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DOES MENOPAUSAL STATUS INFLUENCE SEXUAL RISK? A CROSS-SECTIONAL ANALYSIS OF THE U.S. NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY

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Abstract

Middle-aged and older adults remain sexually active, but the combination of sexual longevity, inconsistent safe sex practices, and poor condom knowledge, increases their likelihood to risk their sexual health. Menopause may influence sexual risk, as post-menopausal women may engage in risky sexual behaviours, while hormonal changes increase physiological vulnerability to sexually transmitted infections. This project explored whether menopause and type of post-menopause (natural versus surgically-induced) influenced sexual behaviour and herpes simplex virus type 2 (HSV-2) seroprevalence, using logistic regression modeling of the U.S. National Health and Nutrition Examination Survey data. Controlling for confounding, menopause was negatively associated with number of sexual partners, negatively associated with condom use in non-partnered low education women, and positively associated with HSV-2. Type of menopause was not associated with any outcomes. This project highlights a need for improved data on sexual behaviour in older adults.

Keywords

Menopause, middle-aged women, STIs, sexual behaviour, sexual risk, condom use, HSV-2, United States, National Health and Nutrition Examination Survey.

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List of Abbreviations

ACASI	Audio computer-assisted self-interview
AIDS	Acquired immunodeficiency syndrome
BMI	Body mass index
CAPI	Computer-assisted personal interview
CATMAT	Committee to Advise on Tropical Medicine and Travel
CDC	Centers for Disease Control and Prevention
CCHS	Canadian Community Health Survey
CI	Confidence interval
ED	Erectile dysfunction
Deff	Design effect
FMP	Final menstrual period
HIV	Human immunodeficiency virus
HPV	Human papillomavirus
HRT	Hormone replacement therapy
HSV-1	Herpes simplex virus type 1
HSV-2	Herpes simplex virus type 2
IDU	Injection drug user
MEC	Medical examination center

MSM	Men who have sex with men
NHANES	National Health and Nutrition Examination Survey
NPHS	National Population Health Survey
OR	Odds ratio
PHAC	Public Health Agency of Canada
SES	Socio-economic status
STI	Sexually transmitted infection
STD	Sexually transmitted disease
STRAW	the Stages of Reproductive Aging Workshop
U.S.	United States
WHO	World Health Organization
WSW	Women who have sex with women

1.0 Introduction

1.1 Rationale

Sexual health plays an important role in the quality of life of middle-aged and older adults. Despite a common misperception that sexual activity ceases or grows unimportant with age, middle-aged and older adults of both genders are having sex, and they have unique sexual health needs. An increasing number of older men and women have access to a healthier and more active sex life, a trend influenced by multiple factors. The emergence of medications for erectile dysfunction (ED), high divorce rates, new trends of internet dating and 'travel and tourism' casual sex, and the overall aging of the Canadian and American populations all contribute to the increase in sexual activity in older adults.

When there is sexual activity with new partners in later life, middle-aged and older adults, particularly women, are at risk of sexually transmitted infections (STIs). Older women are at risk of viral STIs such as human immunodeficiency virus (HIV), the virus that causes acquired immunodeficiency syndrome (AIDS), and type 2 herpes simplex virus (HSV-2), which are both incurable and for which prevalence is cumulative across the lifespan. Older adults seeking new partners of their own age group are quite likely to encounter a partner infected with HSV-2 as approximately one-third of adults are infected with HSV-2 by mid-life.[1, 2] Middle-aged and older adults of both genders often exhibit higher rates of STI risk behaviours and lower rates of safe sexual behaviours than their younger counterparts.[3] Adults over the age of 50 tend to be less knowledgeable about HIV/AIDS and other STIs,[4] perceive themselves to be at low risk regardless of their level of risk behaviours,[5] and are less likely to use condoms[6-9] or undergo STI

testing.[10] Declining immune function and reproductive changes that occur with age render older women physiologically more susceptible to STI transmission, and are more likely to have more severe disease experiences.[11-14] Though middle-aged and older adults have not traditionally been identified as a high-risk population, Indeed, middle-aged and older adults in STI-discordant couples or those with new sex partners carry a significant STI disease burden as a result of risky sexual behaviours.

For middle-aged and older women specifically, there is a well-documented association between increasing age and decreasing frequency of sex. Most middle-aged and older women continue to be sexually active, even in the face of increased sexual dysfunction and decreased sexual interest.[15] Even so, decreased frequency of sex does not necessarily translate to decreased STI risk. Older women are not as well educated about risk factors for STIs compared with their younger counterparts and are less likely to use condoms. Also, all women, but particularly older women, are vulnerable to lower "relationship power" – the ability to influence decisions made for both partners – which is associated with significantly decreased condom usage.[16] A possible cohort effect also exists in current middle-aged women, who were part of the "pill generation", a cohort of women for whom oral contraceptives were the birth control method of choice, and for whom condom use remains infrequent.[14]

Menopause, the permanent cessation of menstruation, is a natural phenomenon that is typically associated with decreased sexual desire and increased sexual dysfunction. As such, menopause is usually assumed to have a minimal impact on STI risk. In fact, post-menopausal women are physiologically more susceptible to STI transmission due to significant estrogen loss which leads to thinning of the vaginal walls, decreased

lubrication, and increased likelihood of abrasion during intercourse.[17] With this increased physiological vulnerability that accompanies menopause, the infrequency of condom use and risky sexual behaviours in middle-aged and older women will increase STI risk. Some women may be less likely to use condoms because there is no longer a need to prevent pregnancy.[9] Other literature exists that implies that sexual function and interest may vary based on whether menopause was achieved naturally or whether it was induced surgically, by the removal of the uterus and/or ovaries. This suggests that STI risk in post-menopausal women may also depend upon the course by which menopause was reached.[18]

Thus, menopause leaves women physiologically more vulnerable to STIs and may increase risky sexual behaviour; some middle-aged women may actually experience a post-menopausal increase in risk of STI infection. No known literature exists to investigate this hypothesis. An exploratory analysis of sexual behaviour and the prevalence of HSV-2 in pre- and post-menopausal middle-aged women would provide a modest first look into the influence of menopausal status on sexual risk.

1.2 Statement of the problem

This project aims to investigate whether 1) menopausal status and 2) type of menopause are associated with risky sexual behaviours and prevalence of HSV-2 in women aged 40 to 59.

1.3 Research objectives

The first research objective is to investigate whether menopause (post- versus pre-menopause) is associated with several sexual health outcomes.

1.1 The number of male sexual partners in the last 12 months, comparing women with no partners to those with one or more partners

1.2 The number of male sexual partners in the last 12 months, comparing women with two or more partners to those with one partner

1.3 The number of sexual partners in the last 30 days, comparing women with one or more partners to those with no partners

1.4 The number of sexual partners in the last 30 days, comparing women with two or more partners to those with one partner

1.5 The number of sexual encounters without a condom in the last 30 days, comparing women with one or more encounters to those with no such encounters

1.6 Herpes simplex virus type 2 seroprevalence

The second research objective is to investigate whether type of menopause (surgically-induced versus natural) is associated with the same sexual health outcomes.

2.1 The number of male sexual partners in the last 12 months, comparing women with no partners to those with one or more partners

2.2 The number of male sexual partners in the last 12 months, comparing women with two or more partners to those with one partner

2.3 The number of sexual partners in the last 30 days, comparing women with one or more partners to those with no partners

2.4 The number of sexual partners in the last 30 days, comparing women with two or more partners to those with one partner

2.5 The number of sexual encounters without a condom in the last 30 days, comparing women with one or more encounters to those with no such encounters

2.6 Herpes simplex virus type 2 seroprevalence

1.4 Hypotheses

For the primary research objective, it is hypothesized that post-menopausal women engage in higher rates of risky sexual behaviours than pre-menopausal women, which in turn places them at higher risk for STIs.

For the secondary research objective, it is hypothesized that natural menopause is associated with higher rates of risky sexual behaviours, which in turn places natural post-menopausal women at higher risk for STIs than surgically-induced post-menopausal women.

For this project, higher rates of risky sexual behaviours are defined as:

- A greater number of male partners in the last 12 months
- A greater number of partners in the last 30 days
- A greater number of sexual encounters without a condom in the last 30 days
- Being HSV-2 positive

2.0 Review of the Literature

2.1 Frequency of sexual activity

Middle-aged and older adults of both genders are sexually active. As many as 80% of adults over the age of 50 consider themselves to be regularly sexually active.[6, 19, 20] A large 29-country study sampling 27,500 men and women aged 40 to 80 years found that 80% of men and 65% of women reported having had sexual intercourse at least once during the past year.[21] Addis et al. considered sexual activity in 2109 women aged 40 to 69, with a mean age of 55.9 years, and found that 70.8% were sexually active; of the sexually active women, 27.4% reported less than monthly activity, 59% reported monthly activity, 76.7% reported weekly sexual activity, and 2% reported daily sexual activity.[19] A recent U.S. national survey by of 3005 adults, 1455 of whom were women, revealed that frequency of sexual activity decreases across the lifespan. Though 57% of the sample (age range 60 to 93 years) had been sexually active since age 60, older individuals were less likely to have been sexually active.[20] Other literature supports the negative association between frequency of sexual activity and age,[22, 23] though the majority of middle-aged women and men are sexually active at least once per month and usually at least once per week.[26]

Sexual activity continues in the 60's, 70's, 80's and older. Two studies on older adults, conducted by Bretschneider and McCoy, and Bergström-Walan and Nielsen, report similar findings that older adults remain sexually active. Bergström-Walan and Nielsen studied 60 to 80 year olds in Stockholm, Sweden, and found that 61% were sexually active through sexual intercourse, mutual stimulation, and masturbation[24] while Bretschneider and McCoy sampled 202 healthy 80 to 102 year olds and found the most

common activities were touching with a partner, masturbation and thirdly, penile-vaginal intercourse.[25] Men in both studies were found to be more sexually active than women at all ages. Interest and activity was found to decline with age for both genders, which is reflective of the general trend in the literature. Interestingly, Bergstrom found in older adults that those who were more frequently sexually active throughout their lifetime were more likely to remain sexually active in older age.[24] The age-related decline of sexual activity is complex and likely has multiple causal factors, but certain factors stand out as indicators of frequency of sexual activity.

An important factor influencing frequency of sexual activity with age is the availability of a sexual partner. Marital status, conceptually a good indicator of an available sexual partnership, is significantly related to increased sexual activity in middle-age and beyond.[19, 23, 26] Ojanlatva et al. found that married middle-aged women in Finland were more frequently sexually active than their single counterparts.[26] Likewise, Patel, Gillespie and Foxman found in a sample of men and women aged 18 to 94, married women were more likely to have engaged in recent sexual activity.[23] In another study on middle-aged Chileans reporting a lack of sexual activity, 18% of the time, the stated reason was due to an absence of a partner.[15]

Frequency of sexual activity in middle-age and beyond has also been associated with other social factors. Addis et al. sampled women aged 40 to 69 years and found that higher education and income, and employment were associated with increased sexual activity.[19] Moderate alcohol consumption and lower body mass index (BMI) were also associated with increased sexual activity.[19] Beutel, Stobel-Richter and Brahler found that in women, previous sexual trauma decreased sexual interest, and therefore also affected

frequency of sexual activity.[27] Blumel et al. reported that sexual inactivity does not seem to be affected by marital status, as 68% of inactive older women were married.[15]

2.2 Satisfaction in sexual relationships

Satisfaction in a sexual relationship is affected by multiple physical, psychological and social factors. Addis et al. found that being African-American, having a lower body mass index (BMI) and lower psychosocial stress is associated with increased relationship satisfaction.[19] Tracy and Junginger also found that depression and anxiety were associated with decreased relationship satisfaction.[28] Aside from the intrinsic benefits to sexual satisfaction, Tracy and Junginger also report that higher relationship satisfaction in lesbians is associated with increased arousal, greater ease in vaginal lubrication, and greater pleasure during sexual activity.[28] Overall, despite the increasing challenges of sexual dysfunction with age, most middle-aged and older adults are satisfied sexually.[21]

2.3 Sexual function

Healthy sexual function is necessary to maintain a satisfactory level of sexual activity in middle-age, and becomes increasingly dependent on physical well-being. The chronically ill or disabled are less likely to remain sexually active.[24] [20] Among those who were sexually active, about half of all men and women reported at least one sexual functioning issue that negatively influenced their sexual experience.[20] Similarly, Blumel et al. reported on their Chilean study that found in those aged 40 to 64 who reported a lack of recent sexual activity, about 50% of the time the reason was sexual dysfunction.[15]

In a national survey of 3005 United States (U.S.) adults aged 57 to 85, Lindau et al. found the most prevalent sexual dysfunctions for women were low desire, difficulty lubricating, and an inability to climax.[20] Those in poor physical health were significantly less likely to be sexually active and significantly more likely to report sexual problems.[20] Supporting these results was a large multi-national cross-sectional study of approximately 27,500 men and women aged 40 to 80 examined by Nicolosi et al. Among women, lack of interest was the most prominent sexual dysfunction (21%); inability to orgasm and difficulties lubricating were both prevalent in 16% of women. Of the women in this study, 39% were affected by at least one dysfunction, compared with 28% reported in the men.[21] Blumel et al. found that 40% of women were affected by low sexual desire.[15] Tracy and Junginger found that similar trends of sexual dysfunction exist in lesbian women, where older age was associated with less sexual desire, greater difficulty with lubrication, and overall lower scores for sexual functioning.[28] Depression and anxiety were associated with decreased arousal, decreased pleasure during intercourse, decreased satisfaction, and increased difficulty in lubricating.[28]

Other studies support the notion that women are more likely to experience decreased sexual desire than their male counterparts, and are more likely to experience a decrease in sexual desire more often than other sexual dysfunctions. In a cross-sectional survey of 2341 German men and women ranging from 18 to 93 years of age, Beutel, Stobel-Richter and Brahler found that sexual desire declines with age for both genders, with the decline of sexual desire beginning for women in their 40's and for men in their 50's, with men reporting more frequent and stronger sexual desire than women.[27] In a mail-out survey in Finland by Ojanlatva et al., many women attributed their lack of desire

to hormones.[26] Despite the finding that married women experienced lower levels of sexual desires, frequency of sex was higher in this martial group compared with single women. This finding that implies that though sexual dysfunction can pose an obstacle to healthy, satisfying sexual health, these difficulties can be overcome.

Addis et al. found associations between some social factors and sexual dysfunction. Their study found that African-Americans in a relationship were more likely than their Caucasian counterparts to be affected by at least one sexual dysfunction.[19] Having achieved a higher level of education, being in a partnered relationship, a post-menopausal status, and mental health problems were also all associated with increased sexual dysfunction.[19]

2.4 Incidence and prevalence of sexually transmitted infections

Sexually transmitted infections, particularly viral STIs such as HIV and HSV-2, affect middle-aged and older adults. The majority of studies on STIs tend to focus primarily on adolescents and younger adults, despite the fact that adults over the age of 40 are sexually active and vulnerable to STIs. Women, people with a low socio-economic status (SES), minority groups, and high risk groups such as sex workers and men who have sex with men (MSM) continue to be at a moderate to high risk of STIs with age, and should be treated by researchers and health care professionals as such.

As reportable diseases to the Centers for Disease Control and Prevention (CDC) in the U.S. and to the Public Health Agency in Canada (PHAC), the incidence of three major bacterial STIs, gonorrhea, chlamydia, and syphilis, are well documented. As bacterial infections are curable once they are detected, the incidence and prevalence of

these diseases tend to be similar. There is a general trend of increasing incidence of all three bacterial STIs in the U.S., Canada, as well as the United Kingdom.[29]

Chlamydia is the most commonly reported bacterial STI in both Canada and the U.S. There were over 1 million cases of chlamydia in 2006 in the U.S., an increase of 6% from the previous year.[2] Chlamydia occurs three times as frequently in women compared to men - a trend that has continued since the late 1980s. It is most common in adolescents and young adults aged 15 to 24 in both countries. In a PHAC report on STIs in 2007, it was also reported that in people 40 years and older, the gender trend reverses and men have higher rates of chlamydia than women.[29] In Canada, males aged 40 to 59 represented 31.7% of cases of chlamydia, and females of the same age group represented 13.2% of cases. Men and women over the age of 60 were 3.6% and 1.4% of cases, respectively. Chlamydia has been increasing over time in certain ethnic groups; African-Americans in the United States are 8 times more likely to be infected than their Caucasian counterparts.[2] The impact of chlamydia is significant, as an undetected infection increases vulnerability to HIV infection, and can lead to complications such as pelvic inflammatory disease in women. Chlamydia rates remain a concern for adults of all ages, including older adults.

Incidence rates of gonorrhea are increasing in both the U.S. and Canada, though only marginally in the United States. There were over 350,000 cases of gonorrhea in the U.S. in 2006, up by about 5%.[2] Young men aged 20 to 29 are most significantly affected by gonorrhea, and the gender gap continues to widen, with an incidence ratio for men vs. women of 1.3:1 in Canada in 1997, and 1.7:1 in 2004.[2, 29] The greatest increase in gonorrhea infection from 1997 to 2004 in Canada was in older men, with the incidence

rate for men aged 40 to 59 increasing from 1.1% up to 2.8%. Less than 15% of gonorrhea episodes occur in women over age 30.[29] African-American women are 14 times more likely than their Caucasian counterparts to be infected with gonorrhea.[2] In general, gonorrhea affects women less significantly than men, particularly in older cohorts.

Syphilis rates have been dropping in the United States and Canada throughout the 1990's and into the early 2000's, but have begun to increase slightly in the past few years. There were 9,800 cases of syphilis in the U.S. in 2006, an increase of 13.8% from the previous year.[2] Syphilis occurs less frequently in women than in men, who represented 88% of syphilis cases in Canada in 2004, and incidence continues to increase in men. The gender ratio has widened as a result, where syphilis incidence in males vs. females was 8:1 in 2004 compared with 4:1 in 2002 and only 1.3:1 in 1997.[29] Female cases in both countries remain relatively evenly distributed across age groups, though the youngest age groups still account for the most cases. The number of syphilis cases is increasing in African-Americans of both genders, and outbreaks continue among men who have sex with men (MSM).[2, 29] While syphilis is the least prevalent of the three bacterial STIs, the impact of this disease is significant as the early stages tend to be asymptomatic, but without treatment, syphilis increases the risk of contracting HIV and is ultimately fatal.

Viral STIs are of greater concern than bacterial STIs in older cohorts. By nature, viral infections are incurable and prevalence accumulates across the lifespan, hence older adults are more likely to encounter potential partners with a viral infection than are younger adults. The viral STIs of greatest importance are human papillomavirus (HPV), HSV-2, the most frequent cause of genital herpes, and HIV. Both HPV and HSV-2 are

highly prevalent and since only those seeking testing or medical treatment are detected, reported rates underestimate the true prevalence of infection. HPV is certainly one of the most prevalent STIs in both Canada and the United States. High-risk HPV is defined as strains of the virus that lead to anogenital cancers (i.e., cervical cancer), while low-risk HPV strains cause genital warts. The estimated Canadian prevalence of cervical infection with high-risk HPV subtypes ranges from 10.8 to 25.8%,[29] while the overall estimated prevalence of high-risk HPV subtypes in American women is 22.5%.[2] These figures were not age-adjusted.

Young women are most affected by HPV and there is a prevalence of infection with high-risk HPV subtypes of 29% in Canadian women aged 20 to 24. The prevalence lowers as age increases, to approximately 12% in women aged 40 to 49 and 6% in women 50 to 65.[29] A secondary analysis of U.S. National Health and Nutrition Examinations Survey (NHANES) data revealed a combined prevalence of high- and low-risk HPV subtypes in 44.8% of women aged 20 to 24, with prevalence rates gradually dropping with increased age, to 25.2% in women aged 40 to 49 and 19.6% in women aged 50 to 59.[2] Rates of HPV infection appear similar in both the U.S. and Canada, when accounting for the difference in reporting of high- versus low-risk types of HPV. In 2006, vaccinations became available in both the U.S. and Canada which protect against the four highest-risk forms to HPV, types 6 and 11, which cause genital warts, and 16 and 18 which are highly associated with cervical cancer.[29] Health promotion campaigns have targeted young women in an attempt to curb the significant cervical cancer risk of HPV.

Genital herpes, caused by infection with herpes simplex virus type 2 or type 1, HSV-2 or HSV-1, is prevalent in Canada and the U.S..[2, 29] It is important to differentiate

the two types of herpes virus, as the more prevalent HSV-1 causes primarily oral herpes (cold sores) while HSV-2 is responsible for the majority of genital herpetic sores. Interestingly, at least one study has shown that infection with one type of herpes virus decreases the likelihood of infection of the other type; hence the risk for those who are already infected with HSV-1 of contracting HSV-2 is significantly reduced.[1] Fleming reported in 1997 a seroprevalence of HSV-2 of 12.9% in the U.S. population over the age of 12.[30] Other literature estimates the overall prevalence of HSV-1 at approximately 80% and 30% for HSV-2.[1, 2, 29] A recent study in Switzerland found a prevalence of HSV-2 of 19.3% in adults aged 35 to 64.[1] Another study examined records of female clients over the age of 15 in a health management organization in Michigan and found that HSV-2 was the most common STI in older women, occurring in 25% of women over the age of 55.[31] Another study of surveillance data in Washington State also found that HSV-2 was the most common sexually transmitted disease (STD) in older women.[32]

HIV is by far the most frequently studied STI, as well as an STI with some of the most serious medical outcomes. The CDC recently reported that 15% of new HIV diagnoses in 2005 occurred in adults over the age of 50.[33] PHAC reported in 2007 that the incidence of HIV/AIDS in the same older cohort of Canadians was at an all-time high of 13.8%.[29] Older adults represented 24% of people currently living with HIV/AIDS, and disproportionately accounted for 35% of deaths in people living with AIDS.[33] Other literature shows similar findings.[34, 35] Levy-Dweck reported that an estimated 19% of people living with HIV/AIDS in the United States were over the age of 50, and that middle-aged adults comprised 10% of HIV incident cases annually,[13] estimates consistent with those reported in other studies.[14, 36] In the U.S., AIDS diagnoses in women increased

by about 7% from 1998 to 2002.[13] Approximately twelve percent of AIDS cases are now diagnosed in women aged 50 and older, with 21% in women over the age of 65.[35]

HIV rates vary significantly by ethnicity. Prevalence rates are twelve times higher among African-Americans than Caucasians (51.7/100,000) and five times higher among Hispanics (21.4/100,000) than among Caucasians (4.2/100,000).[33] AIDS diagnoses are disproportionately increasing among African-Americans, and to a lesser extent, among Asians, and American Indians. Indeed, in 2001 African Americans accounted for 11% of women over age 50, but 50% of all AIDS cases in this group.[37] McQuillan et al. examined HIV antibody test data from NHANES from 1988 to 2002 and found the highest prevalence of HIV was in African-Americans adults aged 40 to 49 (3.58%).[38] African-Americans and Hispanics, especially in older age groups, face a much greater risk for infection with HIV than their Caucasian counterparts. [39]

2.5 Age-related impact of sexually transmitted infections

Physiological vulnerability to all infections, including sexually transmitted infections, increases with age. Older adults have reduced immune function; in particular, CD4+ T cells present age-associated decline in function that result in more rapid disease progression of HIV and poorer medical outcomes.[13, 33, 40] Older adults also tend to report physical symptoms of STIs sooner.[13, 32, 33] Also, over 80% of adults over the age of 65 have at least one chronic illness,[13] some of which share common symptoms with AIDS, including Alzheimer's, Parkinson's and respiratory disease. Occasionally some older adults with AIDS are misdiagnosed by health care professionals with such chronic illnesses that share common symptoms and are more common in older patients.[35,41] Indeed, there is evidence that STIs may go undetected or misdiagnosed in older adults.

One study by el-Sadr and Gettler which posthumously tested the blood serums of 257 patients over the age of 60 who had died in a New York City hospital for other reasons, found that 5% were actually HIV positive but had never been tested and were never diagnosed. [42]

Sometimes AIDS-related symptoms are mistaken for indicators of 'normal' aging, including fatigue, weight loss, and mental confusion.[35] The risk of acquiring new STIs is particularly significant for older women, as age-related vaginal atrophy can lead to increased risk of HIV, HSV-2 and other infections.[33] Older adults also tend to have less social support than younger adults, and hence have greater difficulty coping with disease.[33] Stigma against STIs may also be more severe in older adults.[13] Earlier diagnosis of STIs, and particularly of HIV/AIDS, in older adults is important as disease progression is quicker and more severe with age.

2.6 Risk factors for sexually transmitted infections

Middle-aged and older adults are at risk for HIV and other STIs. Gott reported that approximately 7% of a community-based sample of adults aged 50 or older were engaging in sexual behaviours that placed them at an increased risk for STIs.[6] Men are more likely to take sexual risks than women, such as having multiple partners (3.8% of women compared with 11.1% of men had more than one partner in the last five years), though women are more likely to be exposed due to risky male partners.[6]

The risk profile of the older cohort is different from young adults and adolescents,[14] though they share some common risk factors. In older adults, heterosexual transmission represents approximately 11.0% of cases of HIV in adults over the age of fifty.[35] Specific to older women, heterosexual activity is rapidly becoming the most

common mode of transmission of HIV and other STIs,[14] with rates doubling in just five years from 1991 to 1996 in the United States.[33, 43] About two-thirds of women over the age of fifty who developed AIDS were infected with HIV via heterosexual activity.[13] From a global perspective, heterosexual activity is certainly a significant risk for women, where the primary mode of transmission in developing countries is marital sex, as both single and married men frequently have multiple partners.[14] For women, heterosexual activity is markedly risky with MSM.[34]

Many older adults have multiple sexual partnerships, which can place them at risk for HIV and other STIs. Approximately one-third of older adults have had more than one partner in the past 3 months.[44] Multiple partnerships are more likely in unmarried individuals, and in those of a higher SES. Being in a relationship does not necessarily translate to monogamy; Maes and Louis reported that 10% of adults over the age of 50 are having sexual activity outside of a long-term relationship.[45] A review of the literature on extra-marital sex suggests that anywhere from 20 to 66% of men and 10 to 69% of women have ever had extra-marital sex at some point in their relationship.[46] Similarly, data from the British National Survey of Sexual Attitudes and Lifestyles reveals 1.9% of married women and 4.5% of men had extra-marital sex in the past year, rising to 16.6% in men and 9.3% in women over 5 years.[5] These results have serious implications for the STI risk of older adults who are more likely to be married or in committed relationships.

Levy-Dweck estimates that about one-third of older women are infected from sharing needles during injection drug use (IDU).[13] Other research supports this; the CDC reports that 16% of AIDS cases attributed to IDU are in older adults.[33] Goodroad reports that IDU is slowly increasing as a frequent mode of transmission overall, with a similar

trend in both young and older adults.[35] Older drug users do tend to have safer drug injection practices than their younger counterparts.[12]

Blood transfusions in general are declining as a prominent mode of transmission, though they remain a significant risk for older cohorts with about 2.5% of HIV cases attributable to blood transfusions.[35] Seventy percent of all blood transfusions go to adults over the age of 50. Blood transfusions become more important with age;[34] of all adults living with HIV, sixty-four percent of those over the age of 70 had acquired HIV from transfusions.[13, 35]

While a significant portion of literature on sexual risk behaviours focuses primarily on HIV, some literature exists which describes risk factors for other STIs in older adults. Risk factors for HSV-2 include living in an urban area, being unmarried, being female and having more years of education.[1] A greater number of sexual partners over the lifetime also increases the risk of herpes infection more for women than for men, with a 2.7% increase in women versus 0.6% increased risk in men.[47] Though syphilis is quite rare in older adults, especially in women, factors that can increase the risk for women are being African-American and having multiple sexual partners.[48] Infection with some STIs, such as HSV-2 and chlamydia, increases vulnerability to HIV,[38] hence risk factors for other STIs also indirectly influence the risk for HIV infection.

Sexual risk factors in older women vary in different ethnic groups. A study on American Indian women revealed that 91% had engaged in at least one sexual risk behaviour for HIV over the course of their lifetime, including 19% who had sex with an IDU and 7% who had traded sex for drugs or money.[49] Winningham et al. reported in 2004 that in a sample of 181 African-American women over the age of 40, two-thirds had

reported at least one sexual risk behaviour.[37] African-American women are more likely to be at risk of HIV infection due to crack cocaine use and prior infection with HSV-2.[38] Absalon et al. found that in HIV positive African-Americans and Latinos of both genders in New York, 35% had had multiple partners; nearly 40% had sex with a partner of an unknown HIV status, and half used condoms inconsistently.[50] The women in the study tended to have fewer partners, though they were less likely to use condoms, even with partners of unknown HIV status. Montoya and Whitsett reported that African-Americans and Hispanics are significantly less likely to use condoms compared to Caucasian women.[39] Another study suggests that the disproportionate risk in older African-American women compared to older Caucasian women can be traced to culture, as well as knowledge and perceived risk.[51] Stampley, Mallory and Gabrielson asserted that African-American culture encourages women to look beyond their own personal concerns and needs, which in relationships can translate to less power to assert sexual needs, including safe sex practices.[51] Clearly, risk behaviours differ significantly in African-Americans, Hispanics and other ethnic groups in comparison to Caucasian women.

Sexual risk varies in women of different sexual orientations. Male partners, particularly MSM, are a significant risk for women of all sexual orientations. Most (82%) of women who have sex with women (WSW) have sexual histories that include sex with men.[16] One study revealed that in lesbian and bisexual women attending a sexual health clinic in London, UK, most patients presenting with STIs had sexual histories with men.[16] However, three patients with no history of heterosexual activity presented with an STI – trichomoniasis, HSV-2 and genital warts – implying that WSW transmission of STIs is

not impossible.[16] Koh et al. found that heterosexual women are at the highest risk for STIs, due primarily to a lack of condom use with male partners.[52] Other literature supports this finding.[53] Protective measures are used inconsistently among lesbians, including the use of dental dams, using condoms when sharing sex toys, and proper cleaning of hands and sex toys.[54] The most common form of STI spread in WSW transmission is bacterial vaginosis.[53, 54] It is important to note that bisexual women do not necessarily represent a middle-level of STI risk between the higher-risk heterosexual and lower-risk lesbians; instead, bisexuals tend to present an entirely unique sexual risk profile, as they are more likely to use condoms, but have more MSM partners and more male partners overall, putting them at higher risk when protective measures are not taken.[52] Overall, STI risk generally varies by sexual orientation as a result of differing levels of unprotected sex with male partners, with heterosexual women at the greatest risk for STI infection.

Protective barriers such as condoms provide a very simple and effective method of significantly reducing the risk of STI transmission during sex with a person of known positive or unknown STI status. In older adults, condom use tends to be inconsistent and infrequent. Stall and Catania reported that, overall, Americans over the age of 50 are one-sixth as likely to use condoms during sex compared with people in their twenties.[55,56] Other literature supports this finding.[23, 44, 56, 57] Watson and Bell found that older adults tend to have inconsistent condom use, as they were less likely than young adults to use condoms in both casual and long-term relationships.[9] Similar results were found by Nelson, where 44% of Hispanic women used condoms inconsistently.[7] The most common reason for non-use was a misperception that they were not at risk of STI

infection. Paranjape et al. found that only 13% of women over the age of 50 used condoms frequently.[8] Lindau et al. found that over half (60%) of single older women had not used condoms in the past ten years.[22] Some women from this study agreed that condom use was not necessary for those who can no longer get pregnant.[22] Indeed, older adults seeking new partners can be at significant risk of STI infection with inadequate protection. Lovejoy et al. reported that older adults who know they have an STI often do not take adequate measures to protect their sexual partners. In a cross-sectional survey of 290 HIV-infected adults over the age of 50, Lovejoy et al. found that 38% were sexually active in the past month, with one-third having had at least one occasion of anal or vaginal intercourse without using a condom.[58] Twenty-seven percent of heterosexual men in this study reported using condoms inconsistently, despite their positive HIV status.[58] Inadequate condom use may be one of the most significant risk factors for STI transmission in middle-aged and older women.

There is evidence that many women also face a unique challenge in making safe sexual choices due to an imbalance in 'relationship power,' where women tend to have a lesser ability to influence decisions made for both partners.[5,59] Despite education, income, age or experience, many women find it difficult to assert themselves on decisions in the sexual relationship, including safer sex practices, and often submit to internalized social pressures. Also, many women and their partners interpret safe sex only as a means to prevent pregnancy, making it difficult for these women to insist on condom use when pregnancy is not an issue due to menopause or oral contraceptives.[5, 9] Overall, the inconsistency with which condoms are used by middle-aged women and their partners translates to a significant risk for STI transmission.

2.7 Knowledge of STIs and perception of sexual risk

To effectively protect oneself from STIs, some knowledge of sexually transmitted infections and safe sex practices is crucial. Unfortunately, older adults tend to be less knowledgeable about sexual risks, perceive themselves to be at low risk for STIs regardless of their true risk, and tend not to take appropriate measures to protect themselves. The literature on knowledge of STIs provides some coverage on middle-aged and older populations. Much of the literature considers only HIV-related knowledge, however, and it is unclear whether these studies can be extrapolated to other STIs.

Several studies have been conducted on the HIV knowledge and beliefs of older adults. Neundorfer et al. attributed a lack of information on the prevention of HIV transmission as the primary reason for infection in older HIV positive women.[60] Mack and Bland found that fewer older adults (28%) believed condoms were very effective at preventing the transmission of HIV, compared to younger adults (36%). Some older adults (14.7%) and younger adults (6.3%) said they didn't know how effective condoms were in preventing HIV.[61] The proportion who believed they were at moderate to high risk of HIV infection declined with age; 7.8% of those aged 18 to 49 believed they were at risk versus only 4% in those over 50. Maes and Louis also considered HIV/AIDS knowledge in a sample of adults over age 50 (mean age 71).[45]Most did not believe they were at risk for HIV, despite the fact that 10% indicated extra-marital sexual activity. Zablotsky reported that increased age was associated with having incorrect information on sexual risks, including inadequate knowledge on the effectiveness of condoms and the belief that people with AIDS cannot look healthy.[62] Greater knowledge of AIDS was

associated with reporting safer sex practices.[45] Other studies also show that stronger HIV-related knowledge tends to translate into safer sexual behaviours.[63]

Henderson et al. found that the source of HIV is important. In a study that conducted interviews with primarily African-American women, aged 50 or older in an area with high HIV incidence, results revealed that TV, family and friends were the most common sources of HIV knowledge, and that HIV knowledge was markedly improved when information came from health care professionals, newspapers, or family.[64] Those from a higher socio-economic background had better knowledge of HIV. Overall, these older African-American women were less likely to know about the effectiveness of condoms in preventing HIV, and that kissing is not a viable method of transmission.[64] These results agree with those of McCaig, Hardy and Winn, who reviewed data from the National Health Interview Survey of AIDS knowledge and attitudes and found that people over the age of 50, African-American, Hispanics, residents in areas with high HIV incidence, and people with lower education all had lower knowledge scores and higher misperception scores.[4]

Similarly, Zablotsky and Kennedy reported that older women have lower levels of knowledge about HIV/AIDS and the effectiveness of condoms than their younger counterparts.[3] Knowledge on contracting HIV via sharing needles and unprotected intercourse was excellent in both those aged 50 to 64 and over 65, but many women thought kissing (31% in 50 to 64 and 45% in 65+), drinking glasses (16% for both) and toilet seats (10% for both) were viable transmission methods.[3] In general, the literature implies that older adults, non-Caucasians, and those with a lower education or SES, do not understand HIV – and presumably other STIs – well enough to adopt acceptable

levels of safe sex practices. Conversely, those with better knowledge are more likely to practice safer sex.

2.8 Communication with health care professionals and STI testing

Literature suggests that the sexual health needs of older adults are often under-estimated and under-served by health care professionals. Savasta cited insufficient communication between patients and health care providers as a significant contributor to the increased prevalence of HIV transmission in older adults.[43] Health care professionals are not likely to discuss sexual health with their older patients, nor perceive them to be at risk for STIs, and older patients are less likely to be tested for STIs. According to Grigg, the communication barriers are two-fold: not only are health care professionals unlikely to discuss sexual health issues with older patients, but older adults are also reluctant to discuss sexual issues with health care professionals, more so than their younger counterparts.[40] These findings are supported by several other authors. Murphree and DeHaven found that while less than half of younger low-income primarily African-American women in their study received counselling on condom use from a health care professional, none of the women over 45 years of age received any counselling on safe sex.[57] Gott found in a cross-sectional study on a community-based sample of 319 people aged 50 and older that forty percent of those who expressed sexual health concerns did not seek help from health care professionals.[6] Akers et al. also reported in a cross-sectional study that in women aged 50 and older, only 22% were interested in discussing HIV risk with their physician.[65]

Among African-Americans, interest was significantly lower with age in participants who perceived themselves to be at low risk for HIV, and if their knowledge

of HIV was poor.[65] Lindau et al. found in a sample of older women aged 58 to 93, married women were 80% more likely to discuss sexual health with their physicians than non-partnered women. African-Americans were also 47% more likely to discuss sexual health with their physicians than Caucasians.[22] Many women believed that it was the responsibility of the physicians to address sexual health issues.[22] Stall and Catania reported that when appropriately educated, middle-aged adults can and will work to reduce their sexual risk, and are willing to speak to their physicians about these sexual risks if the physician broaches the topic.[55] Clearly, there is a need for both older adults and health care professionals to communicate more openly about sexual health, in order to properly address the sexual health needs of older adults.

Older adults are not being tested for HIV and other STIs appropriately. Johnson et al. reported that more than half of those in older cohorts who are at an increased risk for HIV are not being tested.[66] Mack and Bland found in national U.S. surveillance data that approximately 26.6% of those aged 50 to 65 were tested for HIV, versus 46.8% of those 18 to 49.[61] The proportion of older adults whose tests were conducted because the patient wished to know their HIV status was less than half of the younger adults.[61] Most tests in older adults were conducted as part of a regular medical exam. Similarly, Aker found that older women who are less knowledgeable about HIV were less likely to be tested for HIV.[65] Wilson examined data from the National Survey on Family Growth and found that only half of the women aged 15 to 44 had been tested for HIV.[67] Formerly married women were the most likely to be tested, as were younger women aged 20 to 39. Other social factors associated with HIV testing were higher education and being from an urban centre. Only 16% reported an HIV test as the sole reason for a visit, with 55% reporting a

blood donation as the reason for the test.[67] African-American women were more likely to be tested for HIV by their physician as part of a regular medical exam than Caucasian women. Sormanti and Shibusawa found that HIV testing is generally associated with being younger and unemployed.[68]

2.9 Emerging trends in the sexual risk of older adults

There are two new topics in the literature that suggest emerging trends in the sexual risk of middle-aged and older adults. Older adults are increasingly likely to use the internet to look for sexual or relationship partners, with older men in particular growing as a new group of internet users. [69, 70] Older adults are making use of the internet, with 87% of Canadian older adults using email and 8% visiting chat rooms,[71], and many also using sites and chat rooms specifically geared towards dating for an older cohort.[70] Love and romance are rated as very important concerns among older adults using the internet.[70] Referring to the power of the internet for sexual expression, Adams, Oye and Parker coined the term 'Triple A' - access, affordability, and anonymity.[72] The internet provides many individuals with greater freedom for sexual expression and exploration than other venues. With greater freedom and lower inhibitions, people who seek out sex partners on the internet, including older adults, may be more likely to engage in risky sexual behaviours, such as unprotected sex with a new partner found on the internet, of unknown STI status; therefore, these older adults should be considered as potentially at an increased risk for contracting sexually transmitted diseases.[70, 72]

The second emerging trend in the sexual risk of older adults is the tendency for risky casual sex while traveling, which is sometimes referred to as 'travel and tourism sex.' Auerbach mentions travel and tourism sex as risk factor for HIV in older adults,[69]

and presumably other STIs as well. Auerbach asserts that a large portion of older adults, particularly women, find themselves for the first time in years without a regular sex partner due to divorce or widowhood, and become interested in meeting new partners. Given the propensity of older adults to leisure traveling, the likelihood exists that older adults seek out sexual partners while traveling.[69] In 2006 the Committee to Advise on Tropical Medicine and Travel (CATMAT) reported general statistics on casual sex encounters while traveling, that approximately one billion people cross international borders annually, with estimates of the prevalence of casual sex encounters ranging widely from 5% to 50%.[73] The CATMAT report acknowledges that international travel is common in some older adults, who have the financial means and the inclination to travel, but little is known on the prevalence of casual sex encounters in this group.[73]

Wright discusses travel and tourism sex in older adults in greater detail, noting the existence of a sub-culture of 'sex tourism,' where people will travel for the specific purpose of engaging in new or exciting sexual activity they would otherwise feel inhibited from doing, including prostitution, bath houses, swinger clubs, or even just casual sex.[74] Sex tourism research typically focuses on younger tourists and gay men, though Wright asserts that older adults are more likely to pursue solitary leisure activities, and solitary travelers are more likely to engage in sexual encounters than those who travel in groups.[74] A combination of factors including an older adults' lack of knowledge about sexual risks, their economic means, and their likelihood to travel in conditions conducive to casual sex encounters, puts those older adults who are engaging in travel and tourism sex at greater risk for STIs than their younger counterparts.

2.10 The menopausal transition

The menopausal transition has important implications for the sexuality of middle-aged and older women. Given the current trend of an increasing number of older adults dating, seeking new partners and leading healthy and active sexual lives, the potential impact of menopause on the sexual behaviour of older women warrants investigation.

The World Health Organization (WHO) broadly defines menopause as 'the permanent cessation of menstruation resulting from loss of ovarian follicular activity.'[75] Although often considered to be a dichotomous state, in the sense that women can be either pre- or post-menopause, menopause in actuality is a transitional process in which a woman gradually moves towards a state of complete amenorrhea. Indeed, menopause is considered by most cultures and populations to be a significant stage in the lifespan of a woman, and beyond the physical changes, also has considerable psychological and social repercussions.

Beyond broad definitions such as the one offered by WHO, the menopausal transition is actually rather difficult to characterize as it is poorly indicated by age,[76] and there is no consensus in the research on when the transition to menopause actually begins and ends. The Stages of Reproductive Aging Workshop (STRAW) staging system, used by the American Society for Reproductive Medicine, is a widely known and accepted staging model of the female reproductive lifespan.[77] The STRAW model identifies three broad phases of reproductive life – reproductive, menopausal transition, and post-menopause. The menopausal transition begins at approximately age 45, though this transition varies widely and may begin as early as 40 or as late as sixty. Early menopausal transition is usually characterized by increasing irregularity in menstrual

cycles. Menstrual periods will start to be missed altogether, until the final menstrual period (FMP) is reached. The FMP signifies the end of the menopausal transition, and post-menopause begins. Since the menopausal transition varies in length and occurs in women at widely varying ages, there are no precursors to indicate when the FMP will occur. Women over the age of 45 who have a year of amenorrhea have a 90% chance of not having another spontaneous menstrual period.[76] As such, the FMP and post-menopausal status are thus generally diagnosed retrospectively, after twelve months of amenorrhea.[76, 78] These twelve months are, in the STRAW model, considered to be the first stage of post-menopause. The first five years after the FMP are typified by the physical symptoms that persist from the menopausal transition. The final stage commences five years following FMP and continues until the end of life.[77]

The physical changes that characterize peri-menopause occur primarily as a result of dramatic hormonal changes. Falling estrogen levels and other hormonal changes also yield other less noticeable physical changes. The vaginal mucosal epithelium becomes thinner; the vaginal wall smooth muscle begins to atrophy; and the vaginal pH becomes more acidic.[77, 78] These changes can occur quite rapidly, sometimes within six to eight weeks.

Noticeable physical symptoms also frequently manifest during menopause. The most common symptoms associated with peri-menopause include vasomotor episodes (i.e. "hot flashes"), vaginal dryness due to inadequate lubrication, and breast tenderness.[17, 76, 78] The most common treatment for both the physical changes and the accompanying symptoms is hormone replacement therapy (HRT), the purpose of which

is to restore estrogen levels closer to pre-menopausal levels, lessening the impact of the loss of estrogen.

Literature on the state of women's psychological health throughout the menopausal transition varies somewhat. Mental health issues can occur in this stage of life. Huerta et al. reported that depression, anxiety, and empty nest syndrome are negatively associated with sexual interest,[79] and that depression is more likely in women who have been post-menopausal for at least one year.[80] This finding is supported elsewhere.[81]

Overall, most women have a neutral to positive attitude towards menopause both before and after menopause.[76, 82] Ethnic differences exist in attitudes towards menopause,[82, 83] with African-Americans appearing to have the most positive attitude, with Caucasian and Hispanic women falling in the middle, and women of Chinese and Japanese descent having the least positive outlook. There is some propensity in the medical community to label menopause as a disease of deficiency, for example the American Association of Clinical Endocrinologists is quoted as stating that "menopause is a state of hormone deficiency that should be treated".[75] Despite this more negative outlook from the medical community, women usually view menopause as a natural life transition.[17] Women who do view menopause as a hormone deficiency or a marker of aging are more likely to request HRT, and female doctors with this perception are more likely to prescribe HRT.[17]

While menopause will naturally and eventually occur in all women, permanent cessation of menses is sometimes caused prematurely as a result of some medical treatments. The most common reasons for premature menopause are either surgical via

removal of the uterus (hysterectomy) or ovaries (oophorectomy), or in breast cancer patients, some chemotherapies will also cause permanent cessation of menses. Premature menopause is not uncommon; there are approximately 654,000 hysterectomies every year in the U.S., 50% of which also include oophorectomies.[18] One in eight women will develop breast cancer and may be treated with chemotherapy that inactivates the ovaries.[18] Women with premature menopause are more likely to have negative attitudes towards the menopause experience,[83] though these women do frequently report relief with the end of menstruation and its inconveniences.

2.11 Premature menopause

Many women who experience premature menopause must also cope with unique psychological issues, including feelings of grief over lost youth, lost womanhood, and sometimes the lost opportunity for child-bearing.[18, 83] One study has shown that women with depression or sexual problems preoperatively are at increased risk for experiencing a worsening of mood and libido postoperatively.[84] The prematurity of menopause seems to have a less significant negative psychological impact on women with chemotherapy-induced menopause compared with those whose menopause was surgically-induced; this may be due to the more prominent concern of surviving the cancer experience. Women with a hysterectomy and/or oophorectomies are more likely to experience more significant menopause-related symptoms, and thus are more likely to undergo HRT.[17] In general, women with premature menopause have a very different menopausal experience from women whose menopause occurred naturally, due to the circumstances which caused the cessation of menses, the more significant physical symptoms, and the challenge of psychological adjustment to abrupt changes in life and self.

2.12 Menopause and sexuality

Most literature on the effects of the menopausal transition on sexuality indicates that there is a negative impact on sexual function.[76,85] Hawton, Gath and Day found that the only difference in sexual functioning between pre- and post-menopausal women was that post-menopausal women were less likely to be interested in or enjoy sex.[86] Gracia et al. reported that post-menopausal women are 2.3 times more likely to experience sexual dysfunction.[87] Declines in sexual function such as decreased sexual responsiveness, decreased libido, increased vaginal dyspareunia (dryness) and decreased sexual frequency have been associated with menopause.[76] Nasbaum reported that sexual difficulties that arise during menopause tend to occur via two main mechanisms: either the physical changes associated with menopause affect a woman's body image, sexual function and a woman's relationship with partners, or neuroendocrine and psychological changes occur that negatively affect ego and self-perception.[17]

Significant decreases in sexual activity tend to coincide with menopause.[15 88] Conversely, women who remain sexually active throughout the menopausal transition tend to experience less dramatic vaginal atrophy.[76, 17] It would thus seem that past frequency of sexual activity may influence post-menopausal women's sexual functioning, where higher rates of past sexual activity may have a protective effect on future sexual function.

Mahar and Sherrard report that post-menopausal women are physiologically more susceptible to STI infection than are pre-menopausal women.[89] Some menopausal women may misinterpret symptoms of an STI as side-effects associated with menopause.[89] Regarding safe sex practices, Sormanti and Shibusawa studied 1280 peri-menopausal

women and found that only 12% reported always using condoms during vaginal sex, and that only 45% had been tested for HIV. Those using condoms were more likely to have higher education, be employed, live with a partner, and have a positive HIV status.[68]

2.13 Summary of findings in the literature

Sexual health remains important to both men and women as they age. Though sexual activity does decline with age, middle-aged and older adults remain sexually active, with men overall reporting higher rates of activity and sexual interest than women. Factors such as marital status, ethnicity, and SES are associated with different patterns in sexual activity in women. Women who are married, with a higher SES, and are non-Caucasian are more likely to have a higher sexual function. Sexually transmitted infections, particularly viral STIs like HSV-2 and HIV which are cumulative with age, are a relevant health concern for sexually active older adults. Overall, middle-aged and older women have a lower risk of acquiring a new STI than their younger counterparts, though they tend to be less knowledgeable about STIs and about condoms which puts them at an increased risk for STI infection. Lower SES, urban, African-American and Hispanic older women tend to be at the greatest risk for acquiring an STI.

Menopause is a unique life transition which has a profound effect on the sexuality of women. Biological changes have a negative effect on sexual function but also a psychological 'freeing' effect from risk of pregnancy, particularly for the baby boomers, for whom condoms were not the birth control method of choice. Having a greater number of male partners and not using condoms are risk factors that put women at an overall at greater risk for STIs, and with the physiological vulnerabilities to STIs that accompany menopause, the potential of an increased STI risk exists for post-menopausal women.

3.0 Methods

To achieve the project objectives, data on sexual behaviour and reproductive health in women aged 40 to 59 will be examined. A Canadian database was sought initially, but datasets including the Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS) did not have sexual behaviour data in adults over the age of 49. In this absence of a known Canadian database which meets the needs of this project, this cross-sectional analysis will draw upon data from the U.S. National Health and Nutrition Examination Survey (NHANES), which provides sexual behaviour data up to age 59.

3.1 Overview of the Data Source

NHANES, an American population survey that collected information on a comprehensive range of health topics, began in the early 1960's on a periodic basis as a large, multi-year survey. Since 1999, NHANES has become a continuous annual survey and a major program of the National Center for Health Statistics in the United States. In its current continuous form, the survey collects cross-sectional data annually from a nationally representative sample of approximately 6,000 people, using both personal interviews and physical examinations. Part of the advantage of converting NHANES into an on-going survey was to allow the combination of two-year cycle data sets to attain sufficiently large sample sizes in research on specific subgroups. This project uses data from the NHANES 2001-2002 and 2003-2004 cohorts, the two most recently available cycles at the time of analysis, to obtain a sample of women aged 40 to 59 on whom reproductive and sexual behaviour survey data are available.

3.2 NHANES Sampling Design

NHANES has implemented a complex probability sampling design that has remained mostly unchanged over the history of the survey. A sample of approximately 6,000 individuals who are nationally representative of the U.S. household population are selected annually, from fifteen counties in the country (Since 2001, 'nationally representative' has referred to the 2000 U.S. Census population distribution). To ensure adequate enrolment of adolescents aged 15 to 19, adults over the age of 60, African-Americans, and Mexican-Americans, these specific populations were purposefully over-sampled. Figure 1 shows an outline of the sampling strategy employed in NHANES from 2001 to 2004.

Figure 1. NHANES sampling strategy.

Target population – All Americans

↓

Study population – All civilian, non-institutionalized English or Spanish-speaking Americans in 2001 to 2004, excluding the homeless

↓

Sampling Frame – All counties in the United States in 2001 to 2004

↓

Sample – Nationally demographically representative Americans in 2001 to 2004 - over-sampled adolescents 15-19, adults 60+, African-Americans and Mexican-Americans

↓

Primary Sampling Units – Single counties or combinations of small counties

↓

Secondary Sampling Units – Non-randomly selected clusters of households

↓

Sampling Element – Individuals – at least one per selected household

3.3 NHANES Response Rate

The response rate for NHANES has been consistently high since the inception of the survey. For 2001-2004, the response rates were approximately 80% for the interview

and approximately 77% for the physical examinations. Table 1 summarizes the response rates for the NHANES cycles used in this project.

Table 1. Response rates for NHANES cycles 2001 to 2004.

NHANES Cycle	Total N selected for sample	Completed Interview		Had Physical Examinations	
		N	% of total	N	% of total
2001-2002	13 156	11 039	83.9	10 477	79.6
2003-2004	12 761	10 122	79.3	9 643	75.6

3.4 NHANES Data Collection

NHANES collects data from individuals using a detailed interview covering socio-economic, demographic, dietary, and health-related information, as well as a physical examination encompassing medical and dental exams, physiologic measurements, and laboratory tests. The personal interviews are computer assisted (computer assisted personal interview – CAPI) and conducted by trained staff in the participants' homes in either English or Spanish. Qualified health professionals conducted the physical exams in the NHANES mobile examination centers (MECs). Although some very minor differences in data collection methods exist between 2-year cycles, every effort was made to minimize method discrepancies to allow the cycles to remain as comparable as possible.

Of specific interest to this research project are the data collection methods employed to gather the demographic, sexual behaviour, and reproductive health survey information, as well as the physical examinations. In the 2001-2002 and 2003-2004 cycles, all NHANES participants completed a household interview where demographic information was gathered. Individuals 16 years of age or older and emancipated minors were interviewed directly while a proxy (e.g. a parent) provided information for

participants less than 16 years of age and for others who were not able to self-report. The sexual behaviour data, considered sensitive information, were collected confidentially from a sub-group of individuals aged 14 to 59 using an audio computer assisted self-interview (ACASI) technology in a private MEC room. The ACASI technology allows the participant to both hear the question through earphones and read the question on the computer screen in either English or Spanish. To ensure further privacy, no translators or proxies were used for the sexual behaviour questions; the participants were required to self-report in order to complete this section of the survey. The reproductive health section collected information from a sub-group of women only, aged 12 years and older, in a MEC private personal interview using CAPI technology. The HSV-2 blood test was collected from participants aged 14 to 49 within the sub-sample of participants who were selected to undergo the MEC physical examination. Blood specimens were collected through venipuncture by a trained medical staff in a private MEC room, and were processed, stored and then shipped to Emory University for testing. NHANES data collection procedures are discussed in further depth on the NHANES website. [90]

3.5 Procedures in Building the Project Database

The publicly accessible NHANES data on the CDC website are available for download and are divided into subsets by questionnaire topic sections, physical examination sections, and lab data. To build this project database it was necessary to merge the demographic, sexual behaviour and reproductive health data files, and the HSV-2 lab results from the 2001-2002 and 2003-2004 cycles. All irrelevant variables were then dropped from the project database. It was necessary to derive new variables in appropriate formats for analysis from the NHANES survey data. A new menopause

variable and an indicator variable for type of menopause (natural versus surgically-induced) were derived; demographic and sexual behaviour variables were simplified into fewer categories; and indicator variables for ethnicity were created for use in the logistic regression models. The final sample size was N=1229. For a detailed breakdown of how final sample was achieved from the NHANES data, see *Appendix A. Derivation of the Project Sample Size.*

Prior to analysis, the data were thoroughly checked for quality. The derived variables were cross-referenced using cross-tabulations using the SAS 9.1.3 SURVEYFREQ procedure with the original variables to ensure proper coding. Pair-wise collinearity was assessed between all independent variables using the SAS CORR procedure and no strong collinear relationships (i.e., R>0.5) were found.

Frequency of missing values was also assessed for all variables; no variables had any missing values, except the number of times the respondent had sex without a condom in the past 30 days. Missing data was not an issue for this project since women with non-responses to important variables were necessarily excluded from the dataset. More specifically, women who did not respond to the question on whether they had any male partners in the last year, or to the question on whether they had any/at least one period in the last year were excluded. Of the women who had responses to these questions, there were no other item-specific missing values. The missing frequency for the condom usage variable is extremely high at 70% due to the fact that only women with two or more partners in the last year were asked this question. The data for this variable were "forward-filled" as much as possible; that is, while this variable was only asked of those who reported having more than one sexual partner in the past year, one can safely assume

that if a respondent reports having no sexual partners in the past year, then the number of times had sex in the past month (with or without a condom) could be entered as zero. However, for respondents who reported having one sexual partner in the past year, one cannot safely assume any value for the number of sexual encounters in the past month. Therefore, these individuals who had one sexual partner in the past year were not able to be included in the condom usage variable due to this inability to account for the skip pattern.

Since NHANES employs a complex probability-based clustered sampling technique, the survey data were weighted appropriately to account for the unequal probability of selection. Weighting values are provided for every observation in the dataset, to allow the data to be demographically representative of the U.S. population. NHANES provides analysts with cross-sectional weights appropriate for use in the two-year cycles; when combining cycles, it becomes necessary to re-calculate a new weight value. For this project combining two cycles NHANES data, the new 4-year cross-sectional weights were re-calculated by dividing the two-year weights by 2.

Also, since the data were obtained using a complex survey design, one must also consider the design effect that will inflate the variance beyond what would be found using a simple random sampling technique. Instructions were provided in the NHANES Analytical Guidelines, which describe a design effect (Deff) variable included for every observation in the dataset. An analysis using Statistical Analysis System (SAS) 9.1 software package determined the mean Deff value for this dataset to be approximately 1.496. The Deff was accounted for in the project analyses by using the NHANES strata and cluster variables.

The sample size for this project was limited by the study objectives and inclusion criteria, and pre-determined by the availability of recent NHANES data. The most recent NHANES data available, from 2001 to 2004, were used. Since the study sought to determine differences among middle-aged women, the sample was limited only to female subjects, with a lower age limit of 40 years. Only individuals aged 18 to 59 were asked to complete the sexual behaviour section of the survey, hence there was a default upper age limit of 59 years. The sample was further restricted to those who were asked to complete both of the sexual behaviour and reproductive health sections of the NHANES questionnaire, which were both asked of different sub-samples of the full NHANES sample. The HSV-2 analyses are further restricted to only those who also underwent a physical examination, which restricts the sample to women between the ages of 40 to 49 only. All available observations were included in the project database. In total, the project sample size for all women aged 40 to 59 years, who had reproductive health and sexual behaviour data, who reported ever having had sex, and whose menopausal status could be determined, was N=1229.

3.6 Exposure Variables

The NHANES survey questions from which the exposure variables were derived are listed in *Appendix B. NHANES Survey Questions.*

3.6.1 Menopausal status

The exposure variable, menopausal status, was measured dichotomously as either pre- or post-menopausal. Menopausal status was determined using the following process:

- If in cycle 2001-2002 the respondent reported having regular periods in the last twelve months, OR
    - The respondent reported the reason for not having regular periods as:
        - pregnant now,
        - breast-feeding,
        - pregnant in the past twelve months,
        - or periods are usually irregular, OR
- If in cycles 2003-2004 the respondent reported at least one period in the past twelve months, OR
    - The respondent reported the reason for not having at least one period as:
        - pregnant now,
        - breast-feeding,
        - pregnant in the past twelve months,
        - or periods are usually irregular,

THEN the respondent was classified as being pre-menopausal. Otherwise:

- If in cycle 2001-2002 the respondent reported the reason for not having regular periods in the past twelve months as menopause, OR
- If in cycle 2003-2004 the respondent cites the reason for not having at least one period in the past twelve months as menopause/hysterectomy, OR
- If in both cycles the respondent affirmed having had a hysterectomy and/or both ovaries removed,

THEN the respondent was classified as being post-menopausal.

If a respondent could not be classified as either pre- or post-menopausal due to missing or uncertain responses, then they were eliminated entirely from the analyses (n=25, 1.99% frequency missing).

3.6.2 Type of Menopause

Whether menopause is achieved naturally or has been artificially induced by removal of either both ovaries or the uterus can have significant psychological and behavioural effects.[18] As such, type of menopause will be considered as an exposure variable in a second analysis. Information on whether menopause was natural or surgical is available for all respondents for whom menopausal status could be determined. Type of menopause was derived from several survey questions asking whether ovaries or uterus had been removed, the age of surgery (if applicable), and the stated age at which the participant had her last period. In respondents identified as post-menopausal, they were classified as having surgically-induced menopause in both cycles if:

- They have had a hysterectomy AND the age of hysterectomy occurred on or before the age of last menstrual period, OR
- They have had <u>both</u> ovaries removed AND the age of oophorectomy (either for both removed, or if they were removed in two separate events, then the second ovary removal) occurred on or before the age of last menstrual period.

Otherwise, the respondents were assumed to have achieved menopause naturally.

3.7 Outcome Variables

The outcomes of interest were three different variables on sexual behaviour and a blood test for HSV-2. In NHANES, sex is defined as 'oral, anal or vaginal intercourse.'[91]

All three sexual behaviour variables were collected as a count of the number of partners, but are re-structured to dichotomous variables for this project. None of the outcome variables were normally distributed; rather, the majority of the values were either zero or one. Thus, linear regression was an inappropriate choice for analysis. Instead, logistic regression analyses were selected and the variables were dichotomized to meet the assumptions of logistic regression. The NHANES survey questions from which the outcome variables were derived are listed in *Appendix B. NHANES Survey Questions.* The outcome variables are defined below.

3.7.1 Number of male sexual partners in the past 12 months

This variable is directly derived from a survey question requesting this information. Information on number of male sexual partners in the past twelve months was requested from all respondents, in both cycles, hence this information was available for nearly all respondents. For this project, this variable was used to create two outcome variables: the first which dichotomized responses into either 'no partners' or 'any partners,' and the second which dichotomized responses into either 'one partner' or 'two or more partners.'

3.7.2 Number of sexual partners in the past 30 days

This variable is derived directly from the responses to a survey question requesting this information. Information on number of partners in the past thirty days was only requested from those who reported having two or more partners in the past twelve months; hence this information was not available for all respondents. Forward-filling was used to account for the skip pattern; where number of partners in last 12 months was zero

or one, it was assumed that number of partners in past 30 days was also zero or one. For this project, this variable was used to create two outcome variables: the first which dichotomized responses into either 'no 'partners' or 'any partners,' and the second which dichotomized responses into either 'one partner' or 'two or more partners.'

3.7.3 Number of sexual encounters without a condom in past 30 days

This variable is derived directly from the responses to a survey question requesting this information. This information was only requested from those who reported having two or more partners in the past twelve months; hence the information was not available for all respondents. Forward-filling was used to partially account for the skip pattern; where number of partners in last 12 months was zero, it was assumed that number of sexual encounters without a condom was also zero. For this project, this variable was dichotomized into those who reported no sex without a condom, and those who reported any sex in the past month without a condom. The unweighted frequency of missing responses for this variable was 70.46% (n=866).

3.7.4 Type 2 herpes simplex virus seroprevalence

This variable is derived directly from a blood test for a viral glycoprotein specific to HSV-2 from the MEC physical examinations. Since only a sub-sample of the NHANES participants underwent the physical exams, and only those aged 17 to 49 had STD blood testing, not all participants have data available for the HSV-2 analyses. The response categories for the HSV-2 variable were 'positive,' 'negative,' and 'indeterminate.' For the purposes of the analyses, the 4 indeterminate values (0.61%)

which were present in the project sample were dropped, to leave a dichotomous outcome variable.

3.8 Other Independent Variables

This research project considered several potentially influential covariates in the statistical analysis. These covariates were selected based on evidence in the literature which suggested possible confounding or effect modifying influence, as well as availability of information in the NHANES dataset. The NHANES survey questions from which the other independent variables were derived are listed in *Appendix B. NHANES Survey Questions.*

3.8.1 Age

As described in the review of the literature, age is associated with menopause and also with risky sexual behaviour, and as such it was considered as a covariate in this analysis. Age was requested in the demographic section of the NHANES questionnaire and hence is available for all respondents. Age was measured continuously, in years. For the purposes of the analyses age was dichotomized at age 50. Since the HSV-2 prevalence data were only available up to age 49, age was dichotomized at 45 for these analyses only.

3.8.2 Ethno-racial group

As described in the review of the literature, sexual behaviour varies in different ethno-racial groups, and as such it was considered as a covariate in this analysis. Ethnicity was requested in the demographic section of the NHANES questionnaire and hence is available for all respondents. There were five response options for ethnicity:

Mexican-American, other Hispanic, 'non-Hispanic Black,' 'non-Hispanic White,' and other/multiracial. For the purposes of the analyses ethnicity was grouped into three categories; non-Hispanic White, non-Hispanic Black and Hispanic/Mexican-American/other (hereafter referred to as 'Hispanic').

3.8.3 Marital status

Sexual behaviour varies by marital status, and as such it was considered as a covariate in this analysis. Marital status was requested in the demographic section of the NHANES questionnaire and hence is available for all respondents. There were six response options for marital status: married, widowed, divorced, separated, never married, and living with a partner. For the purposes of the analyses, marital status was dichotomized into either 'partnered' or 'not partnered.'

3.8.4 Socio-economic status

Socio-economic status (SES) has been shown repeatedly to be associated with improved health, including reproductive health. Reproductive health can have a direct influence on menopausal status (i.e. hysterectomy, etc.). More specifically, highest level of education is an appropriate measure of SES for analyses of sexual health outcomes, as the literature has revealed that formal education plays an important role in knowledge of STI risk and condom use. Furthermore, income is associated with higher rates of missing data; for example, the overall missing rate in NHANES 2003-2004 for household income is 6.2%. As such, highest level of education was selected as a measure for SES. Level of education was requested in the demographic section of the NHANES questionnaire and hence is available for all respondents. Education was grouped into three categories:

completed less than high school education, completed high school, completed more than high school. For the purposes of the analyses, education was dichotomized into completed high school or less or more than high school.

3.9 Statistical Analyses

All analyses were conducted using SAS 9.1.3 to achieve the research objectives.[92] SAS survey procedures were used in all cases to account for the stratified and clustered sampling strategy of NHANES. All analyses were weighted to represent national U.S. estimates for women in the specified age groups. The analysis was conducted in two parts, one for the primary pre- vs. post-menopause and the second for the natural vs. surgically-induced menopause. Each section had 3 steps: descriptive analysis, testing for potential effect modifiers and confounders, and logistic regression analyses.

First, a descriptive analysis was conducted. A weighted Rao-Scott chi-square[93] analysis was used from the SURVEYFREQ procedure to compare all the covariates by the exposure variable, to identify any associations of the covariates with the exposure variable, and to identify whether there was a significant difference between the two levels of exposure. SAS survey procedures use the Taylor series linearization variance expansion method to estimate the increased variance.[94] Weighted point estimates were provided, with the approximated 95% confidence intervals.

Second, tests were conducted to identify potential effect modifiers or confounders. Effect modifiers were tested first, by running weighted survey logistic regression models in the SURVEYLOGISTIC procedure with the exposure variable, the independent variable, and an interaction variable. If the interaction variable had a significant p value at $\alpha = .05$, then the entire conceptual variable was considered to be an

effect modifier (e.g., if the interaction variable for non-Hispanic Black was found to be significant, then ethnicity overall was considered to be an effect modifier). Independent variables were tested next as potential confounders by running a weighted survey logistic regression model using the SURVEYLOGISTIC procedure with the exposure variable and the independent variable; if the parameter of the exposure variable varied by greater than 10% from the unadjusted parameter, then it was considered that the independent variable was likely to be a confounder in the full model.[95] If the interaction term for a variable was found to be significant, and thus a potential effect modifier, then it was not considered for confounding.

Third, the unadjusted and adjusted logistic regression analyses were conducted using the SURVEYLOGISTIC procedure. Logistic regression is an appropriate analytic method given the dichotomous nature of the outcome variables. Simple logistic regression analyses were conducted for all independent variables for each of the outcome variables to acquire information on crude associations. Next, multiple logistic regression was conducted with a full model, including any independent variables that were identified as likely effect modifiers or confounders. Odds ratio (OR) point estimates were weighted and provided with the approximate 95% confidence intervals (CIs), again using the Taylor series linearization variance estimation method.[94]

4.0 Results

4.1 Post- versus pre-menopause

A total of 1229 women between the ages of 40 and 59 had sufficient sexual behaviour and reproductive health information to be included in the project sample. Overall, there were 535 pre-menopausal women, with a weighted frequency of 44.3% (CI 41.4, 47.3) and 694 post-menopausal women with a weighted frequency of 55.7% (CI 52.7, 58.6). Table 2 summarizes the demographics for pre- and post-menopausal women. There was a significant difference in age distribution between the two groups (p=<.0001), with pre-menopausal women being younger. Ethnicity was similar in both groups (p=.4201), with approximately 75% White, 10% Black, and 15% Hispanic. There was a significant difference in education between the two groups (p=0.0318); with the pre-menopausal women being more likely to have a higher education. Marital status was also significantly different, with post-menopausal women being more likely to be widowed or divorced and less likely to be married or never married (p=.0191). Approximately 70% of women were partnered in both groups.

Table 3 and Figures 2 to 4 summarize sexual behaviour and HSV-2 prevalence in pre- and post-menopausal women. Most post-menopausal women (78%) had had at least one male sexual partner in the past year, and at least one sexual partner in the past month. Post-menopausal women were less likely to have a higher number of male sexual partners in the past 12 months (p=<.0001), and partners in the past 30 days (p=<.0001). Most women had not had sex without a condom in the past 30 days (87%), with pre-menopausal women being more likely to have had sex without a condom (p=0.0012).

Table 2. Demographic summary of U.S. post- vs. pre-menopausal women aged 40 to 59 from NHANES 2001-2004 (N=1229).

		Pre-Menopausal (n=535)				Post Menopausal (n=694)				
				95% CI				95% CI		p value
Variable		N	Freq.	Lower	Upper	N	Freq.	Lower	Upper	
Menopause	Natural	-	-	-	-	385	56.9	51.3	62.4	0.0179*
	Surgically-induced	-	-	-	-	306	43.1	37.6	48.7	
Age	40 - 44	284	50.6	44.0	57.3	74	10.3	7.2	13.4	<.0001*
	45 - 49	175	34.4	28.8	40.0	160	24.9	19.5	30.3	
	50 - 54	66	12.5	9.7	15.4	247	34.3	29.5	39.0	
	55 - 59	10	2.4	1.1	3.8	213	30.5	27.2	33.9	
Ethnicity	Non-hispanic White	269	75.4	69.2	81.6	393	75.7	71.0	80.4	0.4201
	Non-hispanic Black	110	10.0	6.9	13.1	153	11.3	7.9	14.6	
	Mexican American	118	6.2	3.7	8.8	93	3.9	2.0	5.8	
	Other Hispanic	19	4.3	1.7	6.9	28	4.4	1.5	7.3	
	Multiracial / Other	19	4.1	1.7	6.5	27	4.7	2.9	6.6	
Education	Less than high school	113	11.2	8.6	13.8	148	15.2	12.4	17.9	0.0318*
	Completed high school	120	21.8	16.9	26.6	171	25.0	22.2	27.9	
	More than high school	302	67.1	61.5	72.6	375	59.8	55.9	63.7	
Marital Status	Married	331	68.7	64.1	73.2	426	65.3	61.4	69.2	0.0191*
	Widowed	13	2.3	0.5	4.1	34	4.7	2.8	6.7	
	Divorced	74	12.3	9.6	15.1	132	18.1	14.7	21.5	
	Separated	30	3.7	1.7	5.8	34	3.4	1.9	4.9	
	Never Married	57	7.9	5.1	10.8	36	4.3	2.6	6.1	
	Living with Partner	30	5.1	2.8	7.4	32	4.1	2.4	5.7	

Frequencies are weighted to U.S. nationally-representative population estimates

*p value from Rao-Scott Chi Square, significant at $\alpha = 0.05$

Table 3. Summary of sexual behaviour and HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40 to 59 from NHANES 2001-2004 (N=1229).

		Pre-Menopausal (n=535)				Post Menopausal (n=694)				p value
				95% CI				95% CI		
Variable		N	Freq.	Lower	Upper	N	Freq.	Lower	Upper	
Number of Male	0	69	12.3	10.0	14.6	199	29.4	24.4	34.4	<.0001*
Sexual Partners in Past	1	414	79.5	76.9	82.1	453	65.3	60.2	70.3	
12 Months (n = 1229)	2+	52	8.2	5.9	10.5	42	5.3	3.0	7.7	
Number of Sexual	0	80	13.9	11.4	16.3	214	31.4	26.8	36.1	<.0001*
Partners in Past 30	1	445	84.4	82.0	86.7	472	67.7	62.8	72.6	
Days (n = 1229)	2+	10	1.8	0.4	3.1	8	0.9	0.1	1.8	
Times had Sex without	0	93	78.2	70.2	86.2	219	91.6	87.5	95.7	0.0014*
a Condom in Past 30	1-4	13	9.1	4.6	13.7	15	5.2	2.1	8.2	
Days (n = 363)	5+	14	12.6	4.1	21.2	9	3.2	0.6	5.8	
HSV-2 seroprevalence	-	286	70.8	67.2	74.5	126	62.9	54.7	71.2	0.0697
(n = 649)	+	148	29.2	25.5	32.8	89	37.1	28.8	45.3	

Frequencies are weighted to U.S. nationally-representative population estimates
HSV-2 seroprevalence data was only available up to age 49.
*p value from Rao-Scott Chi Square, significant at $\alpha = 0.05$

Figure 2. Frequency distribution of male sexual partners in the last 12 months in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004 (N=1229).

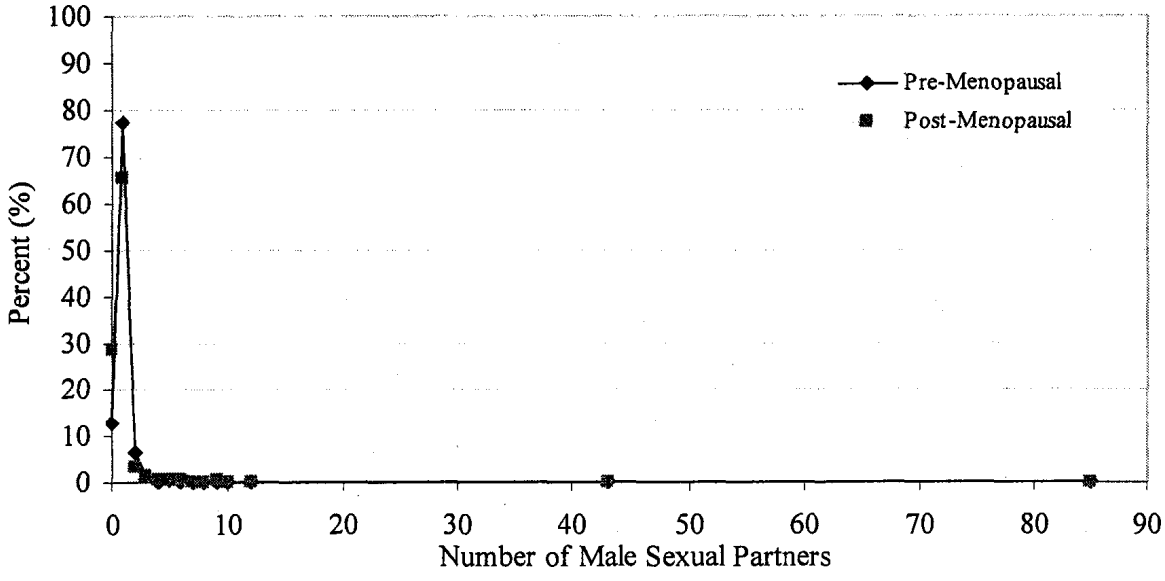


Figure 3. Frequency distribution of sexual partners in the last 30 days in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004 (N=1229).

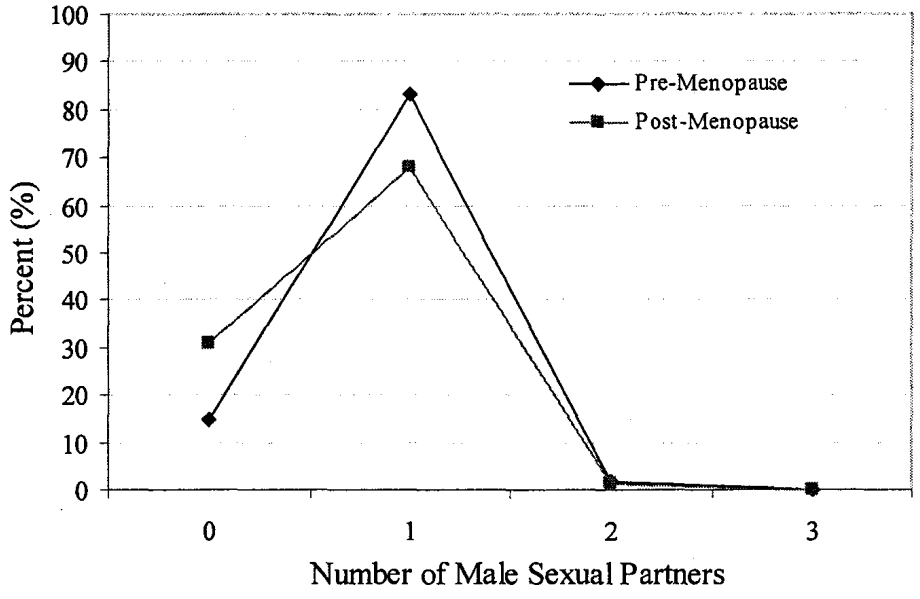
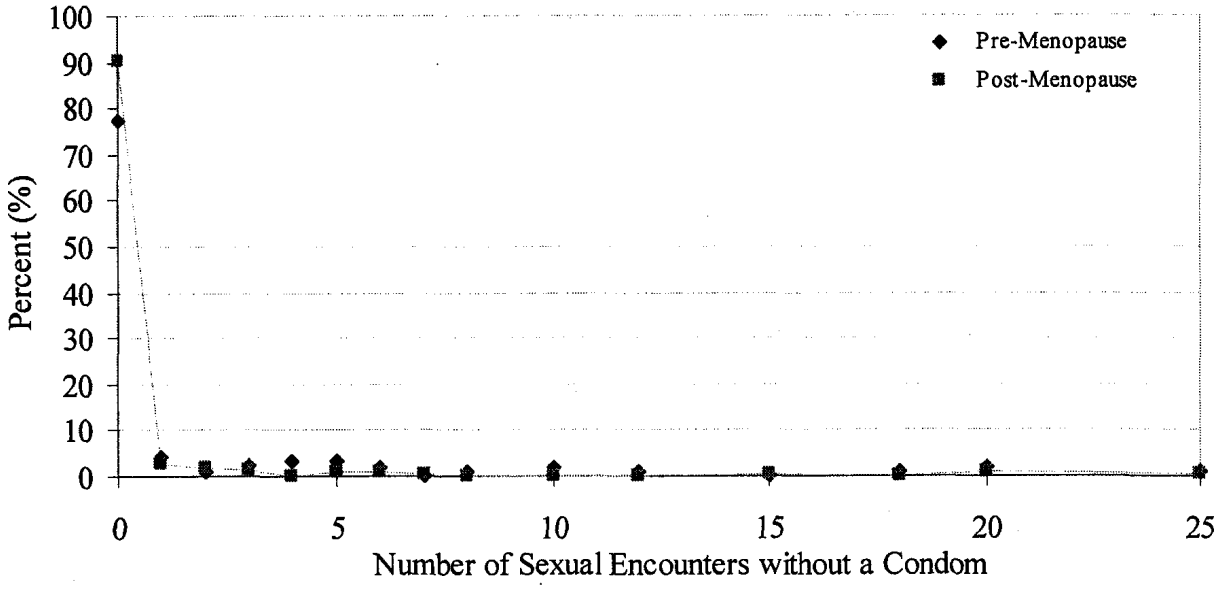


Figure 4. Frequency distribution of sexual encounters without a condom in the last 30 days in U.S. post- vs. pre-menopausal women aged 40-59 in NHANES 2001-2004 (N=363).



Figures 2 through 4 show the frequency distribution of the sexual behaviour outcomes. Number of male sexual partners in the past 12 months ranged from 0 to 43 in pre-menopausal women and from 0 to 85 in post-menopausal women. Number of sexual partners in the past 30 days ranged from 0 to 3 in pre-menopausal women and 0 to 2 in post-menopausal women. Number of sexual encounters without a condom in the last 30 days ranged from 0 to 25 in both pre- and post-menopausal women.

For HSV-2 prevalence, There was no significant difference in HSV-2 prevalence between the two groups (p=.0697). The overall prevalence of HSV-2 in the sample is approximately 30%.

Given the very small cell sizes for two or more sexual partners in the past 30 days (n=10 for pre-menopausal, n=8 for post-menopausal), it was decided that power would be a significant issue for the logistic model comparing two or more versus one sexual partners in the past 30 days and as such, this logistic model was not conducted.

4.1.1 Number of male sexual partners in last 12 months, any vs. none

Table 4. Decision-making for independent variables in final model for number of male sexual partners in last 12 months (any vs. none), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.7929	33.15	Yes	Potential confounder
Ethno-racial group: Black	0.0042*	-0.48	Yes	Potential effect modifier
Ethno-racial group: Hispanic	0.1770	-0.48	Yes	Potential effect modifier
Education	0.1095	-1.72	No	
Marital Status	0.6307	-13.82	Yes	Potential confounder

Table 5. Adjusted and unadjusted weighted logistic regression models for number of male sexual partners in last 12 months (any vs. none), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004 (N=1229).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	-1.0901	0.34	0.24	0.47	<.0001*	-0.9349	0.39	0.24	0.64	0.0002*
Age (50+ vs. <50)	-1.0640	0.35	0.27	0.45	<.0001*	-0.8268	0.44	0.30	0.65	<.0001*
Ethno-racial group (Black vs. White)	-0.4037	0.67	0.40	1.11	0.1166	0.5882	1.80	1.05	3.08	0.0321*
(Black vs. White) x Menopause	0.8061	2.24	1.29	3.89	0.0042*	0.6469	1.91	1.02	3.59	0.0449*
Ethno-racial group (Hispanic vs. White)	-0.4810	0.62	0.35	1.09	0.0964	0.0075	1.01	0.45	2.24	0.9854
(Hispanic vs. White) x Menopause	0.5042	1.66	0.80	3.44	0.1770	0.0982	1.10	0.48	2.55	0.8185
Marital Status (Partnered vs. Non)	2.3056	10.03	7.23	13.92	<.0001*	2.5866	13.29	9.03	19.55	<.0001*

Table 4 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable number of male sexual partners in the last year (any vs. none). The Black ethno-racial variable was found to be a significant effect modifier (p=.0042); hence both ethno-racial variables were included as effect modifiers in the final model. Both age and marital status were found to be significant confounders (33.15% and -13.82% change in menopause parameter, respectively); hence they were both included in the final model.

The weighted, both unadjusted and adjusted, logistic regression models for the dependent variable number of male sexual partners in the last 12 months (any vs. none) are summarized in Table 5. The sample size included in the full model was n=1229. Menopausal status was significant in both models (p=<.0001 unadjusted, p=.0002 adjusted). Age (p=<.0001), Black ethno-racial group (p=.0321), and marital status (p=.0449) were also significant in the adjusted analyses. The adjusted odds ratio for post- versus pre-menopausal women was 0.39 (CI 0.24, 0.64).

In the model for the number of male sexual partners in the last 12 months (any vs. none), the effect of menopausal status was significant, but these results present interesting effect modification by ethnic group. Odds ratios for the three levels of the effect modifier ethnicity were acquired by exponentiating the sum of the relevant parameters. For example, to acquire the odds ratio for non-Hispanic Black, the parameters for menopause (β=-0.9349) and the menopause-Black interaction variable (β=0.6469) are summed and then exponentiated to acquire the OR = 0.75. These stratified odds ratios are summarized in Table 6.

Table 6. Stratified odds ratios for ethno-racial groups for the odds of having any male sexual partner in last 12 months, in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

Non-Hispanic White	Non-Hispanic Black	Hispanic/Other
0.39	0.75	0.43

Non-Hispanic White women were found to be 61% less likely (i.e. OR=0.39) to have any male sexual partners post-menopause compared with pre-menopause, after adjusting for marital status and age. The unadjusted prevalence of any male sexual partners in non-Hispanic White women was 79% post- and 89% pre-menopause.

Non-Hispanic Black women were found to have 0.75 times the odds of having any male sexual partner in the last 12 months post-menopause compared with pre-menopause, after adjusting for marital status and age. The unadjusted prevalence of any male sexual partner in the last 12 months in non-Hispanic Black women was 77% post- and 84% pre-menopause. This association was significant.

Hispanic/other women were 57% less likely (i.e., an OR of 0.43) to have any male sexual partners post-menopause compared with pre-menopause, after adjusting for marital status and age, though this association was not significant, and presented a wide CI. The prevalence of any male sexual partners in Hispanic/other women was 70% post- and 83% pre-menopause.

4.1.2 Number of male sexual partners in last 12 months, two or more vs. one

Table 7. Decision-making for independent variables in final model for number of male sexual partners in last 12 months (2+ vs. 1), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.8439	25.02	Yes	Potential confounder
Ethno-racial group: Black	0.3650	-18.55	Yes	Potential confounder
Ethno-racial group: Hispanic	0.9762	-18.55	Yes	Potential confounder
Education	0.5380	-7.15		
Marital Status	0.9976	38.68	Yes	Potential confounder

Table 8. Adjusted and unadjusted weighted logistic regression models for number of male sexual partners in last 12 months (2+ vs. 1), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004 (N=961).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	-0.2350	0.79	0.46	1.35	0.3899	-0.1813	0.83	0.45	1.54	0.5604
Age (50+ vs. <50)	-0.2171	0.81	0.47	1.39	0.4377	0.0130	1.01	0.57	1.80	0.9645
Ethno-racial group (Black vs. White)	0.9480	2.58	1.71	3.89	<.0001*	0.0655	1.07	0.65	1.76	0.7971
Ethno-racial group (Hispanic vs. White)	-0.4462	0.64	0.34	1.20	0.1658	-0.7896	0.45	0.19	1.07	0.0703
Marital Status (Partnered vs. Non)	-2.2258	0.11	0.07	0.16	<.0001*	-2.2326	0.11	0.07	0.18	<.0001*

Table 7 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable of number of male sexual partners in the past year (2+ vs. 1). Age, ethnicity and marital status were found to be likely confounders (25.02%, -18.55%, 38.68% change in menopause, respectively); hence they were included in the final model.

Table 8 summarizes the weighted, both unadjusted and adjusted, logistic regression models for number of male sexual partners in the past 12 months (2+ vs. 1). The sample size for the final model was n=961. The only significant variable in the adjusted model was marital status (p=<.0001). The adjusted OR for post- versus pre-menopausal women was 0.83 (0.45, 1.54).

4.1.3 Number of sexual partners in last 30 days, any vs. none

Table 9. Decision-making for independent variables in final model for number of sexual partners in 30 days (any vs. none), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.9105	32.28	Yes	Potential confounder
Ethno-racial group: Black	0.0274*	-0.26	Yes	Potential effect modifier
Ethno-racial group: Hispanic	0.2734	-0.26	Yes	Potential effect modifier
Education	0.1099	-1.83	No	
Marital Status	0.5612	-17.55	Yes	Potential confounder

Table 10. Adjusted and unadjusted weighted logistic regression models for number of sexual partners in last 30 days (any vs. none), in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004 (N=1229).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	-1.0467	0.35	0.26	0.48	<.0001*	-0.9094	0.40	0.26	0.63	<.0001*
Age (50+ vs. <50)	-1.0106	0.36	0.27	0.49	<.0001*	-0.7982	0.45	0.30	0.68	0.0001*
Ethno-racial group (Black vs. White)	-0.5453	0.58	0.34	1.00	0.0483*	0.4842	1.62	0.91	2.91	0.1038
(Black vs. White) x Menopause	0.7330	2.08	1.09	3.99	0.0274*	0.5374	1.71	0.81	3.60	0.1562
Ethno-racial group (Hispanic vs. White)	-0.4490	0.64	0.37	1.11	0.1109	0.0714	1.07	0.49	2.37	0.8597
(Hispanic vs. White) x Menopause	0.4249	1.53	0.72	3.27	0.2734	-0.0152	0.99	0.40	2.43	0.9737
Marital Status (Partnered vs Non)	2.4211	11.26	8.51	14.89	<.0001*	2.6936	14.79	10.92	20.02	<.0001*

Table 9 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable of number of sexual partners in the past month (any vs. none). The Black ethno-racial variable was found to be a significant effect modifier (p=.0274), and as such, ethnicity was included in the final model as an effect modifier. Age and marital status were found to be potential confounders (32.28% and -17.55% change in menopause parameter, respectively) and were thus included in the final model.

Table 10 summarizes the weighted, both unadjusted and adjusted, logistic regression models for number of partners in the last 30 days (any vs. none). The sample size for the final model was n=1229. Menopause was significant in both the unadjusted and adjusted models (p=<.0001, p=<.0001). Age and marital status were both statistically significant in the final model as well (p=.0001, p=<.0001). The OR for post- versus pre-menopause was 0.40 (CI 0.26, 0.63).

Odds ratios for the three levels of the effect modifier ethnicity were acquired by exponentiating the sum of the relevant parameters (see example on page 55). These stratified odds ratios are summarized in Table 11.

Table 11. Stratified odds ratios for ethno-racial groups for the odds of having any sexual partner in last 30 days, in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

Non-Hispanic White	Non-Hispanic Black	Hispanic/Other
0.40	0.69	0.40

Non-Hispanic White women were 60% less likely (i.e. OR=0.40) to have any partners in the last month post-menopause compared with pre-menopause, after adjusting

for age and marital status. The prevalence of any partners in the last 30 days in non-Hispanic White women was 68% post- and 88% pre-menopause.

Non-Hispanic Black women were found to have 0.69 the odds of having any partner in the last 30 days post-menopause compared with pre-menopause, after adjusting for age and marital status. This relationship was not significant. The prevalence of any partners in the last 30 days in non-Hispanic Black women was 72% post- and 81% pre-menopause.

Hispanic/other women were found to be 60% less likely to have any partner in the last 30 days post-menopause, compared with pre-menopause, after adjusting for age and marital status. The prevalence of any sexual partners in the last 30 days in Hispanic/other women was 68% post- and 82% pre-menopause. This relationship was not significant.

4.1.4 Number of sexual encounters without a condom in last 30 days, any vs. none

Table 12. Decision-making for independent variables in final model for number of sexual encounters without a condom in last 30 days, in U.S. post- vs. pre-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.9157	37.70	Yes	Potential confounder
Ethno-racial group: Black	0.2587	-1.81	No	
Ethno-racial group: Hispanic	0.8118	-1.81	No	
Education	0.0175*	-0.11	Yes	Potential effect modifier
Marital Status	0.0393*	-8.97	Yes	Potential effect modifier

Table 13. Adjusted and unadjusted weighted logistic regression models for number of sexual encounters without a condom in last 30 days, in U.S. post- vs. pre-menopausal women age 40-59 from NHANES 2001-2004 (N=363).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	-1.1126	0.33	0.16	0.69	0.0030*	0.8070	2.24	0.72	6.99	0.1643
Age (50+ vs. <50)	-1.1786	0.31	0.17	0.57	0.0001*	-0.8328	0.44	0.22	0.87	0.0188*
Education (> HS. vs. HS or less)	0.7454	2.11	0.69	6.45	0.1916	0.6297	1.88	0.60	5.89	0.2804
Education x Menopause	-1.8065	0.16	0.04	0.73	0.0175*	-1.6975	0.18	0.04	0.84	0.0290*
Marital Status (Partnered vs Non)	1.6842	5.39	2.16	13.45	0.0003*	1.6400	5.16	2.01	13.21	0.0006*
Marital Status x Menopause	-1.2671	0.28	0.08	0.94	0.0393*	-1.2669	0.28	0.09	0.91	0.0336*

Table 12 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable of number of times had sex without a condom in the past 30 days (any vs. none). Age was found to be a likely confounder, with a change in the menopause parameter of 37.70%, and was included in the final model. Education and marital status were found to be effect modifiers (p=.0175, p=.0393); these two variables were included in the final model as effect modifiers.

Table 13 summarizes the weighted, both unadjusted and adjusted, logistic regression models for number of times had sex without a condom in the past 30 days (any vs. none). The sample size for the final model was n=363. Age (p=.0188), the education-menopause interaction (p=.0290), marital status (p=.0006), and the marital status-menopause interaction (p=.0336) were all statistically significant in the final model. The OR for post- versus pre-menopausal women was 2.24 (0.72, 6.99), a relationship that was non-significant in the adjusted model (p=.1643).

Given the restricted sample size, additional Rao-Scott chi square analyses were conducted to determine whether the women included in this condom usage sub-set differed significantly from those women who were excluded. It was found that the women in this sub-set were more likely to be pre-menopausal (p=<.0001), younger (p=<.0001), and non-partnered, particularly divorced or never married (p=<.0001).

Education and marital status were both significant effect modifiers in this model. Odds ratios for the four levels of the two effect modifiers were acquired by exponentiating the sum of the relevant parameters (see example on page 55). Due to

significant missing data, only ORs, and not proportions, will be reported. These stratified odds ratios are summarized in Table 14.

Table 14. Stratified odds ratios for education and marital status for the odds of having any sexual encounter without a condom in last 30 days, in U.S. post- vs. pre-menopausal women age 40-59 from NHANES 2001-2004.

	Low Education	High Education
Non-partnered	2.24	0.41
Partnered	0.63	0.12

For women with a high school education or less, non-partnered women had 2.24 times the odds of having sex without a condom at least once in the past 30 days post-menopause, compared with pre-menopause. Partnered women had 0.63 times the odds of having sex without a condom at least once in the past 30 days post-menopause, compared with pre-menopause.

For women with more than a high school education, non-partnered women were 59% less likely (i.e. OR=0.41) to have sex without a condom at least once in the past 30 days post-menopause, compared with pre-menopause. Partnered women had 0.12 times the odds of having sex without a condom at least once in the past 30 days post-menopause, compared with pre-menopause.

4.1.5 Type 2 herpes simplex virus seroprevalence

Table 15. Decision-making for independent variables in final model for HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40-49 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.5343	7.04	No	
Ethno-racial group: Black	0.0291*	8.41	Yes	Potential effect modifier
Ethno-racial group: Hispanic	0.2750	8.41	Yes	Potential effect modifier
Education	0.0328*	10.34	Yes	Potential effect modifier
Marital Status	0.0617	0.59	No	

Table 16. Adjusted and unadjusted weighted logistic models for HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40-49 from NHANES 2001-2004 (N=649).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	0.3579	1.43	0.97	2.11	0.0718	0.8983	2.46	1.24	4.88	0.0103*
Ethno-racial group (Black vs. White)	1.8775	6.54	4.02	10.62	<.0001*	1.8904	6.62	4.03	10.89	<.0001*
(Black vs. White) x Menopause	-0.8673	0.42	0.19	0.92	0.0291*	-0.9098	0.40	0.18	0.92	0.0306*
Ethno-racial group (Hispanic vs. White)	0.5138	1.67	0.94	2.98	0.0820	0.5292	1.70	0.93	3.09	0.0829
(Hispanic vs. White) x Menopause	0.4961	1.64	0.67	4.00	0.2750	0.4588	1.58	0.64	3.91	0.3196
Education (> HS. vs. HS or less)	-0.1000	0.91	0.56	1.47	0.6877	0.0733	1.08	0.65	1.78	0.7752
Education x Menopause	-0.8077	0.45	0.21	0.94	0.0328*	-0.9572	0.38	0.18	0.82	0.0131*

HSV-2 seroprevalence data was only available up to age 49.

Table 15 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable of HSV-2 seroprevalence. Black ethno-racial group and education were found to be effect modifiers (p=.0291, p=.0328); hence ethnicity and education variables were included in the final model as effect modifiers.

Table 16 summarizes the weighted, both unadjusted and adjusted, logistic regression models for the dependent variable HSV-2 blood test. The sample size for the final model was n=649. Black ethno-racial group (p=<.0001), the Black-menopause interaction (p=.0306), and the education-menopause interaction (p=.0131) were all statistically significant in the final model. The OR for post- versus pre-menopause was 2.46 (CI 1.24, 4.88). This relationship was significant (p=.0117).

Given the restricted sample size used in the HSV-2 sub-set analysis, additional Rao-Scott chi square analyses were conducted to determine whether the women included in this analysis differed significantly from the other women in the main project sample. It was found that the women in the HSV-2 sub-set were more likely to be pre-menopausal (p=<.0001), younger, (p=<.0001), single, particularly divorced or never married (p=.0007).

Age was not included in the final model since statistically it did not induce a 10% or greater change in the regression parameter for menopause in the test model, even though age was identified as a confounder on menopause in other models and conceptually may confound the effect of menopause. As such, it is difficult to clearly interpret the effect of menopause on the prevalence of HSV-2 in these analyses without adjusting for age in this model. A post-hoc sensitivity analysis was conducted, which

examined this logistic regression model with and without the age covariate, both as a continuous variable and as a dichotomous variable. In both cases, age was not found to be a likely confounder or effect modifier for this full logistic model. This sensitivity analysis can be found in *Appendix C. Sensitivity analysis of age in the HSV-2 model.*

Education and non-Hispanic Black ethnicity were both significant effect modifiers. Odds ratios for the six levels of the two effect modifiers were acquired by exponentiating the sum of the relevant parameters (see example on page 55). These stratified odds ratios are summarized in Table 17.

Table 17. Stratified odds ratios for education and ethno-racial groups for the odds of being HSV-2 positive, in U.S. post- vs. pre-menopausal women age 40-59 from NHANES 2001-2004.

	Non-Hispanic White	Non-Hispanic Black	Hispanic/Other
Low Education	2.46	0.99	3.88
High Education	0.94	0.38	1.49

In women with a high school education or less, non-Hispanic White women had 2.46 times the odds of being HSV-2 positive post-menopause compared with pre-menopause. The unadjusted seroprevalence of HSV-2 in non-Hispanic White women was 39% post- and 20% pre-menopause.

Non-Hispanic Black women with a high school education or less had 0.99 times the odds of being HSV-2 positive post-menopause, compared with pre-menopause. The unadjusted seroprevalence of HSV-2 in non-Hispanic Black women with high school education or less was 72% post- and 83% pre-menopause.

Hispanic/other women with a high school education or less had 3.88 times the odds of being HSV-2 positive post-menopause compared with pre-menopause. The

unadjusted seroprevalence of HSV-2 in Hispanic/other women was 68% post- and 31% pre-menopausal women. The Hispanic/other ethnicity interaction was not significant.

In women with greater than a high school education, non-Hispanic White women had 0.94 times the odds of being HSV-2 positive post-menopause compared with pre-menopause. The unadjusted seroprevalence of HSV-2 in non-Hispanic White women was 24% post- and 25% pre-menopause.

Non-Hispanic Black women with greater than high school education had 0.38 times the odds of being HSV-2 positive post-menopause compared with pre-menopause. The unadjusted seroprevalence of HSV-2 in non-Hispanic Black women was 37% post- and 53% pre-menopause.

Hispanic/other post-menopausal women with greater than a high school education had 1.49 times the odds of being HSV-2 positive compared with pre-menopausal women. The unadjusted seroprevalence of HSV-2 in Hispanic/other women was 42% post- and 37% pre-menopause. The Hispanic/other interaction was not significant.

4.2 Surgically-induced versus natural post-menopause

A total of 694 post-menopausal women between the ages of 40 and 59 had sufficient information to be included in the sub-set analyses. Overall, there were 385 natural post-menopausal women, with a weighted frequency of 56.9% (CI 51.3, 62.4) and 306 surgically-induced post-menopausal women, with a weighted frequency of 43.1% (CI 37.6, 48.7). Of the 306 surgically-induced post-menopausal women, type of surgeries varied, with 124 women having only a hysterectomy, 142 with a hysterectomy and a single oophorectomy, and 40 with a hysterectomy and double oophorectomies.

Table 18 summarizes the demographics for surgically-induced and natural post-menopausal women. The groups differed significantly by age (p=.0052), with surgically-induced menopause being slightly younger. There was a significant difference in ethno-racial distribution between the two groups (p=<.0343), with slightly more non-Hispanic Black and slightly fewer non-Hispanic White surgically-induced post-menopausal women. There was also a significant difference in education between the two groups (p=0.0024), with the surgically-induced post-menopausal women being more likely to have a lower education. Marital status was similar in both groups (p=.3257).

Table 19 and Figures 5 to Figure 7 summarize sexual behaviour and HSV-2 prevalence in natural and surgically-induced post-menopausal women. Over half of women (63%) had had at least one male sexual partner in the past year, and at least one sexual partner in the past month. Most women had not had sex without a condom in the past 30 days (88%). Approximately 35% of post-menopausal women were HSV-2 positive. None of the outcome variables differed significantly in the two post-menopausal groups.

Table 18. Demographic summary of U.S. surgically-induced vs. natural post-menopausal women aged 40 to 59 from NHANES 2001-2004 (N=694).

		Natural Menopause (n=385)				Surgically-induced (n=309)				p value
				95% CI				95% CI		
Variable		N	Freq.	Lower	Upper	N	Freq.	Lower	Upper	
Age	40 - 44	26	6.3	3.5	9.1	48	15.5	10.1	20.8	0.0052*
	45 - 49	85	24.5	17.5	31.5	75	25.4	19.6	31.2	
	50 - 54	150	36.9	30.6	43.1	97	30.8	24.9	36.7	
	55 - 59	124	32.3	27.2	37.3	89	28.3	22.3	34.3	
Ethnicity	Non-hispanic White	225	76.4	71.4	81.4	168	74.7	68.2	81.3	0.0343*
	Non-hispanic Black	67	8.4	5.5	11.4	86	14.9	10.1	19.8	
	Mexican American	56	3.9	1.9	5.9	37	3.9	1.6	6.3	
	Other Hispanic	20	5.8	2.3	9.4	8	2.6	0.0	5.5	
	Multiracial / Other	17	5.4	2.3	8.5	10	3.8	0.9	6.7	
Education	Less than high school	80	13.3	9.9	16.7	68	17.7	12.5	22.8	0.0024*
	Completed high school	79	19.8	15.7	23.9	92	31.8	24.3	39.4	
	More than high school	226	66.9	62.2	71.7	149	50.5	43.4	57.7	
Marital Status	Married	242	66.5	60.4	72.6	184	63.8	56.6	70.9	0.3257
	Widowed	19	4.7	2.9	6.4	15	4.8	1.1	8.6	
	Divorced	66	15.9	10.7	21.0	66	21.0	15.6	26.5	
	Separated	17	3.2	1.1	5.2	17	3.8	1.6	6.0	
	Never Married	24	5.8	3.6	7.9	12	2.5	0.6	4.4	
	Living with Partner	17	4.0	1.7	6.4	15	4.1	2.0	6.2	

Frequencies are weighted to U.S. nationally-representative population estimates

*p value from Rao-Scott Chi Square, significant at $\alpha = 0.05$

Table 19. Summary of sexual behaviour and HSV-2 seroprevalence in U.S. surgically-induced vs. natural post-menopausal women aged 40 to 59 from NHANES 2001-2004 (N=694).

		Natural Menopause (n=385)				Surgically-Induced (n=306)				p value
				95% CI				95% CI		
Variable		N	Freq.	Lower	Upper	N	Freq.	Lower	Upper	
Number of Male	0	116	30.2	23.8	36.7	83	28.3	21.8	34.8	0.7223
Sexual Partners in Past	1	246	64.0	56.8	71.2	207	67.0	60.9	73.0	
12 Months (n = 691)	2+	23	5.8	2.2	9.4	19	4.7	2.7	6.8	
Number of Sexual	0	124	32.4	26.3	38.5	90	30.1	23.5	36.7	0.5696
Partners in Past 30	1	256	66.4	59.8	73.1	216	69.3	62.7	75.9	
Days (n = 691)	2+	5	1.1	0.0	2.4	3	0.6	0.0	1.3	
Times had Sex without	0	127	91.9	86.7	97.1	92	91.3	85.8	96.7	0.2053
a Condom in Past 30	1-4	9	6.3	1.9	10.6	6	3.6	0.8	6.4	
Days (n = 243)	5+	3	1.9	0.0	4.5	6	5.1	0.2	10.0	
HSV-2 seroprevalence	-	63	66.1	54.4	77.9	63	59.7	46.1	73.3	0.4656
(n = 649)	+	38	33.9	22.1	45.6	51	40.3	26.7	53.9	

Frequencies are weighted to U.S. nationally-representative population estimates.

HSV-2 seroprevalence data was only available up to age 49.

*p value from Rao-Scott Chi Square, significant at $\alpha = 0.05$

Figure 5. Frequency distribution of male sexual partners in the last 12 months in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004 (N=694).

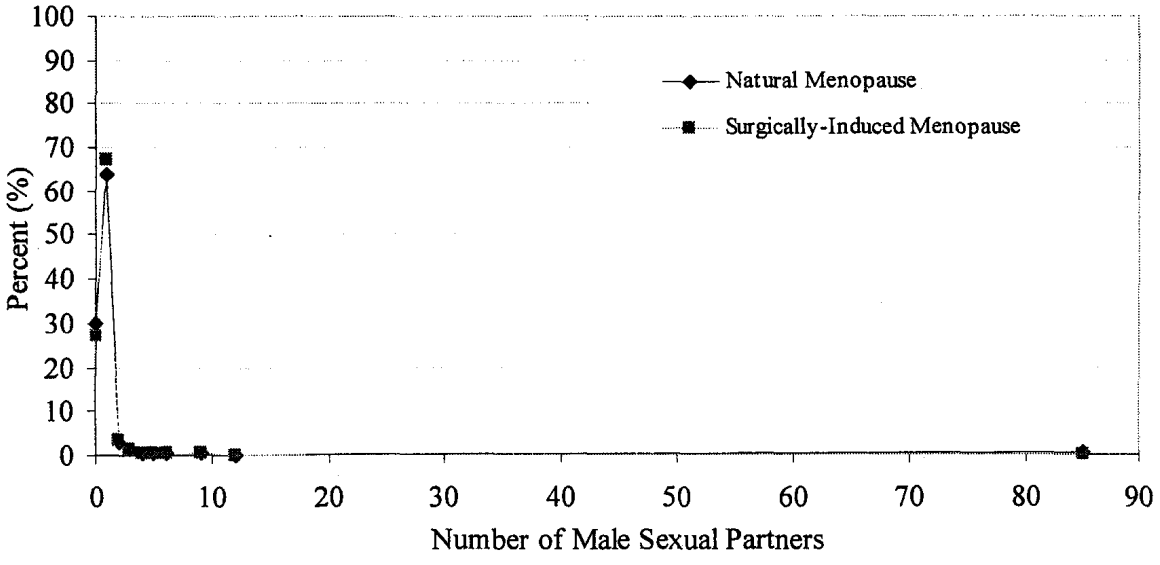


Figure 6. Frequency distribution of sexual partners in last 30 days in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004 (N=694).

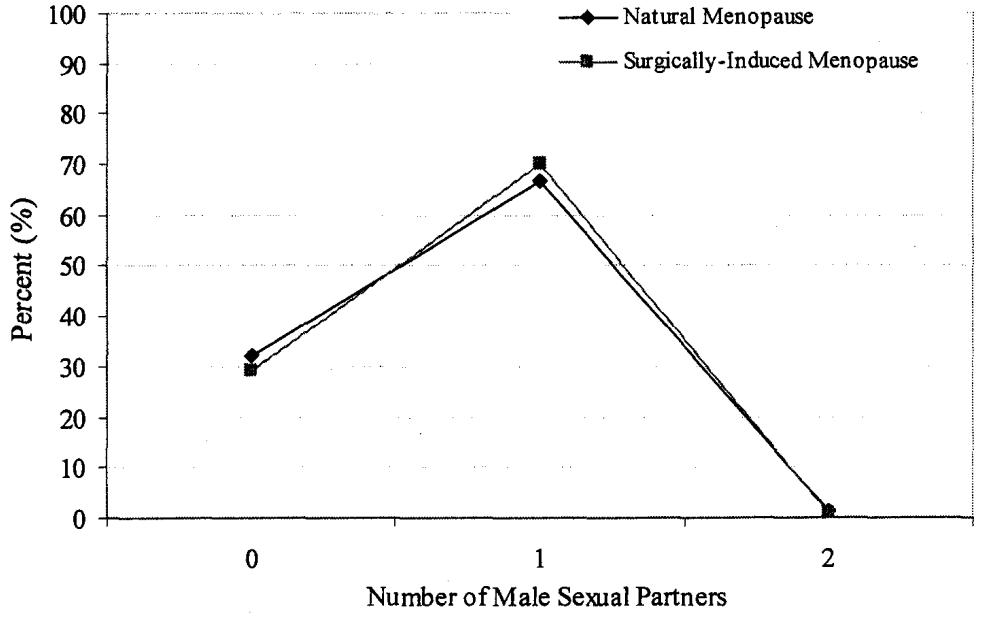
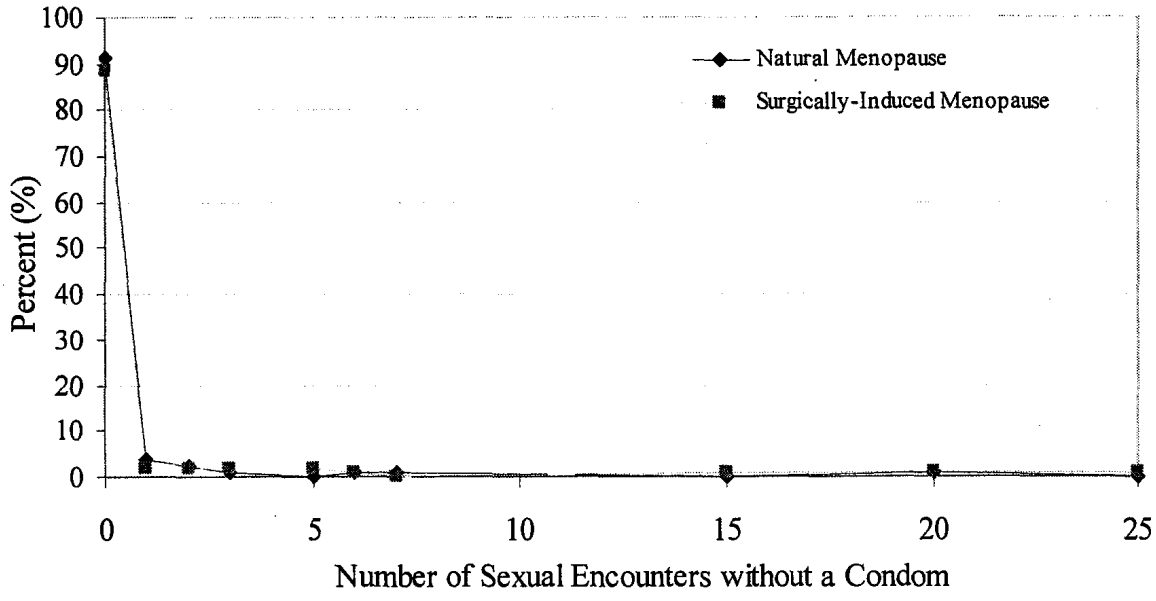


Figure 7. Frequency distribution of sexual encounters without a condom in the last 30 days in surgically-induced vs. natural post-menopausal women aged 49-59 from NHANES 2001-2004 (N=243).



Figures 5 through 7 show the frequency distribution of the sexual behaviour outcomes. Number of male sexual partners in the past 12 months ranged from 0 to 85 in the natural menopausal group and 0 to 9 in the surgically-induced menopausal group. Number of sexual partners in the past 30 days ranged from 0 to 2 in both groups. Number of sexual encounters without a condom in the past 30 days ranged from 0 to 20 in the natural menopausal group and 0 to 25 in the surgically-induced menopausal group.

Given the small cell sizes for two or more sexual partners in the past 30 days (n=5 for natural, n=3 for surgically-induced), it was deemed that power would be a significant issue for the logistic model comparing two or more versus one sexual partner in the past 30 days. Cell sizes were also small for number of times had sex without a condom in the past 30 days (n=12 for 1+ in both natural and surgically-induced). As such, these two logistic models were not conducted.

4.2.1 Number of male sexual partners in last 12 months, any vs. none

Table 20. Decision-making for independent variables in final model for number of male sexual partners in last 12 months (any vs. none) in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004 (N=694).

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Type of Menopause	Included in Final Model	Reason
Age	0.8238	77.61	Yes	Potential confounder
Ethno-racial group: Black	0.2078	24.37	Yes	Potential confounder
Ethno-racial group: Hispanic	0.2950	24.37	Yes	Potential confounder
Education	0.1032	73.44	Yes	Potential confounder
Marital Status	0.4025	-124.70	Yes	Potential confounder

Table 21. Adjusted and unadjusted weighted logistic regression models for number of male sexual partners in last 12 months (any vs. none) in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004 (N=694).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Type of Menopause (Surg. vs. Nat.)	0.0911	1.10	0.75	1.61	0.6424	-0.0404	0.96	0.61	1.51	0.8612
Age (50+ vs. <50)	-0.7586	0.47	0.30	0.74	0.0013*	-0.8106	0.45	0.28	0.71	0.0008*
Ethno-racial group (Black vs. White)	0.4022	1.50	1.02	2.20	0.0412*	1.1248	3.08	1.85	5.12	<.0001*
Ethno-racial group (Hispanic vs. White)	0.0231	1.02	0.58	1.80	0.9362	-0.0304	0.97	0.56	1.67	0.9126
Education (> HS. vs. HS or less)	-0.4213	0.66	0.43	1.00	0.0508	-0.6864	0.50	0.30	0.85	0.0096*
Marital Status (Partnered vs. Non)	2.3157	10.13	6.04	17.01	<.0001*	2.6192	13.72	7.63	24.68	<.0001*

Table 20 shows the decision-making process for selecting independent variables as either effect modifiers or confounders for the dependent variable number of male sexual partners in the last year (any vs. none). All independent variables were found to be likely confounders, so all were included in the final model. The percent changes in type of menopause parameter were 77.61% for age, 24.37% for ethnicity, 73.44% for education, and -124.70% for marital status.

The weighted, both unadjusted and adjusted, logistic regression models for the dependent variable number of male sexual partners in the last 12 months (any vs. none) are summarized in Table 21. The sample size included in the full model was n=694. The OR for surgically-induced versus natural post-menopause was 0.96 (CI 0.61, 1.51). This relationship was not significant (p=.8612). Age, non-Hispanic Black ethnicity, education and marital status were all significant in the final model (p=.0008, p=<.0001, p=.0096, p=<.0001).

4.2.2 Number of male sexual partners in last 12 months, two or more vs. one

Table 22. Decision-making for independent variables in final model for number of male sexual partners in last 12 months (2+ vs. 1) in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Type of Menopause	Included in Final Model	Reason
Age	0.6510	-7.89	No	
Ethno-racial group: Black	0.2719	-46.25	Yes	Potential confounder
Ethno-racial group: Hispanic	0.9830	-46.25	Yes	Potential confounder
Education	0.9118	-15.27	Yes	Potential confounder
Marital Status	0.4178	-88.03	Yes	Potential confounder

Table 23. Adjusted and unadjusted weighted logistic regression models for number of male sexual partners in last 12 months (2+ vs. 1) in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004 (N=495).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Type of Menopause (Surg. vs. Nat.)	-0.2547	0.78	0.37	1.63	0.5028	-0.5247	0.59	0.27	1.32	0.2010
Ethno-racial group (Black vs. White)	0.7273	2.07	1.04	4.13	0.0389*	-0.0042	1.00	0.42	2.37	0.9924
Ethno-racial group (Hispanic vs. White)	-0.4624	0.63	0.18	2.26	0.4775	-0.6516	0.52	0.11	2.49	0.4138
Education (> HS. vs. HS or less)	-0.2677	0.77	0.38	1.55	0.4583	-0.0350	0.97	0.43	2.16	0.9322
Marital Status (Partnered vs. Non)	-2.2195	0.11	0.05	0.23	<.0001*	-2.2717	0.10	0.04	0.27	<.0001*

Table 22 shows the decision-making for selecting independent variables as either effect modifiers or confounders for the dependent variable number of male sexual partners in last 12 months (2+ vs. 1). Ethnicity, education, and marital status were all found to be likely confounders, with percent changes in type of menopause parameter, respectively: -46.25%, -15.27, and -88.03%.

Table 23 summarizes the weighted, both unadjusted and adjusted, logistic regression models for the dependent variable number of male sexual partners in last 12 months (2+ vs. 1) in post-menopausal women. The sample size of the final model was n=495. The OR for surgically-induced versus natural post-menopause was 0.59 (CI 0.27, 1.32). This relationship is not significant (p=0.2010). Marital status was the only significant covariate in the final model (p=<.0001).

4.2.3 Number of sexual partners in last 30 days, any vs. none

Table 24. Decision-making for independent variables in final model for number of sexual partners in last 30 days (any vs. none) in surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Type of Menopause	Included in Final Model	Reason
Age	0.8957	57.71	Yes	Potential confounder
Ethno-racial group: Black	0.5074	10.71	Yes	Potential confounder
Ethno-racial group: Hispanic	0.2946	10.71	Yes	Potential confounder
Education	0.1973	62.70	Yes	Potential confounder
Marital Status	0.4468	-119.94	Yes	Potential confounder

Table 25. Adjusted and unadjusted weighted logistic regression models for number of sexual partners in last 30 days (any vs. none) in U.S. surgically-induced vs. natural post-menopausal women aged 40-59 from NHANES 2001-2004. (N=694).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Type of Menopause (Surg. vs. Nat.)	0.1083	1.11	0.76	1.64	0.5795	0.0050	1.01	0.66	1.54	0.9818
Age (50+ vs. <50)	-0.6693	0.51	0.33	0.80	0.0032*	-0.7109	0.49	0.30	0.79	0.0037*
Ethno-racial group (Black vs. White)	0.1877	1.21	0.81	1.81	0.3626	0.8942	2.45	1.44	4.16	0.0010*
Ethno-racial group (Hispanic vs. White)	-0.0241	0.98	0.55	1.73	0.9342	-0.0799	0.92	0.51	1.68	0.7929
Education (> HS. vs. HS or less)	-0.4311	0.65	0.45	0.95	0.0254*	-0.7475	0.47	0.30	0.75	0.0014*
Marital Status (Partnered vs. Non)	2.4315	11.38	7.27	17.81	<.0001*	2.7183	15.15	9.24	24.85	<.0001*

Table 24 shows the decision-making for selecting independent variables as either effect modifiers or confounders for the dependent variable number of sexual partners in last 30 days (any vs. none). All independent variables were found to be probable confounders, and as such, all were included in the final model. The percent changes in the type of menopause parameter for age, ethnicity, education and marital status are, respectively: 57.71%, 10.71%, 62.70% and -119.94%.

Table 25 summarizes the weighted, both unadjusted and adjusted, logistic regression models for the dependent variable number of sexual partners in the last 30 days (any vs. none) in post-menopausal women. The sample size for the final model was n=694. The OR for surgically-induced versus natural post-menopause was 1.01 (CI 0.66, 1.54). This relationship was not significant (p=.9818). Age, African-American ethnicity, education and marital status were all statistically significant in the final model (p=.0037, p=.0010, p=.0014, p=<.0001, respectively).

4.2.4 Type 2 herpes simplex virus seroprevalence

Table 26. Decision-making for independent variables in final model HSV-2 seroprevalence in surgically-induced vs. natural post-menopausal women aged 40-49 from NHANES 2001-2004.

	Effect Modifier Test	Confounder Test		
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model	Reason
Age	0.1696	-32.69	Yes	Potential confounder
Ethno-racial group: Black	0.7355	8.93	No	
Ethno-racial group: Hispanic	0.4974	8.93	No	
Education	0.6158	97.12	Yes	Potential confounder
Marital Status	0.3370	11.57	Yes	Potential confounder

Table 27. Adjusted and unadjusted weighted logistic regression models for HSV-2 seroprevalence in U.S. surgically-induced vs. natural post-menopausal women aged 40-49 from NHANES 2001-2004. (N=215).

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Type of Menopause (Surg. vs. Nat.)	0.2756	1.32	0.59	2.95	0.5028	0.1115	1.12	0.52	2.39	0.7742
Age (45+ vs. <45)	0.3100	1.36	0.59	3.15	0.4685	0.8500	2.34	1.02	5.36	0.0445*
Education (> HS. vs. HS or less)	-0.9076	0.40	0.19	0.88	0.0251*	-1.1429	0.32	0.16	0.64	0.0013*
Marital Status (Partnered vs. Non)	-1.5664	0.21	0.12	0.37	<.0001*	-1.6550	0.19	0.11	0.33	<.0001*

HSV-2 seroprevalence data was only available up to age 49.

Table 26 shows the decision-making for selecting independent variables as either effect modifiers or confounders for the dependent variable HSV-2 seroprevalence. Age, education and marital status were all found to be likely confounders, with percent changes in type of menopause parameter, respectively: -32.69%, 97.12%, and 11.57%.

Table 27 summarizes the weighted, both unadjusted and adjusted, logistic regression models for the dependent variable HSV-2 seroprevalence in post-menopausal women. The sample size of the final model was n=215. The OR for surgically-induced versus natural post-menopause was 1.12 (CI 0.52, 2.39). This relationship was not significant (p=0.7742). Age and education were significant in the final model (p=.0445, p=.0013).

Given the restricted sample size used in the HSV-2 sub-set analysis, additional Rao-Scott chi square analyses were conducted to determine whether the women included in this analysis differed significantly from the other women in the main project sample. It was found that the women in the HSV-2 sub-set were more likely to be younger, (p=<.0001), single, particularly divorced or never married (p=.0046), more likely to have more male sexual partners in the last 12 months (p=.0017), and more likely to have a greater number of sexual encounters in the last 30 days without a condom (p=.0110).

5.0 Discussion

5.1 Post- versus pre-menopause

The results of the first set of analyses comparing pre- and post-menopausal women were conducted to meet the primary research objective, that is, to investigate whether menopausal status was associated with the outcomes on number of sexual partners, condom use, and HSV-2 infection. Overall, the project sample was roughly divided in half with pre- and post-menopausal women. The pre-menopausal group tended to be younger, better educated, and was more likely to be married or never married, while the post-menopausal group was more likely to be older, have a lower education, and be widowed or divorced. None of these differences are unusual; rather they should be expected, given the similar patterns of demographics in adult women of the same age groups in the general population.

Overall, the rates of higher-risk sexual behaviour are relatively low and imply that most of these women are not at a high risk for new STI infection. Most women had had only one sexual partner in the recent past (78%), and did not have any sex without a condom in the past 30 days (87%). Eight percent of pre-menopausal and 5% of post-menopausal women reported having had more than one male sexual partner in the past 12 months. Thirteen percent of pre-menopausal women and only 3% of post-menopausal women had had 5 or more sexual encounters without a condom in the past 30 days.

5.1.1 Number of male sexual partners in last 12 months, any vs. none

The effect of menopausal status on having any male sexual partners in the last 12 months was different for the three ethno-racial groups, after accounting for age and

marital status. For Caucasian women, these results seem to agree with the literature which concludes that post-menopausal women are less likely to engage in sexual activity,[86] whether due to sexual dysfunction or for other reasons, and the prevalence of any male sex partners is still very high, over 75% for both pre- and post-menopausal women. For African-Americans, these results state that post-menopausal women were also less likely to have at least one male sexual partner post-menopause compared with pre-menopause, but to a lesser degree than other ethno-racial groups. While having one sexual partner in the past year does not necessarily indicate sexual risk, certainly these results on African-Americans implies that the potential for STI risk decreases more slowly post-menopause compared with other ethno-racial groups.

5.1.2 Number of male sexual partners in last 12 months, two or more vs. one

The second model on number of male sexual partners in last 12 months (2+ vs. 1) revealed no significant association with menopausal status, both crude and after adjusting for age, ethnicity, and marital status. In women who have had at least one male partner in the last year, menopausal status does not appear to influence whether women will have more than one male partner, after adjusting for age, ethnicity and marital status. Age and ethnicity also had no significant effect, and all three independent variables had fairly wide CIs.

5.1.3 Number of sexual partners in last 30 days, any vs. none

The analysis on the number of sexual partners in the last 30 days (any vs. none) revealed similar results to the model on the number of male sexual partners in the last 12 months, any vs. none. This model presents results that loosely agree with the results from

the first model on having any male sexual partners in the last 12 months. In both models, the effect of menopausal status varied by ethnicity, after accounting for age and marital status.

For Caucasian women, these results seem to agree with the results of the first model and with the literature concluding that post-menopausal women are generally less interested in sex and are less likely to engage in sexual activity.[86] The prevalence of any sex partners in the last 30 days as not as high for post-menopausal women here (68%) as it was for any male sex partners in the last 12 months (79%). These results likely indicate that Caucasian post-menopausal women are engaging in sexual activity less frequently than pre-menopausal women. For the non-Hispanic Black ethno-racial group interaction, the direction and magnitude of the non-significant effect agreed with that of the first model, that is, non-Hispanic Black post-menopausal women here are less likely to have any sexual partner in the past 30 days than pre-menopausal women, but to a lesser degree than other ethno-racial groups. Overall, this model indicates that having any sexual partners in the last month is negatively associated with menopausal status in Caucasian women, and has no significant association for African-American, Hispanic or other women.

5.1.4 Number of sexual encounters without a condom in last 30 days

This model of number of sexual encounters without a condom in the last 30 days (any vs. none) revealed a significant crude association with menopause and a non-significant association in the adjusted model which accounts for age, for the referent group of non-partnered women with high school education or less. This analysis also revealed a qualitative interaction between marital status, education level and the effect of

menopause on recent condom use. More specifically, the non-partnered post-menopausal women with a high school education or less were more likely to have had sex without a condom in the last month compared with pre-menopausal women; conversely, the non-partnered women with a higher education were less likely to have had sex without a condom in the last month compared with pre-menopausal women.

Thus education plays an important role in non-partnered women, as higher education appears to make non-partnered post-menopausal women less likely to have sex without a condom, and has the reverse effect for non-partnered post-menopausal women with a lower education. This finding seems to coincide with the literature that implies that a fear of pregnancy, not risk of STIs, may be the primary influence for safe sex in some pre-menopausal women,[5, 9] a fear that is removed with menopause.[9] The literature also suggested that older African-American women tend to have lower safe sex practices and poorer knowledge of STIs and condoms then Caucasians,[37,64] though ethnicity was not found to be a likely confounder or effect modifier for this particular analysis. Though the findings from this analysis are interesting and have significant implications, it is also important to recall that the effect of menopause on having sex at least once without a condom in the last 30 days was not significant and had a very wide CI, and as such these associations cannot be considered conclusive.

This model also has the issue of a reduced sample size. The additional analyses, which were conducted to determine the ways in which the condom usage sub-sample differed from the rest of the project sample, revealed that these women were more likely to be pre-menopausal, younger, and non-partnered. It is thus even more important to

interpret the results from this model with care, as they are more representative of a younger, pre-menopausal cohort than the rest of this project attempts to address.

5.1.5 Type 2 herpes simplex virus seroprevalence

Menopausal status has a significant association with the prevalence of HSV-2, as revealed in the adjusted logistic regression model on HSV-2 seroprevalence.

The results from this analysis present effect modification on the effect of menopausal status on the prevalence of HSV-2. Post-menopausal women with a high school education or less all had higher odds of being positive for HSV-2 compared with pre-menopausal women, in non-Hispanic White and Hispanic/other women, though the Hispanic/other interaction was not significant. In women with an education greater than high school, Caucasian post-menopausal women had similar odds of being HSV-2 positive compared with pre-menopausal women. The odds of non-Hispanic Black and Hispanic/other post-menopausal women were less than the non-Hispanic White and much lower than in the lower educated women. These results imply that menopause does not significantly influence whether African-American women will be HSV-2 positive, as both pre- and post-menopausal African-Americans have a very high unadjusted prevalence rate of HSV-2. Thus, education reduces the odds of being HSV-2 positive from pre- to post-menopause in all ethno-racial groups.

These findings coincide well with the literature in several ways. First, literature on physiological changes during menopause shows that post-menopausal women are more vulnerable to STIs.[89] The findings here indicate that a significant effect, where post-menopausal women are more likely to be HSV-2 positive than pre-menopausal women, which may be due in part to this physiologically increased vulnerability. This trend could

be influenced by increasing age, and the literature shows HSV-2 increases with age. [32] These findings show Hispanics and other minority groups have higher prevalence rates of STIs and STI risk behaviours than Caucasians, which the literature also supports,[7] and the analysis also revealed a very high unadjusted prevalence rate in non-Hispanic Blacks which coincides well with the literature.[37] Finally, education modified the influence of menopause on the prevalence of HSV-2, and level of education has been shown repeatedly to be positively associated with safer sex practices, which can reduce the risk of contracting HSV-2. [58]

The HSV-2 analysis also had a reduced sample size, though not as diminished as that of the condom usage analysis. Testing revealed significant differences between the group of individuals participating in this sub-set analysis compared with the others in the project sample. It was found that the HSV-2 sub-group were younger, more likely to be pre-menopausal and non-partnered. Also, HSV-2 data were only available up to the age of 49, whereas most of the analyses in this project involved a sample up to the age of 59. This difference from the HSV-2 sub-sample compared with the overall project sample makes it more difficult to extrapolate these results to all middle-aged and older women in the U.S.

5.2 Surgically-induced versus natural post-menopause

The results of the second set of analyses comparing surgically-induced versus natural post-menopausal women were conducted to meet the secondary research objective, that is, to investigate whether type of post-menopause is associated with the outcomes on number of sexual partners, condom use, and HSV-2 infection. Overall, the surgically induced-menopausal group tended to be younger, lower educated, more likely

to be non-Hispanic Black, while the natural post-menopausal group was more likely to be older, have a higher education, and be non-Hispanic White. The age difference makes sense, given that surgery must occur in younger participants before natural menopause occurs in order that menopause be considered surgically-induced. African-Americans tend to have lower education than Caucasians in the United States, however the reasons why non-Hispanic Black, lower educated women would be significantly more likely to have pre-menopausal hysterectomies or oophorectomies than non-Hispanic White, higher educated women is unknown, and may be a spurious relationship. The CDC released surveillance data on hysterectomies from 1994 to 1999 in the U.S. which showed that the overall estimated hysterectomy rate for African-Americans was 6.2 per 1,000 while the rate for Caucasians was 5.3 per 1,000, though these differences were not statistically significant.[96]

There were no significant differences in sexual behaviour or HSV-2 seroprevalence between the two groups of post-menopausal women. Most women had had only one sexual partner in the recent past (65%), and did not have any sex without a condom in the past 30 days (86%). Six percent of surgically-induced post-menopausal and less than 5% of natural post-menopausal women reported having had more than one male sexual partner in the past 12 months. Only 2% of surgically-induced post-menopausal women and 5% of post-menopausal women had has 5 or more sexual encounters without a condom in the past 30 days. Overall, these rates of higher-risk sexual behaviour are relatively low and imply that most of these women are not at a high-risk for STI infection.

5.2.1 Number of male sexual partners in last 12 months, any vs. none

In the model for number of male sexual partners in the last 12 months (any vs. none) natural post-menopause was associated with a lower likelihood of having had any male sexual partners compared with surgically-induced post-menopause, though this association was not significant. Age, non-Hispanic Black ethnicity, education, and marital status were all significant in the adjusted model, suggesting that younger, African-American, lower educated, and partnered women have significantly higher odds of having any male sexual partners in the past 12 months. Here, the findings on the influence of the covariates coincide well with the literature, but this analysis fails to reveal any significant results on the influence of type of menopause on the number of male sexual partners in the past year.

5.2.2 Number of male sexual partners in last 12 months, two or more vs. one

The second model on number of male sexual partners in last 12 months (2+ vs. 1) also revealed no significant association with type of menopause. It would seem that in post-menopausal women who have had at least one male partner in the last year, having surgically-induced or naturally-achieved menopause does not make women more or less likely to have more than one male partner, even after adjusting for ethnicity, education and marital status. Marital status remained the only significant covariate in the final adjusted model, with an adjusted OR of 0.10, meaning that partnered women were just 10% as likely to have more than one partner in the past year than non-partnered women. This association of marital status and recent number of sexual partners fits logically with what one would expect from most partnered individuals. However, again the type of

menopause does not appear to have any significant effect on whether post-menopausal women have one or more than one male sexual partner in the past year.

5.2.3 Number of sexual partners in last 30 days, any vs. none

The analysis on the number of sexual partners in the last 30 days (any vs. none) again failed to reveal a significant association with the type of menopause. Age, non-Hispanic Black ethnicity, education, and marital status were all significant in the adjusted model, suggesting that younger, African-American, lower educated, and partnered women have significantly higher odds of having any sexual partners in the past 30 days. Marital status is again the most significant covariate with an OR of over 15, which should be interpreted as partnered women being 15 times more likely to have a partner in the last month, after adjusting for menopausal status, age, ethnicity and education. Here, the findings on the covariates coincide well with the results from the literature, much like the results from the analysis on the number of male sexual partners in the last 12 months. Once again, this analysis does not reveal any significant results regarding the influence of type of menopause on the number of male sexual partners in the past year.

5.1.4 Type 2 herpes simplex virus seroprevalence

The model investigating the seroprevalence of HSV-2 also did not find a significant association with type of menopause, even after adjusting for age, education, and marital status. The other variables were all significant, implying that older, lower educated and non-partnered women were more likely to be HSV-2 positive than younger, higher educated and partnered women. These results from the covariates again coincide

well with the literature, but type of menopause did not appear to affect the seroprevalence of HSV-2.

This HSV-2 analysis once again had a reduced sample size. Testing revealed significant differences between the groups of individuals participating in this sub-set analysis compared with the project sample. It was found that the HSV-2 sub-group were younger, single, more likely to have had more male sexual partners in the past 12 months, and more likely to have more sexual encounters in the last 30 days without a condom. This is in addition to the fact that HSV-2 data were only available up to the age of 49, whereas most of the analyses in this project involved a sample up to the age of 59. This difference from the HSV-2 sub-sample compared with the overall project sample makes it more difficult to extrapolate these results to all middle-aged and older women in the U.S., and given the riskier nature of the sub-sample, likely over-estimates the STI risk of the original project sample.

5.3 Project Strengths

This project has several significant strengths. First, NHANES was conducted using strong data collection methods, which produce reliable and valid data, and limits vulnerability to common types of bias. The personal interviews were conducted using CAPI technology, which enforces consistent skip patterns and data coding. Given the sensitive nature of sexual behaviour, the NHANES used computer-assisted self interview technology for these types of questions. This encouraged a higher response rate and provided a safer environment to provide honest responses. Finally, the laboratory and physiologic data used by the NHANES are easier for researchers to interpret.

The NHANES Analytic Guidelines also describes its high standards of rigour in data collection to minimize non-sampling and measurement errors. Data collection protocols are extensive, and are developed and reviewed by the public health and scientific community. NHANES field staff participate in comprehensive training and annual refresher training for Interviewers and MEC staff, both prior to and during data collection. Extensive quality control procedures are also applied as data are collected. (NHANES) Thus, one can be confident that the NHANES data are as valid as reasonably possible, given normal human error and the effects of conducting a study in survey design.

Another characteristic of this study which can be considered a strength is the biologic plausibility of menopausal status as a causal factor influencing sexually risky behaviours. Despite the fact that this cross-sectional study is exploratory in nature and is the first of its kind to examine menopause as an influence on risky sexual behaviour, the NHANES dataset is sufficiently large that the power should have been satisfactory to achieve the primary study objective.

5.4 Project Limitations

Overall, NHANES can be considered a source of high quality data, though some sources of bias exist nonetheless. As with all surveys, NHANES self-report data are subject to issues such as recall bias and misunderstanding the question, resulting in differential misclassification. The data are also subject to non-sampling errors such as measurement error. There are also some differences in the survey questions in the two cohorts, 2001-2002 and 2003-2004. The most notable difference relevant to this project is that a survey question, from which the project definition of menopausal status was

derived, was worded differently from cycle to cycle; in 2001-2002, the question asked for the reason for not having *regular* periods in the last 12 months, whereas in the 2003-2004 cohort, the question asked for the reason for not having *any* periods within the last 12 months. This discrepancy makes this project definition of menopause less reliable, as women who would have been classified as menopausal in one cycle may not necessarily have been classified the same way in the other cycle.

Furthermore, there were issues in definitively determining type of post-menopause. The survey data provided enough information to reasonably conclude whether post-menopausal women had achieved menopause either naturally or by surgical means, although there was an assumption made that if menopause was not surgically-induced then it must have been achieved naturally. However, surgery is not the only possible reason for premature menopause; indeed, it was not possible to determine whether women had perhaps chemotherapy-induced post-menopause. Depending on the respondents' interpretation of the survey questions, a chemotherapy-induced post-menopausal woman could have been either classified as pre-menopausal since she could have responded that a medical condition prevented her from having any/regular periods in the last 12 months; see *Appendix B. NHANES Survey Questions.* Alternatively, she could have been classified as post-menopausal if she opted to simply respond that menopause was the reason for not having any/regular periods. There were 140 women in the project sample who indicated that they had medical conditions that influenced menstruation. An alternate approach for this project would have been to exclude these women from the sample and accept reduced generalizability in exchange for more easily interpreted results in the sub-analysis on type of post-menopause.

There are significant drawbacks to using secondary data. Ultimately, the data were collected for another purpose besides the project objectives at hand, and in some ways the NHANES data fail to fully meet the needs of this project. First, though the upper age limit of 59 years for individuals surveyed on sexual behaviours is higher than any known Canadian database, NHANES unfortunately still excludes a significant proportion of older adults who are potentially engaging in some form of risky sexual behaviours. The upper age limit of 49 years for the HSV-2 lab testing is even more age-restrictive than the sexual behaviour interview. It would likely be much easier to raise the upper age limit of the STI lab testing than it would be to raise it for the sexual behaviour interview, since blood samples are already collected from NHANES participants over the age of 49 for testing other physiological measures, whereas there are certain social challenges to overcome in asking sexual behaviour questions of older participants in a government-led population survey. More specifically, policy makers, researchers and health care professionals appear to be working under the false assumption that sexual health becomes unimportant or irrelevant with age, or that older adults are unwilling or afraid to discuss their sexual health; yet, the literature reveals that though frequency of sex decreases with age, sexuality and sexual health remain important to older adults, and furthermore, that many older adults are willing to engage in discussion if the opportunity is granted. [22,55] Future research on sexual health in Canada and the United States should purposefully encompass adults of all age groups to make up for the knowledge gap that exists in the literature.

Other project limitations arise from using a secondary data source. The sexual behaviour questions were less than ideal for this project. First, the sexual behaviour

interview used a skip pattern which only included those participants who had more than one partner in the past 12 months to respond to questions about the number of partners and the number of times has sex without a condom in the past 30 days. While it is acknowledged that this skip pattern was trying to isolate higher-risk individuals, it also thus limits the sample and makes the responses to these questions less applicable to the overall population. Also, while the question on condom usage provides useful information on the number of potential exposures to STIs, it fails to put the unsafe sexual encounters into context of overall sexual activity. This project would have benefited from a survey question investigating condom usage in proportion to total sexual activity. More specifically, it would be particularly beneficial to have data on condom use with partners of unknown or known positive STI status.

It was also difficult to assess the true relationship status of participants in using only marital status information. While marital status is a close proxy to relationship status, it assumes that marriage is monogamous, and it fails to account for the complex changes in relationship status that occur in dating, casual or even 'serious' or 'exclusive' dating relationships, changes which would undoubtedly affect sexual behaviour and thus be relevant for this project.

5.5 Implications and Conclusions

This project investigated whether post-menopausal women are at higher risk of STIs than pre-menopausal women, and whether the STI risk of post-menopausal women varies by whether menopause was achieved naturally or was surgically-induced. Several associations were found, overall. Menopausal status was associated with recent number of sexual partners, where Caucasian post-menopausal women were less likely to have any

recent partners compared with Caucasian pre-menopausal women, and where African-American post-menopausal women were also less likely to have any recent partners, compared with pre-menopausal African-American women, but to a lesser degree than Caucasians. It was revealed that non-partnered, lower educated post-menopausal women were over two times more likely to have had sex without a condom at least once in the past month compared with pre-menopausal women, though the influence of menopausal status on the number of sexual encounters without a condom was not significant. There was also a significant association with menopause and HSV-2 prevalence, where Hispanic post-menopausal women had nearly four times the odds of being HSV-2 positive compared with pre-menopausal women of the same ethnicity and education level. There was no significant difference between African-American pre- and post-menopausal women, but this should be considered with regard to the observed higher prevalence of HSV-2 in all African-Americans regardless of menopausal status. Type of menopause was not found to have a significant influence on any of the sexual behaviours nor for HSV-2 seroprevalence in post-menopausal women.

While the use of secondary data from NHANES introduced some limitations regarding defining project measures and extrapolating the results to all U.S. middle-aged and older women, nevertheless the NHANES data were a superior source to other possible Canadian or U.S. data sources since it had a higher age limit on sexual behaviour information and thus more accurately represented the study population. Indeed, this project was intended as an early exploration into the relatively untouched topic of menopausal status influencing sexual risk. It implies a need for more extensive research into the risky sexual behaviour and STI risk of middle-aged and older adults. It also

highlights the need for U.S. and Canadian databases with less restrictive upper age limits on sexual behaviour data collection.

Overall, this project draws attention to the concerning lack of adequate attention to the sexual health needs of older adults, the lack of literature, and a lack of data, government-initiated or otherwise. If health care professionals are to meet the sexual health needs of the growing proportion of middle-aged and older adults in the United States and Canada, the first steps must be for researchers to initiate discussion with older adults, and to place greater importance on gathering and disseminating sexual health behaviour data in adults of all ages.

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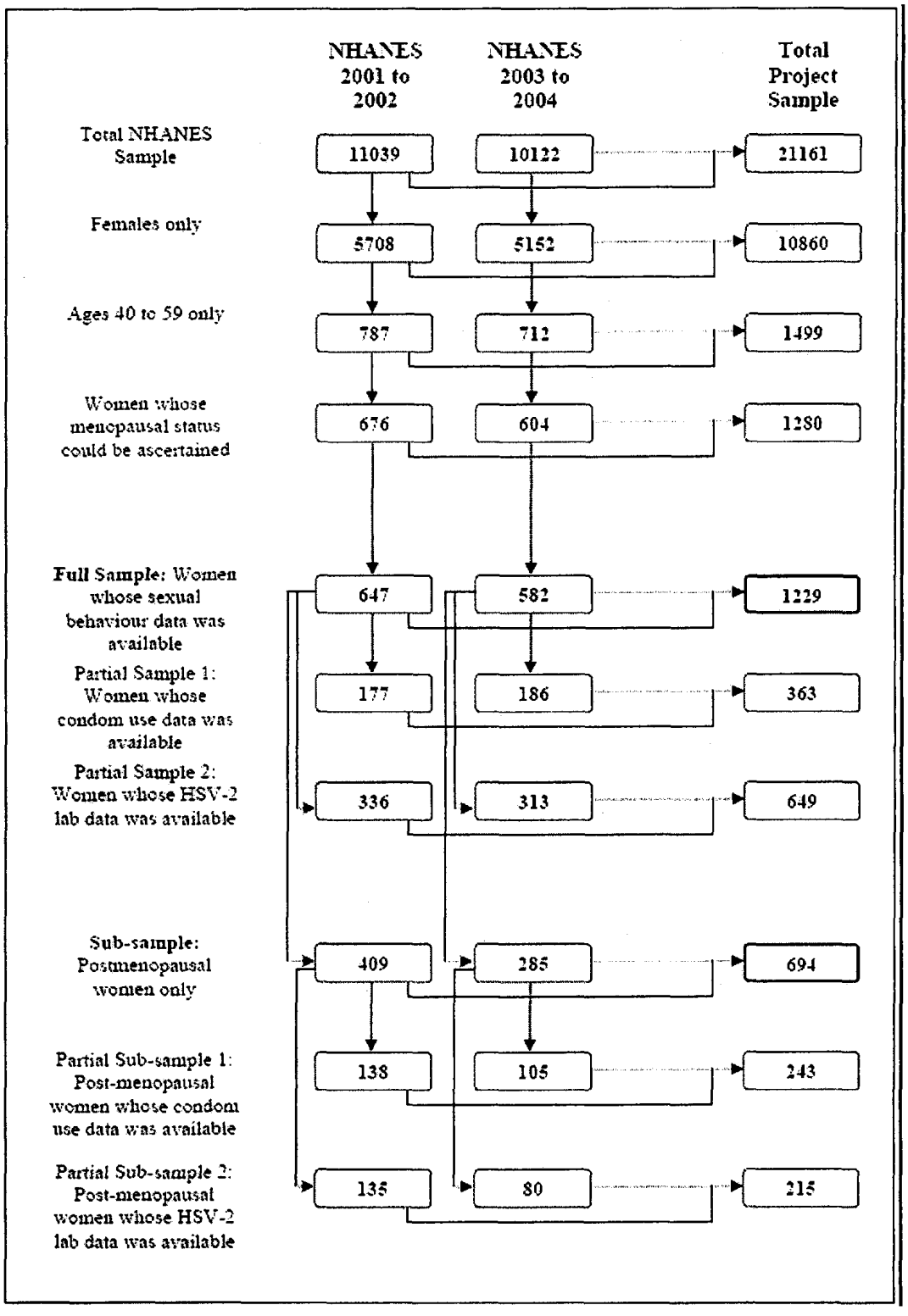
Appendix A. Derivation of the Project Sample Size

The following figure depicts the process used to derive the project sample size from the total NHANES sample available from cycles 2001-2002 and 2003-2004.



Appendix B. NHANES Survey Questions

Demographics

Gender – Acquired from Screener Module 1, 2001-2002/2003-2004

SCQ.101 (Ask if not obvious) Is {name of potential respondent} male or female?

Male.....1

Female.....2

Refused.....7

Don't know.....9

Ethnicity – Acquired from Screener Module , 2001-2002/2003-2004

SCQ.260 (Show Card 1) Do any of the groups on this card represent {your/{NAME}'s} national origin or ancestry?

Mexican-American/Mexican.....1

Other Hispanic or Latino.....2

Both Mexican and other Hispanic.....3

Not Hispanic (go to SCQ.270).....4

Refused.....7

Don't know.....9

SCQ.270 (Show Card 2) What race do you consider {yourself/NAME} to be? Please select one or more. Check all that apply.

American Indian or Alaskan Native.....1

Asian.....2

Black or African American.....3

Native Hawaiian or Pacific Islander.....4

White.....5
Other.....6
Don't know.....9
Refused.....7

Age – Acquired from Screener Module 1, 2001-2002/2003-2004

SCQ.290 What is {your/{NAME}'s} birth date?

_ _ _ _ _ _ _ _ MM DD YYYY
Refused.....77 77 7777 (go to SCQ.292)
Don't know..... 99 99 9999 (go to SCQ.292)

SCQ.292 About how old {are you/is NAME}?

_ _ age in years

Marital status – Acquired from Screener Module 2, 2001-2002/2003-2004

SFQ.180 {Is NAME/Are you} now married, widowed, divorced, separated, never married or living with a partner?

Married.....1
Widowed.....2
Divorced.....3
Separated.....4
Never married.....5
Living with partner.....6
Refused.....7
Don't know.....9

Education – Acquired from Demographics/Background/Occupation questionnaire, 2001-2002/2003-2004

DMQ.140 What is the highest grade or level of school {you have/NAME has} or the highest degree {you have/NAME has} received? (Hand card DMQ1 Read hand card categories if necessary.

Never attended/Kindergarten only.....0
1st grade.....1
2nd grade.....2
3rd grade.....3
4th grade.....4
5th grade.....5
6th grade.....6
7th grade.....7
8th grade.....8
9th grade.....9
10th grade.....10
11th grade.....11
12th grade, no diploma.....12
High school graduate.....13
GED or equivalent.....14
Some college, no degree.....15
Associate degree: Occupational, technical, or vocational program....16
Associate degree: Academic program.....17
Bachelor's degree (Example: BA, AB, BS, BBA).....18
Master's degree (Example: MA, MS, MEng, Med, MBA).....19
Professional school degree (Example: MD, DDS, DVM, JD).....20
Doctoral degree (Example: PhD, EdD).....21
Refused.....77
Don't know.....99

Sexual Behaviour (ACASI questionnaire)

Ever had sex, 2001-2002/2003-2004

The next set of questions is about your sexual behavior. By sex, we mean vaginal, oral or anal sex. Please remember that your answers are strictly confidential. Have you ever had sex?

Yes.....1
No.....2
Refused.....7
Don't know.....9

Male partners in last 12 months, 2001-2002/2003-2004

SXQ.220 In the last 12 months, with how many men have you had sex?

Verbal Instructions to SP: Please enter a number or enter zero for none.

– –
Refused.....77
Don't know.....99

Partners in last 30 days – asked only of those who had >1 partners in the last 12 months, 2001-2002/2003-2004

SXQ.241 In the past 30 days, with how many people have you had sex?

Verbal Instructions to SP: Please enter a number or enter zero for none.

– –
Refused.....77
Don't know.....99

Number of times had sex without a condom in last 30 days – asked only of those who had >1 partners in the last 12 months, 2001-2002/2003-2004

SXQ.250 In the past 30 days, how many times did you have sex without a condom?

Verbal Instructions to SP: Please enter a number or enter zero for none.

_ _

Refused.....77

Don't know.....99

Reproductive Health (CAPI questionnaire)

Regular periods – 2001-2002

RHQ.030 {Have you/Has NAME} had regular periods in the past 12 months? (Please do not include bleedings caused by medical conditions or surgeries.)

Yes.....1

No (go to RHQ.040).....2

Refused.....7

Don't know.....9

Reason for not having periods - 2001-2002

RHQ.040 What is the reason that {you have/NAME has} not had regular periods in the past 12 months?

Pregnant now.....1
Breast feeding.....2
Pregnant in past year.....3
Periods usually irregular.....4
Going/gone through menopause....5
Medical conditions/treatments.....6
Refused.....7
Don't know.....9

Any periods – 2003-2004

RHQ.030 {Have you/Has NAME} had at least one menstrual period in the past 12 months? (Please do not include bleedings caused by medical conditions, hormone therapy, or surgeries.)

Yes.....1
No (go to RHQ.042).....2
Refused.....7
Don't know.....9

Reason for not having periods - 2001-2002

RHQ.040 What is the reason that {you have/NAME has} not had a period in the past 12 months?

Pregnancy.....1
Breast feeding.....2
Menopause/hysterectomy.....7
Medical conditions/treatments.....8
Other.....9
Refused.....77
Don't know.....99

Time of last period – 2001-2002/2003-2004

RHQ.050 When did {you/NAME} have {your/her} last period?

Having it now.....1
Less than 2 months ago.....2
3-5 months ago.....3
6-8 months ago.....4
9-11 months ago.....5
12 or more months ago.....6
Refused.....7
Don't know.....9

Ever had hysterectomy - 2001-2002/2003-2004

RHQ.280 {Have you/Has NAME} had a hysterectomy, that is, surgery to remove {your/her} uterus or womb?

Yes (go to RHQ.290)....1
No.....2
Refused.....7
Don't know.....9

Age at hysterectomy - 2001-2002/2003-2004

RHQ.290 How old {were you/was NAME} when {you/she} had {your/her} (hysterectomy/uterus removed/womb removed)?

_ _ _ Enter age in years

Refused.....777

Don't know.....999

Ever had ovaries removed - 2001-2002/2003-2004

RHQ.300 {Have you/Has NAME} had at least one of {your/her} ovaries removed (either when {you/she} had {your/her} uterus removed or at another time)?

Yes (go to RHQ.310)....1

No.....2

Refused.....7

Don't know.....9

One or two ovaries removed - 2001-2002/2003-2004

RHQ.310 Were both ovaries removed or only one?

Both (go to RHQ.320)...1

One.....2

Refused.....7

Don't know.....9

Both ovaries removed at same time - 2001-2002/2003-2004

RHQ.310 Were both ovaries removed or only one?

Same time.....1

Different times.....2

Refused.....7

Don't know.....9

Age when ovaries were removed - 2001-2002/2003-2004

RHQ.330 How old {were you/was NAME} when {you/she} had {your/her} (ovary/ovaries) removed?

_ _ _ Enter age in years

Refused.....777

Don't know.....999

Age when ovaries were removed – Asked if RHQ.310 = 2, 2001-2002/2003-2004

RHQ.340 How old {were you/was NAME} when {you/she} had {your/her} (ovary/ovaries) removed?

_ _ _ Enter age in years

Refused.....777

Don't know.....999

Appendix C. Sensitivity Analysis of Age in the HSV-2 Model

Age is dichotomized as 40-49 / 50-59 years for all sexual behaviour outcome models, and dichotomized as 40-44 / 45-49 years for the HSV-2 models. By comparing age as continuous versus a dichotomous variable in the following tables, it is revealed that dichotomizing age in the HSV-2 pre- versus post-menopause logistic model does not alter the results. Age, in both cases, would not be selected as either an effect modifier or as a confounder.

Table 28. Effect modifier and confounder test results for age as a continuous and dichotomous variable in the HSV-2 pre- versus post-menopause analysis.

	Effect Modifier Test	Confounder Test	
Variable	p value for Interaction Variable	% change in β for Menopause	Included in Final Model
Age - continuous	0.4523	8.97	No
Age - dichotomized	0.5343	7.04	No

Going further, if age was included in the final logistic model, still the results would not be greatly altered. Tables 29, 30, and 31 show that the inclusion of age as either continuous or dichotomous does not yield any changes in significance, or important changes in p values or odds ratios.

Table 29. Adjusted and unadjusted weighted logistic models for HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40-49 from NHANES 2001-2004 (N=649). (Duplicate of Table 13)

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	0.3579	1.43	0.97	2.11	0.0718	0.8983	2.46	1.24	4.88	0.0103*
Ethno-racial group (Black vs. White)	1.8775	6.54	4.02	10.62	<.0001*	1.8904	6.62	4.03	10.89	<.0001*
(Black vs. White) x Menopause	-0.8673	0.42	0.19	0.92	0.0291*	-0.9098	0.40	0.18	0.92	0.0306*
Ethno-racial group (Hispanic vs. White)	0.5138	1.67	0.94	2.98	0.0820	0.5292	1.70	0.93	3.09	0.0829
(Hispanic vs. White) x Menopause	0.4961	1.64	0.67	4.00	0.2750	0.4588	1.58	0.64	3.91	0.3196
Education (> HS. vs. HS or less)	-0.1000	0.91	0.56	1.47	0.6877	0.0733	1.08	0.65	1.78	0.7752
Education x Menopause	-0.8077	0.45	0.21	0.94	0.0328*	-0.9572	0.38	0.18	0.82	0.0131*

Table 30. Adjusted and unadjusted weighted logistic models for HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40-49 from NHANES 2001-2004 (N=649), including dichotomous age covariate.

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	0.3579	1.43	0.97	2.11	0.0718	0.8777	2.41	1.22	4.76	0.0117*
Age (45+ vs. <45)	0.1742	1.19	0.82	1.72	0.3564	0.1764	1.19	0.81	1.76	0.3711
Ethno-racial group (Black vs. White)	1.8775	6.54	4.02	10.62	<.0001*	1.8946	6.65	4.01	11.03	<.0001*
(Black vs. White) x Menopause	-0.8673	0.42	0.19	0.92	0.0291*	-0.9060	0.40	0.18	0.93	0.0323*
Ethno-racial group (Hispanic vs. White)	0.5138	1.67	0.94	2.98	0.0820	0.5372	1.71	0.94	3.12	0.0800
(Hispanic vs. White) x Menopause	0.4961	1.64	0.67	4.00	0.2750	0.4226	1.53	0.60	3.88	0.3740
Education (> HS. vs. HS or less)	-0.1000	0.91	0.56	1.47	0.6877	0.0739	1.08	0.65	1.79	0.7756
Education x Menopause	-0.8077	0.45	0.21	0.94	0.0328*	-1.0024	0.37	0.17	0.78	0.0086*

Table 31. Adjusted and unadjusted weighted logistic models for HSV-2 seroprevalence in U.S. post- vs. pre-menopausal women aged 40-49 from NHANES 2001-2004 (N=649), including continuous age covariate.

	Unadjusted					Adjusted				
			95% CI for OR					95% CI for OR		
Variable	β	OR	Lower	Upper	p value	β	OR	Lower	Upper	p value
Menopausal Status (Post vs. Pre)	0.3579	1.43	0.97	2.11	0.0718	0.8630	2.37	1.19	4.73	0.0143*
Age (continuous)	0.0341	1.04	0.96	1.12	0.4058	0.0265	1.03	0.95	1.12	0.5260
Ethno-racial group (Black vs. White)	1.8775	6.54	4.02	10.62	<.0001*	1.8918	6.63	4.02	10.94	<.0001*
(Black vs. White) x Menopause	-0.8673	0.42	0.19	0.92	0.0291*	-0.8936	0.41	0.18	0.94	0.0343*
Ethno-racial group (Hispanic vs. White)	0.5138	1.67	0.94	2.98	0.0820	0.5275	1.70	0.93	3.09	0.0845
(Hispanic vs. White) x Menopause	0.4961	1.64	0.67	4.00	0.2750	0.4370	1.55	0.62	3.90	0.3536
Education (> HS. vs. HS or less)	-0.1000	0.91	0.56	1.47	0.6877	0.0742	1.08	0.65	1.79	0.7734
Education x Menopause	-0.8077	0.45	0.21	0.94	0.0328*	-0.9823	0.37	0.18	0.78	0.0092*