

Type 2 Diabetes and Women's Health in British Columbia: A Review of the Evidence

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Women's
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Table of Contents

Foreword	6
Executive Summary	7
Overview	7
Introduction	7
Type 2 Diabetes is a Women's Health Issue	7
Causes and Risk Factors	8
<i>Predisposing Risk Factors</i>	8
<i>Metabolic Syndrome</i>	8
<i>Overweight/Obesity</i>	9
<i>Social Determinants</i>	9
Populations at Risk	9
<i>Aboriginal Women and Women of Other Ethnicities</i>	9
<i>Girls and Adolescents</i>	9
<i>Women with Mental Illness</i>	10
<i>Pregnancy</i>	10
<i>Maturing Women</i>	10
Limitations to Current Research on Type 2 Diabetes in Women	10
Conclusion	11
Considerations for Action	11
Overview	12
Introduction	12
Background – Diabetes Mellitus	13
The Growth of Type 2 Diabetes is Reaching Epidemic Levels	14
Type 2 Diabetes is a Women's Health Issue	14
Review of the Evidence	15
Causes of Type 2 Diabetes	16
Genetic/Familial Risk	16
Prenatal and Early Life Conditions	17
Socioeconomic Conditions	18

Environmental Influences	18
Women's Health: Risk Factors for Developing Type 2 Diabetes	19
Biomedical Risks Factors in Women	19
<i>The Metabolic Syndrome</i>	19
<i>Abnormal Glucose Metabolism</i>	19
<i>Obesity, Overweight, and Physical Inactivity</i>	20
<i>Polycystic Ovarian Syndrome</i>	20
Social Determinants of Women's Health	21
Overview	21
<i>Poverty</i>	22
<i>Access, Utilization, and Quality of Health Care</i>	22
Populations at Risk	23
<i>Ethnic Groups</i>	24
<i>Girls and Adolescents</i>	25
<i>Women with Mental Illness</i>	26
<i>Diabetes in Pregnancy</i>	27
<i>Maturing Women</i>	28
Consequences of Diabetes	29
Mortality	29
Cardiovascular Disease	29
Microvascular Complications of Diabetes	29
Adverse Pregnancy Outcomes	30
Poverty	30
Therapeutic Options in Women	31
Strategies and Policies	32
Overview	32
Diabetes Promotion	32
Diabetes Prevention in British Columbia	33
<i>Primary Prevention</i>	33
<i>Secondary Prevention</i>	34
<i>Tertiary Prevention</i>	34

Implications, Challenges, and Opportunities36

 Major Findings.36

 Early Intervention is Critical in Diabetes Prevention and Care37

 Addressing Social Inequalities in Health.37

 Gender-Inclusive Health Planning is Critical37

 Improvements to Population and Public Health Surveillance are Needed38

 Limitations to Current Knowledge of Type 2 Diabetes in Women38

Considerations for Action39

Conclusion40

References41

Foreword

The Provincial Health Services Authority (PHSA) has commissioned three papers to examine women's health in the areas of diabetes, heart disease and respiratory disease. The other two papers, "Women's Heart Health: An Evidence Review", and "Women's Respiratory Health: An Evidence Review", can be found at www.phsa.ca/PopulationHealth.

This work has been undertaken as a follow-up to an earlier 2007 PHSA report, "Life Expectancy as a Measure of Population Health", showing that the health of BC women is not improving as quickly as the health of women in many other jurisdictions as measured by the rate of gain in life expectancy. The main reasons for this were found to be relatively high mortality rates from diabetes, heart disease and respiratory disease.

These three papers, through a gender-based analysis, examine the possible explanations for these increased disease-specific mortality rates.

All three papers reach the conclusion that the health of BC women could be improved through addressing women's fundamental living and working conditions, particularly for "at risk" populations—the poor, single mothers, recent immigrants, aboriginal women and women of other ethnicities, maturing women, women with mental illness and/or addiction, and others who are marginalized or excluded from society.

More specific policy considerations were not included in the mandate for these three papers. In other work being conducted in PHSA, however, the following policy options are being analyzed in the BC context:

1. improved food security and income security
2. universal access to affordable child care
3. improved access to safe, affordable housing
4. improvements to the public education system
5. improvements to the built environment
6. improved access to effective preventive and curative health services.

Gender-based considerations of these policy areas will be important to offer insights as to specific action that will improve women's health.

John Millar
PHSA Executive Director
Population Health Surveillance & Disease Control Planning

Executive Summary

Overview

In anticipation of the 2010 Olympic and Paralympic Winter Games, the BC provincial government set an ambitious goal: that BC would be the healthiest jurisdiction to ever host the games. However, recent health surveillance reports predict British Columbians will fall short of this goal, as multiple indicators of population health are not improving as quickly relative to past host nations.

The relative decline in health appears to be due to the increase in the number of British Columbians that are inactive, consume an unhealthy diet, and/or are classified as overweight/obese. As a result, an increased proportion of people are developing preventable diseases associated with these factors, such as heart disease and type 2 diabetes. Of note, health surveillance data from 1994-2005 indicates that BC women had higher mortality rates for heart and respiratory diseases than women from other host nations, and were experiencing a faster increase in overweight/obesity and diabetes than BC men. In fact, the slipping health status ranking of BC women has been identified as the main barrier to achieving a number one overall ranking in health status by 2010.

To support development of evidence-based strategies that address these trends of concern in women's health, the Population and Public Health Program of the Provincial Health Services Authority (PHSA) and the Women's Health Research Institute have collaborated in producing this evidence review. Our objective is to synthesize current knowledge regarding one component of the emerging women's health crisis in BC - type 2 diabetes - to provide a solid information base from which to build appropriate considerations for action.

Introduction

Diabetes mellitus is a disease characterized by the body's inability to produce or properly use insulin, a hormone required to convert sugar, starch, and other food sources into energy, which manifests as hyperglycemia. If untreated or poorly managed over extended periods of time, hyperglycemia is associated with damage, dysfunction, and failure of various organs (kidneys, eyes, nerves, heart, and blood vessels), heart disease, stroke, hypertension, and premature death. In addition, hyperglycemia during pregnancy can cause serious life-threatening complications to both mother and child.

There are three main types of diabetes that affect women: type 1, type 2, and gestational diabetes. We focus primarily on type 2 diabetes, as the recent increase in prevalence is entirely due to new cases of this type. Moreover, because type 2 diabetes can be prevented or delayed with social and/or clinical intervention in up to 60% of cases, it is possible that the implementation of women-focused strategies will positively impact or reverse current trends.

Type 2 Diabetes is a Women's Health Issue

A women's health issue can be defined as a disease or condition unique to, more prevalent, or more serious in women, that has distinct causes or manifests differently in women, or that has different interventions or

outcomes when they occur in women. As such, type 2 diabetes qualifies as a women's health issue for a number of reasons:

- In the past decade, diabetes has increased by 105% in BC women versus 45% in BC men
- Several modifiers of diabetes are unique to women: pregnancy, gestational diabetes, polycystic ovary syndrome, and menopause
- Women with diabetes report higher levels of depression and lower quality of life
- Risk of morbidity and mortality from the most common complication of diabetes, cardiovascular disease, is significantly higher in women
- Women are at greater risk for developing secondary complications, including blindness, neuropathy, and insulin-related cancers

Causes and Risk Factors

There is no single cause for the increasing number of cases of diabetes in women. Although contributing factors are discussed individually in this review, it should be emphasized that they do not act in isolation but rather interact in a complex manner.

Predisposing Risk Factors

Type 2 diabetes appears to run in families, suggesting a genetic predisposition to the disease. Although genetic factors are likely to be equally prevalent in women and men, differences in social and environmental experiences throughout life could alter interactions between these genes and the environment, creating disproportionate increases in risk among women. Exposure to malnutrition in utero and/or poor conditions during early life may increase the risk of developing type 2 diabetes in later life, and female children appear to be especially sensitive to these early life effects. To minimize risk, all women, especially those with multiple risk factors, should be aware of and have access to optimal nutrition during pregnancy. Conditions experienced in adulthood have a moderating effect on the relationship between early life conditions and diabetes risk, particularly among women, suggesting that early intervention programs could be successful in preventing or delaying onset of type 2 diabetes.

Metabolic Syndrome

The metabolic syndrome is a combination of risk factors, including abdominal obesity, dyslipidaemia, glucose intolerance, and hypertension, that significantly increases risk for developing type 2 diabetes. Women appear to have an increased tendency to develop these conditions in comparison to men of equivalent body mass and height. This may explain why women have a poorer prognosis for cardiovascular morbidity and mortality than men with type 2 diabetes. The establishment of comprehensive guidelines for the prevention and management of the metabolic syndrome in women should be a priority.

Overweight/Obesity

Although the prevalence of overweight/obesity is higher among BC men, there is evidence that diabetes risk is greater for women: the relative risk of developing type 2 diabetes is fourfold greater for women versus men of equivalent body mass index. It is well documented that physical activity can greatly reduce the odds of developing type 2 diabetes in those that are overweight/obese. However, this relationship appears to differ between the sexes: physical activity substantially decreases risk among men, but the relationship in women is much weaker. This may be due to sex-specific characteristics, including hormonal differences, variation in fat distribution, and differences in types and intensity levels of physical activity. The development of physical activity guidelines sensitive to women's needs is required.

Social Determinants

Social determinants of health that play a significant role in the development of type 2 diabetes in women include poverty, access and utilization of care, quality of care, and gender-specific issues. In general, high rates of diabetes are strongly correlated with multiple indicators of low socioeconomic status (SES). There are many complex interrelationships between SES and education, health knowledge, health behaviours, and quality of care, all of which can promote development of several chronic diseases. Women in particular are more likely to be poor and experience social deprivation, and thus more vulnerable to the associated risks. To be successful, prevention and disease management programs must incorporate comprehensive policy interventions above and beyond lifestyle modification that are inclusive to women.

Populations at Risk

Aboriginal Women and Women of Other Ethnicities

Aboriginal women and women of Hispanic, South Asian, Asian and African descent appear to be at increased risk for developing type 2 diabetes. This is partly because of ethnic variation in risk factor prevalence, and partly because of effects of ethnicity on shaping the nature of social experiences and quality of the health care received. There is an urgent need to develop culturally sensitive health care and education programs targeting these vulnerable populations, and to re-evaluate how existing health care policy is administered within these communities.

Girls and Adolescents

Although type 2 diabetes has traditionally been associated with onset after 50 years of age, the increasing number of cases of type 2 diabetes among children, adolescents, and young adults is a serious emerging public health issue. Overweight/obese girls are at increased risk of developing diabetes, and experience more severe diabetes-related complications than boys. Being physically active during childhood greatly reduces the lifetime risk of developing type 2 diabetes, yet the proportion of young people engaging in physical activity in Canada has steadily decreased in recent years, particularly among females. It is therefore imperative to establish programs to increase the number of young girls engaging in physical activity.

Women with Mental Illness

Mental health disorders can increase risk for type 2 diabetes, and conversely, diabetes can increase the risk of mental illness. Depression is more prevalent in women than men with diabetes which is of serious concern: comorbid depression and diabetes results in greater decrements to health than the combination of diabetes with any other chronic disease. In addition, depression is a categorical risk factor for nonadherence to important aspects of diabetes self-care (i.e. foot exams, monitoring glucose, treatment schedules). A priority in public health should be to increase awareness and understanding of the relationship between mental illness and diabetes among health care providers, women with diabetes, families and caregivers.

Pregnancy

Trends toward earlier age of onset of diabetes have resulted in an increased number of women affected by diabetes during pregnancy. Poorly controlled glucose levels during the first trimester can result in congenital malformations and spontaneous abortion, while in the second and third trimesters, it can result in excessively large babies, posing a risk to both mother and child during delivery. It is highly recommended to establish a pre-conception pregnancy plan, and to optimize medical care and self-management of diabetes during pregnancy. Further emphasizing the need to promote healthy pregnancy is research showing that children exposed to diabetes *in utero* are predisposed to overweight/obesity and type 2 diabetes later in life.

Maturing Women

Weight gain, central adiposity, and insulin resistance can increase with age, promoting development of type 2 diabetes, especially among women with pre-existing risk factors. Decreased functionality of major organ systems from concurrent conditions increases the risk for microvascular complications, cardiovascular disease morbidity, and ultimately, mortality associated with diabetes in older women. There is a direct association between diabetes and impaired cognitive functioning and vascular dementia, and women appear to be at greater risk than men. The underlying reasons for this sex difference are unresolved, but given that women have a longer life expectancy than men, health officials need to re-examine the ability of the health care system to meet the future needs of women.

Limitations to Current Research on Type 2 Diabetes in Women

Several limitations came to light in conducting this review, namely a lack of sex/gender-based approaches in research studies, limited sex-disaggregated population health surveillance data, and considerable knowledge gaps in the scientific literature. There is an urgent need for primary data collection and surveillance to identify clinical, social, and environmental factors that influence diabetes outcomes among BC women. In particular, there is a need for provincial information regarding factors associated with diabetes in Aboriginal women, women of South Asian, Asian, and Hispanic descent, lower-income women, girls and adolescents, as well as diabetes care during pregnancy. It is critical to increase knowledge in order to develop and implement interventions effectively, and to evaluate these interventions in a meaningful way.

Conclusion

A one-size-fits-all approach is not optimal for prevention and treatment of a disease that affects women and subpopulations of women differently. A customized policy of care, dependent on the ethnic makeup of the target population, should be devised to attain effective prevention and control of diabetes within BC.

Based on better practices evidence, five considerations for action are put forward. Some of the proposed actions are supported by unequivocal evidence (e.g., research suggests that early detection and intervention is crucial to effective diabetes management). In some cases, there is less evidence supporting specific strategies for addressing diabetes in women (e.g., gender and sex-specific diabetes care guidelines). We cannot afford to sit and wait, however, for more research to direct us to “best” practices before taking action. Instead, we must use the best available evidence, in combination with expert opinion, to develop the most effective approach possible. This approach entails the use of “better practices” as a means of moving forward more aggressively to address this pressing women’s health issue. In the context of population health, better practices are defined as plausible, appropriate, evidence-based and well-executed actions and processes that will reduce the current and future burden of disease (Canadian Tobacco Control Research Initiative, 2002). By adopting a better practices approach we are also following the lead of public health researchers who advocate the use of better practices where best practice evidence is too limited to be relevant or transferable (Rychetnik et al. 2002).

Considerations for Action

Based on this review, there are a number of better practices where action should be considered. They are as follows:

7. **Promotion and prevention:** Province-wide recognition that type 2 diabetes is a serious women’s health issue is imperative. This could be achieved through comprehensive communication campaigns accessible to women of all ages, ethnicities, and socioeconomic status.
8. **Expanding research:** Improvements in health and disease surveillance; specifically, classification of data by sex and diabetes type, and incorporation of appropriate indicators of social status and context in future assessments of diabetes burden could address knowledge gaps. More research into mechanisms by which real and perceived factors alter risks for diabetes in all women, as well as within populations at risk, is warranted.
9. **Implementing better practice and guidelines:** Targeted screening and early intervention programs sensitive to women’s needs could prevent or delay onset in many of those at risk. Development of gender- and sex-specific diabetes care guidelines, including recommendations for broad-based follow-up of women with gestational diabetes, may be beneficial.
10. **Including sex, gender, and diversity lens in provincial strategies:** Development of multi-factorial, gender- and diversity-inclusive primary, secondary, and tertiary prevention strategies for health care providers and the general public may reduce incidence of diabetes in women.
11. **Sub-populations at risk:** An increased level of understanding of the living arrangements, economic sufficiency, barriers to access and utilization of care, health knowledge and behaviours, and overall health and well-being is needed of populations at risk.

Overview

As outlined in the Provincial Health Services Authority (PHSA) five-year strategic plan, a key objective is to increase emphasis on prevention, promotion and protection (PHSA 2007). To accomplish this, a priority area is creating and strengthening existing programs aimed at preventing chronic diseases before they occur, which could potentially improve the quality of life for thousands of people in British Columbia (BC), as well as greatly reduce the burden on the provincial healthcare system. In particular, the PHSA has emphasized implementation of programs incorporating knowledge and evidence arising from scientific research (PHSA 2007). To support the development of evidence-based health policies and programs to address recent trends of concern in BC women's health, the Population and Public Health Program of the PHSA and the Women's Health Research Institute have collaborated in producing this evidence review.

Introduction

In anticipation of the 2010 Olympic and Paralympic Winter Games, the BC government set an ambitious goal: that BC would be the healthiest jurisdiction to ever host the Winter Olympics. To meet this goal, policymakers and BC health authorities made a commendable effort with the development of comprehensive programs aimed at encouraging British Columbians to lead healthier lifestyles. There is no doubt that these programs have had and will continue to have a positive impact on the health of British Columbians. However, despite these efforts, recent health surveillance reports predict that British Columbians will not retain the first place ranking relative to all other Olympic host jurisdictions: Although BC was ranked 1st in a review of health status data from 1994-2005, we are expected to drop to a 3rd place ranking by 2010.

Closer examination of surveillance data revealed that while BC men continue to hold the first-ranking position in life expectancy at birth (LEo) values and are projected to maintain this position until 2010, BC women currently rank 3rd against leading nations and are projected to fall to 7th place by 2010. Although life expectancy of BC women continues to increase annually, the drop in ranking is primarily due to a relatively slower rate of increase in LEo among BC women in comparison to other countries.

Not only is life expectancy of BC women increasing at a slower rate relative to other countries, but also relative to BC men. On average, women in BC live an estimated 5 years longer than men. However, the annual rate of increase in life expectancy is 0.148 years in women, and in men, 0.271 years (Fang 2007). A similar reduction in the gap in life expectancy rates between the sexes has been seen in other developed countries, mainly due to improvements in men's life expectancy (Beckles and Thompson-Reid 2001). However, increases in prevalence of and mortality from several preventable diseases are also negatively impacting growth of life expectancy. As stated in the recent PHSA report "Life expectancy as a measure of population health", the reduced rate of increase in life expectancy among BC women can essentially be attributed to higher mortality rates from ischemic heart disease and respiratory diseases, as well as an increase in prevalence of the overweight/obese and diabetic (Fang 2007). This report strongly affirms that policymakers and health authorities need to address recent trends in BC women's health in order to improve the overall health status of British Columbia.

In this systematic review, we synthesize the current state of knowledge regarding a major trend of concern: the recent increase in the number of women in BC with type 2 diabetes, a disease often attributed to obesity/overweight and associated health knowledge and behaviours. Current predictions are that within the

next few years, the number of people with diabetes in BC could increase by as much as 90% (BC Chronic Disease Management Program 2002). Women appear to be particularly at risk: in comparison to men, the prevalence of diabetes is increasing much more rapidly in women. However, many studies have now shown that through modest exercise and proper nutrition, the onset of Type 2 diabetes among populations at risk could be reduced by about 60% (Tuomilehto et al. 2001). Accordingly, this review will be of value in the recommendation of appropriate strategies to prevent or delay onset of type 2 diabetes among all women in BC, as well as within subpopulations particularly at risk, and to improve the standard of care and consequent quality of life for women currently affected by the disease.

Background – Diabetes Mellitus

Diabetes mellitus (commonly referred to as diabetes) is a disease characterized by the body's inability to produce or properly use insulin, a hormone required to convert sugar, starch, and other food sources into energy. There are three main types of diabetes that affect women:

- Type 1 diabetes is a disease in which the pancreas produces little or no insulin. This form typically develops during childhood or adolescence, and accounts for approximately 10% of all cases of diabetes in BC. Persons with type 1 diabetes must monitor their blood sugar levels and inject themselves daily with insulin in order to survive.
- Type 2 diabetes is a metabolic disorder in which either the pancreas produces very little insulin, or the pancreas still produces insulin but cells in the body have become "insulin-resistant" and do not respond properly to the hormone. Type 2 is the most common form of diabetes, accounting for 90% of cases in BC. Type 2 usually develops in adults over 40. In some cases, blood sugar can be controlled through lifestyle modification (i.e. healthy eating, regular exercise, weight loss), although oral medications and/or insulin may be required to maintain target glucose levels.
- Gestational diabetes is a form of insulin resistance diagnosed in some women during pregnancy. Three to five percent of all births in BC are complicated by gestational diabetes (BCRCP 2001). Again, lifestyle modification may help keep blood sugar levels within an acceptable range, but if this is not effective, medications and/or insulin injections may be required to normalize maternal blood glucose and avoid complications for the infant.

Although the three main types of diabetes are caused by different underlying factors, all forms manifest as elevated blood sugar levels (hyperglycemia). If untreated or poorly managed over extended periods of time, hyperglycemia is associated with significant long-term sequelae, including damage, dysfunction, and failure of various organs (i.e. kidneys, eyes, nerves, heart, and blood vessels), heart disease, stroke, and hypertension, as well as an increased likelihood of premature death. In addition, hyperglycemia during pregnancy can cause serious life-threatening complications in both mother and child.

In this report, we focus on the issue of type 2 diabetes in women, as the recent increase in diabetes prevalence is entirely due to new cases of this form. In addition, because type 2 diabetes can be prevented or delayed with lifestyle modification in most cases, it is possible to reverse current trends with the implementation of effective strategies and policies. We also discuss gestational diabetes, as this condition is specific to women's health, and is often a precursor to development of type 2 diabetes later in life.

The Growth of Type 2 Diabetes is Reaching Epidemic Levels

Diabetes, long considered a disease of minor significance, is fast becoming one of the main threats to human health in the 21st century (Zimmet 2000). The past two decades have seen an explosive increase in the prevalence of diabetes, mainly attributed to pronounced changes in the human environment, behaviour and lifestyle (Zimmet, Alberti et al. 2001). In other words, the increased prevalence of diabetes is primarily due to a rise in new cases of type 2 diabetes, a disease strongly associated with an unhealthy lifestyle (Lipscombe and Hux 2007). In 2004, a report published by the World Health Organization (WHO) predicted that there would be a 39% rise in the global rate of diabetes from 2000 to 2030 (Wild, Roglic et al. 2004). Alarming, rates of diabetes have already exceeded these estimates in many countries, including Canada (Lipscombe and Hux 2007). Diabetes is now one of the fastest-growing chronic diseases, currently ranked as the 7th leading cause of death in the nation (Public Health Agency of Canada 2006).

BC is consistently ranked highest among all provinces in Canada in categories such as health status and health care outcomes (Health Canada 2004). Nevertheless, it is estimated that 7.1% of the population in BC (approximately 325 000 people) will be diagnosed with diabetes by the year 2010 (Tuomilehto, Lindstrom et al. 2001; Rathmann, Haastert et al. 2005; Statistics Canada 2007), and the majority of these cases will likely be type 2. However, since symptoms of type 2 diabetes develop gradually, up to one third of persons with the disease are unaware that they have diabetes. For this reason, the *actual* percentage of BC population with diabetes in 2010 will without doubt be higher than 7.1%.

The prevalence of type 2 diabetes is increasing dramatically due to a number of factors: the population is aging, obesity rates are rising, and lifestyles are becoming increasingly sedentary. Paradoxically, part of the problem also relates to the recent advances and achievements in public health. In general, people are living longer because of increased awareness of public health issues and elimination of many communicable diseases. Moreover, improvements in health care and treatment interventions have resulted in increased longevity among people currently affected by diabetes.

Type 2 Diabetes is a Women's Health Issue

A "women's health issue" can be broadly defined as diseases or conditions that are unique to, more prevalent or more serious in women, have distinct causes or manifest themselves differently in women, or have different interventions or outcomes when they occur in women (U.S. Public Health Service 1985). Using these criteria, type 2 diabetes can clearly be differentiated as a women's health issue.

- In 2005, an estimated 78,185 women and 85,525 men in BC had diabetes¹, meaning that from 1994 to 2005, the prevalence of diabetes increased by nearly 105% among women, more than twice that of BC men (45.5%; Statistics Canada 2007)
- Several modifiers of diabetes are unique to women: pregnancy, gestational diabetes, polycystic ovary syndrome, and menopause
- Women with diabetes report higher levels of depression and lower quality of life than men with diabetes (Scott, Bruffaerts et al. 2007)

¹ Population aged 12 and over who report that they have been diagnosed by a health professional as having diabetes

- The risk of morbidity and mortality from cardiovascular disease (CVD), the most common complication of diabetes, is significantly higher in women versus men (Grundy, Cleeman et al. 2005)
- Women are also at greater risk than men for developing other secondary complications, including blindness, neuropathy, and insulin related cancers (Lipscombe, Goodwin et al. 2006; Bentley-Lewis, Koruda et al. 2007)

Review of the Evidence

The primary findings from the literature reviewed are outlined in relation to the following:

- Causes of Type 2 Diabetes
- Women's Health: Risk Factors for Developing Type 2 Diabetes
- Consequences of Diabetes
- Strategies and Policies
- Implications, Challenges, and Opportunities

We conclude with several broad-based recommendations for consideration in addressing the issue of type 2 diabetes in women.

Causes of Type 2 Diabetes

Responding effectively to the challenge of type 2 diabetes requires a solid understanding of the origin and progression of the disease. Many people have a genetic predisposition for developing precursor conditions of diabetes (i.e. overweight/obese, impaired glucose tolerance), but progression to diabetes among those at risk is also influenced by environmental, economic, and social conditions that are experienced throughout the course of life, as well as the psychological and social resources that are available to these individuals. It has been estimated that biological and genetic factors account for 15% of the overall health status of Canadians, while socioeconomic conditions, the health care system, and the physical environment account for 50%, 25%, and 10% respectively (CIFAR 2002). This model can be extended to accurately describe the etiology of many chronic conditions affecting British Columbians, including type 2 diabetes, as all of the factors listed above manifest in behaviours that increase or decrease the likelihood of developing diabetes.

In this section, we will first review what is currently known about the biological and genetic origins of type 2 diabetes, and then focus on aspects of the physical and socioeconomic environment that influence the progression of the disease, with special consideration of the role that each factor has in increasing the prevalence of diabetes in women.

Genetic/Familial Risk

Several different sources of evidence suggest that genetic factors play a role in susceptibility to type 2 diabetes. A family history is a major risk factor: In Canada, 8.5% of individuals with diabetes also have a diabetic parent and/or sibling, whereas only 2% report an absence of first-degree relatives with the disease (Millar and Young 2003). Twin studies have found greater concordance for type 2 diabetes between identical as compared to non-identical twins (Barroso 2005). Aggregation of the disease within families, particularly studies demonstrating an increased risk among children of parents that are both affected (Meigs, Dagostino et al. 1997; Meigs, Cupples et al. 2000), and risk-factor clustering between certain heritable disorders (i.e. schizophrenia, polycystic ovary syndrome) and diabetes also suggest a genetic component (Ehrmann, Sturis et al. 1995; Yildiz, Yarali et al. 2003; Fernandez-Egea, Miller et al. 2008; Sam, Sung et al. 2008).

Of note, a family history of diabetes could also signal a shared home environment that increases the risk of developing the disease, i.e. health behaviours, physical activity levels, smoking and alcohol consumption within the home. However, even when these factors, along with age, sex, and education are taken into account, the odds that an individual with a diabetic parent or sibling have been or will be diagnosed with the disease are nearly three times higher than in a person without such a family history (Millar and Young 2003).

Genetic factors predisposing an individual to diabetes are probably equally prevalent in women and men, but because social and environmental experiences differ between the sexes throughout the course of life, interactions between genes and the environment could potentially result in disproportionate increases in risk among women. More basic and epidemiological research is needed to further clarify this issue.

Prenatal and Early Life Conditions

The “thrifty phenotype” hypothesis (Barker, Hales et al. 1993) was originally based on epidemiological observations linking low birth weight with the risk of adult disease (Hales and Barker 2001). The proposed mechanism is that in response to intrauterine malnutrition, a fetus becomes “programmed” for susceptibility to insulin resistance. In effect, cells begin to “ignore” the insulin signal that normally stimulates glucose storage, out of the necessity to direct all available glucose towards development of essential tissues and organs. This leads to permanent changes in structure and function of the metabolic machinery that would continue to be beneficial to the child if conditions remained poor in postnatal life (Hales and Barker 2001). However, in the presence of plentiful or even adequate nutrition, these adaptations become detrimental, predisposing the child to obesity, cardiovascular disease, and diabetes in adult life (Ozanne and Constancia 2007).

In addition to malnutrition, associations between overnutrition during pregnancy and early life and development of diabetes in adult life have been demonstrated (Armitage, Taylor et al. 2005). Both excessive maternal food intake and consumption of a high-fat diet during pregnancy appear to be correlated with future impairments in glucose tolerance among affected offspring, which leads to type 2 diabetes in many cases (McCance, Pettitt et al. 1994; Manderson, Mullan et al. 2002). To minimize disease risk, the ideal strategy would be to ensure that all women, especially those with multiple risk factors, are aware of the importance of and/or have access to optimal nutrition during pregnancy (Cottrell and Ozanne 2007). More research is needed to fully understand the processes involved in fetal programming so that interventions can be timed to align with critical windows in fetal development.

Although yet to be explored in humans, animal studies have demonstrated that female offspring are more susceptible to malnutrition and overnutrition during pregnancy and lactation (Thone-Reineke, Kalk et al., 2006). The physiological mechanism underlying sex-specific programming remains unclear, although it has been speculated that fetal growth and development rates differ between the sexes, which may alter response to malnutrition in females (McMillen and Robinson, 2005). More basic research is necessary to elucidate this mechanism, and intensified surveillance among women and children at risk is needed to investigate whether similar sex-specific trends exist in humans.

Complementing the fetal programming hypothesis are studies that have found that conditions experienced during early childhood also increase risk of developing type 2 diabetes in later life. Although clinical symptoms typically manifest in adulthood, several markers for diabetes are already evident in adolescents and young adults that experienced adverse conditions in early life (Best, Hayward et al. 2005). Poor nutrition, low family socioeconomic status (SES), and individual and parental education level are associated with insulin resistance, obesity, and a lower socioeconomic trajectory, all factors that heighten the risk for diabetes later in life (Lawlor, Ebrahim et al. 2005; Lawlor, Tooth et al. 2005; Lawlor, Patel et al. 2007). In women, there is also a strong association between early life health problems (i.e. poor growth and developmental trajectories) and diabetes incidence, suggestive of a critical postnatal period where continued exposure to poor conditions has a lasting effect on physiology, a relationship absent in men (Best, Hayward et al. 2005). Interestingly, among women only, adult SES has a moderating effect on the relationship between early life conditions and risk of developing diabetes (Best, Hayward et al. 2005). This suggests that the development of diabetes in women is sensitive to both early and adult life conditions, and that early intervention for women at risk could potentially counteract adverse effects of early life and effectively prevent or delay onset of type 2 diabetes.

Studies investigating fetal programming and early life conditions are unique in that potential causes and effects are separated temporally by as much as 50 years. As such, it should be emphasized that many other factors may intervene during the life course of an individual, and that correlational associations do not necessarily imply causation.

Socioeconomic Conditions

Type 2 diabetes is predominantly a disease of the poor: High rates of diabetes are strongly correlated with multiple indicators of low socioeconomic status or SES (Green, Hoppa et al. 2003). There are many complex interrelationships between SES and education, health knowledge, health behaviours (i.e. diet, physical activity, smoking and alcohol consumption), and access to, utilization and quality of health care, each of which can promote development of several chronic diseases within this population. The forces associated with poverty and disempowerment create social imbalances that increase rates of diabetes in vulnerable populations, and individual-based prevention programs that focus only on lifestyle modification would likely be ineffective in correcting these imbalances. Women in particular are more likely to be poor and experience social deprivation, and thus more vulnerable to the associated risks. To be successful, prevention and disease management programs must also incorporate comprehensive policy interventions above and beyond lifestyle modification that are inclusive to women.

Environmental Influences

Most studies to date have focused on effects of genetics and individual-level factors, however, an increasing number of reports suggest that accumulation of environmental pollutants within the body might also play a role in the development of type 2 diabetes. Several studies have proposed that chronic exposure to environmental pollutants could potentially accelerate onset of or exacerbate existing diabetes via disruption of glucose and lipid metabolism. Evidence to date in humans is correlational, but biologically plausible explanations do exist for the association between environmental pollution and diabetes. The potential for xenobiotics to disrupt glucose and lipid metabolism is a well-developed theory in toxicology, and studies in animals have demonstrated that exposure to several chemicals (i.e. dioxins, PCBs, organochlorine- and DDT/DDE-based pesticides) can result in excretion of glucose in the urine (glucosuria), abnormal blood lipid levels (dyslipidaemia), increased gluconeogenesis, and fatty liver (Porta 2006).

As this is a relatively new research area, very few studies have characterized sex differences in exposure to environmental pollutants and/or examined sex differences in associations between exposure to environmental pollutants and increased susceptibility to type 2 diabetes. To date, studies have been heavily male-biased because certain populations of men (i.e. veterans, factory and migrant farm workers) have experienced the highest levels of occupational exposure to toxic compounds (Lee, Jacobs et al. 2006; Porta 2006; Codru, Schymura et al. 2007; Cox, Niskar et al. 2007; Lee, Lee et al. 2007; Jones, Maguire et al. 2008). However, a recent study conducted in Ontario found that prevalence of diabetes was significantly higher (17%) in women exposed to high levels of traffic-related air pollution, a relationship absent in men (Brook, Jerreft et al. 2008). However, a major limitation of this study was that estimates of prevalence were corrected for differences in age, body mass index, and neighbourhood income only. More clinical, toxicological, and epidemiological research is needed in this area, and future studies should attempt to control for additional variables that could influence relationships between environmental pollution, diabetes, and sex.

Women's Health: Risk Factors for Developing Type 2 Diabetes

As touched upon in the preceding section, type 2 diabetes is a multifactorial disease that shows heterogeneity in many respects. Here we will take a closer look at the proximate mechanisms underlying some of the clinical risk factors associated with diabetes, and examine how gender- and sex-specific issues modify the expression of these risks in women.

Biomedical Risks Factors in Women

There are several medical conditions that contribute to the development of type 2 diabetes in women. In this section, we focus on some of the most common health conditions associated with increased risk for developing diabetes in women, including the metabolic syndrome, abnormal glucose metabolism, overweight and obesity, cardiovascular disease, and endocrine disorders.

The Metabolic Syndrome

Previous conceptions of diabetes are undergoing a radical change, particularly as data are beginning to suggest that the risk of complications commences many years before the onset of clinical diabetes. Medical opinion is moving away from classifying type 2 diabetes as a relatively distinct entity, and towards inclusion of the disease as one manifestation of a much broader underlying disorder - the metabolic syndrome (Grundy, Cleeman et al. 2005). The metabolic syndrome is a combination of risk factors, including abdominal obesity, dyslipidaemia, glucose intolerance, and hypertension, that significantly increases risk for developing type 2 diabetes as well as cardiovascular morbidity and mortality (Meigs, Dagostino et al. 1997; Grundy, Cleeman et al. 2005).

It has been well documented that women with type 2 diabetes have a poorer prognosis for cardiovascular-related morbidity and mortality than men with type 2 diabetes, a difference that persists even after adjusting for age and other risk CVD factors (i.e. smoking, body mass index; Lawlor, Ebrahim et al. 2005; Koenig, Baumert et al. 2006; Lawlor, Patel et al. 2007). The basis of this sex difference is unclear, but one possible explanation is that the prevalence of the metabolic syndrome is higher among women than men with diabetes (Bentley-Lewis, Koruda et al. 2007). There do appear to be sex-specific risk factors that predispose women to the development of the metabolic syndrome. These fixed characteristics include an increased tendency to abdominal fat deposition (e.g. central adiposity), and disproportionately greater risks in developing cardiovascular complications associated with dyslipidaemia and hypertension in comparison to men (Bentley-Lewis, Koruda et al. 2007). Current guidelines for the management of metabolic syndrome emphasize lifestyle modification, for example weight loss and physical activity, as first-line therapies (Grundy, Cleeman et al. 2005).

Abnormal Glucose Metabolism

Impaired glucose tolerance (IGT), defined as hyperglycemia (glucose levels intermediate between normal and diabetes) two hours after administration of a standard glucose load, is a condition believed to affect

more than 200 million people worldwide (Zimmet, Alberti et al. 2001). Many lifestyle intervention programs aimed at preventing type 2 diabetes have focused on persons with impaired glucose tolerance, as the condition places individuals at a much higher risk for developing diabetes (40% will progress to diabetes within 5-10 years, Zimmet, Alberti et al. 2001). For this reason, IGT may also be considered a key stage in the natural history of progression of type 2 diabetes. The diagnosis of IGT, especially in apparently healthy and ambulatory individuals has very important prognostic implications (Zimmet, Alberti et al. 2001). There is some evidence that IGT is more common in women than men, as well as a stronger predictor for risk of cardiovascular disease in women, although the basis of this relationship remains unclear (Tuomilehto, Lindstrom et al. 2001; Rathmann, Haastert et al. 2005).

Obesity, Overweight, and Physical Inactivity

Obesity has emerged as one of the most serious public health concerns of the 21st century; obesity in Canadians has increased by 20-30% in the past decade alone (Katzmarzyk and Mason 2006). In 2003, 42% of all British Columbians over 18 were overweight or obese, and only 58% of British Columbians over the age of 12 met the criteria for being physically active (Statistics Canada 2003). Physical activity is believed to be the most important factor behind the dramatic increase in overweight/obesity, although excess food and caloric intake are also significant contributors (Kelly and Booth 2003).

Although the prevalence of overweight/obesity is higher among BC men than women (Fang 2007), there is evidence that the risk of diabetes associated with being overweight is relatively greater for women. For reasons yet unknown, the probability of developing diabetes is four times greater for women that are overweight/obese versus non-overweight women, whereas the probability is less than three times greater in overweight/obese men relative to non-overweight men (Hux and Tang, 2003). If we compare overweight women and men of equivalent body mass index, the relative risk² of developing type 2 diabetes is fourfold greater in women (CPHI 2004).

The effects of physical activity on risk factors for chronic disease have been well studied, with overall indications that physical activity improves the metabolic profile and reduces the odds of developing type 2 diabetes. However, this relationship appears to differ between the sexes. While it has been consistently demonstrated that physical activity substantially decreases the risk of diabetes among Canadian men, the relationship in women is much weaker (Zhu, St-Onge et al. 2004; Boule, Bouchard et al. 2005). Authors have speculated that this may be due to sex-specific characteristics, including hormonal differences, variation in fat distribution, and differences in types and intensity levels of physical activity (Boule, Bouchard et al. 2005). Further research is required to determine the mechanism behind this observed sex difference, so as to develop effective physical activity guidelines that are relevant to women (Brien and Katzmarzyk 2006).

Polycystic Ovarian Syndrome

Polycystic ovarian syndrome (PCOS) is the most common endocrine disorder affecting reproductive aged women; it is estimated that 6-10% of women may be affected (Norman, Dewailly et al. 2007). The syndrome is characterized by excessive androgen secretion and/or activity, which negatively affects multiple body

² Relative risk: odds ratio adjusted for age, education, income, marital status, language, ethnicity, region, physical activity level, fruit/vegetable consumption, and smoking patterns

systems, resulting in menstrual dysfunction, infertility, hirsutism (excess body hair), acne, and obesity. Compared with women without the disorder, prevalence of abnormal insulin activity (8% vs. 35%) and the metabolic syndrome (23% vs. 46%) is much higher among women with PCOS (Glueck, Papanna, et al. 2003), therefore increasing prevalence of type 2 diabetes (1% vs. 8%; Baillargeon and Carpentier, 2007). In addition, type 2 diabetes is four times as high in perimenopausal women with a history of PCOS compared with control individuals (32% vs. 8%; Cibula, Cifkova, et al. 2000). The cause of PCOS is unknown, but evidence suggests that there is a strong genetic component that may interact with conditions experienced during gestational development, individual-level factors, or both. Because the syndrome is relatively common, and the risks of developing type 2 diabetes are significantly increased, women with PCOS are excellent candidates for early intervention and prevention programs.

Social Determinants of Women's Health

Social determinants of health likely play a significant role in the development of type 2 diabetes in women. In this section, we focus on specific examples of gender-based inequities associated with decrements in women's health, which could potentially increase the risk for developing diabetes in women: poverty, access and utilization of care, and quality of care. These determinants differ in terms of overall impact on the health of women, but each plays an important role in shaping gender disparities in health. Importantly, they share some commonalities (especially those related to distribution of power and resources). We focus specifically on inequalities related to gender, but it should be noted that 1) this is not an exhaustive review of all determinants of women's health, and 2) although we list each determinant as a discrete entry here, they do not act in isolation but rather interact in a complex manner.

Overview

A common misconception is that health is determined largely by individual choice, a perspective often exemplified in the study of non-communicable "lifestyle-associated" diseases (Zimmet, Alberti et al. 2001). Traditionally, a lifestyle or risk factor approach to understanding chronic disease has centered on the assumption that an individual can control the majority of factors that determine health. Accordingly, lifestyle modification programs focus on individual-level behaviours, such as tobacco reduction or cessation, physical activity, stress reduction and improved diet. However, individual-level health behaviours are fundamentally affected by social context, such as socioeconomic status, gender and psychosocial issues, and complicated by co-occurring disorders and social experiences, which are themselves gendered and unevenly distributed across the population. Therefore, more recent investigations of persistent differences in health among Canadians have shifted towards social determinants, which are factors mainly outside of an individual's control. In many cases, social determinants explain far more of the variation in the incidence and death from various diseases than individual health behaviors (Raphael 2004). This approach does not imply that behavioural choices do not play a role in the development of type 2 diabetes, but rather emphasizes that these choices tend to be heavily structured by one's material conditions in life. For these reasons, we have avoided the term "lifestyle" factors and rather referred to these as individual-level factors.

Social determinants of health are the economic and social conditions that influence the health of individuals, and include factors such as income and social status, social support networks, education, food security, housing, employment and working conditions, personal health practices and coping skills, gender and culture (Health Canada 1998). A significant amount of research investigating these issues has been

conducted in Canada (Lalonde 1974; Epp 1986; Health Canada 1998); still, some argue that Canada is well behind other jurisdictions in moving from theory to practice (Raphael and Bryant 2004, 2006), or applying this knowledge to economic and social policies that support health (Raphael 2004).

Poverty

Across all age categories, women are more likely than men to experience economic insecurity (Tang, Chen et al. 2003; Lawlor, Ebrahim et al. 2005; Rathmann, Haastert et al. 2005; Rathmann, Haastert et al. 2006). There are several reasons for this pattern: Women are more likely than men to hold part-time or lower-paying jobs, and are also more prone than men to discontinuous employment due to pregnancy and care-giving responsibilities (Walters 2003). Lower-paying jobs are less likely to include employment benefits such as additional health insurance coverage, resulting in inadequate protection against the costs of preventative health care (Beckles and Thompson-Reid 2001). Even though the work force is comprised of more women than ever before, women still assume most of the responsibility for household chores, which limits the time available to engage in exercise and health-promoting activities (Walters 2003). Because women tend to live longer than men do, there are also an increasing number of elderly women living alone on a limited income with very little social support.

There is an inverse relationship between socioeconomic status and health: a lower SES is associated with higher rates of morbidity and mortality, and women in particular experience disproportionately more health problems related to poverty than men (Yu and Raphael 2004). Some explanations for this relationship in women are that lower SES is associated with decreased access to health care services, as well as an increased tendency to perceive many life events as negative and uncontrollable, which affects willingness to seek help (Beckles and Thompson-Reid 2001).

Access, Utilization, and Quality of Health Care

Women have different experiences than men with health care, which translate into differences in access, quality of care, and health outcomes. In Canada, health care delivery is based on a premise of universal access for all insured residents. However, women have been affected by both real and perceived economic and social inequities throughout their lives, and it would be somewhat naïve to assume that equal treatment at the point of care could obviate this (Baxter 2007). Many women face additional challenges in navigating the health care system due to inequities associated with poverty, ethnicity, and age. Of note, women in British Columbia report the lowest patient satisfaction rates for overall health care services, hospital care, and physician care in Canada; which is surprising since BC outperforms all other provinces in terms of health indicators (Hamilton 2006). Clarification of this apparent mismatch between standard of care and patient satisfaction in women needs to be a priority area in provincial health research.

A statistic often cited is that women seek health services more frequently, and use a greater variety of these services than men. However, there is good evidence that this is related to sex-specific care, and not necessarily a predisposition to seeking help as is often assumed (Raphael and Bryant 2004). It is highly unlikely that the current trends in BC are due to an “artificial” increase – the increased prevalence of diabetes is simply not attributable to a greater number of women seeking care, being tested for and subsequently diagnosed with diabetes than men.

Although gender-based differences in diabetes care have not been well studied, there is evidence that women may receive a lower standard of care than men in other clinical settings (Romo, Amaral et al. 2004). A recent Canadian study demonstrated that in an acute care context, women were less likely to be admitted to intensive care units and/or receive life-supporting treatments, and more likely to die following critical illness than men (Fowler, Natasha et al. 2007). The authors suggest that these discrepancies may be due to gender-based differences in presentation of critical illness and/or decision-making processes of the patient and the health care team. Another Canadian study of sex differences in the rate of joint replacement surgeries found that although women had a greater need than men for surgery and expressed an equal willingness to undergo the procedure, they were less likely than men to discuss the procedure with their physician, resulting in fewer recommendations for surgery (Hawker, Wright et al. 2000). In agreement with these findings, a large multicentre observational study examined critical care delivery at the end of life, and found that patient-physician communications regarding preferences for care were often suboptimal, an effect particularly pronounced among women and older patients (Hamel, Davis et al. 1999).

Bierman (2007) suggests that if we are to optimize health outcomes for women and men, we need to implement three strategies:

First, sex- and gender-based analyses should become routine in all health research, and when differences are detected, further analyses should be performed to elucidate the contributing factors. Second, health indicators need to be stratified to assess whether sex and gender disparities are present, and if disparities are identified, interventions designed to reduce and eliminate these disparities must be initiated. Third, we need to move beyond descriptive studies of this issue and prioritize research that will identify the underlying pathways leading to sex and gender disparities in order to develop evidence based interventions to achieve sex and gender equality in health and health care.

For example, we know that the percentage of individuals with diabetes in BC currently receiving the recommended level of care is well below the provincial target of 80%, and there is some indication that women in particular are receiving fewer services than men. This includes testing of glycated hemoglobin, microalbumin, and lipid levels (BC Chronic Disease Management Program 2005). However, we need to do more than describe differences in this way, and start examining and identifying the factors underlying sex differences in health care to better address and eliminate these disparities.

Populations at Risk

There are more women than men in BC because women have a higher life expectancy across all age groups. The ratio of women to men increases with age, and is most marked among the elderly.

These population dynamics point to several important implications for health policy, for the planning of diabetes services for women, and for the planning of research. First, the projected rapid growth of female populations at increased risk of developing diabetes (i.e. middle-aged, elderly, ethnic groups) suggests that even under an oversimplified assumption of constant prevalence, prevalence of diabetes among women in BC will dramatically increase. **Therefore, health officials need to re-examine the ability of the health care system to meet the future needs of women. Second, development of gender-inclusive prevention education for the population and the medical profession needs to be prioritized.** Third, research efforts must expand to achieve and understanding of the mechanisms and pathways by which

both real and perceived factors alter risks for diabetes among Aboriginal women and women in other ethnic groups. Finally, as the “feminization” of old age continues, government at all levels as well as universities, foundations, and other organizations must expand their efforts to understand the living arrangements, economic sufficiency, access to health care services and health and well-being of elderly women.

Ethnic Groups

There is abundant evidence that women belonging to certain ethnic groups are at increased risk for developing type 2 diabetes. Research indicates that this is partly attributable to ethnic variation in risk factor prevalence, suggesting that biological differences may exist in susceptibility to type 2 diabetes between populations. In addition, ethnic background can also place women at risk by shaping the nature of social experiences, as well as specifically determining the quality of the health care received. We cannot change inherent physical characteristics, but we can develop health care and education programs targeting specific populations, and re-evaluate how health care policy is administered within these communities.

Aboriginal Women

Type 2 diabetes is considered a relatively new disease among Aboriginal populations in Canada (Young and Krahn 1988; Brassard, Robinson et al. 1993). With recent social, economic, and cultural upheavals, Aboriginal people have undergone a transition in health, with declining rates of communicable diseases and increasing rates of chronic illnesses (Liu, Hanley et al. 2006). Obesity and type 2 diabetes have reached epidemic levels in most Canadian Aboriginal communities. Prevalence ranges from 25-80% in different populations (Delisle and Ekoe 1993; Harris, Gittelsohn et al. 1997; Young, Reading et al. 2000), and varies with language and cultural affiliations, geographic location and degree of isolation, both nationally (Young, Szathmary et al. 1990) and regionally (Pioro, Dyck et al. 1996). Of concern, over 80% of Aboriginal persons with diabetes consider their health care to be in drastic need of improvement, requiring more staff, chronic care facilities, home care, teaching about medications, education about prevention, and mental health counselling (FNIRHS 1999).

The current situation among Aboriginal women is dire. Aboriginal women are five times more likely to develop type 2 diabetes and once diagnosed, five times more likely to die prematurely in comparison to national incidence and mortality rates (Mao, Moloughney et al. 1992). It is estimated that as many as 13% of pregnancies in Aboriginal women are complicated by gestational diabetes, which substantially increases the risk that the affected child will develop diabetes in later life (Harris, Caulfield et al. 1997; Godwin, Muirhead et al. 1999; Rodrigues, Robinson et al. 1999). In fact, Aboriginal status is an independent predictor of gestational diabetes, even in the presence of other known risk factors (Dyck, Turnell et al. 2002). Moreover, unlike any other ethnic group in Canada, the prevalence of overweight/obesity, the metabolic syndrome, and diabetes is higher among Aboriginal women than men (Liu, Hanley et al. 2006). Although the disproportionate burden of type 2 diabetes among Aboriginal women has been recognized for several decades (Young, Szathmary et al. 1990; Young, Reading et al. 2000), the situation has grown progressively worse. Effective prevention and management will require continued community involvement and increased collaboration among Aboriginal organizations, government, and health care professionals.

Other Ethnic Groups

Canada accepts proportionately more immigrants and refugees than any other country in the world (Van Kessel 1998), and 77% of new Canadians are from populations that appear to be at higher risk for developing type 2 diabetes (Hispanic, Asian, South Asian, or African descent; Perez 2002). In general, reports indicate that immigrants to Canada, especially recent arrivals, enjoy better health and are less likely to develop chronic diseases such as CVD, cancer, or diabetes than Canadian-born counterparts (Hyman 2001). However, many studies have also shown that this apparent health advantage disappears among immigrants that have resided in Canada for more than ten years (Chen, Ng et al. 1996). According to the 2000/01 CCHS, female immigrants had the highest adjusted odds ratio³ for a diagnosis of diabetes relative to non-immigrants (Perez 2002). This pattern may be attributable to a higher proportion of reported overweight/obesity and physical inactivity among established women immigrants versus Canadian-born women, although evidence directly proving this relationship is lacking (Perez 2002). Alternatively, biological risk factors may differ among ethnic groups; for example, Asian and South Asian individuals appear to be more prone to abdominal fat deposition, a risk factor for type 2 diabetes, than individuals of European ancestry (Lear, Humphries et al. 2007). Detailed longitudinal analyses in which health behaviours and indicators are well documented within immigrant populations are urgently needed to establish links between health status and incidence of chronic disease.

Girls and Adolescents

Although type 2 diabetes has traditionally been characterized by onset after 50 years of age, recent increases in the incidence of type 2 diabetes among children, adolescents, and young adults are a serious emerging public health issue. Although type 1 diabetes is still the main form of the disease present in young children, if current trends continue unabated, it is expected that within 10-20 years type 2 will be the predominant form affecting children in North America (Beckles and Thompson-Reid CDC 2001).

The appearance of type 2 diabetes in younger age groups raises many clinical questions, namely how to differentiate between type 1 and type 2 diabetes at diagnosis, which medications (apart from insulin) are safe to use in children, and how to reformulate intervention strategies to better address a younger target population. With this increase in diabetes prevalence in children and adolescents, we can also anticipate a corresponding rise in diabetes-related complications (i.e. hypertension, hyperlipidaemia, nephropathy, retinopathy) over the next few decades. Further, studies indicate that the progression of clinical complications may actually be more rapid when diagnosis occurs at a younger age, raising the possibility of a more serious public health challenge than anticipated. (Pinhas-Hamiel and Zeitler 2007). There is also evidence that overweight/obese girls are at increased risk of developing diabetes, and that the prevalence and severity of secondary complications is higher among girls than boys (Beckles and Thompson-Reid CDC 2001). These issues need to be addressed urgently. Long-term impacts of this downward shift in disease onset could potentially have devastating effects on educational attainment and employment due to premature morbidity and mortality, and on reproductive health due to negative effects on fertility and pregnancy.

Physical activity can reduce the lifetime risk of developing type 2 diabetes, particularly if these behaviours are adopted at a young age (Alfano, Klesges et al. 2002). The health benefits are clear: decreased numbers of overweight and obese individuals, increased psychological well-being, and carryover of this behavior

3 Adjusted for age, education, and income

promoting improved health in adulthood (Baranowski, Mendlein et al. 2000; Boreham and Riddoch 2001; Cavill, Biddle et al. 2001). Despite this, the proportion of young people engaging in physical activity in Canada has steadily decreased in recent years (Irving, Adlaf et al. 2003; O'Loughlin and Tarasuk 2003). Among female children and adolescents, there is a trend towards even lower physical activity in comparison to males (Loucaides, Plotnikoff et al. 2007). It is therefore imperative to establish programs to increase the number of young girls engaging in physical activity. Older female adolescents tend to report the lowest levels of exercise, and would benefit most from such interventions (Ammouri, Kaur et al. 2007). Within this population, stress, low self-esteem, and depressive symptoms negatively influence physical activity levels (Ammouri, Kaur et al. 2007). In addition, unlike boys, physical activity levels in girls tend to be strongly influenced by parental health behaviours and the strength of relationships within the family (Ammouri, Kaur et al. 2007; Sanchez, Norman et al. 2007). The success of an intervention targeted towards girls would likely be enhanced if strategies for dealing with these additional issues were incorporated.

Women with Mental Illness

Mental health disorders can increase risk for type 2 diabetes, and conversely, diabetes can increase the risk of mental illness (Prince, Patel et al. 2007). The added dimension of comorbid mental illness has a profound effect on help-seeking, treatment, and prognosis of diabetes (Moussavi, Chatterji et al. 2007; Prince, Patel et al. 2007). Health services are not provided equitably to persons with mental illness: they are less likely to be placed on glycated hemoglobin (HBA1C) and cholesterol monitoring, to have retinal examinations, or to receive medical visits, and tend not to receive treatment for complications until the situation is critical (Frayne, Halanych et al. 2005; Goldberg, Kreyenbuhl et al. 2007).

Depression is more prevalent in women (ca. 28%) than men with diabetes (ca. 18%; Anderson, Freedland et al. 2001). This is of serious concern, as the combination of depression and diabetes results in greater decrements in health than those from diabetes alone, depression alone, or the combination of diabetes with other chronic physical diseases (Moussavi, Chatterji et al. 2007). Issues of comorbidity with mental illness are particularly relevant to women, as disparities associated with mental illness would be ancillary to gender-based disparities. In addition, depression is a categorical risk factor for nonadherence to treatment, and studies have shown that even low levels of depressive symptomatology are associated with nonadherence to important aspects of diabetes self-care (i.e. foot exams, monitoring glucose, maintaining treatment schedules; (Gonzalez, Safren et al. 2007). In the health care sector, recognition of and quality of care for comorbid mental and physical health conditions must be improved (Prince, Patel et al. 2007). It should also be a public health priority to increase awareness and understanding of the relationship between mental illness and chronic disease among women with diabetes and those at risk, as well as their families and caregivers.

Less is known about sex-specific interactions between other mental illnesses and diabetes, for example, bipolar disorder, anxiety disorder, and schizophrenia. It is well known that prevalence of type 2 diabetes among persons with schizophrenia is much higher than in the general population, i.e. 10-15% versus 2-3% (Lamberti, Crilly et al. 2004). However, schizophrenia is far more prevalent in men, and so most studies have not specifically examined this issue in women. There is little data available regarding mental illness and diabetes in Canadian women, and even less information about this relationship within at-risk populations.

Diabetes in Pregnancy

Diabetes is increasingly affecting women during their reproductive years. Approximately 7% of pregnancies in Canada are complicated by diabetes; of these 90% are classified as gestational diabetes mellitus (GDM), 7% are type 2 diabetes, and 4% type 1 diabetes (Reece and Homko 1998). Poorly controlled glucose levels during the first trimester can result in congenital malformations and spontaneous abortion, while in the second and third trimesters, it can result in excessively large babies (macrosomia), posing a risk to both mother and child during delivery (Kelly, Evans et al. 2005). In addition, children exposed to diabetes in utero are predisposed to overweight/obesity issues during childhood and adolescence, and an increased risk of developing type 2 diabetes later in life (Martin-Gronert and Ozanne 2006; Metzger 2007).

Gestational diabetes is defined as glucose intolerance with onset or first recognition during pregnancy (Metzger, Buchanan et al. 2007). Since many women with GDM eventually develop overt type 2 diabetes and both conditions are characterized by insulin resistance (Kim, Newton et al. 2002; Albareda, Caballero et al. 2003), some have speculated that they represent sequential points on a continuum of disease (Reece and Homko 1998; Farrell, Neale et al. 2002). In Canada, the recommended follow-up for women with GDM is re-evaluation of glucose tolerance within 6 months of delivery and counseling to reduce modifiable risk factors (CDA Clinical Practice Guidelines Expert Committee 2003). Whether or not the counseling offered is effective in reducing risk is not known, but is an issue that should be explored.

Postpartum screening is especially important among women with multiple risk factors for developing type 2 diabetes, including increased age and parity, family history of diabetes, pre-pregnancy weight gain, postpartum weight retention, and overweight/obesity (Russell, Dodds et al. 2008). Improved surveillance of these factors among women that experience GDM would effectively identify women at risk of progression to type 2 diabetes. Alternatively, indicators of GDM severity that are routinely monitored in clinics and hospitals (i.e. insulin use, neonatal hypoglycaemia, and recurrence in subsequent pregnancies) are also highly predictive of progression to diabetes (Kelly, Evans et al. 2005), and could also be used to identify those that would benefit most from more intensive post-partum intervention.

Recently there has been some debate regarding the value of universal screening for gestational diabetes (Soares, Dornhorst et al. 1997; Wen, Liu et al. 2000; Carr 2001; Brody, Harris et al. 2003). Although prenatal screening is routine in Canada (CDA Clinical Practice Guidelines Expert Committee 2003), evidence that it is effective in reducing adverse pregnancy outcomes is inconsistent (Jarrett 1996; Garner, Okun et al. 1997; Soares, Dornhorst et al. 1997). For example, an Ontario-based study demonstrated that since the onset of standard prenatal screening, a higher proportion of pregnant women with diabetes have been identified, but there has been no corresponding reduction in diabetes-related adverse outcomes such as congenital abnormalities, neonatal hypoglycaemia, and perinatal death (Wen, Liu et al. 2000). It is not clear why this situation would exist; presumably, early detection and treatment of gestational diabetes would reduce the risks to both mother and child. This apparent lack of improvement in perinatal outcomes warrants further investigation.

Most clinicians agree that prenatal screening is still the most effective tool in reducing rates of macrosomia and consequent caesarean sections (Kelly, Evans et al. 2005), a highly beneficial outcome as women with diabetes are at a significantly higher risk of developing C-section wound infections post surgery (Takoudes, Weitzen et al. 2004). In addition, prenatal screening still has considerable diagnostic value among women with multiple risk factors (Caliskan, Kayikcioglu et al. 2004; Kelly, Evans et al. 2005), and could potentially

aid in identification of women and children at risk of developing type 2 diabetes in the future, facilitating early intervention and prevention programs (Silverman, Metzger et al. 1995; Soares, Dornhorst et al. 1997). Given the high risks associated with undiagnosed diabetes in pregnancy, it is still advisable to include prenatal screening in obstetrical practice until a better alternative is available (Kelly, Evans et al. 2005).

Maturing Women

Research shows that both body mass index and insulin resistance increase with aging, which can promote the development of type 2 diabetes in women at risk. The menopause per se does not appear to increase risk of developing diabetes, although it can promote a change in body fat distribution towards increased central adiposity, subsequently increasing the risk for developing diabetes (Bentley-Lewis, Koruda et al. 2007). However, studies have shown that regular physical activity can reduce this tendency for weight gain and adverse changes in body composition (Sternfeld, Bhat et al. 2005). Although older women are subject to the same complications of diabetes as persons of any other age, decreased functionality of major organ systems from concurrent conditions put older women at increased risk for microvascular complications, cardiovascular disease morbidity, and ultimately, mortality associated with diabetes (Beckles and Thompson-Reid 2001; CDC 2007).

Longitudinal epidemiological studies have demonstrated a direct association between diabetes and impaired cognitive functioning and vascular dementia in older adults (Allen et al. 2004; Biessels et al. 2006). These cognitive impairments may be more pronounced among individuals with Type 2 diabetes (Stewart and Liolitsa 1999; Strachan et al. 1997), and there is evidence that women are at a disproportionately greater risk than men (Coker and Shumaker 2003). Although the underlying sex difference in pathogenesis remains unclear, chronic hyperglycemia, vascular disease, repeated hypoglycemic episodes and direct effects of insulin on the brain have been implicated (Biessels et al. 2002).

Consequences of Diabetes

Mortality

Eighty percent of those diagnosed with diabetes will die from the disease (Zimmet, Alberti et al. 2001). A recent US study found that in the last 30 years, progress in reducing mortality rates among persons with diabetes has been limited to men, and that the difference in mortality rates between women with and without diabetes had nearly doubled in the last decade (Gregg, Gu et al. 2007). The authors speculate that the lack of improvement in mortality rates among women could be due to sex- and gender-based differences in management of the most common complication of diabetes, cardiovascular disease. In general, this does not seem to be the case in Canada (Lipscombe and Hux 2007); however, similar trends may emerge as diabetes prevalence increases.

Cardiovascular Disease

Elevated blood sugar levels damage the endothelial walls of blood vessels. Although diabetes is most often defined by microvascular damage to the smaller blood vessels of the eyes, kidneys, and extremities, the life-threatening component of the disease is macrovascular damage to the heart and larger blood vessels. Premature death due to fatal heart attacks and strokes are the main correlates of the 10-20 year reduction in life expectancy observed in persons with diabetes. Evidence suggests that even in the absence of pre-existing vascular disease, people with diabetes have an equivalent risk of coronary heart disease to those without diabetes that have already experienced a myocardial infarction (Haffner, Lehto et al. 1998). Many diabetes care guidelines, including those endorsed by the Canadian Diabetes Association, state that the first priority in the prevention of diabetes complications should be the reduction of cardiovascular risk (CDA Clinical Practice Guidelines Expert Committee 2003).

In order to develop effective interventions, more research is needed to gain a better understanding of this excess CVD risk so as to identify modifiable determinants. In addition, a priority in health research should be to include a greater proportion of women with diabetes in clinical trials of novel drug therapies and interventions for CVD.

Microvascular Complications of Diabetes

Diabetes can lead to life-threatening and disabling complications. It is the single largest cause of blindness, and a leading cause of kidney failure and lower limb amputations among women in Canada (O'Brien, Patrick et al. 2003; Health Canada 2005). Knowledge about sex differences in the development and progression of these long-term complications in Canadians with diabetes is limited. In other countries, a higher proportion of women with diabetes report visual impairments (Hayward, Burden et al. 2002), while a higher proportion of men with diabetes are diagnosed with kidney disease (Gall, Hougaard et al. 1997; Ravid, Brosh et al. 1998).

Prevention of complications is a key issue in disease management because of the huge premature morbidity and mortality associated with type 2 diabetes. Several major studies have emphasized the importance of intensive control of blood glucose to prevent the retinal, renal and neuropathic complications of diabetes,

and active medical intervention for the reduction of the risk of diabetes complications (Shamoon, Duffy et al. 1993; Turner, Holman et al. 1998).

Future studies are needed to determine if sex-specific differences in the incidence and progression of diabetes-related complications in Canada, with adequate representation of ethnic groups most at risk.

Adverse Pregnancy Outcomes

A key feature associated with adverse pregnancy outcomes is a lack of contraceptive use prior to pregnancy (Cooper, Gordon et al. 2007). The use of effective and reliable contraception needs to be emphasized among reproductive-age women to reduce the occurrence of unplanned pregnancies. Women with diabetes can safely use the combined oral contraceptive pill, intrauterine contraceptive devices, progesterone injections, patches and implants as methods of birth control (Cooper, Gordon et al. 2007).

It is highly recommended to establish a pregnancy plan well in advance of conception to achieve a healthy pregnancy; it is particularly important that diabetic women receive preconception folic acid supplementation, and that medical care and self-management of diabetes during the preconception and pregnancy periods is optimized (Casson 2006; Cooper, Gordon et al. 2007). Clinicians and health care workers should prioritize medical care before and during pregnancy in diabetic women, and ensure adequate surveillance of large babies (Holt 2007). All women with diabetes of reproductive age need to be well aware of the risks associated with pregnancy and that maintaining good glycemic control before and during pregnancy can significantly reduce these risks. Because gestational and type 2 diabetes are more common in Aboriginal women and other ethnic groups, specialized programs taking into account ethnic and cultural differences should be developed to maximize knowledge transfer as well as adherence to clinical guidelines.

Poverty

A low SES increases the risk for developing diabetes, and a diagnosis of diabetes can further contribute to a lower SES. Statistics Canada reports that Canadians over age 35 living with diabetes are more likely than those without diabetes to have lower levels of income (Millar and Young 2003). In particular, an increasing number of those living with diabetes are elderly persons living alone and in poverty, with medical costs 2 to 5 times higher than those without diabetes (CDA 2005). Due to differences in life expectancy, a higher proportion of these elderly individuals are women living on a fixed income.

A recent survey of members of the Canadian Diabetes Association revealed that approximately 50% of CDA members reported paying between 50-200 dollars per month out-of-pocket for diabetes medications and supplies, and 25% report that they either could not afford or could not access through insurance plans the medications and supplies recommended by their doctor (CDA 2005). Of the 17 diabetes medications approved for use in Canada, only eight can be fully accessed under the BC Fair PharmaCare plan: BC Fair Pharmacare does not list five of the approved diabetes medications at all, and restricts access to five of them (CDA diabetes report 2005).

Therapeutic Options in Women

The Canadian Diabetes Association (CDA) recently published the *Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada*, which provided recommendations regarding the level of care that should be provided to **all** individuals with diabetes (CDA Clinical Practice Guidelines Expert Committee 2003). The rationale for establishing these guidelines was to translate clinical and evidence-based research into information healthcare professionals could apply in everyday practice. However, with the exception of chapters devoted to gestational diabetes and erectile dysfunction, the guidelines are sex-aggregated.

In BC, the provincial standards for diabetes care are detailed in the BC Diabetes Care Guidelines, which incorporate the CDA guidelines into a chronic disease management framework (BC Guidelines and Protocols Advisory Committee 2007). Similarly, the BC guidelines do not specifically address gender- or sex-specific aspects of diabetes care. It is not clear whether this is due to knowledge gaps in diabetes care and treatment in women. There is very little information available regarding sex- and gender-based differences in drug or treatment efficacy, apart from abundant reports of medications that are contraindicated during pregnancy.

The development of best practice guidelines that take a multidisciplinary approach to diabetes and women's health should be a priority. Once developed, comprehensive training could be made available to ensure that all health care professionals are aware of the social and cultural aspects that shape women's experiences of diabetes care, particularly in relation to enhancing success of self-management programs.

Strategies and Policies

Up to now, we have reviewed the causes, risk factors, and consequences of type 2 diabetes in women, and briefly mentioned opportunities for intervention. Here, we provide a more comprehensive account of provincial strategies currently in place to reduce the incidence and burden of type 2 diabetes in BC in order to present a picture of the current situation for women, and to provide context for our recommendations for consideration.

Overview

Diabetes is one of the more costly chronic diseases in terms of care and management, and is a major cost driver in health care in BC: in 2004, 760 million dollars was spent on services for people with diabetes, more than 2 million dollars a day (Auditor General of British Columbia 2004). Furthermore, maintaining glucose control and treatment of complications is complex and costly: the direct health care costs of diabetes ranging from 2 to 15% of health care budgets across Canada (Lipscombe and Hux 2007). There are also considerable “hidden” costs associated with lost productivity due to premature morbidity and mortality from diabetes.

Interventions aimed at preventing or delaying the onset of diabetes would not only reduce the financial burden attributable to diabetes and secondary complications, but also costs associated directly with risk factors: Overweight and obesity is estimated to cost the province 730-830 million dollars annually (Colman 2001), while costs of physical inactivity exceed 570 million dollars a year (Colman and Walker 2004). In addition, diabetes prevention can have intergenerational effects, as improvements to maternal health will reduce a mother's own risk, as well as her child's future risk of developing diabetes. Finally, most interventions aimed at preventing diabetes would also be effective in reducing the risk of cardiovascular disease and other chronic diseases. Therefore, the potential exists for simultaneous improvement of multiple indicators of health and well-being, and reduction of the considerable health care costs associated with these additional factors.

Interventions should be designed with consideration of the unique needs of women, and should also be flexible as some degree of modification may be required to appeal to different age classes, and ethnic, religious, and cultural groups. Women and community organizations should be fully engaged as active partners in policy decisions and in program planning, implementation, and evaluation, and there should be accountability for adoption of approaches to improve the health status of women. Measurable outcomes for programs and policies should be established so that the progress and impact can be evaluated and approaches modified as needed.

Diabetes Promotion

Despite the physical and financial toll of diabetes, the public has generally not perceived diabetes as a serious disease or women's health issue. As a result, many efficacious health behaviours that could reduce the burden of disease are not widely practiced. We must achieve province-wide recognition that diabetes is a serious public health and women's health issue, attracting maximal attention from policy makers, public health professionals, advocates for women's issues, researchers, and the general public, in order to affect

change. Promotion of diabetes as a serious issue in women's health among the general population could enhance future reception of and adherence to various prevention and intervention initiatives. Educational programs should be designed to appropriately consider age, language, literacy level, culture, race, ethnicity, motivation, and other relevant factors including access to personal, family, and community resources.

Diabetes Prevention in British Columbia

What is most needed in BC is a coordinated suite of best practices that span the three major levels of prevention:

1. **Primary prevention:** Programs designed to control modifiable risk factors at the population level. These programs focus on controlling environmental factors that impede health in BC and encouraging capacity to improve health among all women.
2. **Secondary prevention:** Programs that identify at-risk populations in BC (i.e. pregnant women, children/adolescents, Aboriginal women and other ethnicities), and use early detection and intervention programs to inform and assist these women.
3. **Tertiary prevention:** Programs that involve intensive management of women already affected by diabetes to reduce morbidity and premature mortality.

Individually, outcomes of primary, secondary, and tertiary prevention programs can be subtle, but when programs at different levels are designed specifically to dovetail with one another, they can have synergistic effects. New initiatives should build on this concept of synergy, using existing resources, services and natural links between local, provincial, and federal agencies and organizations in both the public and private sectors.

Primary Prevention

The objectives of primary prevention are self-evident. To truly make an impact, we need to create conditions that facilitate the following among BC women:

- Increased levels of physical activity
- Reduced caloric intake
- Reduced consumption of fats, particularly saturated fats
- Increased consumption of fibre, particularly from fruits and vegetables

These steps seem simple, but effective primary prevention should incorporate a wider range of actions than providing information and shifting responsibility to the individual to make the "right choice". It is of little use to promote adoption of a healthier diet to a woman who does not have access to or cannot afford to buy this food, or to emphasize regular exercise to a single mother who does not have the time or resources needed to achieve this goal.

The BC Ministry of Health does not have a diabetes-specific prevention strategy; rather,

“Diabetes prevention is addressed through an integrated, risk factor-based strategy that seeks to prevent most prevalent chronic disease categories, including Type 2 diabetes, cardiovascular disease, chronic respiratory disease and cancer, by targeting the risk factors that are common to them all; tobacco use, physical inactivity, poor nutrition and overweight/obesity”

(In “Follow up to 2004/5 Report 3”, Auditor General of British Columbia 2007)

Several primary prevention initiatives with the overarching goal of improving health status of British Columbians are currently underway, including the ActNow campaign. ActNow BC is an integrated chronic disease prevention strategy that targets high-risk individual behaviours. The focus is on encouraging people to make healthier choices and promoting the creation of health-supporting environments. Programs that are currently in place include:

- Action Schools! BC – aimed at increasing activity levels of students and creating health supporting environments in schools
- Active Communities: designed to help communities increase activity levels
- The School Fruit and Vegetable Program: provides students with a vegetable or fruit snack twice a week.

The effectiveness of these programs in terms of reversing current trends and future projections of diabetes of women in BC is not yet known, but many studies do recommend increased investment into school, workplace, and community-based developments such as the examples listed above. Province-wide success of these programs will be contingent on dissemination of best practices and lessons learned; as such, knowledge synthesis, translation, and exchange will play a critical role in planning next steps.

Secondary Prevention

The objectives of secondary prevention are to identify women at imminent risk for developing type 2 diabetes, and then provide these women with treatment to prevent or delay onset of the disease. In general, success of secondary prevention programs is dependent on availability of cost-effective screening tools, and accuracy in recognizing populations that should be screened. British Columbia lacks a comprehensive policy towards secondary prevention of diabetes; although the ActNow initiative specifically target “lifestyle” factors that cluster in persons at high risk: inactivity, poor nutrition, overweight and obesity.

Tertiary Prevention

Management of diabetes is a complex task, requiring lifelong continuity of care and flexibility to adjust as the patient ages or circumstances change. As multiple interventions are required to manage diabetes, diabetes-related complications, and in some cases, additional chronic diseases (i.e. depression, cardiovascular disease), there must be coordination between several care providers: physicians, specialists, nutritionists, and diabetes educators. Successful management of diabetes also requires the patient to take an active role: individuals need to make lifestyle changes, adhere to a treatment and dietary regimen, and constantly monitor their own condition.

British Columbia does not employ a specific diabetes care strategy; instead, diabetes is incorporated in the recently adopted Chronic Disease Management (CDM) model. The CDM model is an evidence-based, integrated approach, and the effectiveness of this model in a variety of settings is well-supported in the literature. Already there has been evidence of improvement in several endpoints, including decreased mortality rates, and an increase in the number of recommended services provided to persons with diabetes (Auditor General of British Columbia 2007).

Of note, several recent initiatives within the provincial health care sector, including provision of financial incentives to doctors that improve quality of care for people with chronic conditions (including diabetes), the establishment of the Diabetes Collaborative, which has produced standard provincial guidelines and disease management toolkits, and promotion of a comprehensive self-management training program, show some promise (Auditor General of British Columbia 2007). In particular, self-management training provides patients with the emotional support, knowledge and skills required to proactively manage their disease, take a more active role in monitoring performance measures, and live a more active, healthy lifestyle. Since the early 1990s, many European countries have employed governmentally sponsored diabetes self-care programs, with positive results. This could partially explain more favorable trends in morbidity and mortality among women with diabetes that have been observed among these countries in comparison to BC and Canada (Fang 2007).

Implications, Challenges, and Opportunities

Major Findings

This review highlights that diabetes is indeed a women's health issue. Type 2 diabetes is poised to become one of the greatest challenges in health care in the province, as is the case already in many other developed countries.

The main issues that have been identified as playing an important role in the increased burden of diabetes in BC women are:

- Adolescent girls, young women, and elderly women increasingly constitute high-risk groups because of declining dietary habits and levels of physical activity, and increasing overweight and obesity
- Aboriginal women and women of South Asian, Asian, Hispanic and African descent are at increased risk for multiple reasons; deterioration in health status of female immigrants is related to the adoption of maladaptive health behaviours
- More women are living in poverty, which is an independent risk factor for type 2 diabetes, and negatively affects many aspects of diabetes management and care among those with the disease; the number of elderly women living alone in poverty is expected to continue to increase exponentially over the next few decades
- Persisting gender and ethnic disparities exist in health and health care, which disproportionately increases diabetes risk in women
- Women are at greater risk for developing precursor conditions such as abnormal glucose metabolism and the metabolic syndrome, and are more likely to develop comorbid heart disease, especially first fatal events, than men and women without diabetes

Several factors may also influence the development of diabetes in women, although the relationship is not well established:

- Women appear to be more sensitive to pre-disposing risks such as genetic factors, *in utero* effects and early life conditions
- Exposure to environmental pollutants may increase susceptibility to type 2 diabetes, particularly in women
- Environmental and social factors such as public transportation, availability of nutritious foods, safe neighbourhoods, accessible exercise facilities, housing, familial structure, psychosocial factors and social support networks may differentially influence risk of diabetes, as well as outcomes of diabetes prevention programs in women
- The development of sex- and gender-inclusive recommendations for diabetes drug therapy and lifestyle interventions, as well as gender-specific self-management programs would likely be beneficial to women

Early Intervention is Critical in Diabetes Prevention and Care

Research suggests that early detection and intervention is crucial to effective diabetes management. The evidence is unequivocal: several large-scale clinical trials have demonstrated that if metabolic control is achieved early in the course of diabetes, this substantially reduces development and progression of the disease and significantly reduces microvascular complications (retinopathy, neuropathy, and nephropathy; LeRoith, Fonseca et al. 2005). In addition, most studies emphasize the role of self-management: Effective diabetes control necessitates that women become experts in their own care – knowing what medications to take and when, adopting a healthy diet, and incorporating regular exercise into daily life.

Addressing Social Inequalities in Health

While it is widely accepted that social and gender inequalities have profound effects on patterns of health and illness, there are very few examples of interventions designed specifically to address social determinants of chronic disease in women. We need to move beyond merely documenting gender-based disparities and towards establishing creative interventions to remedy these imbalances. This will require increased investment and support of novel research initiatives, as interventions targeting the social and economic sources of chronic disease at the provincial level would be more effective than health care interventions geared towards the individual (Walters 2003). Large-scale interventions of this type are beyond the scope of the provincial health care sector, but collaboration between multiple levels of government and key stakeholders may permit the development of wide ranging programs with the aim of social change.

Gender-Inclusive Health Planning is Critical

The argument presented by Pederson in the report “Gender Inclusive Health Planning” prepared for the BC Women's Health Bureau in 2001 continues to be highly relevant today. Pederson suggests that if we are to optimize health outcomes for women and men, we need to consider the following:

When it comes to health, sex and gender matter. Current literature indicates that women and men differ in important ways when it comes to health status and health service utilization, particularly from a lifespan perspective. Recognizing that there are known and yet to be discovered differences in the health between men and women should lead us to question whether to take an approach that incorporates these differences when designing services, allocating resources and setting strategic priorities. A lack of attention to gender and sex differences in health planning may result in oversights, errors, and oversimplifications. Adoption of a gender-inclusive approach to health planning will allow for exploration of differential needs and consequences of health in both men and women, which in turn increases the likelihood that health programs and services will be more relevant and appropriate to both women and men in BC.

Improvements to Population and Public Health Surveillance are Needed

Detailed information regarding diabetes care in BC is currently limited, yet information is often a key component of successful interventions. If establishing effective diabetes prevention and control strategies at the provincial level is a priority, a better understanding of the health practices of women with diabetes and the factors that affect women's access to appropriate diabetes care is necessary.

The 2005 Canadian Community Health Survey (CCHS) included an optional Diabetes Care Module⁴, which collected in-depth information regarding current care practices, including frequency of glucose testing, foot and eye examinations among people with diabetes (CCHS 2005). Results revealed that the best predictors for receipt of the recommended level of care were access to a regular primary care physician and current insulin use⁵. No significant differences were found between the sexes in frequency of glucose testing, foot or eye examinations; however, since BC did not participate in the CCHS Diabetes Care survey, this data may not be representative of current practices among women in this province.

Over the next few years, many organizations including Statistics Canada, the Public Health Agency of Canada and the Canadian Institute for Health Information, will be collaborating on more in-depth analysis. This is required to better understand the health practices of Canadians with diabetes and the factors that affect the receipt of appropriate diabetes care (Sanmartin and Gilmore 2006). It is imperative for BC to be involved in these future efforts in order to best address the issue of diabetes and women's health.

Limitations to Current Knowledge of Type 2 Diabetes in Women

There is an urgent need for primary data collection and surveillance to identify clinical, social, and environmental factors that influence diabetes outcome among BC women. In particular, there are huge knowledge gaps in provincial information regarding factors associated with diabetes in non-white women (especially non-Aboriginal ethnicities), low-income women, girls and adolescents, as well as diabetes care during pregnancy. It is critical to increase knowledge of these groups in order to develop and implement interventions effectively, and to evaluate these interventions in a meaningful way.

4 The diabetes care module was selected by all regions in Newfoundland and Labrador, Prince Edward Island, New Brunswick, Ontario, Manitoba, and Yukon.

5 Only 20% of people with type 2 diabetes require treatment with insulin

Considerations for Action

Based on this review, there are a number of better practices where action should be considered. They are as follows:

1. **Promotion and prevention:** Province-wide recognition that type 2 diabetes is a serious women's health issue is imperative, which could be achieved through comprehensive communication campaigns accessible to women of all ages, ethnicities, and socioeconomic status.
2. **Expanding research:** Improvements in health and disease surveillance; specifically, classification of data by sex and diabetes type, and incorporation of appropriate indicators of social status and context in future assessments of diabetes burden could address knowledge gaps. More research into mechanisms by which real and perceived factors alter risks for diabetes in all women, as well as within populations at risk, is warranted.
3. **Implementing better practice and guidelines:** Targeted screening and early intervention programs sensitive to women's needs could prevent or delay onset in many of those at risk. Development of gender- and sex-specific diabetes care guidelines, including recommendations for broad-based follow-up of women with gestational diabetes, may be beneficial.
4. **Including sex, gender, and diversity lens in provincial strategies:** Development of multi-factorial, gender- and diversity-inclusive primary, secondary, and tertiary prevention strategies for health care providers and the general public may reduce incidence of diabetes in women.
5. **Sub-populations at risk:** An increased level of understanding of the living arrangements, economic sufficiency, barriers to access and utilization of care, health knowledge and behaviours, and overall health and well-being is needed of populations at risk.

Conclusion

A one-size-fits-all approach is not optimal for prevention and treatment of a disease that affects women and subpopulations of women differently. A customized policy of care, dependent on the ethnic makeup of the target population, should be devised to attain effective prevention and control of diabetes within BC.

Based on better practices evidence, five considerations for action are put forward. Some of the proposed actions are supported by unequivocal evidence (e.g., research suggests that early detection and intervention is crucial to effective diabetes management). In some cases, there is less evidence supporting specific strategies for addressing diabetes in women (e.g., gender and sex-specific diabetes care guidelines). We cannot afford to sit and wait, however, for more research to direct us to “best” practices before taking action. Instead, we must use the best available evidence, in combination with expert opinion, to develop the most effective approach possible. This approach entails the use of “better practices” as a means of moving forward more aggressively to address this pressing women’s health issue. In the context of population health, better practices are defined as plausible, appropriate, evidence-based and well-executed actions and processes that will reduce the current and future burden of disease (Canadian Tobacco Control Research Initiative, 2002). By adopting a better practices approach we are also following the lead of public health researchers who advocate the use of better practices where best practice evidence is too limited to be relevant or transferable (Rychetnik et al 2002).

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