clients' language or be easily accessible (Rhodes, 2003). South Asians also perceive that responsibility for the management of health conditions remains with the health care provider (Lawton, 2006; Stone et al., 2005). The role of health care professionals is to articulate the care plans to their clients and the role of clients is to follow these orders (Stone et al., 2005).

Relationships with care providers

An integral barrier to health services access and use is the perception of health values between South Asians and health care providers. Often, for recent immigrants, little common ground exists with the client/care provider interaction in terms of health beliefs, extent of knowledge, power balance and social status (Nunez and Robertson, 2006). In this process, a client's 'cultural' input is often not recognized or dismissed as irrelevant (Rhodes, 2003; Whittemore, 2007) given that health care providers are strongly influenced or socialized by their profession. Spector (2004) argues that the views of professionals trained in the modern medicine model are so rigid that they adamantly dismiss South Asian's strong beliefs and reliance on other alternative forms of interventions such as homeopathic and naturopathic medicine.

One important component of this disparity is the lack of cultural knowledge and cultural insensitivity of health professionals about their clients (English and Le, 1999; Inouye, 1999). This often occurs when care providers face language barriers, engage in stereotypes and generalizations or misinterpret culturally-dense messages (Inouye, 1999). Abundant evidence exists suggesting that the needs of clients would be improved if the care providers were better informed and sensitive to clients' cultural and social orientations, beliefs, knowledge and attitudes about health and wellbeing (Rhodes, 2003; Stone et al., 2005).

Language and common cultural origins were seen as important components of a supportive relationship with their care providers (Rhodes, 2003) and many feel that a practitioner's ability to speak their language is key to effective communication (Rhodes, 2003). Results from a study of diabetic Spanish-speaking patients showed that patient's satisfaction level was much higher for Spanish-speaking physicians than physician who spoke English only (Huff and Kline, 1999).

Language

Language is considered a key cultural barrier contributing to disparity in health access and utilization, especially among new immigrants (Rampaul and Ahmad, 2000; Sriskantharajah and Kai, 2007). Some studies have shown that English fluency, rather than ethnicity, has a stronger influence on health care use. Fiscella et al. (2002) studied the link between cultural factors such as race, ethnicity and language with four types of health care visits and concluded that among the four groups compared (Whites, Blacks, English-speaking Hispanics and Spanish-speaking Hispanics), the Spanish-speaking Hispanics had statistically lower usage rates of these services. Their findings further reinforce the notion that language proficiency is a key predictor of ethnic disparities in health care utilization (Fiscella, 2002).

Another study comparing Latino and non-Latino Whites with hypertension or diabetes found that patients' overall well-being, use of medical practitioners and health perceptions correlated much more strongly with common language of clients and their care providers (in this case, Spanish) than with their ethnicity (Fernandez, 2004).

2.4. The South Asian population in Canada

People of South Asian origin refers to those with ancestral links to the countries of India, Pakistan, Bangladesh and Sri Lanka. Demographic data from the 2006 Canadian Census show that the proportion of non-European ethnic groups is substantial (16.2%) and is rising faster than the European-based ethnic groups. According to the 2006 Canadian Census, there were close to 1,316,770 (or 4.2% of total) people of South Asian ethnicity residing in Canada, making it one of the largest ethnic minority groups behind the Chinese (1,346,510) and Aboriginals (1,678, 240). In BC, the South Asian population totalled approximately 265,600, representing 6.5% of BC's total population.

Table 6. Population by ethnic origin, Canada and BC, 2001 and 2006 Census years

	Canada		BC	
	2001	**2006**	**2001**	**2006**
Population Count				
South Asian	984,090	1,316,770	216,125	265,595
Chinese	1,094,700	1,346,510	373,825	432,435
Aboriginal	1,365,065	1,678,235	222,330	250,900
All Other	26,195,180	26,899,515	3,056,595	3,125,455
Total, All	29,639,035	31,241,030	3,868,875	4,074,385
South Asians as proportion of total population				
%	3.3	4.2	5.6	6.5
South Asian population by province of residence				
Ontario	592,500	---	---	---
BC	210,400	---	---	---
Alberta	72,400	---	---	---
Quebec	62,600	---	---	---
All other	25,300	---	---	---

Source: Statistics Canada, 2001 and 2006 Census of Population, Statistics Canada catalogue no. 97-562-XCB2006006

The South Asian population is growing much faster than the overall Canadian population. From 2001 to 2006, the South Asian population grew by 33.8% while the total Canadian population increased by 5.4%. According to the 2001 Census, most (84%) of the South Asian population was concentrated in two provinces: Ontario (62%) and BC (22%) of the total Canadian South Asian population. Close to 8% of Canadians of South Asian origin resided in Alberta.

In the 2006 Canadian Census, approximately 746,900 of the total Canadian population identified their ‘mother tongue’ (for example, the language first spoken) as one of the Indo-Aryan languages. Of this group, nearly one-half (or 367,500 total) acknowledged Punjabi as their mother tongue, approximately 20% as Urdu and approximately 15% as Tamil.

At the BC level, approximately 200,000 South Asians identified their mother tongue as an Indo-Aryan language. The most identified language, Punjabi, was selected by 79% of South Asians as being their mother tongue followed by Hindi (11%) and Urdu (3.5%).

Table 7. South Asian population by Mother Tongue, Canada and BC, 2006 Census

Mother tongue	Canada	BC
Punjabi	367,505	158,750
Urdu	145,805	7,025
Tamil	115,880	---
Gujarati	81,465	---
Hindi	78,235	23,340
Bengali	45,685	---
Total Indo-Aryan languages	746,870	200,400

Source: Statistics Canada, 2006 Census of Population, Statistics Canada catalogue no. 97-555-XCB2006015

The language most often spoken at home is another indicator providing additional context for Canadians of South Asian origin. Data from the 2006 Canadian Census show that approximately 272,200 people in Canada spoke Punjabi most often at home, followed by Urdu (94,610), Tamil (86,545) and Gujarati (50,535).

These data on mother tongue and language most often spoken at home reflect the heterogeneity of the people making up the four countries of South

Asia. For example, people from Sri Lanka and the southern parts of India speak Tamil. Bengali is the main language of Bangladesh with Urdu and Punjabi as the two primary languages of Pakistan. Gujarati is spoken in the north-western Indian state of Gujarat. Gujarati's have mainly settled in the urban centres of Ontario and in the eastern United States. Punjabi's ancestral area is the northern Indian state of Punjab. As the language and population data in the tables suggest, a large proportion of the South Asian population in Canada are Punjabis with most settling in the provinces of BC and Ontario.

Table 8. South Asian language spoken most often at home, Canada and BC, 2006 Census

Language	Canada	BC
Punjabi	272,195	115,535
Urdu	94,610	4,130
Tamil	86,545	2,170
Gujarati	50,535	2,720
Hindi	39,015	10,945
Bengali	32,005	995

Source: Statistics Canada, 2006 Census of Population, Statistics Canada catalogue no. 97-555-XCB2006028

According to the 2001 Census, Canadians of South Asian origin reported their religion as follows: 28% Sikh, 28% Hindu, 22% Muslim and 16% Christian. Punjabis belong to the religion of Sikhism and people from Pakistan and Bangladesh are mainly Muslims and practice Islam. Approximately 80% of the Indian population in India belong to the Hindu religion, including Gujaratis. Tamils, from the country of Sri Lanka, practice Buddhism.

3. METHODS

This paper estimates the prevalence of type 2 diabetes for Canadians of South Asian origin using a descriptive epidemiological approach with data from the Canadian Community Health Survey (CCHS) Cycle 2.1, a cross-sectional survey conducted by Statistics Canada in 2003. Geographical analysis were limited to the national level in order to produce stable results and allow meaningful statistical significance testing given the relatively small sample size for South Asians. Even though the CCHS collects data for ages 12 and above, analysis for this investigation were restricted to age 20 and above to allow comparisons of the results from this investigation to other national and international studies which typically assess the prevalence of type 2 diabetes for the adult age groups.

3.1. Data source

The primary data source for this paper is the Canadian Community Health Survey (CCHS) Cycle 2.1, conducted by Statistics Canada from 2002 to 2003. The CCHS 2.1 provides cross-sectional, individual-level information on various health determinants, health status, health care utilization and socioeconomic and demographic attributes for 136 health regions across Canada. The target population includes household residents aged 12 and older, excluding those living on Indian Reserves, Canadian Forces Bases, medical institutions and some remote areas. Data are based on both personal and telephone interviews using computer-assisted interviewing software.

Data collection for the first cycle (1.1) began in 2000, over a 12-month period beginning in September to minimize the seasonal effects on respondents and has occurred every two years until 2005. In order to improve its effectiveness, the methodology of CCHS was revised in 2007 to allow data collection on an ongoing basis instead of every two years.

The CCHS survey has two main components: the common content and the optional content. The common content, collected from all respondents, remains consistent over time while the optional content is based on the regional and/or organizational needs wishing to address emerging health issues. The CCHS Cycle 2.1 questionnaire is approximately 45 minutes in length with about 25 minutes of common content and the rest for optional and demographic information.

Sampling for the CCHS Cycle 2.1 is based on two primary frames with approximately 50% of respondents selected from the area frame and the remaining 50% from the list frame of telephone numbers. Sample sizes were allocated on provincial and the regional population sizes. The survey allows computer-assisted interviewing and is translated into four additional languages: Chinese, Punjabi, Inuktitut and Cree. In order to minimize language barriers, interviewers were selected with wide ranging language abilities.

A total of 166,222 households were selected for participation, of which 144,836 responded for an overall household response rate of 87.1%. From these

144,836 households, 134,072 individuals were selected for response rate of 80.7%.

Results of this paper are based on the ‘master’ data file accessed through Statistic Canada’s Remote Access programs. These data files differ from the Public Use Microdata Files (PUMF) containing grouped, summarized or suppressed data to control for small counts and minimize the risk of disclosure associated with small sample sizes.

3.2. Measures and definitions

3.2.1. Type 2 diabetes

Diabetes mellitus is a chronic disease characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. There are several types of diabetes, however, Type 2 diabetes accounts for over 90% of all cases. Three common type of diabetes include:

- Type 1 diabetes requires total insulin replacement because the body does not make adequate amounts of this hormone. Type 1 diabetes typically occurs in children and young adults;
- Type 2 diabetes, related to insulin resistance (lack of the ability of the body to respond to insulin appropriately) and often accompanied by obesity and high cholesterol and other factors occurs most often after age 30 and increases with age; and
- Gestational diabetes occurs during pregnancy in a small proportion of women and disappears after birth.

Type 2 diabetes is detected using two blood tests: the fasting plasma glucose (FPG) or the oral glucose tolerance test (OGTT). The FPG test measures blood glucose levels after an overnight fast while the OGTT test measures blood glucose levels once after an overnight fast and again two hours following a sugar-rich drink.

The CCHS Cycle 2.1 included questions about several chronic health conditions. The selection of specific conditions to be included in the interview was made by Statistics Canada based on input from an expert committee. Thus the list of questions on diabetes is by no means exhaustive. For this investigation, diabetes prevalence is based on self-reports, however, respondents can report diabetes, or other chronic diseases, only if they have been diagnosed by a health professional as having diabetes (or other chronic condition(s)).

The CCHS questionnaire does not differentiate between type 1 or type 2 diabetes; as a result, the prevalence reported in this paper is assumed to be type 2 diabetes based on the fact that type 1 diabetes beyond age 20 is very infrequent.

Specifically, the question on chronic conditions is as follows:

CCC_QINT011: Now I'd like to ask about certain chronic conditions which you may have. We are interested in "long-term conditions" which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.

CCC_Q101: Do you have diabetes?

Other questions related to diabetes include:

How old were you when this was first diagnosed?

When you were first diagnosed with diabetes, how long was it before you were started on insulin?

Do you currently take insulin for your diabetes?

In the past month, did you take pills to control your blood sugar?

3.2.2. Ethnic grouping

Survey participants were grouped into four cultural or ethnic classifications: White, South Asian, Chinese and Aboriginal. Canadians of South Asian origin are those with ancestral links to the Indian subcontinent, includes countries of India, Pakistan, Bangladesh or Sri Lanka. Chinese includes those with ancestral links to China (including Hong Kong) or Taiwan. Aboriginal refers to people belonging to North American Indian, Metis or Inuit ethnic origins.

Cultural/ethnic groupings into South Asian, Chinese, Aboriginal and White origin were based on the following question:

SDE_Q7: *People living in Canada come from many different cultural and racial backgrounds. Are you:*

White?

Chinese?

South Asian (e.g., East Indian, Pakistani, Sri Lankan)?

Black?

Filipino?

Latin American?

Southeast Asian (e.g., Cambodian, Indonesian, Laotian, Vietnamese)?

Arab?

West Asian (e.g., Afghan, Iranian)?

Japanese?

Korean?

Aboriginal (North American Indian, Metis or Inuit)?

Other - Specify

In addition, diabetes prevalence and population proportions were computed for the following ages: 20 and above, 20-49, 50-64, 65 and above and 50 and above. All other prevalence and proportions were estimated for the 20 and above age group.

The social and economic measures included in this study were the year of immigration into Canada, language spoken with doctor, education levels and income levels. *Year of immigration into Canada* was grouped as follows: prior to 1975, 1976-1990, 1991-2003. Due to small sample sizes at the ethnic group levels, *respondents' education level* and *household income level* (less than $30,000, $30-$59,999, $60,000 and above) were grouped into three categories (refer to tables in Results section). The respondent education levels were grouped as follows:

<u>Secondary graduation or lower</u> = grade 8 or lower + grade 9-10 +

grade 11-13 + secondary graduation.

<u>Some post-sec or college</u> = some post-sec + trade cert./dip +

college cert./dip + university certificate < bachelor.

<u>Bachelor's degree or higher</u> = bachelor's degree + university certification >

bachelor's degree.

Language spoken to doctor included three South Asian languages in the CCHS questionnaire: Punjabi, Hindi and Tamil.

As per risk factors and lifestyle conditions, *BMI* (body mass index) categories used for this analysis are 'underweight' (less than 18.5), 'normal' weight (18.5 to 24.9), 'overweight' (25 to 29.9) and 'obese' (30 or more). Again, due to small sample sizes, the 'underweight' and 'normal' categories were combined. *Level of physical activity* was assessed on the summary physical activity index which groups activity level into 'active', 'moderate' or 'inactive' based on the total energy expenditures calculated using the responses on multiple questions about the various forms and levels of physical activity performed by respondents in the past three months. *Daily consumption of fruits and vegetables* was summarized into two categories: those consuming fewer than five fruits or vegetable per day versus those who consume five or more daily. *Alcohol consumption* refers to the type of drinker as 'regular' drinker, 'occasional' drinker and 'non-drinker'. 'Regular' drinker refers to someone consuming alcohol once per month in the past year, 'occasional' drinker as less than once per month over the one year and 'non-drinker' as having no alcohol. *Smoking* was grouped as 'daily' smoker, 'occasional' smoker and 'non-smoker'.

‘Occasional’ smoker is someone who is not a daily smoker or has smoked less than 100 cigarettes lifetime while ‘non-smokers’ are former smokers or never smokers.

Health status and use of *health care services* were assessed using various selected measures such as self-assessed health, prevalence of chronic diseases (high blood pressure and heart disease) and use of preventive services (ever had a physical check-up without health problem, ever had a flu shot, ever had blood pressure taken, ever had PAP smear test, ever had mammogram, ever had a PSA blood test). Self-rated health was based on the following question:

GEN_Q01 In general, would you say your health is:

excellent?

very good?

good?

fair?

poor?

The categories ‘excellent’ and ‘very good’ were combined into ‘v.good to excellent’ and ‘fair’ and ‘poor’ were grouped into ‘poor to fair’.

3.3. Analytical techniques

Statistical analysis were performed with SPSS statistical software 14.0. Based on Statistic Canada’s release guidelines of CCHS data, point estimates on sample respondents totalling 30 or less were not reported and the sample error and coefficient of variation not calculated. For weighted estimates based on sample sizes of 30 or more, the following guidelines with respect to the coefficient of variation were used.

Table 9. Coefficients of variation guidelines

Type of estimate	CV (in %)	Guidelines
Acceptable	0.0≤ CV ≥ 16.5	Estimates can be considered for general release.
Marginal	16.6≤ CV ≥ 33.3	Estimates can be considered for general release but should be accompanied by a warning cautioning the high sampling variability associated with the estimates.
Unacceptable	CV > 33.3	Data should not be released due to unacceptable quality.

Descriptive statistics on weighted data were computed on the proportions of adults aged 20 and older for various demographic, socio-economic status, risk factors and health-related characteristics. For each ethnic group, the unadjusted prevalence of diabetes was estimated.

The independent variables used in this investigation, such as age, gender, ethnicity, education levels, income levels, length of immigration and risk factors such as overweight and obesity, smoking status, alcohol consumption physical activity levels, consumption of fruits and vegetables, were based on existing evidence and research studies.

Standard errors and coefficients of variation were calculated with the bootstrap variance estimation technique using Statistic Canada’s BOOTVAR program. Bootstrap variance technique was developed to allow meaningful calculations for the CCHS survey which uses complex sampling design. The BOOTVAR uses SPSS (and SAS) macros to calculate variance estimates for totals, ratios and differences between ratios as well as regression and logistic regression. For Chi Square cross-tabulations and testing statistical significance on proportions using the bootstrap algorithm, missing data were excluded. The White ethnic group represented the reference group.

The association between diabetes and ethnicity, sex, age, income, education, body mass index, physical activity, alcohol use and smoking was calculated using logistic regression analysis, with diabetes as the dependent variable. Missing data were excluded from this analysis with the Whites as the reference group.

4. RESULTS

4.1. Sample demographic characteristics

Tables 10 and 11 present the age and gender distributions of the sample and estimated populations groups described in this report. Of the total 125,464 respondents aged 12 years and over in this survey, 1,372 were of South Asian cultural or ethnic origin, 3,545 of Aboriginal cultural or ethnic origin, 1,956 of Chinese cultural or ethnic origin and 112,555 of White cultural or ethnic origin. The South Asian cultural or ethnic origin group represented approximately 1.1% of the total survey respondents while the largest ethnic group, the Whites, comprised 89.7% of the survey sample.

The study population used for this analysis consisted of all survey respondents aged 20 years and over, totalling 107,896 individuals. The South Asian ethnic or cultural group consisted of 1,139 respondents (or 1.1% of the total sample).

The sample respondents from the four ethnic groups varied considerably by age and sex distribution. For example, on average, South Asian respondents were almost nine years younger than Whites with mean age of 42.4 years compared with 51.2 years for Whites, 44.4 years for Chinese and 41.1 years for Aboriginals.

This younger age distribution was also reflected in the distribution of population proportions by age groups as approximately 70% of South Asians respondents belonged to the 20 to 49 years age group compared with 47.7% in Whites. Only about 10% of the South Asian total sample was 65 years and over compared with 25.5% in Whites and 24.1% for all respondents (Table 10).

Table 10. Sample size (non-weighted) population counts by age and gender, 2003

Population Measure	Total Respondents	White	Chinese	Aboriginal	South Asian
Age 12 or older:					
Mean age (st. dev)	45.5±20.4	46.4±20.4	38.8±18.2	35.3±17.3	37.8±17.1
Total sample count	125,464	112,555	1,956	3,545	1,372
Male	58,465	51,392	901	1,554	741
Female	69,145	61,163	1,055	1,991	631
Age 20 or older:					
Mean age (st. dev)	50.4±17.6	51.2±17.6	44.4±15.9	41.1±15.3	42.4±15.1
Total count	107,896	97,622	1,575	2,748	1,139
Male	48,492	43,805	711	1,151	605
Female	59,404	53,817	864	1,597	534
Pop'n by age groups:					
20-49 years	53,666	46,577	1,045	1,984	796
50-64 years	28,188	26,148	317	511	228
65+ years	26,042	24,897	213	253	115
Count, age 50 or older	54,230	51,045	530	764	343

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

The proportion of female respondents aged 20 years or older was much higher for all groups except South Asians, which interestingly, had more males (53.1%) than females (46.9%).

The weighted population data are based on a total of 22,592,281 individuals aged 20 and over and represent 605,921 South Asians or 2.7% of the total weighted population (Table 11). This proportion is lower than the actual proportion of South Asians in Canada. According to the 2006 Census, 4.2% of the Canadian population identified themselves as South Asian. The mean weighted age for South Asians was 41.2 years and 47.3 years for Whites, a difference of about 6 years compared with a difference of almost 9 years in the sample data. The weighted data for the White ethnic group had a higher proportion of population in the 20 to 49 year age group and a lower proportion in the 65 years and older group compared with the sample data for this ethnic group.

Table 11. Estimated (weighted) population counts by age and gender, Canada, 2003

Measure	Total Respondents	White	Chinese	Aboriginal	South Asian
Age 12 or older:					
Mean age (st.deviation)	42.6±18.7	43.5±18.9	38.8±16.6	35.5±16.4	38.1±16.2
Total count	25,834,366	21,877,072	873,641	282,095	689,961
Male	12,696,053	10,713,035	416,932	126,684	385,911
Female	13,138,312	11,164,036	456,710	155,412	304,050
Age 20 or older:					
Mean age (st.deviation)	46.4±16.6	47.3±16.8	42.3±15.0	40.4±14.5	41.2±14.8
Total count	22,592,281	19,227,363	759,705	226,723	605,921
Male	11,037,124	9,360,538	367,409	99,237	337,793
Female	11,555,157	9,866,825	392,296	127,486	268,128
Counts by age groups:					
20-49 years	13,605,115	11,363,316	534,509	168,189	442,854
50-64 years	5,339,090	4,716,795	153,521	42,859	112,517
65+ years	3,648,074	3,374,251	71,675	15,675	50,549
Proportions by age groups (%):					
20-49 years	60.2	57.9	70.4	74.2	73.1
50-64 years	23.6	24.5	20.2	18.9	18.6
65+ years	16.1	17.5	9.4	6.9	8.3
Proportions by sex (%):					
Male	48.9	48.7	48.4	43.8	55.7
Female	51.1	51.3	51.6	56.2	44.3

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

4.2. Diabetes overview

Self-reported diabetes in CCHS was captured by asking responders if they had been told by a health professional that they have diabetes. Based on this question, the estimated prevalence of self-reported diabetes for all respondents aged 20 and over was 5.2%. As seen in Table 12, the estimated prevalence of diabetes varied by province from a low of 4.0% in Alberta to a high of 7.3% in Newfoundland and Labrador. Generally, the Atlantic provinces of Newfoundland Labrador, Nova Scotia, New Brunswick and Prince Edward Island had the highest prevalence of diabetes, whereas lowest rates of diabetes were seen in Alberta and in northern Canada, specifically, Yukon, Northwest Territories and Nunavut. BC's rate of 5.1% was similar to the Canadian average.

Table 12. Diabetes prevalence by province, age 20 and over, Canada, 2003

Province	Respondent count, Total	Count: has diabetes	Diabetes (%)
Nfld and Lab.	401,990	29,481	7.34
Nova Scotia	696,773	42,974	6.17
N.Bruinswick	560,480	34,270	6.11
Manitoba	791,521	46,151	5.83
PEI	102,849	5,800	5.64
Saskatchewan	685,406	37,231	5.44
Ontario	8,982,564	471,613	5.25
Quebec	5,636,608	291,897	5.18
BC	3,096,548	158,326	5.12
Yukon	21,264	941	4.43
NWT	27,572	1,129	4.10
Alberta	2,247,528	88,793	3.96
Nunavut	10,456	98	0.94
Canada	23,261,560	1,208,704	5.20

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

Prevalence of diabetes varied by sex, age and ethnicity with male respondents reporting higher prevalence rates than females, regardless of ethnicity and age.

Overall, South Asians' self-reported rate of 8.0% for those aged 20 years and older was statistically significantly higher than the total Canadian population (5.2%), the White ethnic group (5.1%) and the Chinese ethnic group (4.4%). The Aboriginal diabetes rate was slightly higher than the South Asian group (8.6%). In addition, the prevalence of diabetes for the entire survey cohort aged 12 years over was highest in South Asians at 7.0%, followed by 6.9% in Aboriginals and 4.5% in Whites.

Age was a considerable factor in diabetes prevalence for all ethnic groups: the mean age of diabetics varied by ethnicity and the prevalence of diabetes increased with age (Table 13). The mean age of South Asian respondents with self-reported diabetes (53.7 years) was youngest among all ethnic groups. For example, the mean age of Whites with self-reported diabetes was 61.6 years, followed by Chinese (59.3 years) and Aboriginals (54.5 years).

The prevalence of diabetes by age group showed that among South Asians, the percentage of self-reported diabetes increased from 4.5% in the 20-49 years age group to 16.1% in the 50-64 years age group to a high of 20.5% in the 65-plus years age group. As mentioned above, this pattern exists - to varying degrees - among all ethnic groups as well as the total Canadian population. However, the prevalence of diabetes in the 50-64 years South Asian ethnic group was especially pronounced and statistically significant, compared with the overall

Canadian population as well as the White and Chinese ethnic groups. Compared with the Whites and Chinese ethnic groups, South Asians were almost twice as likely to be diabetic in this age group. Further, nearly one-in-five (20.5%) South Asians self-reported being diabetic in the 65-plus age group, a proportion much higher than all other ethnic groups except Aboriginals. The Aboriginal ethnic group had the highest rates of diabetes in the 50 years and older population (24.0%) in Canada, followed by South Asians at 17.3%.

Diabetes prevalence by sex showed considerable variation among all ethnic groups with males generally having higher rates of diabetes than females. South Asian males had statistically significantly higher rates of diabetes than White males both in the age 20 and above and age 50 and above groups.

As seen in Table 13, the initial diagnosis of diabetes among South Asians occurred at a younger age than the other ethnic groups. The mean age at which initial diabetes diagnoses occurred was 44.6 years in South Asians and 51.4 years in Whites. A statistically significantly higher proportion of South Asians (62.5%) were diagnosed prior to age 50 compared with approximately one-third (34.7%) of Whites.

Table 13. Prevalence of diabetes by age and gender, age 20 and over, Canada, 2003

Measure	Total	White[†]	Chinese	Aboriginal	South Asian
Diabetes prevalence by age and gender (%)					
12 years or older	4.6	4.5 (4.3, 4.7)	3.9 (2.7, 5.0)	6.9* (5.4, 8.4)	7.0* (5.3, 8.7)
20 years or older	5.2	5.1 (4.9, 5.3)	4.4 (3.1, 5.7)	8.6* (6.7, 10.5)	8.0* (6.0, 9.9)
50 years or older	10.4	9.9 (9.5, 10.3)	10.9 (7.4, 14.5)	24.0* (18.2, 29.8)	17.3* (12.2, 22.4)
By age group:					
20-49 years	1.7	1.6 (1.4, 1.7)	F	3.2*[E] (2.1, 4.4)	4.5*[E] (2.7, 6.4)
50-64 years	8.3	7.7 (7.3, 8.2)	F	24.5* (17.4, 31.5)	16.1*[E] (10.3, 21.9)
65 years or older	13.5	13.0 (12.3, 13.6)	18.2[E] (10.9, 25.4)	22.7[E] (13.4, 31.9)	20.5[E] (10.3, 29.8)
By age and gender:					
Male, age 20+	5.6	5.5 (5.2, 5.8)	4.4[E] (2.5, 6.3)	7.2[E] (4.6, 9.8)	8.6*(6.0, 11.1)
Female, age 20+	4.8	4.7 (4.5, 4.9)	4.4[E] (2.5, 6.2)	9.7* (7.1, 12.4)	7.2[E] (4.2, 10.3)
Male, age 50+	11.9	11.3 (10.7, 11.9)	10.7[E] (5.3, 16.2)	23.0*[E] (14.7, 31.2)	19.5*[E] (12.6, 26.5)
Female, age 50+	9.1	8.7 (8.3, 9.2)	11.2[E] (6.6, 15.8)	24.9*[E] (16.3, 33.5)	14.6[E] (7.0, 22.2)
Mean age, diabetics (years)	60.7±13.9	61.6±13.9	59.3±13.2	54.5±11.9	53.7±13.2
Age of initial diabetes diagnosis					
Mean age of diagnosis (yrs)	50.8±15.9	51.4±16.0	50.1±15.0	45.6±13.9	44.6±13.0
Proportion by age group (%):					
Diagnosis before age 50	38.0	34.7 (32.7, 36.7)	50.3 (34.6, 66.0)	56.6* (44.7, 68.4)	62.5* (49.8, 75.2)
Diagnosis after age 50	62.0	65.3 (63.3, 67.3)	49.7 (34.0, 65.4)	43.4* (31.6, 55.3)	37.5* (24.8, 50.2)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category

* Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

4.3. Social and economic characteristics

4.3.1. Education and income

South Asians had a slightly lower proportion of population with less than secondary schooling and secondary graduation compared with the White and total population groups, but this difference was not statistically significant. South Asians, however, were statistically less likely to have completed a trade/college or university affiliated certificate or diploma (30.6%) compared with Whites (42.3%). South Asians were statistically significantly much more likely to have completed a university degree (34.9%) than Whites (19.0%). Generally, the prevalence of diabetes varied by education with those in the lower education levels having higher prevalence of type 2 diabetes. Due to small numbers, the association between education and type 2 diabetes was unclear for all ethnic groups. However, prevalence of diabetes in South Asians with secondary education was two-times higher than those with a university degree or higher (Table 14).

South Asians' mean household income of $66,090 was lower than the White group ($68,646) but higher than both the Chinese and Aboriginal groups. Approximately one-fifth (20.3%) of South Asians had income of $30,000 or less and this was similar to Whites. A further 35.1% of South Asians were in the $30,000 to $59,999 income group followed by 44.6% who made $60,000 or more per year. Results comparing income levels and prevalence of diabetes show an inverse association between income and diabetes prevalence, even though this association was inconclusive for the Chinese and for South Asians in the highest income group due to small numbers. South Asians with income less than $30,000 had the highest prevalence of diabetes (16.7%) among all ethnic groups.

The following two variables, ‘year of immigration into Canada’ and ‘language spoken to doctor’ provide a glimpse into the degree of acculturation among South Asians and their ability to use the English language and have access to medical practitioners who speak their ancestral language (in this case, primarily Punjabi and Hindi). Consequently, these two indicators necessarily do not require multi-ethnic comparisons but rather provide valuable information on the South Asian responders’ social context.

As seen in Table 14, the average length of time in Canada was 14.1 years for South Asians and this was reflected in the period of immigration with the majority (52.2%) of South Asians immigrating to Canada during the 1991 to 2003 time span. Close to one-third (31.9%) of South Asians immigrated from 1976 to 1990 period with the rest (15.9%) immigrating prior to 1975. Overall, the Chinese ethnic group’s immigration patterns were similar to the South Asian group. The prevalence of diabetes was lowest in the most recent immigrants (6.5%) compared with 11.6% for those immigrating from 1976 to 1990 period and 11.3% for those prior to 1975.

Most (72.8%) South Asians spoke English with their doctor followed by 22.5% who conversed in one of three South Asian languages: Punjabi, Hindi or Tamil.

Table 14. Social and economic characteristics and diabetes prevalence, age 20 and older, Canada, 2003

Measure	Total	White[†]	Chinese	Aboriginal	South Asian
Education level (%)					
Secondary graduation or lower	38.1	38.8 (38.3, 39.3)	34.8* (31.3, 38.2)	55.1* (51.3, 58.8)	34.4 (30.4, 38.5)
Some post-secondary or college	41.5	42.3 (41.8, 42.7)	28.2* (25.1, 31.4)	39.2 (35.5, 42.9)	30.6* (26.6, 34.6)
Bachelors degree or higher	20.3	19.0 (18.5, 19.4)	37.0* (33.7, 40.3)	5.8* (4.0, 7.6)	34.9* (31.2, 38.7)
Prevalence of diabetes by education					
Secondary graduation or lower	7.6	7.5 (7.1, 7.8)	7.2[E] (4.3, 10.0)	9.6 (7.1, 12.2)	10.9[E] (7.1, 14.8)
Some post-sec or college or diploma	4.0	4.0 (3.7, 4.2)	F	7.6*[E] (4.5, 10.6)	F
Bachelor's degree or higher	2.9	2.5 (2.1, 2.8)	F	F	5.6*[E] (3.0, 8.2)
Household income					
Mean household income ($)	67,313	68,646	58,000	46,913	66,090
Household income (%)					
Less than $30,000	21.1	20.2 (19.8, 20.6)	28.2* (24.9, 31.6)	41.4* (37.3, 45.4)	20.3 (17.4, 23.2)
$30,000 - $59,999	31.7	31.3 (30.8, 31.8)	31.8 (28.4, 35.3)	30.8 (26.8, 34.9)	35.1 (31.0, 39.1)
$60,000 or more	47.2	48.5 (48.0, 49.0)	39.9* (36.4, 43.5)	27.8* (24.0, 31.5)	44.6 (40.6, 48.6)
Diabetes prevalence by household income					
Less than $30,000	9.3	9.5 (9.0, 10.1)	F	11.6 (8.3, 14.9)	16.7*[E] (10.3, 23.0)
$30,000 - $59,999	5.3	5.2 (4.9, 5.6)	F	5.0[E] (2.9, 7.1)	6.7[E] (3.7, 9.6)
$60,000 or more	3.1	2.9 (2.7, 3.1)	F	6.8[E] (2.4, 11.2)	F
Length of time in Canada (yrs)	n/a	33.3	14.9	n/a	14.1
Year of immigration into Canada (%)					
Prior to 1975	42.2	66.1 (64.5, 67.7)	15.7* (13.0, 18.4)	n/a	15.9* (12.9, 18.9)
1976-1990	26.6	17.8 (16.6, 19.1)	34.4* (30.8, 38.0)	n/a	31.9* (28.0, 35.9)
1991-2003	31.2	16.1 (14.8, 17.4)	49.9* (46.0, 53.7)	n/a	52.2* (47.7, 56.6)

Measure	Total	White[†]	Chinese	Aboriginal	South Asian
Diabetes prevalence by period of immigration					
Prior to 1975	9.5	8.9 (7.8, 9.9)	9.6[E] (5.0, 14.2)	n/a	11.3[E] (6.8, 15.8)
1976-1990	5.2	1.6[E] (1.0, 2.2)	6.1*[E] (3.2, 9.0)	n/a	11.6*[E] (6.6, 16.5)
1991-2003	2.7	F	F	n/a	6.5*[E] (3.8, 9.2)
Language spoken to doctor (%)					
English	75.1	76.3 (75.9, 76.7)	35.4* (32.1, 38.6)	93.8* (91.5, 96.2)	72.8 (69.0, 76.6)
Punjabi, Hindi or Tamil	n/a	n/a	n/a	n/a	22.5 (18.9, 26.2)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

n/a not applicable

† Reference category

* Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

4.4. Risk factors and lifestyle characteristics

4.4.1. Body Mass Index (BMI)

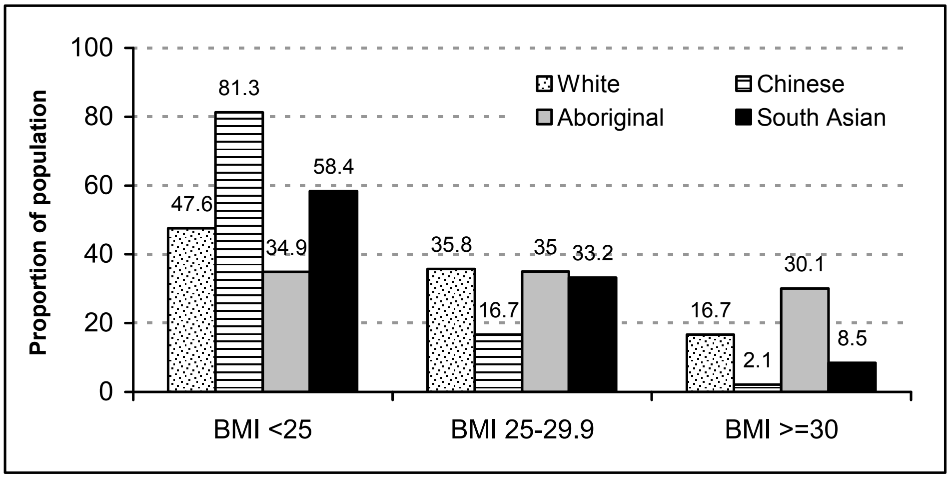
Body mass index is the ratio of a person's weight in relation to his/her height (kg/m). Self-reported height and weight data from the CCHS were used to compute the BMI into three major categories: <25.0 (underweight or normal weight); 25.0-29.9 (overweight); and >=30 (obese).

The mean height of South Asians at 1.68m was taller than Chinese (1.65m) but shorter than the Aboriginals (1.69m) and Whites (1.70m). South Asians' mean weight (69.1kg) was considerably lower than Whites (75.2kg).

As shown in Table 15, the estimated prevalence of self-reported BMI differed across the four ethnic groups. For instance, the mean BMI of South Asians (24.4) was lower than both the White (26.0) and Aboriginal (27.8) groups, but was higher than the Chinese (22.5). The mean BMI was higher among males than females for all ethnic groups except Aboriginals.

Population proportions by BMI category show that the 'underweight' and 'normal weight' category varied from a high of 81.3% in the Chinese to low of 34.9% in Aboriginals, with 58.4% of South Asians falling in this weight range which was statistically significantly higher than Whites (Figure 2). A similar proportion of South Asians (33.2%) were considered overweight compared to Whites (35.8%) and Aboriginals (35.0%). A statistically significantly lower proportion of South Asians (8.5%) were obese compared with Whites (16.7%).

Figure 2. Population proportions by Body Mass Index categories by ethnic group, age 20 and older, Canada, 2003



Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

Overall, 41.6% of South Asians were either overweight or obese and this was statistically significantly lower than Whites (52.4%). A much higher percentage of Aboriginals (65.1%) were either overweight or obese. According to the proposed revised BMI cut-offs for South Asians, nearly two-thirds (65.1%) were overweight or obese (BMI >=23).

4.4.2. BMI and diabetes

Overall, South Asians with self-reported diabetes weighed much less (mean wt, 71.9kg) than Whites (83.2kg). Among non-diabetics, a similar pattern emerged, however, the difference in mean weight between diabetics and non-diabetics was less pronounced in South Asians (71.9kg in diabetics versus 68.8 kg in non-diabetics) than in Whites (83.2 kg in diabetics versus 74.8 kg in non-diabetics).

Table 15. Risk factors and behavioural characteristics and diabetes prevalence, age 20 and older, Canada, 2003

Measure	Total	White[†]	Chinese	Aboriginal	South Asian
Summary measures, total					
Mean height (m)	1.69±0.10	1.70±0.10	1.65±0.09	1.69±0.10	1.68±0.10
Mean weight (kg)	74.3±16.6	75.2±16.6	61.5±11.2	79.8±18.6	69.1±14.1
Mean BMI, total	25.8±4.9	26.0±4.9	22.5±3.3	27.8±5.7	24.4±4.1
Mean BMI, male	26.4±4.4	26.6±4.4	23.1±3.1	27.8±5.2	25.0±3.8
Mean BMI, female	25.1±5.2	25.3±5.2	21.8±3.3	27.8±5.7	23.8±4.5
Summary measures, Diabetics					
Mean height (m)	1.68±0.10	1.68±0.10	1.62±0.08	1.68±0.10	1.66±0.09
Mean weight (kg)	81.6±18.8	83.2±18.5	62.6±10.8	84.5±19.4	71.9±12.7
Mean BMI	28.9±5.7	29.3±5.7	23.9±3.3	30.0±6.5	26.0±3.5
Summary measures, non-Diabetics					
Mean height (m)	1.70±0.10	1.70±0.10	1.65±0.09	1.69±0.10	1.68±0.10
Mean weight (kg)	73.9±16.3	74.8±16.3	61.4±11.2	79.4±18.4	68.8±14.2
Mean BMI	25.6±4.7	25.8±4.8	22.4±3.3	27.6±5.6	24.4±4.1
Population proportion by BMI category (%)					
Under or normal weight (<=24.9)	49.5	47.6 (47.1, 48.1)	81.3 (78.8, 83.8)*	34.9* (31.1, 38.6)	58.4* (54.6, 62.2)
Overweight (25-29.9)	34.8	35.8 (35.3, 36.2)	16.7* (14.2. 19.1)	35.0 (31.0, 39.0)	33.2 (29.6, 36.8)
Obese (>=30)	15.7	16.7 (16.3, 17.0)	2.1*[E] (1.2, 2.9)	30.1* (26.6, 33.7)	8.5* (6.2, 10.7)
Overweight/Obese (>=25)	50.6	52.4 (51.9, 52.9)	18.7* (16.2, 21.3)	65.1* (61.4, 68.9)	41.6* (37.8, 45.4)
BMI by revised categories for South Asian ethnic group (%)					
Under or normal weight (<23.0)	29.1	27.3 (26.9, 27.7)	61.0* (57.7, 64.4)	19.9* (17.0, 22.9)	34.9* (31.3, 38.5)
Overweight or obese (>=23.0)	70.9	72.7 (72.3, 73.1)	39.0* (35.6, 42.3)	80.1* (77.2, 83.0)	65.1* (61.5, 68.7)
Prevalence of diabetes by BMI category					
Under or normal weight (<=24.9)	2.7	2.4 (2.2, 2.6)	3.4* (2.2, 4.6)	6.4*[E] (2.8, 10.0)	6.0*[E] (3.6, 8.0)
Overweight (25-29.9)	5.7	5.5 (5.2, 5.8)	F	6.6[E] (4.2, 9.0)	10.9*[E] (6.5, 15.3)
Obese (>=30)	12.1	12.0 (11.3, 12.7)	F	F	F
Overweight/Obese (>=25)	7.7	7.5 (7.2, 7.9)	8.9[E] (4.4, 13.4)	10.3* (8.0, 12.6)	11.2[E] (7.4, 15.0)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category * Significantly different from reference category/group (p < 0.05)

E Coefficient of variation 16.6% to 33.3% (interpret with caution) F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

Body mass Index and diabetes prevalence cross-tabulations show that prevalence of diabetes increased with increasing BMI among all ethnic groups. Among South Asians, diabetes prevalence increased from 6.0% in the underweight and normal weight range to 11.2% in the overweight and obese category. South Asians had statistically significantly higher prevalence of type 2 diabetes than Whites in both the underweight/normal weight and the overweight categories. It is interesting to note that the South Asians had the highest prevalence rate of diabetes in the overweight and obese category.

The mean BMI of South Asian diabetics was 26.0 kg/m – which falls slightly in the overweight category – but was much lower than Whites (29.3 kg/m) and Aboriginals (30.0 kg/m). The mean BMI of non-diabetics was only slightly lower (24.4 kg/m) than self-reported diabetics (25.9 kg/m) in South Asians. However, this difference was more pronounced among both the Whites and Aboriginals, suggesting the occurrence of diabetes at lower BMI in South Asians. For example, the mean BMI of White or Aboriginals with self-reported diabetes was above 29.

4.4.3. Physical activity

The CCHS assessed physical activity of respondents through multiple questions and used these responses to build composite indicators of physical activity. The summary physical activity index groups activity level into ‘active’, ‘moderate’ or ‘inactive’ based on the total energy expenditures calculated using the responses on multiple questions about the various forms and levels of physical activity performed by respondents in the past three months. For example, this index captures energy expended from moderate physical activities such as walking and gardening to more vigorous activities such as bicycling, jogging or running into separate scores.

Based on the physical activity index, South Asians had the highest proportion of respondents (63.1%) among the four ethnic groups who were in the 'inactive' category. For example, only 19.6% of South Asians were in the 'active' group or those who engage in high intensity activities and a slightly lower proportion (17.3%) were 'moderately active' or those who engage in less intense activities such as walking, leisurely swim and gardening. The proportion of South Asians who were active was statistically significantly lower than the Whites and those who were inactive were statistically significantly higher than the Whites.

A smaller percentage of females than males were active in all ethnic groups but the level of physical activity among South Asian females was alarmingly low. For example, only 13.7% of South Asian females were active, the lowest proportion among all ethnic groups, while 70.0% were inactive, the highest proportion among the three comparison groups (Table 16).

The pattern of diabetes by activity level for South Asians and Whites showed higher prevalence of diabetes with lower activity levels.

4.4.4. Fruit and vegetable consumption

Daily fruit and vegetable consumption was assessed by asking the responders about the number of fruits and vegetables consumed per day.

Canada's Food Guide to Healthy Eating recommends that adults consume five to ten servings of fruits and vegetables on a daily basis.

The pattern of total fruit and vegetable consumption was similar among the White and South Asian ethnic groups with about 37.6% of South Asians and 41.3% of Whites consuming at least the recommended level of five or more fruits and vegetables per day (Table 16). The proportion of respondents consuming less than five fruits and vegetables among the Chinese and Aboriginals was even lower.

4.4.5. Alcohol and tobacco consumption

To estimate the type of drinker, respondents were asked about the frequency of drinking in the past 12 months. Regular drinkers were classified as having at least one drink per month in the past 12 months and occasional drinkers as having less than one drink per month in the past 12 months.

As seen in Table 17, alcohol consumption among South Asian respondents was statistically significantly lower than alcohol consumption in the White ethnic group. For example, 39.0% of South Asians were 'regular' drinkers compared with 67.7% of Whites. Further, South Asians had the highest proportion of non-drinkers (51.4%), compared with 15.5% among Whites. As the male to female alcohol consumption data indicates, majority of the non-drinkers were women since 72.1% of South Asian women were non-drinkers. Only 17.9% of South Asian women were regular drinkers compared with 55.6% of South Asian men. The gender difference among the Whites was considerably less.

Table 16. Risk factors and behavioural characteristics and diabetes prevalence, age 20 and older, Canada, 2003

Measure	Total	White[†]	Chinese	Aboriginal	South Asian
Physical activity index (%) – Both sexes					
Active	23.9	24.3 (23.8, 24.7)	18.5* (15.8, 21.1)	27.2 (23.4, 31.0)	19.6* (16.4, 22.8)
Moderate	25.3	26.0 (25.5, 26.4)	24.4 (21.4, 27.4)	18.3* (15.7, 20.9)	17.3* (14.5, 20.1)
Inactive	50.8	49.8 (49.3, 50.3)	57.2* (53.8, 60.6)	54.5* (50.6, 58.4)	63.1* (59.3, 67.0)
Physical activity index (%) - Male					
Active	27.1	27.5 (26.8, 28.2)	20.2* (15.9, 24.5)	34.1 (27.7, 40.4)	24.1 (19.6, 28.7)
Moderate	25.1	25.7 (25.1, 26.3)	22.6 (18.4, 26.9)	17.8* (13.5, 22.1)	18.1* (13.8, 22.3)
Inactive	47.9	46.8 (46.1, 47.6)	57.2* (52.1, 62.3)	48.1* (42.0, 54.3)	57.8* (52.4, 63.2)
Physical activity index (%) - Female:					
Active	20.9	21.2 (20.7, 21.8)	16.8* (13.3, 20.3)	22.0 (17.7, 26.4)	13.7* (9.9, 17.5)
Moderate	25.5	26.2 (25.6, 26.9)	26.0 (21.9, 30.1)	18.7* (15.4, 22.0)	16.4* (12.7, 20.0)
Inactive	53.6	52.6 (51.9, 53.3)	57.2 (52.4, 62.0)	59.3* (54.4, 64.2)	70.0* (65.1, 74.9)
Prevalence of diabetes by physical activity index					
Active	3.6	3.4 (3.1, 3.8)	4.6[E] (2.2, 7.1)	4.7[E] (1.4, 7.9)	6.1[E] (2.3, 9.9)
Moderate	4.4	4.2 (3.8, 4.5)	F	9.4*[E] (5.1, 13.8)	12.4*[E] (6.9, 17.9)
Inactive	6.1	6.1 (5.8, 6.4)	4.3 (2.5, 6.1)	10.7*[E] (7.8, 13.5)	7.1[E] (4.7, 9.5)
Daily consumption of total fruits and vegetables (%)					
Less than 5	59.1	58.8 (58.3, 59.3)	69.7* (66.4, 73.1)	65.6* (61.3, 69.9)	62.4 (58.4, 66.3)
5 or higher	40.9	41.3 (40.8, 41.8)	30.3* (26.9, 33.6)	34.4* (30.1, 38.8)	37.6 (33.7, 41.6)
Diabetes prevalence by daily consumption of total fruits and vegetables					
Less than 5	4.9	4.8 (4.5, 5.0)	4.6[E] (2.9, 6.3)	7.8* (5.8, 9.7)	8.0*[E] (5.4, 10.7)
5 or higher	5.1	5.0 (4.8, 5.3)	F	8.5[E] (4.8, 12.2)	7.2[E] (4.1, 10.2)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category

* Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

The prevalence of diabetes by type of drinker showed no association for South Asians but alcohol appeared to be a protective factor for the larger total population and White groups.

The tobacco use question asked the responders if they smoked cigarettes daily, occasionally or not at all. Occasional smokers are non-daily smokers or those who have smoked less than 100 cigarettes lifetime. Non-smokers includes both never smokers and/or former smokers. The data summarized in Table 17 show that only 8.0% of respondents of South Asian ethnicity smoked cigarettes on a daily basis compared with 41.1% of Aboriginals, 20.0% of Whites and 8.2% of Chinese. Among South Asians, tobacco use, like alcohol consumption, was strongly influenced by one’s gender. Only 4.0% of South Asian females were current smokers compared with 11.2% of males. These smoking prevalence rates among South Asians were statistically significantly lower than the smoking rates in Whites. As seen in Table 17, the association between type 2 diabetes and tobacco smoke was unclear.

Table 17. Risk factors and behavioural characteristics and diabetes prevalence, age 20 and older, Canada, 2003

Measure	Total	White†	Chinese	Aboriginal	South Asian
Type of drinker (%) – Both sexes					
Regular drinker	64.1	67.7 (67.2, 68.1)	34.0* (30.6, 37.3)	45.6* (41.7, 49.5)	39.0* (35.0, 43.0)
Occasional drinker	17.3	16.8 (16.5, 17.2)	28.5* (25.5, 31.5)	23.3* (20.0, 26.5)	9.6* (17.8, 21.2)
Non-drinker	18.5	15.5 (15.2, 15.8)	37.5* (34.1, 40.9)	31.1* (27.2, 35.1)	51.4* (47.6, 55.3)
Type of drinker (%) – Male					
Regular drinker	73.9	77.1 (76.6, 77.7)	43.4* (38.3, 48.5)	53.2* (47.3, 59.1)	55.6* (50.3, 60.9)
Occasional drinker	12.0	10.9 (10.5, 11.3)	29.9* (25.2, 34.6)	18.5* (14.3, 22.7)	9.3 (6.5, 12.1)
Non-drinker	14.1	12.0 (11.6, 12.4)	26.7* (21.9, 31.6)	28.3* (22.2, 34.4)	35.0* (29.9, 40.3)
Type of drinker (%) – Female					
Regular drinker	54.8	58.7 (58.0, 59.3)	25.1* (21.0, 29.3)	39.6* (34.9, 44.4)	17.9* (13.7, 22.2)
Occasional drinker	22.4	22.5 (21.9, 23.0)	27.2* (23.4, 31.0)	27.0 (22.5, 31.5)	9.9* (6.8, 13.1)
Non-drinker	22.8	18.9 (18.4, 19.4)	47.7* (42.9, 52.4)	33.4* (28.4, 38.4)	72.1* (67.4, 76.9)
Prevalence of diabetes by type of drinker					
Regular drinker	3.3	3.3 (3.1, 3.5)	F	4.2[E] (2.4, 5.9)	8.5*[E] (5.3, 11.7)
Occasional drinker	6.3	6.5 (6.1, 7.0)	F	8.6[E] (5.2, 12.1)	F
Non-drinker	10.6	11.3 (10.6, 12.1)	F	F	7.5*[E] (4.8, 10.2)
Type of smoker (%) – Both sexes					
Daily	19.1	20.0 (19.6, 20.5)	8.2* (6.4, 10.0)	41.1* (37.4, 44.9)	8.0* (5.9, 10.2)
Occasional	5.0	4.9 (4.7, 5.2)	2.5* (1.5, 3.5)	10.2* (8.1, 12.3)	4.1 (2.6, 5.6)
Non-smoker	75.9	75.0 (74.6, 75.5)	89.3* (87.3, 91.3)	48.7* (44.9, 52.4)	87.6* (85.5, 90.2)
Daily smokers by sex:					
Male	20.9	21.4 (20.8, 22.0)	13.6* (10.2, 17.1)	40.8* (34.9, 46.6)	11.2* (7.9, 14.6)
Female	17.3	18.7 (18.2, 19.3)	3.1*[E] (1.6, 6.5)	41.4* (36.7, 46.1)	4.0*[E] (1.6, 6.5)
Prevalence of diabetes by type of smoker					
Daily	3.7	3.7 (3.3, 4.0)	F	7.4* (4.7, 10.1)	F
Occasional	2.6	2.6 (1.9, 3.3)	F	F	F
Non-smoker	5.7	5.6 (5.4, 5.9)	4.8 (3.3, 6.2)	9.4* (6.7, 12.0)	8.4* (6.3, 10.5)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category * Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

4.5. Health status and chronic disease characteristics

Table 18 provides summary of self-reported rating of respondents' overall self-reported health based on five-point scales. This five-point scale was grouped into three categories. Results showed considerable variability among the ethnic groups with South Asians generally rating their overall health higher than the Whites but lower than the Chinese and the Aboriginals. Forty-four percent of South Asians self-rated their health as 'very good to excellent', 33.5% as 'good' and 22.1% as 'poor to fair'.

A large number of chronic diseases are reported in the CCHS for the surveyed population, however, only those associated with type 2 diabetes or those relevant to the South Asian ethnic group are reported here. The prevalence of chronic disease in Table 18 show lower rates for South Asians compared with Whites. For example, a statistically significantly lower proportion of South Asians (57.5%) reported a chronic condition compared with Whites (72.9%) and Aboriginals (73.2%).

Further, only 3.3% of South Asians had heart disease and 13.7% identified having high blood pressure. However, the prevalence of heart disease and high blood pressure increased in those with self-reported diabetes. For example, heart disease prevalence increased to 10.3% and high blood pressure to 41.1% in South Asians and 23.1% and 53.0% respectively in Whites. Generally larger increases were seen in the other ethnic groups.

A higher proportion of South Asians with high blood pressure had self-reported diabetes (24.0%) than Whites (15.8%) even though a statistically significantly lower proportion of South Asians had high blood pressure than Whites.

4.6. Health services utilization characteristics

Respondents were asked about their use of health care services and the level of satisfaction associated with these services. Not surprisingly, almost all respondents (95.2%) received at least one health service in the past 12 months (Table 19). This proportion was slightly lower (93.7%) in South Asians. Approximately one-fifth (19.6%) of South Asian respondents received hospital care in the past 12 months, a statistically significantly lower proportion than the Whites (31.4%).

Besides the medical and acute care services, respondents were asked a series of questions on the use of preventive health services. As the data in Table 19 show, overall, the South Asian respondents had lower utilization levels for the selected services. For example, the proportion of South Asian responders who in the past ever had a physical check-up without a health problem was lower (55.2%) than respondents in the White ethnic group (70.0%).

Influenza immunization, regular blood pressure monitoring, PAP smear test, mammography screenings and PSA blood test are all well-established preventive services that are highly effective screening tools for numerous chronic diseases including diabetes. Overall, South Asians were less likely to utilize

Table 18. Health status and chronic disease and diabetes, age 20 and older, Canada, 2003

Measure	Total	White†	Chinese	Aboriginal	South Asian
Self-rated health (%)					
V.good to excellent	40.7	40.0 (39.5, 40.5)	51.7* (48.3, 55.1)	51.8* (47.6, 56.0)	44.4 (40.4, 48.4)
Good	36.6	37.3 (36.8, 37.8)	30.5* (27.1, 33.9)	32.8* (28.9, 36.7)	33.5 (29.7, 37.4)
Poor to fair	22.6	22.7 (22.3, 23.2)	17.8* (15.1, 20.5)	15.4* (12.6, 18.1)	22.1 (18.7, 25.4)
Chronic diseases (%)					
Heart disease	5.0	6.1 (5.9, 6.3)	2.3*[E] (1.1, 3.5)	6.1 (4.3, 7.9)	3.3*[E] (2.1, 4.5)
High blood pressure	16.4	17.0 (16.6, 17.3)	12.4* (10.0, 14.8)	14.7 (12.0, 17.4)	13.7* (10.8, 16.6)
Any chronic condition	71.3	72.9 (72.5, 73.4)	54.9* (51.5, 58.3)	73.2 (69.8, 76.5)	57.5* (53.4, 61.5)
Chronic disease in Diabetics					
Heart disease (%)	21.9	23.1 (21.4, 24.8)	F	16.8[E] (7.4, 26.2)	10.3*[E] (3.8, 16.9)
High blood pressure (%)	52.5	53.0 (51.0, 55.0)	56.8 (41.8, 71.7)	47.3 (36.3, 58.3)	41.1 (28.3, 53.9)
Prevalence of diabetes by chronic disease					
Heart disease (%)	20.1	19.3 (17.9, 20.7)	F	23.6[E] (10.4, 36.7)	F
High blood pressure (%)	16.6	15.8 (15.0, 16.6)	20.1 (12.7, 27.4)	27.6* (19.4, 35.9)	24.0* (15.8, 32.1)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category

* Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

these preventive services than the Whites (Table 19). For example, a statistically significantly lower proportion of South Asians (63.7%) have ever had a PAP smear test compared with Whites (91.8%). Similarly, only 47.7% of South Asian female respondents versus 68.4% of White female respondents have ever had a mammogram screening. The use of the PSA blood test was also much lower among South Asians (25.9%) than the Whites (45.1%). The utilization rates for pap smear test, mammogram and PSA blood test were statistically significantly lower in South Asians compared with Whites.

Perhaps one consequence of diabetes occurring at a younger age among South Asians is that they have the highest proportion of diabetics that currently take insulin to control their diabetes. For example, one-quarter (25.1%) of South Asian diabetics took insulin compared with 21.4 of Whites and 22.8% of Aboriginals.

Table 19. Health services utilization characteristics and diabetes, age 20 and older, Canada, 2003

Measure (%)	Total	White†	Chinese	Aboriginal	South Asian
Currently takes insulin	21.2	21.4 (19.6, 23.2)	F	22.8^{E} (13.1, 32.5)	25.1^{E} (12.6, 37.3)
Received health care services in past 12 months	95.2	95.4 (95.1, 95.7)	91.8* (88.9, 94.6)	92.1 (85.8, 98.4)	93.7 (90.8, 96.7)
Received hospital care in past 12 months.	30.1	31.4 (30.7, 32.2)	13.3* (9.4, 17.2)	34.4 (28.4, 40.4)	19.6* (13.8, 25.3)
Ever had blood pressure taken	97.1	97.7 (97.3, 98.2)	93.7 (89.2, 98.1)	94.9* (93.2, 96.6)	90.5 (82.9, 98.1)
BP taken within last 12 months	78.4	78.5 (77.6, 79.5)	78.9 (68.7, 89.2)	75.2 (65.8, 84.7)	72.5 (60.5, 84.5)
In past had physical check-up without a health problem	69.3	70.0 (69.0, 71.1)	38.1*^{E} (19.8, 56.4)	68.4 (60.0, 76.8)	55.2^{E} (36.3, 74.0)
Ever had flu shot	47.1	47.3 (46.8, 47.8)	46.2 (42.8, 49.7)	47.8 (43.6, 51.9)	42.9 (39.0, 46.9)
Ever had PAP smear test	89.2	91.8 (91.4, 92.2)	65.8* (61.3, 70.2)	87.9* (84.6, 91.2)	63.7* (57.6, 69.8)
Ever had mammogram	66.8	68.4 (67.7, 69.1)	53.4* (47.7, 59.0)	53.5* (47.6, 59.3)	47.7* (40.2, 55.2)
Ever had a PSA blood test	42.7	45.1 (44.0, 46.2)	25.5* (19.6, 31.4)	31.3*^{E} (20.2, 42.3)	25.9* (18.1, 33.7)

Data source: 2003 (Cycle 2.1) Canadian Community Health Survey, Statistics Canada

† Reference category

* Significantly different from reference category/group ($p < 0.05$)

E Coefficient of variation 16.6% to 33.3% (interpret with caution)

F Estimate based on small sample size (30 or less) or coefficient of variation greater than 33.3% (estimate suppressed due to extreme sampling variability)

4.7. Logistic regression analysis

Logistic regression analyses were done to assess the association of diabetes as the dependent variable and ethnicity, age, sex, household income, education, body mass index, physical activity level and cigarette smoking as independent variables. Physical activity level and cigarette smoking were later dropped from the regression model due to their weak association with diabetes. Both un-adjusted odds ratios (Table 20) and adjusted odds ratios (Table 21) are presented to illustrate the strong association of ethnicity with type 2 diabetes.

Table 20. Un-adjusted odds ratios relating diabetes to ethnicity, age, sex, household income, education and body mass index, age 20 and older, Canada, 2003

Measure	Odds	p-value	95% CIL	95% CIU
Ethnicity				
White†	1.00	-----	-----	-----
Chinese	0.87	0.35	0.62	1.19
Aboriginal	1.77	<0.001	1.38	2.23
South Asian	1.62	<0.001	1.23	2.12
Age:				
20-49†	1.00	-----	-----	-----
50-64	4.27	<0.001	3.77	4.84
65+	7.08	<0.001	6.18	8.11
Sex:				
Female†	1.00	-----	-----	-----
Male	1.27	<0.001	1.16	1.40
Household income:				
Less than $30,000	1.76	<0.001	1.53	2.02
$30,000 - $59,999	1.26	<0.001	1.10	1.43
$60,000 or more†	1.00	-----	-----	-----
Education level:				
Secondary grad. or lower	1.40	<0.001	1.18	1.68
Some post-sec or college	1.22	<0.023	1.03	1.46
Bachelor's degree or higher†	1.00	-----	-----	-----
Body Mass Index				
Under/Normal wt. (<=24.9)†	1.00	-----	-----	-----
Overweight (25-29.9)	2.01	<0.001	1.78	2.26
Obese (>=30)	4.71	<0.001	4.15	5.34

† Reference category p<0.05 considered statistically significantly

Table 21. Adjusted odds ratios relating diabetes to ethnicity, age, sex, household income, education and body mass index, age 20 and older, Canada, 2003

Measure	Odds	p-value	95% CIL	95% CIU
Ethnicity				
White†	1.00	-----	-----	-----
Chinese	1.93	<0.001	1.31	2.86
Aboriginal	1.95	<0.001	1.46	2.61
South Asian	2.92	<0.001	2.06	4.16
Age:				
20-49†	1.00	-----	-----	-----
50-64	4.41	<0.001	3.90	4.99
65+	7.54	<0.001	6.60	8.61
Sex:				
Female†	1.00	-----	-----	-----
Male	1.26	<0.001	1.15	1.37
Household income:				
Less than $30,000	1.77	<0.001	1.55	2.02
$30,000 - $59,999	1.28	<0.001	1.13	1.46
$60,000 or more†	1.00	-----	-----	-----
Education level:				
Secondary grad. or lower	1.45	<0.001	1.22	1.73
Some post-sec or college	1.24	0.017	1.04	1.48
Bachelor’s degree or higher†	1.00	-----	-----	-----
Body Mass Index				
Under/Normal wt. (<=24.9)†	1.00	-----	-----	-----
Overweight (25-29.9)	1.95	<0.001	1.74	2.19
Obese (>=30)	4.63	<0.001	4.10	5.22

† Reference category p<0.05 considered statistically significantly

Note: all variables listed in the left-hand column were included in the logistic regression model

Significant associations were found for ethnicity, age, sex, household income, education and BMI.

Prevalence of type 2 diabetes varied by ethnicity with South Asians, Chinese and Aboriginals having higher odds than Whites in the adjusted analysis (Table 21). The odds ratio for diabetes for South Asians versus Whites was 1.6 in un-adjusted but 2.9 when adjusted with both being statistically significant. Age was strongly positively associated with diabetes. The odds of diabetes were 4.4 times higher for the 50 to 64 year age group and 7.5 for the 65+ age group compared with the 20 to 49 year age group. The odds of diabetes in males were statistically significantly higher (1.3) than females. With increasing levels of income, the odds ratio for diabetes decreased. For example, the odds ratio for those in the lowest income group (annual income less than $30,000) compared with those in the highest income group (annual income of $60,000 or higher) was 1.8 and statistically significant. A similar pattern was seen for education levels, with statistically significant higher odds of diabetes in those with lower education levels. Persons with high school graduation or lower were 1.5 times more likely to have diabetes than those with a university degree. As seen in Tables 20 and 21, the association between diabetes and body mass index was positive and statistically significant. For example, the odds of diabetes were 2.0 times higher and statistically significant for those with BMI of 25 to 29.9 (overweight) compared with those having BMI of less than 25 (under weight or normal weight). Further, compared to those with BMI of less than 25, the odds increased to 4.6 for those considered obese (BMI ≥30).

It is worth noting that when the logistic regression model was adjusted for the independent variables seen in Tables 20 and 21, the relationship between diabetes and all these variables (for example, age, sex, household income, education and BMI) except ethnicity changed marginally in the un-adjusted versus adjusted analysis. In South Asians, the odds of diabetes increased from 1.6 to 2.9 during this adjustment, indicating strong influence of ethnicity on diabetes for this group.

5. DISCUSSION

This investigation showed that Canadians of South Asian origin are at considerable risk of diabetes and have one of the highest prevalence rates of diabetes among the three comparison groups used in this analysis. Results from this investigation also confirm that among this group, diabetes occurs at much younger age and at lower body mass index than in other ethnic groups, including Whites.

Self-reported prevalence of diabetes from the CCHS shows that the South Asian rate of 8.0% for the 20 years or older population was higher for the overall Canadian population (5.2%), the Whites (5.1%), the Chinese (4.4%) except for the Aboriginals (8.6%). These results confirm the existing evidence from many United Kingdom, United States and Indian studies (as summarized in previous sections of this paper) inferring elevated risk of type 2 diabetes in the South Asian ethnic group.

While these results infer a higher prevalence of type 2 diabetes among South Asians, the age-specific results presented here show considerable variability and therefore require caution in their interpretation. Having said that, the prevalence of type 2 diabetes estimated here is well within the range of what has been reported by other studies. For example, some of the largest studies of migrant South Asians residing in the UK have reported similar rates of type 2 diabetes in this ethnic group compared with the host population. The Coventry Study by Simmons, Williams and Powell (1989) found slightly higher prevalence of type 2 in South Asians aged 20 yeans and above (men 11.2%, women 8.9%) compared with this study. Jonnalagadda and Diwan (2005) reported a similar prevalence (18%, aged 50+) in South Asians residing in the United States. Further, Ramachandran et al. (2001) and Gupta et al. (2003) found close to 10% of South Asians in India with type 2 diabetes.

Diabetes tends to occur at a much younger age in South Asians (Misra et al., 2007; Mohan et al., 2007) both in their ancestral countries and in migrants (Tziomalos et al., 2008) and this was seen in this study. The mean age of those with self-reported diabetes in this investigation was lowest in South Asians (53.7 years) and highest in Whites (61.6 years). Population surveys in India have also concluded the highest prevalence of type 2 diabetes in the 40 to 60 years age group with a steep increase in prevalence prior to age 50 (Mohan et al., 2007). King, Aubert and Herman (1998) reported that in developing countries, the middle age group (45-64 years) has the largest number of diabetes as opposed to the 65-plus age group in the developed countries (King et al., 1998). They also stressed that the younger age of onset of type 2 diabetes in developing counties will lead to more chronic complications of diabetes, health care needs and associated costs (King et al., 1998).

In addition, the mean age at which initial diabetes diagnoses occurred was much lower in South Asians (44.6 years) compared with Whites (51.4 years). A recent study from the UK comparing South Asians and Europeans reported that

South Asians develop type 2 diabetes nearly eleven years earlier than Europeans and the age at diagnosis among South Asians was similar to this investigation (45.9 years) (Mukhopadhyay, Sattar and Fisher, 2005). In this study, 62.5% of the total diabetes in South Asians was diagnosed prior to age 50 compared with 34.7% in Whites. Only 37.5% of total South Asian diabetics were diagnosed after age 50 as opposed to 65.3% of cases in Whites.

5.1. Education, income and diabetes

Results from this investigation show that the association between two socio-economic status indicators - education and income – was well established for the larger Whites group but less so in South Asians. Respondents with lower education and income levels had higher rates of diabetes than those in the higher education and income levels. This inverse association between socioeconomic status and diabetes is well established in western countries (Evans, Newton, Ruta, MacDonald and Morris, 2000; Robbins, Vaccarino, Zhang and Kasl, 2001). Evans et al. (2000) found a 60% higher risk of type 2 diabetes in those belonging to the lowest income group as compared with the highest income group.

In South Asian countries, the association of income and type 2 diabetes has generally been in contrast to what is observed in developed countries. For example, in South Asia, income is directly associated with prevalence of type 2 diabetes (Ramachandran, Snehalatha, Vijay and King, 2002) whereas in western countries, income and type 2 diabetes are inversely associated (Robbins et al., 2001). In India, the overall prevalence of type 2 diabetes, obesity and cardiovascular disease in the upper and middle income groups compared with the lower income group is statistically significantly higher (Mohan et al., 2007). The ability of higher income groups to purchase and consume increased animal fat and elevated caloric intake, coupled with non-physical work environments, has been a major contributor to this shift (Mohan et al., 2001).

5.2. Body Mass Index and diabetes

Results from this investigation confirm that the prevalence of type 2 diabetes among South Asians was higher despite lower BMI. Compared with the Whites, South Asians were lighter, shorter, had lower BMI, and had a lower proportion of respondents who were either overweight or obese. This has also been shown to be true in a recent Canadian study showing that this group was also more likely to develop diabetes at a lower BMI and body weight than the Whites and Aboriginals (Anand et al., 2000). Consequently, revisions to BMI cut-offs for South Asians have been proposed to increase the sensitivity of this measure by be reclassifying overweight to BMI of 23 or higher (instead of 25) and obesity to BMI of 25 or higher (instead of 30) (Lovegrove, 2007).

Further, self-reported data, compared with directly measured BMI data, often underestimate the prevalence of overweight and obesity given that women under-report their weight and men over-report their height (Katzmarzyk and Ardern, 2004; Roberts, 1995). Height is especially overestimated by both short and tall individuals, regardless of sex (Roberts, 1995). Self-reported data from the CCHS survey have shown to underestimate obesity by about 8% (Tjepkema, 2006).

5.3. Alcohol, smoking and diabetes

Canadians of South Asian origin were less likely to consume alcohol and tobacco which is consistent with other studies (Barnett et al., 2006). In this study, 39.0% of South Asians were regular drinkers compared with 67.7% of Whites. Tobacco use also was much lower in South Asians with 8.0% being daily smokers versus 20.0% in Whites. However, smoking rates vary considerably within the South Asian group with men from Bangladesh having considerably higher smoking rates than men from India or Pakistan (Tziomalos et al., 2008). Punjabi Sikhs have significantly lower rates of smoking but higher rates of alcohol consumption than Muslims and Hindus (Williams, Bhopal and Hunt, 1994). Even though the prevalence of alcohol and tobacco use was generally lower in females across all four ethnic groups, the difference was much more prominent among South Asians. Only 17.9% of women from this group were regular drinkers and only 4.0% were daily smokers. The Canadian study by Anand et al. (2000) reported similarly lower prevalence of smoking in Canadians of South Asian origin men and women (16.6% in men and 2.1% in women) compared with White Europeans.

5.4. Physical activity and diabetes

The lower levels of physical activity seen in this investigation among South Asians are consistent with existing evidence. A systematic literature review of 17 studies assessing physical activity all showed lower levels in South Asians (Fischbacher, Hunt and Alexander, 2004). Results from this study show that a higher proportion of respondents in this ethnic group were inactive regardless of whether they were diabetic or not. This is of concern given that physical inactivity and obesity are two key risk factors of insulin resistance (Barnett et al., 2006).

Women are especially prone to reduced physical activity (Sriskantharajah and Kai, 2007) and this was evident in this investigation with 70.0% self-reporting being inactive. High rates of physical inactivity in both sexes among Canadians of South Asian origin was reported by Davachi, Flynn and Edwards (2005). Evidence about why these differences occur is limited. Factors associated with migration, language difficulties, gender roles and cultural attitudes and values all contribute to lower levels of participation in sports and physical activity among South Asians (Eyler, 2002; Jenum et al., 2005).

South Asian diabetic patients interviewed by Lawton et al (2006) indicated that time dedicated towards family obligations (such as child minding, assisting with family business, etc.) and towards traditional household activities (such as cooking, cleaning and child minding) took precedence over their own health-related activities such as exercise. Generally, these types of activities are perceived as a form of physical activity by this group whereas Whites view engagement in recreational activities as being active (Eyler, 2002). Culturally, South Asian females, especially new immigrants, are socialized to avoid seeking work outside the home and typically engage in minimal outdoor activity and involvement in sports which further hinders their familiarity with neighbourhoods resulting in self-isolation and lower motivation towards physical activity (Lawton, 2006).

Walking is seen as popular and more feasible form of physical activity by South Asian women given it's non-threatening nature and easy incorporation into daily schedules (Sriskantharajah and Kai, 2007). Physical activity regiments geared towards moderate activity, versus those stressing vigorous activity levels, are more receptive to South Asian women (Sriskantharajah and Kai, 2007).

Some other factors associated with lower levels of physical activity, especially among new immigrants, are fear of racism and lack of access to recreational facilities resulting from financial and transportation challenges even though the income levels of South Asians in this investigation were similar to Whites (Hayes et al., 2002). This is further complicated by their inability to speak the local language (Eyler, 2002).

While many of the barriers associated with physical activity and healthy behaviours - such as time constraints, existing chronic health conditions, motivation, family support, weather, lack of facilities, etc. - are common among all ethnic groups (Jenum et al., 2005), the level and capacity to overcome these constraints differ for South Asians, given the broad range social stigmas and cultural beliefs.

5.5. Diet and diabetes

South Asians' diet - consisting of higher and faulty fat intake, higher carbohydrates and lower proteins – coupled with reduced physical activity levels is considered a major factor in their increased susceptibility to diabetes, cardiovascular disease and other associated diseases (Landman and Cruikshank, 2001; Raheja et al., 1996).

In this investigation, one measure of diet – daily consumption of total fruits and vegetables – was assessed but it's association with diabetes or ethnicity was inconclusive even though diabetes prevalence was higher in South Asians than Whites regardless of the amount of daily fruit or vegetable consumption. A recent Canadian study comparing Canadians of South Asian, Aboriginal, Chinese and European origin concluded that South Asians consumed the most carbohydrates and Chinese the least and that higher consumption of carbohydrates was associated with lower HDL cholesterol levels (Merchant et al., 2007). Lower HDL cholesterol levels were associated with insulin resistance in South Asians (Merchant et al., 2007). Davachi, Flynn and Edwards (2005) also measured high energy intake among Canadians of South Asian origin and noted that this high energy intake was primarily due to consumption of large quantities of food and food rich in starch and calories.

The impact of migration and urbanization on dietary changes is well established (Landman and Cruikshank, 2001). Evidence suggests that South Asians – and all migrants in general – tend to adopt the western, cholesterol-rich diet after migration (Bedi et al., 2006), with an increase in caloric intake (Abate and Chandalia, 2007). This “dietary acculturation” includes reduced vegetarian status and increase in animal fat, sodium and simple sugars consumption (Misra and Ganda, 2007). Younger migrants are more likely to change their dietary habits to more energy-dense foods (Misra and Ganda, 2007). Raj, Ganganna and Bowering (1999) compared the dietary habits of South Asians in the US among those that were recent residents (less than 10 years in US) or long-time residents (more than 10 years in US) and concluded that fatty and high energy foods were common among both groups and tended to be concentrated at social gatherings, festivals and religious ceremonies. Consumption of fruit juices, alcoholic beverages and other processed foods such as chips and colas had increased in both groups while the consumption of traditional foods had decreased. A decade long study of South Asian women in the UK revealed that their fat intake had become similar to the general population (Landman and Cruikshank, 2001).

Evidence suggests that the length of migration in the host country not only impacts the dietary practices of ethnic populations, but also the extent of health promoting behaviours (Jonnalagadda and Diwan, 2005). Having said that, studies have shown that food and food preparation practices among migrants are retained and are often resistant to change given that they are symbolic of cultural and religious beliefs (Chowdhury, Helman and Greenhalgh, 2000).

5.6. Health status, chronic disease and diabetes

Results from this investigation show that South Asians rated their self-reported health similar to Whites. The prevalence of chronic conditions, specifically heart disease and high blood pressure, was statistically significantly lower in South Asians than Whites. These results are reflective of the research evidence suggesting that South Asians may underreport their illnesses - as a result of language or difficulty understanding certain diseases – or the illness may actually be less prevalent in South Asians due to the “healthy immigrant” effect (Mohanty et al., 2005). The healthy immigrant effect suggests that immigrants generally tend to be healthier than people of their native country resulting from the fact that Canada screens potential immigrants’ health status during the application process and allows entry to those meeting certain health status criteria (Perez, 2002). However, studies have shown that the “healthy immigrant effect” dissipates over time and the health of immigrants with long term residence in Canada shifts towards Canadian-born population (Perez, 2002).

The lower prevalence of heart disease in South Asians found in this investigation (3.3%) is contradictory to existing research evidence. Studies from the UK and Canada have shown higher risk of cardiovascular disease and mortality among South Asians compared with White Europeans.

South Asians also tend to have higher rates of blood pressure (Bedi et al., 2006) which is contradictory to the lower rates seen in this investigation. A review of published literature by Agyemang and Bhopal (2002) assessing levels of blood pressure in this group against White Europeans from the UK suggested a multitude of factors attributing to these differences. For example, the authors concluded that, generally, South Asians had lower mean systolic but higher diastolic blood pressure compared with Whites. Older South Asians had higher blood pressure but the younger South Asians had lower blood pressure than Whites. Level of blood pressure among South Asians varied by UK geography indicating environmental risk factors with mean blood pressure varying considerably within the South Asian subgroups. For example, Bangladeshi men and women generally had lower blood pressure than men and women from India or Pakistan. One possible explanation for the lower rate of hypertension in this study could be due to its lower level of diagnoses given that a smaller proportion of South Asians get their blood pressure taken on a regular basis compared with Whites.

Results from this investigation show that South Asians generally had lower utilization of health services compared with Whites and this is consistent with existing literature. One major source of concern was the large gap in the use of well-established preventive health services such as regular blood pressure monitoring, PAP smear test, mammography screenings and PSA blood test.

Understanding barriers faced by South Asians is important in managing chronic illnesses such as type 2 diabetes and cardiovascular disease. For example, cultural factors influence a patient’s ability to communicate with their care provider and impact the patient’s adherence to disease management care plans.

Utilizing and receiving adequate and timely care is important for patients with chronic diseases to manage their disease and minimize complications. For example, proper glycemic management by type 2 diabetics is shown to improve long-term complications associated with the eye and kidney (Harris, 2001). However, studies have shown that knowledge of the risks associated with undiagnosed diabetes is poor among South Asians (Rankin and Bhopal, 2001; Stone et al., 2005).

Studies have shown that South Asians are reluctant to initially seek primary care and then to share their symptoms with health care providers (Rhodes and Nocon, 2003). The reasons for this are numerous: language difficulties, unfamiliarity with the health care system, transportation issues and lack of knowledge about common illnesses and their symptoms (Mayberry, 2000; Rhodes, 2003; Rhodes and Nocon, 2003). South Asians are also likely to seek alternative care providers prior to medical consultations (Rhodes and Nocon, 2003). Keeping doctor's appointments is challenging among women and seniors given their dependency on the availability of an accompanying adult able to speak the local language (Rhodes and Nocon, 2003). As a result, acquiring basic care can be an arduous experience, often over-laden with cultural expectations and responsibilities leading to inaction in obtaining health care services and further delaying in diagnosis and management of existing condition(s) or disease.

Language is cited as a key cultural barrier contributing to disparity in health access and utilization (Fernandez, 2004; Rampaul and Ahmad, 2000; Sriskantharajah and Kai, 2007). For many new immigrants and those unable to speak the local language, it is a critical factor in, first, getting entry into the health care system and second, for establishing an ongoing relationship with care providers and third, for acquiring necessary health care services and other health-related information pertaining to disease management and engagement in healthy life activities (Rhodes, 2003). Language has shown to have a positive effect on keeping appointments, adhering to medications and other therapies and generally providing a better outlook of positive health for clients (Fernandez, 2004). In one study, 60% of the Southeast Asians respondents in San Diego identified language as a major barrier in acquiring health care services (Inouye, 1999). Among South Asian women, language was identified as a significant barrier towards attending health and physical activity promoting sessions (Sriskantharajah and Kai, 2007). In another study, authors cited language as a barrier among South Asian patients for their difficulty in remembering names of medications related to diabetes management and for showing little interest in attending diabetes clinics held in the community (Stone et al., 2005). Language difficulties tend to be less prevalent in younger South Asians than the elderly (Williams and Harding, 2004).

One strategy South Asians often utilize to overcome the language barrier is using family members, children and/or other relatives as interpreters for both health care visits and written materials (Rampaul and Ahmad, 2000; Stone et al., 2005). While there is considerable benefit to the use of interpreters, South Asian clients also identified numerous concerns associated with this approach including lack of privacy, lack and unreliability of interpreter availability, feeling of dependence, patient’s discomfort discussing certain topics or diseases in front of their children and interpreter error or mistranslation of prescription doses (Rampaul and Ahmad, 2000; Rhodes, 2003).

6. CONCLUSIONS AND IMPLICATIONS

This investigation provides estimates of population-based prevalence of diabetes and its risk factors for Canadians of South Asian origin. Results show that the odds of type 2 diabetes were statistically significantly higher in South Asians than Whites with ethnicity showing a strong association with the prevalence of type 2 diabetes. Besides ethnicity, type 2 diabetes was also associated with age, sex, household income, education, and body mass index. Other main findings of this investigation include:

- The prevalence of diabetes in Canadians of South Asian origin, aged 20 and above, was 8.0%. The odds ratio for diabetes for South Asians versus Whites was 2.9 and statistically significant.
- Prevalence increased with age: 4.5% in 20-49 year olds, 16.1% in 50-64 year olds and 20.5% in 65 and above group.
- South Asians were more likely to be initially diagnosed with diabetes at a younger age (mean age = 44.6 years) among the four ethnic groups.
- Nearly one-in-five South Asian male aged 50 and above was diabetic.
- Overall, South Asians were younger, were more likely to have a university education and averaged slightly lower income than Whites.
- South Asians' mean BMI (24.4) was lower than Whites (26.0) and the proportion of the population who were overweight or obese (BMI>=25) was statistically significantly lower in South Asians (41.6%) than Whites (52.4%).
- South Asians were statistically significantly less likely to be physically active, drink alcohol or smoke cigarettes. Among South Asians, these

differences were much greater by sex, with females having lower rates of physical activity, alcohol use and smoking than males.

- Prevalence of chronic diseases other than type 2 diabetes (blood pressure, heart disease or any chronic condition) was statistically significantly lower in South Asians compared with Whites.
- The majority of South Asians (52.2%) immigrated to Canada from 1991 to 2003 with an average length of 14.1 years in Canada.

While understanding the causal pathway of type 2 diabetes and its risk factors is still being refined, results from this paper do support the hypothesis that conventional risk factors such as age, body mass index, smoking and alcohol use play a somewhat tempered role in the development of type 2 diabetes in South Asians. These differences in the epidemiology of type 2 diabetes in this group illustrate an important point: the conventional methods used to assess the risk and management of type 2 diabetes need revision to reflect the unique distribution of this chronic disease in South Asians. The existing risk assessment protocols and risk factors for type 2 diabetes are primarily based on Caucasians of European origin and not on South Asians. And given that the South Asians' average length of time in Canada is relatively short (14.1 years), the impact of migration, cultural norms and barriers associated with acculturation and language difficulties all translate into unique challenges and risks often not observed in host populations. As such, the response associated with the identification and management of a complex chronic disease such as type 2 diabetes must be culturally responsive and involve the South Asian community in its design and implementation.

Present evidence suggests that the elevated risk of insulin resistance found in South Asians is thought to play an important role in the susceptibility of this ethnic group to non-insulin dependent diabetes. The association between three environmental risk factors - diet, physical activity and obesity - and insulin resistance is well established, but promotion strategies that incorporate these modifiable factors into culturally appropriate health care programs are needed.

Regardless of the existing or postulated mechanisms for the higher prevalence of type 2 diabetes in this group, the resultant morbidity and mortality associated with this chronic disease cannot be ignored. Measures to address the growing epidemic of type 2 diabetes in Canadians of South Asian origin include:

1) Need for reliable data, longitudinally collected, to better understand needs, practices and risk factors associated with type 2 diabetes and for developing relevant interventions. The majority of existing evidence on South Asians and type 2 diabetes is based on descriptive epidemiological studies. Evaluative data on utilization, management and health care outcomes associated type 2 diabetes for this ethnic group are lacking.
2) Implement early diagnosis and control of hyperglycemia given that the onset of diabetes occurs at a younger age and at lower BMI. Early diagnosis and control of hyperglycemia to reduce long-term health complications is important. This likely will entail the development of revised national guidelines and screening procedures to assess risk of type 2 diabetes and to reflect the current literature on ethnic differences associated with this chronic disease. At a minimum, the identification of 'at

risk' people is needed in order to implement primary and secondary preventive measures.

3) Provision of culturally appropriate type 2 diabetes services is crucial since cultural beliefs and values play an important role in the access and utilization of health services and in attitudes towards health-improving behaviours and the management of type 2 diabetes among South Asians. Incorporating cultural factors and influences in addressing the health care needs of the South Asian population is critical and can be accomplished through three inter-related strategies: provision of culturally-relevant community based services; minimize ethno-cultural barriers; and employ culturally competent health care workers.

    i. Provision of culturally appropriate services and education on prevention, diagnosis and treatment of type 2 diabetes must occur through community-based organizations that understand the cultural and linguistic heterogeneity of this group. Stereotyping Canadians of South Asian origin as having homogenous beliefs and health practices predisposes policy makers to the erroneous assumption that health care practices and programs are transferable from one group to another. South Asians have differing health outcomes and cultural beliefs and these differences will likely depend on their country of origin, religion, language, customs and extent of acculturation and the length of time they have been in Canada. Immediate action is necessary, first, on the identification of type 2 diabetes and, second, on its management in the South Asian community. A significant component of any service provision would be an educational and marketing tool outlining the significance, prevention and management of type 2 diabetes in Canadians of South Asian origin. This educational component must be community based and involve South Asian community agencies, leaders, health care professionals, media, temples, mosques and churches.

ii. Reduction of ethno-cultural barriers impacting utilization of health care services. Ethno-cultural barriers such as language and communication styles, cultural ignorance, discrimination and other socially-determined stigmas faced by South Asians all determine their ability to access and utilize health care services. Language is considered a key cultural barrier contributing to disparity in health access and utilization. Language is critical in first getting entry into the health care system, establishing ongoing relationships with health care workers, keeping appointments and adhering to prescribed therapies. Gender roles, family obligations, unfamiliarity with the health care system, transportation issues and lack of knowledge about common illnesses and their symptoms are some other common barriers identified by South Asians.

iii. Provision of culturally competent health care providers. Increasing the cultural competence of care providers entails increasing their knowledge, attitudes and skills about multicultural care. This includes increasing practitioner's cultural capacity and understanding cultural beliefs, norms and gender roles; minimizing stereotypes on race, religion and other cultural domains; and incorporating cross-cultural knowledge into meaningful interactions with clients. Provision of culturally competent care will address some of the concerns identified by South Asian diabetic clients: lack of input in establishing care plans, inadequate information exchange and insecurity about not being taken seriously.

One particular example which illustrates health care providers' cultural incompetence is the use of additional family members by clients in decision making. South Asians often include family members in consultations, care plans and in educational sessions which signifies trust and reliance on family members in the management of disease(s) and in health-enhancing programs. Involving children and spouses is seen as enhancing the motivation level of the patient. Care providers, however, often view this as unnecessary and lacking privacy.

6.1. Limitations

Determining the prevalence of diabetes in the population presents multiple challenges. Generally, diabetes tends to be under-diagnosed, as disease outcomes associated with type 2 diabetes may precede clinical diagnosis for many years. Thus, a considerable proportion of adults with diabetes are not likely to be diagnosed. Some estimates have suggested as much as one-third of adults fall in the undiagnosed category (Millar and Young, 2003).

The questions pertaining to diabetes in CCHS Cycle 2.1 do not allow us to differentiate between type 1 and type 2 diabetes given the generic nature of the questions pertaining to diabetes. However, given that this investigation is based on age 20 and over, the impact of respondents with type 1 diabetes on the estimated prevalence of type 2 diabetes would be minimal. Further, the survey has limited questions on diabetes, especially on how the disease is being managed by diabetics. The next cycle of the survey, Cycle 3.1, has additional questions on diabetes-related complications and how well they are being screened and managed by the patient and primary health care professionals.

Further, two important correlates which predict South Asians increased risk of developing diabetes – waist-to-hip ratio and familial linkage – could not be explored in this investigation since data on waist and hip measurement or family history of diabetes were not included in the CCHS Cycle 2.1. Family history of type 2 diabetes in South Asians has been shown to be a strong predictor in the development of type 2 diabetes in future generations (Radha and Mohan, 2007).

Typically, two sources of data are used to estimate disease prevalence: administrative data bases and self-reported surveys or questionnaires. Administrative databases and disease registries are thought to provide a more comprehensive source from which to assess population prevalence given that they capture persons who are seen, diagnosed an/or treated with the conditions in the health care system. However, cases of undiagnosed diabetes and people who do not seek medical service are not captured in these data. As a result, prevalence is likely underestimated by these data sources.

The approach used in this report relies on self-reports of diabetes and as result, no validation with a direct measure or by existing diagnostic test results was done. This method has two limitations: first, people may not know that they have diabetes; and second, the criteria in making a diagnosis vary among physicians. Consequently, self-reporting in population surveys is known to underestimate actual rates of disease in the population (Foroughi et al., 2005). As discussed earlier in this paper, self-reported data for important risk factors such as BMI and weight often underestimate the prevalence of these factors. Men are shown to over-estimate their height while women under-estimate their weights (Katzmarzyk and Ardern, 2004). Non-response may also be an issue with surveys. Nationally, the response rate was 81%, however, this does not consider the non-response for individual questions which can be significant for some complex or very specific questions.

The sample sizes as proportion of the total Canadian population by ethnicity show that CCHS Cycle 2.1 may not be reflective of the four ethnic groups used in this investigation. According to the 2001 Census, South Asians represented 3.3% of the Canadian population whereas the South Asian sample from the CCHS represented only 1.1% of the total sample. Similarly, the total survey sample represented 1.6% people of Chinese ethnic origin and 2.8% Aboriginals while the Census 2001 population for the Chinese was 3.7% and for

Aboriginals 4.6%, of the total Canadian population. One potential source for this type of sample distribution is the fact that identification of ethnicity could be misinterpreted since its meaning is not always uniform across individuals.

The age composition of a population will influence the prevalence of type 2 diabetes since it is strongly and positively associated with this condition. Age-adjustment is often done to minimize this effect and to allow meaningful comparison of variables among groups. While age was adjusted in the logistic model, the same could not be done for the point prevalence estimates presented in this study. This would suggest that for the ethnic groups with younger populations (for example, South Asians), the variables which increase with advancing age (for example, type 2 diabetes) may be underestimated. This means that the prevalence of type 2 diabetes, body mass index, heart disease, high blood pressure and utilization of health services may be underestimated, while the prevalence may be overestimated for variables such as physical activity, alcohol consumption and smoking.

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