

**TRAJECTORIES OF RISKY SEXUAL BEHAVIOR, DEPRESSIVE SYMPTOMS, AND
SUBSTANCE USE IN A COHORT OF MIDDLE-AGED AND OLDER ADULTS IN THE
PITT MEN'S STUDY**

by

Sin How Lim

BSc, National University of Singapore, 1998

MS, University of New Haven, 2003

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This dissertation was presented

by

Sin How Lim

It was defended on

March 26, 2009

and approved by

Dissertation Advisor:

Anthony J. Silvestre, Ph.D.

Professor

Department of Infectious Diseases and Microbiology, Graduate School of Public Health,
University of Pittsburgh

Committee Members:

Kevin H. Kim, Ph.D.

Associate Professor

Department of Education in Psychology, School of Education,
University of Pittsburgh

Nina Markovic, Ph.D.

Associate Professor

Department of Epidemiology, Graduate School of Public Health,
University of Pittsburgh

Ronald D. Stall, Ph.D.

Chair and Professor

Department of Behavioral and Community Health Sciences, Graduate School of Public Health,
University of Pittsburgh

Anthony J. Silvestre, Ph.D.

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There is a general misperception that sexuality and sexual orientation are not important in the lives of older adults. Older gay and bisexual men remain an invisible population in which health behaviors and health status are less well-known. While an enormous body of research has documented the disparities of substance use, depression, and HIV prevalence among Men who have Sex with Men (MSM) compared to heterosexual men, less is known about how patterns of substance use, depression, and risky sexual behavior evolve as MSM age.

Using a semi-parametric, group-based approach, this study investigated the effect of aging on risky sexual behavior, depression, and illicit drug use in a cohort of middle-aged and older MSM in the Pitt Men's Study.

In the three presented manuscripts, results indicate that the majority of participants did not have unprotected anal intercourse partners or use illicit drugs, and reported very low depressive symptoms across the age range of the study. At the same time, the analysis identified trajectory groups with respect to midlife exposure to risky sexual behavior, chronic depressive symptoms, and multiple illicit drug use. Several correlates such as socio-demographic variables,

health behaviors (smoking and binge drinking), and psychological variables (HIV-related attitudes) were differentially associated with the trajectory groups.

The results of the study refuted the negative stereotypes of older gay and bisexual men as “sad, undesirable, and depressed”, yet the study managed to provide a more realistic picture of the development of mental health and HIV risk behaviors of this cohort from middle to early old age. This confirms the diversity and heterogeneity of this population noted by previous researchers.

Public Health Significance: Using this epidemiologic approach, future researchers can identify subgroups of men who are at most risk for depression, substance abuse, and risky sexual behaviors over an extended period of time. As a result, public health resources such as prevention and intervention programs can be allocated to these men in a cost-effective way. In addition, investigations of the risk factors associated to each trajectory group may give clues to different etiologies of group characteristics among a cohort of aging sexual minorities.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	x
1.0 INTRODUCTION.....	1
1.1 DISSERTATION OVERVIEW AND OBJECTIVE	1
1.2 BACKGROUND AND SIGNIFICANCE	3
1.2.1 The Study Population: Description and Definition.....	4
1.2.2. Contextual Factors in Research in Older Gay Men.....	6
1.2.3 Developmental Theories for Older Gay Men	11
1.2.4 Sexuality and Risky Sexual Behavior among Older Adults	14
1.2.5 Sexuality and Risky Sexual Behavior among Older MSM.....	17
1.2.6 Depression among Older Adults	19
1.2.7 Depression among Older MSM	22
1.2.8 Co-occurrence of Depression and Substance Use	27
1.2.9 Substance Use among Older MSM.....	28
1.2.10 Limitations of Existing Literature.....	31
1.2.11 TABLES.....	33
1.2.12 FIGURE	48
2.0 ARTICLE ONE: DIFFERING TRAJECTORIES OF HIV RISKY SEXUAL BEHAVIOR AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO HAVE SEX WITH MEN (MSM)	49
2.1 ABSTRACT	50
2.2 INTRODUCTION.....	51
2.3 METHODS	55
2.3.1 Study Sample.....	55
2.3.2 Measures	56
2.3.3 Statistical Analyses.....	59

2.4	RESULTS	61
2.5	DISCUSSION	66
2.6	TABLES.....	72
2.7	FIGURES.....	76
2.8	REFERENCES.....	77
3.0	ARTICLE TWO: CHANGING TRAJECTORIES OF DEPRESSIVE SYMPTOMS AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO HAVE SEX WITH MEN (MSM)	80
3.1	ABSTRACT.....	81
3.2	INTRODUCTION.....	82
3.3	METHODS	85
3.3.1	Study Sample.....	85
3.3.2	Measures	86
3.3.3	Statistical Analyses.....	89
3.4	RESULTS	90
3.5	DISCUSSION	95
3.6	TABLES.....	101
3.7	FIGURES.....	105
3.8	REFERENCES.....	106
4.0	ARTICLE THREE: TESTING THE CO-OCCURRENCE OF DEPRESSIVE SYMPTOMS AND MULTIPLE ILLICIT DRUG USE AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO HAVE SEX WITH MEN (MSM).....	110
4.1	ABSTRACT	111
4.2	INTRODUCTION.....	112
4.3	METHODS	114
4.3.1	Study Sample.....	114
4.3.2	Measures	115
4.3.3	Statistical Analyses.....	117
4.4	RESULTS	119
4.5	DISCUSSION	124
4.6	TABLES.....	128

4.7	FIGURES.....	132
4.8	REFERENCES.....	134
5.0	GENERAL DISCUSSION	138
5.1	SUMMARY OF FINDINGS	138
5.2	PUBLIC HEALTH SIGNIFICANCE.....	141
5.3	FUTURE RESEARCH.....	143
5.4	CONCLUSION	145
	BIBLIOGRAPHY	146

LIST OF TABLES

Table 1 Characteristics on empirical studies of older gay men	33
Table 2 Results of the reviewed studies of older gay men	37
Table 3 Selection criteria of the study	72
Table 4 Bayesian Information Criteria (BIC) for two-group to seven-group models	72
Table 5 Four-group model: Group assignment based on the average posterior probabilities (<i>AvePP_j</i>) of group membership and Odds of Correct Classification	73
Table 6 Five-group model: Group assignment based on the average posterior probabilities (<i>AvePP_j</i>) of group membership and Odds of Correct Classification.....	73
Table 7 Socio-demographic, behavioral, and psychosocial characteristics of each group	74
Table 8 Selection criteria for the study	101
Table 9 Bayesian Information Criteria (BIC) for two-group to four-group models	101
Table 10 Three-group model: Group assignment based on the average posterior probabilities (<i>AvePP_j</i>) of group membership and Odds of Correct Classification	102
Table 11 Four-group model: Group assignment based on the average posterior probabilities (<i>AvePP_j</i>) of group membership and Odds of Correct Classification	102
Table 12 Socio-demographic, behavioral, and psychosocial characteristics of each group	103
Table 13 Selection criteria for the study	128
Table 14 Bayesian Information Criteria for two-group to six-group models.....	129
Table 15 Group assignment based on the average posterior probabilities (<i>AvePP_j</i>) of group membership and Odds of Correct Classification	129
Table 16 Socio-demographic, behavioral, and psychosocial characteristics of multiple illicit drug use trajectory group.....	130
Table 17 Cross-tabulation of group membership of trajectory of multiple illicit drug use with group membership of trajectory of CES-D scores	131

LIST OF FIGURES

Figure 1 Syndemic production of health problems among older gay and bisexual men.....	48
Figure 2 Estimated trajectories of number of unprotected anal intercourse (NUAI) partners from age 42.5 to 62. Group 1, low exposure group (48.0%); Group 2, decreasing exposure group (19.3%); Group 3, midlife exposure (14.6%); Group 4, high exposure group (18.1%); total n = 259. Dash lines represent the 95% confidence intervals on trajectories.	76
Figure 3 Trajectories of CES-D scores. Group 1, well-adjusted group (44.7%, n=122); Group 2, mildly depressed group (39.2%, n=108); Group 3, chronically depressed group (16.1%, n=45); total n = 275. Dash lines represent the 95% confidence intervals on trajectories	105
Figure 4 Trajectory of multiple illicit drug use. Group 1, “No use group” (44.5%, n=124); Group 2, “Single drug group” (36.7%, n=102); Group 3, “multiple drug group” (18.9%, n=47); total n = 273. Dash lines represent the 95% confidence intervals on trajectories	132
Figure 5 Trajectory of CES-D scores. Group 1, “Not depressed group” (45.1%, n=122); Group 2, “Mildly depressed group” (38.5%, n=106); Group 3, “Chronically depressed group” (16.3%, n=45); total n = 273. Dash lines represent the 95% confidence intervals on trajectories.....	133

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1.0 INTRODUCTION

1.1 DISSERTATION OVERVIEW AND OBJECTIVE

Older gay and bisexual¹ men comprise a marginalized and underserved population. These individuals are generally invisible to the mainstream media and there is a paucity of research on their health and medical conditions. Understanding the aging experiences of gay and bisexual men is important for many reasons: for providing role models for younger gay men, for gerontologists who wish to examine the diversity among elders, and for public health professionals who wish to design culturally competent health services and prevention or intervention programs for this population. Older gay and bisexual men, in addition to experiencing the same geriatric problems as the general elderly population, may be at greater risk for HIV/AIDS, other sexually transmitted diseases, depression, and alcohol and drug abuse due to differential risk factors in the MSM (Men who have Sex with Men) communities (2008). The differential risk factors could be explained, in part, by many contextual and social factors: stigma and discrimination, isolation from their community and families, and barriers to receive health services.

While previous research has reported the resiliency of these individuals, trajectories of sexual behavior, mental health and health behaviors, to our knowledge, have not been studied. The overarching goal of this dissertation is to examine clearly defined aspects of the aging experience among gay and bisexual men. Specifically, the three related dissertation projects

¹ The dissertation employs the term “gay and bisexual” and “Men who have Sex with Men (MSM)” interchangeably but I recognize that MSM only specifies sexual behavior and includes men who do not identify themselves as gay or bisexual

examine the effects of aging on risky sexual practices, depression, and illicit drug use in a cohort of older men who have sex with men (MSM) using an innovative longitudinal statistical model.

The three dissertation papers identify trajectories of the following:

- 1) Risky sexual behavior, defined as number of unprotected anal intercourse partners from middle to early old age among Men who have Sex with Men (MSM) and describe the characteristics that can distinguish the trajectory groups
- 2) Depressive symptoms, measured by The Center for Epidemiologic Studies Depression Scale (CES-D) from middle to early old age among Men who have Sex with Men (MSM) and describe the characteristics that can distinguish the trajectory groups
- 3) Multiple illicit drug use from middle to early old age among Men who have Sex with Men (MSM) and test if the trajectories of multiple illicit drug use co-occur with the trajectories of depressive symptoms

The three manuscripts that form this dissertation uses the life-course perspective to add to the literature on sexual orientation and health, and to extend our understanding of the interactions of sexual minority status, health, and aging using a modern statistical epidemiological analysis.

1.2 BACKGROUND AND SIGNIFICANCE

How do gay and bisexual men age? Do all older gay men conform to the negative stereotypes as lonely, desolated, and depressed? Older gay men, much alike to the men in general population, comprise a heterogeneous group. The diversity in the life-course experiences in this population has been recognized (Herdt, Beeler, & Rawls, 1997). However, knowledge on patterns of aging experience in this cohort is lacking. The existing models of adult development and aging are heteronormative and based exclusively on heterosexual persons. Gay men may face different developmental issues across the life span compared with heterosexual men. One thing that is certain is that a number of contextual factors such as sociopolitical and cultural attitudes towards sexual minorities will always have profound influence on the developmental and aging experience of this population.

As gay men grow older, they may have to overcome additional developmental tasks, which involve a complex interaction of the personal evaluation of aging and feedback by the socio-environment. Development may “differ across individuals, with historical time, culture and ecological circumstances, and within individuals as function of development and experience” (Wahler & Gabbay, 1997). In addition, other individual-level characteristics such as race or ethnicity, socioeconomic status, childhood, adolescent and adulthood experiences, gay identity development, physical health and mental health status may impact the aging experience of older gay men. By examining the trajectories of risky sexual behavior, depressive symptoms, and substance use in a cohort of aging gay and bisexual men, this dissertation hopes to add to the knowledge of the adult development of gay and bisexual men.

1.2.1 The Study Population: Description and Definition

An accurate estimate of the magnitude of this population is difficult because few national surveys consider sexual orientation. Moreover, sexual orientation is a multidimensional concept involving the interaction of several constructs: sexual attraction, desires, behavior, fantasies, and self-identity (E.O. Laumann, Gagnon, Michael, & Michaels, 1994). These different markers do not correlate completely and the use of different measures of sexual orientation will almost certainly yield different estimates of the size lesbian, gay, and bisexual (LGB) population. The concern about “coming-out” to the researchers and the bias of not reporting a perceived socially undesirable behavior and identity certainly underestimates the prevalence of same-sex orientation.

Based on the few existing studies on sexual orientation, the estimates of gay, lesbian, and bisexual (LGB) population in the United States range from 3% to 8% (Kinsey, Pomeroy, & Martin, 1948; E.O. Laumann, et al., 1994; Sell, Wells, & Wypij, 1995). Assuming that this proportion of sexual minority status remains the same in the adults above age of 65, there would be 1 to 2.8 million LGB seniors in America (Cahill, South, & Spade, 2000). Gates (2004) estimated that about 2.4 million Americans over the age of 55 are LGB individuals. This estimate was calculated by multiplying the 8.8 million LGB adults in America by the proportion of individuals in the same-sex couples who were over 55 of age (The National Survey of Family Growth found that 4.1% of adults are LGB and The American Community Survey found about 26% of individuals in the same-sex couples were above age 55) (personal communication, Gates, 2008).

With the aging of the “baby boomers” generation, there will be a dramatic increase in the older LGB population. By 2030, it is estimated that there will be between 2 million to 6 million LGB seniors in America (Cahill, et al., 2000). Hence, the need to understand the health issues and health care needs of this population has never been greater. While substantial health disparities, especially with respect to sexually transmitted disease, mental health, alcohol, tobacco and drug use have been reported among gay and bisexual men of all ages compared to heterosexual men (Wolitski, et al., 2008), less is known about the health of older gay and bisexual men specifically.

There are several reasons for the paucity of research on this population. First, the attitude towards sexuality and aging in our society has been negative and has hindered general discussion on this topic (Hillman, 2000). Second, pervasive anti-homosexual bias has resulted in a general denial of the existence of the sexual minorities, both in general population and research (Grossman, 2008). Older LGB individuals have been ignored by traditional gerontological survey research, in which measures of sexual orientation have rarely been included. Moreover, perceived hostility against sexual minorities may discourage many older gay men from participating in research that would require them to self-identify as gay. These individuals are generally invisible in the mainstream society for reasons of self-preservation and survival (Grossman, 2008). Consequently, knowledge of the demographic profile and health of older gay and bisexual men is scarce.

Table 1 and Table 2 show the empirical studies published in peer-reviewed journals and book chapters in major publications on LGB aging. Various research methods, including one-on-one interviews, focus groups, and questionnaires have been employed to solicit information about health and aging experience of this population. In order to recruit a more diverse sample of

participants, previous investigators have recruited participants from various sources such as gay organizations, gay bars, friendship networks, and through gay newspaper advertising.

Most previous studies have focused on the social aspects and psychosocial adaptations among older gay men. The earlier research studies began by challenging the stereotypes of older gay men as being unwanted, lonely, depressed and isolated. After positive features of aging experience has been reported, a few researchers began to examine the underlying protective processes of aging, such as social relationships among the older sexual minorities. The more recent research has concentrated on identifying the needs for health services and social programs for this population (Boxer, 1997).

1.2.2. Contextual Factors in Research in Older Gay Men

Historical Context

The historical context plays an important role in shaping the life and experiences of sexual minorities (A.R. D'Augelli & Patterson, 1995; Kimmel, Rose, Orel, & Green, 2006). The current population of older gay men grew up in the environment and socio-political culture that holds the views that homosexuality was pathological, sinful and immoral. Homosexual acts were considered a crime and gay bars which served as one of the few social opportunities for gay men and lesbians were often raided by police. The commonly held belief that gay men were generally maladjusted and experienced psychological disorders was refuted by Hooker's groundbreaking study, which found no differences in psychological adjustment between homosexual and heterosexual men (Hooker, 1956). It was after the 1969 Stonewall Riot in Greenwich Village, New York City, marked the dawn of the modern gay liberation movement. It was not until 1973, because of the cultural change and pressure from gay activists, that the American Psychiatric

Association removed homosexuality from the Diagnostic and Statistical Manual of Mental Health Disorders.

It has been documented that gay men who grew up and socialized in different historical periods have different attitudes towards homosexuality and different ways to construct their identities (Kochman, 1997; Rosenfeld, 1999). The older gay men who were born in the 1920s and who came of age before the 1969 Stonewall Riot have lived most of their lives in a very homophobic environment. This generation of individuals, known as the pre-Stonewall generation, may choose to live very quiet, discreet lives and are largely invisible. Many of them conformed to the social pressure to get married, and some were hiding their sexual orientation. There is evidence that these men were more likely to internalize homophobia (Grossman, D'Augelli, & O'Connell, 2001), less likely to embrace their sexual identity (“come-out”) (Floyd & Bakeman, 2006), and more likely to sustain their stigmatization and victimization related to homosexuality (Meyer, Dietrich, & Schwartz, 2007). These individuals were also less likely to disclose their sexual orientation for fear of discrimination and rejection of health services (Brotman, Ryan, & Cormier, 2003; Clover, 2006). However, the generation of gay men who came of age after the Stonewall riot, who now aged 50 years and older, are more open about their sexual orientation compared to the pre-Stonewall generation. The post-Stonewall generation of gay men, who will be part of the first class of baby boomers retiring in 2010 and thereafter, will be more likely expect health services and social support systems tailored to their needs (Cahill, et al., 2000).

The emergence of the AIDS epidemic in the early 1980s is another historical event that has had profound impact on this population. A large population of gay and bisexual men was depleted by the disease, and the survivors experienced the grief over the loss of friends and

lovers. The long-term impact of the epidemic on this generation is yet unknown. Issues such as health care needs, burdens of care, and “survival guilt” may impact the mental health of these individuals in later life. It can be argued that those who survived the AIDS epidemic may be different in psychosocial characteristics from those who died from HIV/AIDS. For example, those who died from HIV/AIDS may be more likely to have led a high-risk lifestyle and/or have been lacking of protective support system compared to those who survived the epidemic. Moreover, some of those who were infected in the late 1980s and early 1990s are surviving because of the availability of the highly-active antiretroviral therapy. Although we cannot determine this survival bias of this generation of gay men, it is a potential bias that cannot be ignored. It is also generally believed that the cohort effects largely explain the generational differences among older and younger gay men in sexual behavior and mental health observed in previous studies.

Heterosexism and Homophobia

By and large, older sexual minorities live in the social environment of heterosexism. Herek (1990) defines heterosexism as “an ideological system that denies, denigrates and stigmatizes any non-heterosexual form of behavior, identity, relationship or community”. The origin of discrimination against LGB individuals rests on at least two assumptions: (1) “natural laws”—that same-sex orientation is “unnatural” to God’s law, and sexual activities between two same-sex persons are crimes against nature (2) Homosexual people can and should become heterosexual. A similar term to heterosexism is homophobia. The stigma, social stress, and discrimination as a result of heterosexism and homophobia have resulted in common minority stress that LGB individuals endure (Diplacido, 1998; Meyer, 2003). These social stressors,

together with structural factors such as inadequate assessment, prevention, and treatment programs may result in the health disparities in this population.

Research has documented cases of heterosexism and homophobia against older sexual minorities ranging from hate-crime victimization (Balsam, Rothblum, & Beauchaine, 2005; Morrow, 2001) and discrimination in health services (Brotman, et al., 2003) to a lack of legal protection for same-sex couples (Cahill, et al., 2000). Meyer and Dean (1998) defined internalized homophobia as “the gay person’s direction of negative social attitudes towards self, leading to devaluation of the self and resultant internal conflicts and poor self-regards”. Research has shown the older gay men, especially those who came of age before the Stonewall-era were more likely to internalize homophobia (Cahill, et al., 2000). Internalized homophobia, fear of discrimination and unequal treatment has fostered a sense of vigilance in maintaining secrecy over sexual orientation among older gay men. These individuals are afraid to disclose their sexual orientation to health care providers, which has promoted a general invisibility of older gay men and lesbians in the health care system.

In a survey study of 416 LGB adults aged 60 and older, D’Augelli and Grossman (2001) found that victimization was common in the older LGB people in their study. Two-thirds had experienced verbal abuse based on their sexual orientation in their lifetime, 29% had been threatened with violence, and 16% had been assaulted because of their sexual orientation. More physical attacks were also associated with negative psychological sequelae such as lower self-esteem, more loneliness, and more mental health problems (A. R. D’Augelli & Grossman, 2001). Some older LGB individuals, having lived in a homophobic environment most of their lives, are used to hiding their sexual orientation and may under-report victimization (Balsam & Daugelli, 2006; Cook-Daniels, 1997). As they become more dependent on others for their needs of daily

living, LGB elderly may become vulnerable to abuse and victimization. For example, the *New York Times* recently reported that currently LGB elderly are facing prejudice and discrimination in nursing care facilities (Gross, 2007).

Ageism

As they are aging, gay elderly face additional stigma due to ageism, defined as set of negative attitudes or over discrimination based on age (Butler, 1969). Butler described three aspects of ageism as

(1) Prejudicial attitudes toward the aged, toward old age, and toward the aging process, including attitudes held by elderly themselves

(2) Discriminatory practices against the elderly, particularly in employment, but in other social roles as well

(3) Institutional practices and policies which, often without malice, perpetuate stereotypic belief about the elderly, reduce their opportunities for satisfactory life, and undermine their personal dignity

It is generally believed that gay male communities put a greater emphasis on youth compared to the society at large (Gagnon & Simon, 1973). Youthfulness is widely believed to be necessary for socio-sexual success (M.S. Weinberg, 1970). Older gay men are not short of derogatory labeling, they are often referred as “dirty old men”, “old queens”, “menopausal queens” (Francher & Henkin, 1973). One researcher even found that older gay men were ridiculed within the gay communities as the “fagots’ fagots” (Kochera, 1973). The prevalent myth describes these individuals as senile, incapable of having satisfactory sex lives, depressed and lonely (Kelly, 1977). The assumptions of the myth are such that gay men lose their strength,

physical attractiveness, sexual potency, and cannot find a life partner, or will be lonely when they become older.

Kooden (1997) observed, from his psychotherapy clients, that internalized ageism occurs when “an individual accepts and incorporates cultural negative attitudes about aging into his self-identification”. Many older gay men may internalize “ageism” and become less active in gay community affairs and prefer a social space that is secluded from the gay community (M. S. Weinberg & Williams, 1974). In Hosteler’s (2004) study of 94 self-identified single gay men 35 and older (mean age = 52), older age was associated with aging concerns, even after adjustment of race, income, social support, acceptance of and satisfaction with single status, and perceived likelihood of future partnership. In a sample of 185 gay men and lesbians, both young and older gay men were found to have more negative attitudes toward aging compared with lesbians due to more concern about loss of physical appearance in gay men (Schope, 2005). In addition, negative attitudes among gay men towards aging bodies may lead to marginalization of these individuals (Jones & Pugh, 2005)

Kimmel (1978) observed that the lack of role models of gay parents or gay great-parents and lack of information about gay adult development, compounded with the stigma of homosexuality and ageism have resulted the highly negative views on gay male aging. The double stigma because of dual minority status in the society is often theorized by researchers as “double jeopardy” (Grossman, 2008; Kimmel, et al., 2006)

1.2.3 Developmental Theories for Older Gay Men

The developmental theories for gay men have been proposed by several researchers, including Friend (1990) and Kooden (1997). In addition, Erickson’s (1950, 1959) concepts of “intimacy”,

“generativity” and “ego integrity” may be relevant to the development of middle life and late adulthood of gay men. The need for “intimacy” may be particularly difficult for same-sex relationship because of social stigma. More research is needed to examine how older gay men maintain the intimacy, with his partner, work, and family. Although the concept of “generativity” is often interpreted as child-bearing and child-rearing, there may be evidence for the needs for “generativity” in older gay men such as taking care of younger generations of extended family, devoting themselves in professional activities, community works, and even leisure pursuits (De Vries & Blanco, 2004). And for “ego integrity”, the formation of positive sexual identity, “coming-out” is considered a necessary step to self-develop as a member of sexual minorities (Friend, 1990; Kooden, 1997).

Friend posits that “coming-out” and achieving affirmative sexual identity are the keys for older gay men to age successfully. Friend observed that there are three groups of older LGB: the stereotypic, passing, and affirmative older LGB. The stereotypic and passing LGB were more afraid to disclose their sexual orientation, experienced internalized homophobia and psychological tolls of heterosexism. On the other hand, the affirmative older LGB, having reconstructed the social stigma of heterosexism into something positive, attained high levels of psychological adjustment and life satisfaction. Friend further explained that, older gay men, by having crisis-competence, flexible in gender role, and reconstruct personal meanings of heterosexism and ageism, can adapt and adjust to the challenges of aging. This adaptation would require cognitive, behavioral, and emotional skills. Building on the successful aging theory from Friend, Kooden proposed that gay men must first “eliminate internalized ageism and develop a positive attitude towards aging”.

The “Syndemic Model” for Health Problems in Older Gay Men

This dissertation builds on the syndemic models by Stall and colleagues (2008). The term “syndemic” was first proposed by Singer (2003) who observed intertwining Substance Abuse, Violence, and AIDS epidemics (also known as SAVA epidemics) affecting the urban poor. Stall and colleagues (2008) proposed that a set of psychosocial health problems are interacting and as psychosocial health problems increase both HIV infection and risk-taking also increase. The theoretical model was designed to explain the emergence of substance use, depression, and risky sex behavior and other social problems within the minority of MSM who are vulnerable to these problems. This syndemic framework is useful for conceptualizing and studying etiology and course of HIV/AIDS due to multiple biopsychosocial determinants of disease. This is particularly true for older gay and bisexual men who may have suffered multiple health disparities in earlier life due to oppressive culture under which these individuals have experienced discrimination, victimization, and violence. Based on the developmental theories proposed by Friend and Kooden, I have incorporated two important factors relevant to the health of older gay men in the syndemic model: the timing of gay identity development, and internalized ageism. Research has shown that older gay men who came of age before Stonewall riot are more likely to internalize homophobia. In addition, in order to have positive outlook on life, older gay men must re-construct their negative attitudes and beliefs towards aging (Figure 1).

1.2.4 Sexuality and Risky Sexual Behavior among Older Adults

Research findings from the classic triad, Alfred Kinsey (1948), Masters and Johnson (1966), and Eric Pfeiffer (1968) demonstrated that frequency of sexual intercourse, sexual desire, and masturbation inevitably decline as men age. These findings have been confirmed by longitudinal data from Massachusetts Male Aging Study (Araujo, Mohr, & McKinlay, 2004). Although there is a physiological decline in sexual function as men age, many researchers attributed the reduction in sexual activities in older men not to aging per se, but to deteriorating health, medications, availability of partner, and a range of social factors (McKinlay & Feldman, 1994). As men age, although their sexual activity decrease and prevalence of erectile dysfunction increase (E. O. Laumann, Paik, & Rosen, 1999), many of them remain sexually active (Bortz, Wallace, & Wiley, 1999; Lindau, et al., 2007)

The above studies did not specifically study sexuality in older gay men. Many large studies on sexuality do not include questions on sexual orientation (Schiavi, 1999), even if they included sexual orientation questions, only few older participants were included, rendering inference to this older sexual minorities difficult (Bell & Weinberg, 1978; Edward O Laumann, JH, RT, & S, 1994).

In the past few years, researchers began to recognize that older adults are at risk for HIV/AIDS (Chiao, Ries, & Sande, 1999; Mack & Ory, 2003). Data from the Centers for Disease Control and Prevention shows the HIV/AIDS diagnoses in older adults increased from 2001 to 2006. The percentage of adults older than 50 among the new AIDS cases in America has increased from 11% in 1995 to 15.5% in 2006 (CDC, 2006; Mack & Bland, 1999). The advent of the Highly Active Anti-Retroviral Therapy (HAART) has improved the quality of life and prolonged the survival of

people living with HIV. In addition, incidence of HIV infection among adults over the age 50 remains stable over the years. Hence, older adults living with HIV has become an ever-growing proportion of HIV/AIDS cases in America (Martin, Fain, & Klotz, 2008). However, an integrative literature review of the literature on HIV risk factors in older adults revealed the paucity on research on this topic, which may be due to inadequate education of HIV risk and perception of low risk among older adults as well as insufficient patient/provider communication (Savasta, 2004). Recently, few studies began to examine sexual behaviors with the focus of HIV/AIDS in older adults.

The study of Research on Older Adults living with AIDS and HIV (ROAH) reported that heterosexual transmission is the primary mode of HIV transmission among older adults living with HIV/AIDS living in New York City (Karpiak, Shippy, & Cantor, 2006). Half of the participants did not have sex in the past three months, may be due to the fact that 70% of the participants live alone. However, among those who were sexually active in the past three months, 33% had unprotected vaginal or anal sex. Alcohol and drug use were found to be related to unprotected sex.

In a study of 624 older men who were infected or at risk for HIV, Cooperman and colleagues (2007) showed that both HIV-positive and HIV-negative men were sexually active and participated in risky sex behavior. Yet, HIV-positive men were significantly less sexually active, and had a greater prevalence of erectile dysfunction and sildenafil use. HIV-negative men reported less condoms use in the past 6 months than HIV-positive men. The association of HIV status and risky sex behavior remained significant after controlling for daily alcohol use, frequency of sexual activity, and sildenafil use.

In a study of HIV-positive older adults recruited from the AIDS organizations in New York City, Columbus, OH, and Cincinnati, OH (N=310), Lovejoy and colleagues (2008) found that more than one-third of the HIV-infected older adults in the sample were sexually active. The sample were stratified by heterosexual men, gay and bisexual men, and heterosexual women. Heterosexual men (72%) comprised the most sexually active group compared to gay and bisexual men (36%) and heterosexual women (21%). However, among the sexually active participants, gay and bisexual men (37%) were least to report consistent condom use, compared to heterosexual women (35%) and heterosexual men (27%). The authors suggested that sexual power-differentials in relationships of gay and bisexual men may explain a higher risky behavior exhibited by this group.

A recent study (N=210) from a Southern city of the U.S. found that 20% of HIV-positive older adults recruited from the primary care clinics (aged 45 and above) were not using condom consistently while having vaginal or anal sex within the past six months (Illa, et al., 2008). Moreover, 33% had multiple sexual partners within the past six months. Negative mood, which measures depression, tension, anger, vigor, fatigue, confusion, and perceived stigma were associated with inconsistent condom use.

In summary, it is clear that older adults are sexually active and some are engaging in risky sexual behavior. Safer sex message and age-appropriate interventions are needed for this population (Orel, Spence, & Steele, 2005). In particular, older gay and bisexual men may be at even higher risk compared to heterosexual men and women. The age-related change in sexuality and psychosocial factors related to HIV behaviors need to be investigated in this population

1.2.5 Sexuality and Risky Sexual Behavior among Older MSM

Previous research has shown that sexual activity and sexual desire persist as gay men age. In a secondary data analysis (N=4212), Gray and Dressel (1985) found no significant differences in the number of sex partners over the 12-month period, the amount of sexual activity among older and younger gay men. In a survey of 87 gay men aged between 40 to 77, Pope and Schulz (1990) reported that 91% of the respondents were still sexually active. Although there was an age-related decline in sexual interest and frequency of sex, majority of the participants reported no change in their enjoyment in sex.

The sexual repertoire of older gay men may differ from the younger counterparts. In a nationwide study of gay men over the age of 50 in Australia, Van de Ven and colleagues (1997) reported that older gay men had a less extensive range of anal practices than the younger men. The older gay men in the sample were more versatile with regular partners, “switching between insertive and receptive roles”.

In addition, several qualitative studies have revealed that sexual intimacy is especially important for some older gay men (Murray & Adam, 2001; Wierzalis, Barret, Pope, & Rankins, 2006). However, the over-emphasis on youth culture and physical attractiveness in the gay male culture do not serve aging gay and bisexual men well. Loneliness and having the need for sex and intimacy were common concerns in these previous studies. The need for intimacy may be so powerful that these individuals were willing to trade off safe sex. The psychosocial factors associated with risky sexual behavior need to be further investigated.

The current HIV studies among MSM focus on the younger age group. These studies rarely include a sizeable number of participants over the age of 60. Since the emergence of the

Acquired Immunodeficiency Syndrome (AIDS) epidemic in the early 1980s, the syndrome has been popularly, if inaccurately, characterized as a disease of young, gay white man. Data from the Centers for Disease Control and Prevention (CDC) shows that persons older than 50 years constituted more than 10% of new cases of AIDS in the United States, and overall 75% of the new cases were MSM, and thus accounted for the highest percentage of cases by exposure category among this age group (CDC, 2005)

As early as in the 80s, MSM older than 50 in San Francisco reported a range of risky sex behavior (Ron Stall, Catania, & Pollack, 1989). In a national telephone survey, Stall and Catania (1994) found that Americans older than 50 years old, across sexual orientation, were less likely to use condoms during vaginal and anal intercourse and undergo HIV testing compared with younger persons. In another national behavior telephone survey, the Behavioral Risk Factor Surveillance System (BRFSS), Mack and Bland (1999) also found that older adults were much less likely to be tested for HIV than younger adults.

There is converging evidence that some older gay men are engaging in risky sex over time. A serial, cross-sectional surveys of thousands of MSM demonstrated that MSM born in or before 1964 are engaging more risky sexual behavior over time, at a rate comparable to their younger counterparts (Chen, Weide, & McFarland, 2003). Recently, Osmond and colleagues (2007) reported that the HIV prevalence among MSM above 50 years old has increased from 14.9% in 1997 to 26% in 2002 in the probability sample of MSM living in San Francisco. In the probability-based, household sample of urban MSM, Dolcini and colleagues (2003) found that 19% of men in their fifties and 3% for men in their sixties were infected with HIV. Thirty percent of older MSM who were HIV-positive were African American. Injection drug use,

moderate/heavy drug use, and affiliation with gay community were significantly associated with HIV. Multiple sexual partners were also common among this sample of older MSM.

In a recent study of people living with HIV in London over the age of 50, Elford and colleagues (2008) reported that older HIV-positive gay men were just as likely to report high-risk sexual behavior, defined as having unprotected anal intercourse with a partner with unknown or serodiscordant HIV status as younger men. One third of the HIV-positive gay men in the study were found to be diagnosed with HIV in their 50s and 60s. Elford and colleagues termed the group of men who managed to avoid infection during the 30s and 40s but were infected over the age of 50 years the “late converters”. They called for future research to examine the circumstances in which the “late converters” were engaging in risky sexual behavior so that age-appropriate prevention strategies can be developed for the older gay men.

1.2.6 Depression among Older Adults

Depression is an illness that has long been studied in human history. The investigation of depression can be dated back to the Hippocratic physicians. Today, depression is considered a mood disorder. According to the fourth edition of the American Psychiatric Association’s Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) two classes of mood disorders in adults are defined: depressive disorders and bipolar disorders. Depressive disorders can be further divided to different subtypes: major depressive disorder, dysthymic disorder, seasonal affective disorder, psychotic depression, postpartum depression, and depression not otherwise specified.

Depression is common among elderly, the “symptoms and signs of late-life depression are ubiquitous with aging” (Blazer, 2003). Elderly people are especially vulnerable for

depression because of aging-related processes, chronic medical illnesses, cognitive impairment, and psychosocial adversity (Alexopoulos, 2005). Depression, in turn, leads to reduced quality of life, functional impairment, disability (Bruce, 2001; Penninx, Leveille, Ferrucci, van Eijk, & Guralnik, 1999), dementia (Jorm, 2000b) and to the extreme case, suicides (Conwell, Duberstein, & Caine, 2002) and death (Penninx, Geerlings, et al., 1999). In addition, depression incurs high health care costs and burdens to care-givers. It has been recognized by researchers and clinicians that late-life depression comprises a heterogeneous group of disorders, which differ in etiology, pathophysiology, and prognosis. The core symptoms of clinically significant depression have been identified by clinicians and epidemiologists. However, there is no consensus on how to classify those who need psychiatric services versus those who do not (Blazer, 2004). In addition, the definition of case and non-case depends on the particular investigation or clinical inquiry. Standardized interviews such as the Structured Clinical Interview for the Diagnostic and Statistical Manual Diagnoses (SCID) and the Diagnostic Interview Schedule (DIS) are the two most frequently used diagnostic instruments used in community and clinical epidemiological studies. Another approach for case identification is to use self-rating symptoms scale such as the Center for Epidemiologic Studies Depression Scale (CES-D) and the Geriatric Depression Scale. The following are the standard diagnostic criteria for major depression and minor depression in the elderly:

Major depression is diagnosed in the Diagnostic and Statistical Manual, Fourth Edition (DSM-IV), when one or both of two core symptoms (depressed mood and lack of interest), along with four of the following symptoms must be present for at least two weeks: feelings of worthlessness or inappropriate guilt; diminished ability to concentrate or make decisions, fatigue, psychomotor

agitation or retardation, insomnia or hypersomnia, significant decrease or increase in weight or appetite, and recurrent thoughts of death or suicidal ideation.

Minor depression is diagnosed when one of the core symptoms of major depressive disorder must be present. Another operational definition of minor depression includes a score of 16+ on the Center for Epidemiologic Studies Depression Scale (CES-D) but not meeting criteria for major depression, or a score of 11-15 on the CES-D.

Besides major depression and minor depression, other types of late-life depression include dysthymic depression (chronic depression that lasts for at least 2 years), bipolar I depression, and adjustment disorder with depressed mood (Alexopoulos, 2005).

Estimation of prevalence in the elderly depends on the case identification, sample characteristics (community or clinical sample, age and sex). It is estimated that 1-4% of the general older population has major depression, 4-13% has minor depression, while 8-16% has clinically significant depressive symptoms (Blazer, 2003). These prevalences are estimated from community samples of adults older than 65. The prevalences of depression are generally higher in clinical samples, such as nursing home residents or hospitalized veterans. Women, older age, ethnic minority in general have higher rates of depression.

Current understanding of the etiology of late-life depression is based on the biopsychosocial model, which proposes the development of depression in later life involve genetic or biological, psychological, and social risk factors (Bruce, 2002).

Research studies have shown that depressive symptoms decrease from midlife to late life but possibility of “survival bias” (older adults who are most affected by depression are at greater

risk for mortality and hence difficult to be included in research studies) cannot be discounted (Jorm, 2000a).

1.2.7 Depression among Older MSM

Homosexuality is by and large a stigmatized identity and behavior in our society. It was long considered a mental disorder until Hooker's groundbreaking study in the 1950s found no differences in psychological adjustment between gay and straight men (Hooker, 1956). It was only in 1973, because of the cultural change and pressure from gay activists, that the American Psychiatric Association (APA) removed homosexuality from the Diagnostic and Statistical Manual of Mental Disorders (DSM). However, recent studies suggest that the relationship between psychiatric disorders and sexual orientation is more complex than Hooker perceived. Several systematic reviews of the current studies on mental health and LGB adults have concluded that lesbian, gay, bisexual (LGB) individuals are vulnerable for psychiatric disorders and suicide-related morbidity than heterosexuals (Cochran 2008). Current research suggests that these mental health disparities may be attributed to the harmful effects of the homophobia (Diaz, Ayala, Bein, Henne, & Marin, 2001), minority stress (Meyer, 1995, 2003), discrimination (Mays & Cochran, 2001), violence and victimization (Herek, Gillis, & Cogan, 1999; Hershberger, Pilkington, & D'Augelli, 1997; Otis & Skinner, 1996) this sexual minority population endures.

In a study using a probability sample of urban MSM, Mills and colleagues (2004) found that urban men who have sex with men (MSM) experienced three-fold greater prevalence of distress and depression than men in the general population. Both distress and depression were found to be associated with lack of a domestic partner, not identifying as gay, queer or

homosexual, experiencing multiple episodes of anti-gay violence, and very high levels of community alienation.

Older LGB adults and mental disorders

Although LGB individuals are found to be at higher risk for mental health morbidity, it is not certain that these disparities can be generalized to older LGB individuals. Perhaps with the view that LGBT youth are more vulnerable, researchers in the field of LGBT health are more interested in studying LGBT youth. Evidence of risk of suicide-related morbidity in sexual minority populations is derived from studies on LGBT youth. Studies that use probability samples of the general population yield small samples of LGB persons and therefore further specification on age, race, and ethnicity cannot be determined.

The current view of mental health disparities among LGB persons is that these disparities can be explained by social and contextual factors. There are many reasons to suspect older LGB adults are at greater risks for mental disorders. Maintaining robust mental health is necessary for aging successfully (Rowe & Kahn, 1987). Advancing old age is almost always accompanied by many stressors and challenges, including increased risks for many chronic diseases, cognitive and physical function decline, which associate with depression (Stuck, et al., 1999). Estimates of prevalence of clinically significant depression among community-dwelling older adults range from approximately 8% to 16% (Blazer, 2003). Depression decreases quality of life and increases the risk for functional decline, disability (Bruce, 2001) and death (Penninx, Geerlings, et al., 1999) in older adults, even after adjustment for potential confounding variables such as sociodemographic factors, health status and health behaviors.

A common theme in the literature on older sexual minorities is that these individuals bear the burden of “double jeopardy”. In a seminal review paper, Meyer (2003) put forth the minority stress model, which posits that minority group members are at risk for some psychological problems because they face unique, chronic stressors due to stigma, prejudice, and discrimination from the society. The minority stress may be elevated in aging sexual minority who have experienced more stigma and violence throughout their lives (Morrow, 2001). Based on the minority stress theory, I hypothesize that older gay men are at elevated risk for mental disorders because of dual minority status: age and sexual orientation. In addition, previous qualitative studies revealed that some older gay men were lonely, worried about reduced sexual attractiveness, and were having difficulty finding partners (Clover, 2006; Murray & Adam, 2001).

Empirical studies on depression in older gay men

With the aim to examine the relationship between depression, sexual orientation and social support in an elderly population, Dorfman and colleagues (1995) sampled 108 people (55 women and 53 men) between ages of 60 and 93 years, of whom 56 were homosexual (23 women and 33 men) and 52 were heterosexuals (32 women and 20 men) from local senior and church organizations. They found 15% of the entire sample, including both heterosexual and homosexual elderly were depressed, which is consistent with the prevalence in other studies on elderly samples. There was no significant difference in depression levels between heterosexual and homosexual elderly, after controlling for education, partner status, and gender. The variability in depression scores can be explained in part by social networks. Heterosexual and homosexual elderly did not differ in overall levels of social support. However, the sources of

social supports differed: older gay men and lesbians derived significantly more support from friends than from family.

In the largest research study on LGB seniors, Grossman and his colleagues (2001) surveyed 416 LGB people older than 60 years from 18 gay organizations (17 in the US and 1 in Toronto) to study their psychosocial and aging-related issues (A. R. D'Augelli & Grossman, 2001; A. R. D'Augelli, Grossman, Hershberger, & O'Connell, 2001; Grossman, et al., 2001). Most participants reported low levels of internalized homophobia. Twenty-seven percent of respondents experienced loneliness, and 13% reported being isolated. The majority (65%) reported experiencing verbal abuse based on their sexual orientation over their lifetime. Thirty-two percent reported having been victims of violence and 16% reported having been assaulted. Most gay and bisexual males reported fairly high level of self-esteem on the Rosenberg Self-Esteem Scale. Participants reporting more victimization had lower levels of mental health. Consistent with the findings from the earlier studies, the social support networks of the participants comprise friends who know about their sexual orientation. The authors attributed the good mental health of the respondents to their mastery of sexual identity development.

Using data from the Urban Men's Health Study, Rawls (2004) examined disclosure of sexual orientation and prevalence and risks for depression among the older urban MSM. Twenty-one percent of the respondents reported Center for Epidemiologic Studies Depression Scale (CES-D) scores of 16 and above, indicating the presence of minor depressive symptoms or distress. And 12% reported CES-D scores of 22 and above, indicating presence of major depression. About a quarter of the respondents were open about their sexual orientation to all who knew them. Contrary to the general belief that more acceptance to and openness about one's sexual identity confers better mental health, lower levels of disclosure were not associated with

psychological distress or depression in these old gay men. Education and race were not related to CES-D scores but unemployment and difficulties having a satisfying sexual relationship were strongly related to depression.

The finding on mental health from current studies on older gay men is inconclusive because potential selection bias cannot be eliminated. The studies usually involve small samples of older men who self-identify as gay or bisexual and participate in gay organizations. Earlier studies, conducted with the aim to refute negative stereotypes of older gay men, may have painted an overly optimistic picture of the mental health of this cohort. These studies usually employed convenience sample of white, well-educated, economically advantaged, urban-dwelling older gay men. These samples of self-identified gay men were more open about their sexual orientation, actively involved in the gay community, and enjoyed support from an extensive network of gay friends. Even a large study as Grossman's may not be free from selection bias.

Although Dorfman's study did not find significant difference in depression levels between heterosexual elders and homosexual elders, differences may be explained by higher socio-economic status of homosexual elders. The use of Geriatric Depression Scale in Dorfman's study may also limit the comparison in other studies using the CES-D scale. In Grossman's study, self-esteem but not depression was assessed. However, given that self-esteem and depression are highly related, participants in Grossman's study probably experienced low level of depression, which may be manifestation of selection bias as discussed before.

By using a more representative sample of gay men, Rawls found that 21% of older men who have sex with men (MSM) living in the city were having depressive symptoms and distress, giving a more realistic description of the mental health in this subpopulation. Although this

prevalence of depression appeared to be higher than that of the general older adult population, the authors were not able to do heterosexual/homosexual subgroup analyses because of the lack of heterosexual control group.

In summary, previous research shows that LGB individuals are at elevated risk for mental health morbidity. Many epidemiologic studies also show that older adults experience greater psychiatric morbidity. However, depression in older sexual minorities, the intersection of these two groups, has not received adequate investigations, nor have studies examined longitudinal stability or age-related changes of depression within LGB populations.

1.2.8 Co-occurrence of Depression and Substance Use

Co-occurrence of mental and substance use disorders have long been documented in the general population (Alaja, et al., 1998; Kessler, et al., 1996) and have implications across biological, treatment, and services domains. Findings from the National Drug Use Survey, Epidemiologic Catchment Area (ECA) study, the National Comorbidity Survey, and the International Consortium in Psychiatric Epidemiology have each shown that mood disorders are strongly associated with drug use disorders (Compton, Thomas, Conway, & Colliver, 2005). Furthermore, the co-occurrence of two disorders has a significant negative impact on the course, prognosis, and outcomes of both types of disorders (Gonzales & Insel, 2004). Currently, a more integrated approach to the treatment of both disorders is generally accepted to be the most promising treatment strategy (Harris & Edlund, 2005).

The co-occurrence of mental and substance use disorders has also been documented in the populations of persons living with HIV (Bing, et al., 2001), including middle-aged and older adults living with HIV (Justice, et al., 2004). As the number of persons living with HIV are

growing and aging, investigation of the interaction of HIV/AIDS, aging, mental health and substance use co-morbidities is becoming increasingly important (Stoff, 2004). In a small sample, Rabikin and colleagues (2004) reported that HIV-infected older adults did not show the decline in depression and substance use disorders that has been observed in the general population.

The co-morbid phenomenon was also observed among gay and bisexual men. A body of research has shown that gay and bisexual men have far higher rates of substance use and experience greater burden of psychiatric disorders than the men in the general population (Cochran & Mays, 2008; Ostrow & Stall, 2008). In a cross-sectional analysis of urban men who have sex with men (MSM), Stall et al. demonstrated that multiple drug use, childhood sexual abuse, depression, and risky sexual behavior were associated with higher prevalence of HIV (R. Stall, et al., 2003). Stall and colleagues (2008) explained the co-occurrence of these psychosocial conditions using a syndemic model which places these variables in the context of homophobia (internalized, social, institutional), gay identity development, minority stress, and resilience at multiple levels (individual, social, community) and throughout the life course (childhood, adolescence, adulthood).

1.2.9 Substance Use among Older MSM

Research on alcohol and drug use in MSM has grown substantially in the past twenty years. However, little is known on this topic among older MSM in particular. Society's negative view of aging sexual minorities and neglect by traditional gerontological research has resulted in the paucity of empirical data on the health and conditions of this population. Prevalence of alcohol and substance use in older MSM is difficult to determine. Population-based studies of substance

use rarely include measures for sexual orientations and investigations of alcohol and drug use in MSM usually include a few older MSM, making conclusive inference of substance use in this older group difficult. In addition, research studies use varying sampling methods (no surprisingly, initial studies on alcohol use sampled gay men in gay bars have resulted in over-estimation of alcohol use) and measures to estimate prevalence (differences in the time period asked in the questionnaire, frequency of use), making comparison of findings across studies difficult.

Despite the methodological limitations in the literature, a series of published review articles have shown that while prevalence of alcohol use does not appear to differ when compared with the entire population, the prevalence of drug use in MSM is far higher than in men in the general population (Ostrow & Stall, 2008). Prevalences of certain drug usage are especially higher in MSM, especially amyl, butyl, and isopropyl nitrites (commonly known as “poppers”), methamphetamine, and other stimulants are associated with sexual behavior, and are considered “gay sex drugs”.

Unlike heterosexual men, these high rates of alcohol and drug use appear to continue as they grow older (McKirnan & Peterson, 1989; Skinner & Otis, 1996; R. Stall & Wiley, 1988). In a large household sample of homosexual and heterosexual men in San Francisco (n=1034), Stall and colleagues (1988) showed that alcohol consumption and drug use decline slightly for the homosexual men while substance use declined precipitously in the heterosexual men from age 35-44 to age 45-54. There was a significant differences between homosexual and heterosexual men aged 45 to 54 (13% vs 7.6% respectively). In another large study of convenience sample of homosexual men and women in Chicago (n=3400), McKirnan & Peterson (1989) observed a similar trend. The lifetime and frequent marijuana and cocaine use declined slightly in the older

group (>35 of age) but the rates were about four fold greater than the rates of use in the men in the general population in the same age group. In a large sample of lesbian and gay men in two Southern cities in the US (n=1067), Skinner & Otis (1996) reported that while the prevalences of marijuana, inhalants and cocaine remain higher in older gay men, the prevalences of these drug sharply reduced in the older age group (>35 of age) in the men in the general population.

These investigators attributed the lack of age-related decline of alcohol and drug use in gay men to the disparaged cultural and social roles of sexual minorities. For example, the lack of social responsibilities that increase with age that accompanied marriage, having children may explain the continued substance use in later life. McKirnan suggested that a subgroup of “socially marginalized” older gay men may rely on bars or other social settings due to continuing discrimination and stigmatization.

Previous studies have found that high prevalent use of alcohol and drug in MSM contribute to adverse health consequences including HIV seroconversion (Chesney, Barrett, & Stall, 1998; Plankey, et al., 2007), hepatitis infection (Cohen, Russell, Golub, & Mayer, 2006), poor mental health (Houston & McKirnan, 2007), as well as social problems such as violence and social isolation. Given the magnitude of the health and social consequences of substance use, especially increased HIV transmission risk, and the observations that MSM may bring substance use patterns into later life, we need to understand how MSM bring substance use pattern into later life, and the risk factors that are associated with this heavy use trajectory.

The only study that specifically assessed drug and alcohol use in gay men older than 60 year old found that only 9% of the participants could be classified by “problem drinkers”, assessed by the Alcohol Use Disorder Identification Test (AUDIT) (Grossman, et al., 2001).

Those who were identified as “problem drinkers” reported more mental health problem. Interestingly, none of the participants reported drug use. This is currently the largest study on older gay/bisexual men and lesbian. Research participants were recruited from gay organizations and the participants were socially active and enjoyed support from the community. Thus the finding cannot be generalized to the broader populations of older gay men who are more socially isolated.

1.2.10 Limitations of Existing Literature

These studies (reviewed above) are indicative of the special status of this cohort, but reflect the scarce, incomplete, and fragmented nature of research on this population. The following are the methodological challenges in current research:

1. Sampling methodology: previous research relied heavily on convenience sampling and resulted in only study of older gay men accessible to researchers. None of the reviewed studies on older and gay bisexual men include population-based samples. Hence, the findings from these studies may not be generalizable to older gay men of racial minority, poor, disabled and socially withdrawn.
2. Earlier studies did not directly use comparable measures for health outcomes. Most research was qualitative in nature and was not designed to examine physical health and mental health per se. For example, most studies assessed psychological well-being and asked questions on happiness, loneliness, but not for medical conditions, such as diabetes or depression. Probing for information on these medical conditions will obviously have more public health significance. For example, standard measure for depressive symptoms such as Center for Epidemiologic Studies of Depression (CES-D).

3. The majority of previous studies were exploratory in nature. Data presented were anecdotal and descriptive rather than quantifiable or subjected to statistical testing.
4. Almost all previous studies have been cross-sectional. To date, previous research studies have employed the cross-sectional study design, thus the findings provide only snap-shots of aging experience of the study population. A few studies attempted to examine the developmental trends by comparing different age cohorts. Therefore, in order to elucidate the age-related change of risky sexual behavior, depression, and substance use in this population, we need to analyze the longitudinal data on this topic.

1.2.11 TABLES

Table 1 Characteristics on empirical studies of older gay men

Study	Location	Study Design and Methods	Sample Recruitment	Sample size	Race	Age range (mean)
Weinberg (1970)	New York City, Connecticut, New Jersey, San Francisco	Self-administered questionnaire, mail-back questionnaire 30% response rate	Gay organizations, private parties, bars and clubs	1100	94% white	<26 to >45
Francher & Henkin (1973)	New York City	Ethnographic study	Gay gatherings, organizations, bars, steam baths, private gay parties	10	White	50+
Minnigerode (1976)	N/A	Self-administered questionnaire	Gay organizations, local motorcycle club, friendship networks, and bars	95	White	25-68
Kelly (1977)	Los Angeles	Questionnaire, interview	Popular gay beach and the Los Angeles Metropolitan Community Church, advertisements in gay-oriented newspapers, and the friendship networks	193 questionnaires 48 interviews	N/A	16-79 30 participants were above 65 years
Kimmel (1977, 1978)	New York City	Life history interview	Gay community counseling center, gay discussion group, gay religious groups, snow-ball, personal ads	14	All white	55-81 (M=64.9)
Laner (1978)	N/A	Analysis of data from personal ads	Newspapers personal advertisements	318 straight men 233 gay men	N/A	18-68
Minnigerode & Adelman (1978)	San Francisco	In-depth interview	Friendship network, G40+, a gay organization for homosexual people 40 years of age and older	6 gay men 5 lesbians	N/A	60-77

Table 1 (Continued)

Study	Location	Study Design and Methods	Sample Recruitment	Sample size	Race	Age range (mean)
Harry & DeVall, (1978)	Detroit	Self-administered questionnaire 53% response rate	Gay organizations, gay bars	243	N/A	<18 to >50
Bell & Weinberg (1978)	San Francisco Bay area	Interview	Public advertisement, bars, personal contacts, gay baths, organizations, mailing lists, and public places	686 gay men 283 lesbians 337 heterosexual men 140 heterosexual women	267/1446 (18.5%) black	<25 to >46
Benette &Thompson (1980)	Australia	Self-administered questionnaire	Sidney gay bars, gay religious organizations, college and university gay groups, gay social organizations, a homosexual newspaper and friendship circles and personal contacts	478	N/A	16-74 (32.2)
Berger (1980)	South Florida	Self-administered questionnaire	Local social organizations, advertisements in local gay publications, friendship network	112	All white	41-77
Friend (1980)	Metropolitan area of the Northeast	Self-administered questionnaire	Advertisement in local gay newspaper, gay community center, gay counseling center, gay/feminist bookstore	43 questionnaire 25 of the 43 intensive interview	N/A	32-76 (M=48.15)
Gray & Dressel (1985)	US, Canada	Secondary data analysis from self-administered questionnaire	Gay bars, clubs and mailing lists from <i>Blueboy</i> , a gay magazine, snowball	4212	N/A	16-78
Lee (1987)	Canada	In-depth interview Longitudinal study, 4 years of follow-up	Not described Participants lived from New Brunswick to Edmonton, few retired in Florida	47	All white	50-80

Table 1 (Continued)

Study	Location	Study Design and Methods	Sample Recruitment	Sample size	Race	Age range (mean)
Pope & Schulz (1990)	Chicago	Self-administered questionnaire	Local group for gay men 40 years of age or older	87	N/A	40-77 29 (33%) were in 50-59 age 21 (24%) were in 60+ age cohort
Adelman (1991)	San Francisco	Interview	Friendship networks, advertisements, gay/lesbian organizations	27 gay men 52 lesbians	All white	Mean age of gay men is 65.6 Mean age of lesbian is 64.5
Quam & Whitford (1992)	Midwestern city	Questionnaire	Gay and lesbian aging conference at a local university, social and religious organizations, newspaper advertising	41 gay men 39 lesbians	N/A	50-73
Kooperman (1994)	San Francisco, Canada	Self-administered interview	Social organization of older gay and bisexual men, snowballing	191	98% white	50-80
Dorfman (1995)	Southern and Central California	Self-administered, mail-in questionnaires	Gay and lesbian elderly organizations, support groups and churches, and at gay and lesbian events Senior citizens' center and church organizations for heterosexual elderly	23 lesbians 33 gay men 32 heterosexual women 20 heterosexual men	85% white	60-93 (M=63.9)
Van de Ven et al. (1997)	Australia	National telephone survey	Nationwide sample media, radio, magazine, gay communities, health center, gyms, gay brothels, sex shops, sauna	2583 (total) 256 (> 49 years)	97% white	Less than 25 to greater than 49 years
Murray & Adam, (2001)	Toronto, Canada	One-to-one interview, Focus-group	Toronto gay bars, bathhouse, community venues, advertising in a gay community newspaper, AIDS-	46 (total) 19 (focus group) 27 (one-on-one)	21 out of 27 are white for one-on-one	40-71 (M=45.4) for one-on-one interview

Table 1 (Continued)

Study	Location	Study Design and Methods	Sample Recruitment	Sample size	Race	Age range (mean)
			related service organizations	interview)	interview	
Grossman et al. (2001)	18 sites in USA 1 site in Canada	Self-administered questionnaire	Community-based sampling, snowballing	416 lesbian, gay and bisexuals 297 gay or bisexual men	95% white	60 to 91
Dolcini et al. (2003)	San Francisco, New York, Los Angeles and Chicago	Household telephone interview Self-report and biologic measures of HIV sero-status	Two-phase adaptive sampling Probability sample of urban MSM	507	92% white	≥ 50 years
Jimenez (2003)	Chicago	Interviewer-administered questionnaire	Minority outreach, AIDS prevention organization serving minority gays/bisexuals	110	89% black 11% Latino	≥ 50 years
Rawls (2004) †	San Francisco, New York, Los Angeles and Chicago	Secondary data analysis using data from the Urban Men's Health Study Household telephone interview	Two-phase adaptive sampling Probability sample of urban MSM	372	92% white	50-85
Kokkema & Kuyper (2007)	Netherlands	Community-based survey Case-control Questionnaire	Population registers of 11 municipalities in 3 regions were used for sampling heterosexual elders Senior organizations, friendship networks, and gatherings for aging gay and lesbians were used to recruit LGB elders	152 LGB adults 3466 Heterosexual adults	White	50+

†-studies were published as book chapters, LGB-Lesbian, Gay and Bisexual persons

Table 2 Results of the reviewed studies of older gay men

Study	Measures	Findings	Comments
Weinberg (1970)	8-item composite measures by Rosenberg (1965)	<ul style="list-style-type: none"> • Older gay men appear to achieve better psychological adjustment than younger gay men despite reduced interaction with the homosexual scene and sexual frequency as they age. • There were no age-related differences in scores on loneliness, depression, feelings of interpersonal awkwardness • Older (over 45) gay men were less worried about their homosexuality being revealed, showed higher stability of self-concept, and were less likely to have desire to have psychiatric treatment than younger (under 26, 26-35,36-45) gay men (all <i>p</i> values <.001) • As age increases, gay men were more self-accepted although the age difference is not significant (<i>p</i>=0.1) • As age increases, gay men reported less psychosomatic symptoms although age difference is not significant (<i>p</i>=0.1) • Replication study which recruited subjects unaffiliated with homophile organizations supports findings 	<p>Study included large convenience sample of gay men</p> <p>Some of the comparisons of young vs old gay men may not be valid today because younger gays of today are more likely to “come-out”.</p>
Francher & Henkin (1973)	N/A	<ul style="list-style-type: none"> • Dispelled the stereotypes of older gay men as despaired and desolate—older gay men appeared to adjust well to aging • Adjustment to aging may be due to more flexible societal sex role for homosexual men • Put forward the notion of “crisis-competency”. Having dealt with life crisis which involve around management of a secret identity and often accompanied with alienation and loneliness from traditional culture and structure of society 	First study to suggest the theory of “crisis-competency”
Minnigerode (1976)	Perceived health status General life satisfaction Adjective checklist	<ul style="list-style-type: none"> • The mean chronological onset of middle age was 41.29 years (sd=9.11) • The mean chronological onset of old age was 64.78 (sd=7.89) • These data did not differ from those of the men in the general population, therefore dispel “accelerated aging” among homosexual men • Those who reported better physical health estimated that old age occurred later in life • Those who reported poorer physical health or lower personal adjustment anticipated early onset of “old age” 	Homosexual men look more like heterosexual men on age-status labeling Physical health and psychological health may be more important in predicting onset of aging

Table 2 (Continued)

Study	Measures	Findings	Comments
Kelly (1977)	N/A	<ul style="list-style-type: none">• Dispute the myth about older gay men• 63% of those between 56 and 65 frequented bar• No one over age 65 reported that he had disengaged from activities in the gay subculture• Majority of participants saw fifty years at the point where middle-age ended (twenty years later than many stereotypes hold), disputed “accelerated aging”• 83% of the respondents over age 65 reported being sexually satisfied• Major concerns of aging were loneliness, loss of physical attractiveness, and failure to accept the aging process• Author attributed problems faced by older gay men to discrimination and social prejudice	Purely descriptive, no tables or statistical tests for testing difference between older homosexuals and younger homosexuals
Kimmel (1977,1978)	N/A	<ul style="list-style-type: none">• Identified a wide diversity in milestone of identity development, living situation, and aging experiences• There was a variation in preferred age of partner• Sex remained important in the lives of the respondents	Very insightful piece—provide the rationales for studying adult development of gay men
Laner (1978)	N/A	<ul style="list-style-type: none">• Homosexual men did not differ from heterosexual men in the age claimed in personal advertisement, in other word, homosexual advertisers were not younger than heterosexual advertisers. Hence, “accelerated aging” among homosexual men was not supported• There was no difference in proportions of hetero- and homosexual advertisements who sought young or younger-than-self partners	Motivations for advertisement were not available. Looking for casual sex or looking for long-term relationship will be of different motivation and may explain the patterns the age of the advertisers and the age of partners sought
Minnigerode & Adelman (1978)	N/A	<ul style="list-style-type: none">• Homosexual men were more likely than homosexual women to rate age-related physical change negatively• Homosexual men tend to view their homosexuality in terms of their sexual activity• Lesbians generally viewed their homosexuality in terms of personal identity and/or interpersonal relationships• All respondents reported gaining self-acceptance and self-esteem• All men remained sexually active while women varied in their sexual lives• For homosexual men, awareness about one’s sexual orientation generally occurred earlier in their lives	Qualitative and descriptive, provided some general differences among homosexual men and women

Table 2 (Continued)

Study	Measures	Findings	Comments
Table 1 (continued)			
Harry & Devall (1978)	Youth orientedness: "I like to the person I have sex with.. Younger than myself, About the same age as me, Older than me"	<ul style="list-style-type: none"> • Homosexual women, generally identified themselves as lesbians only after their first homosexual experience, generally occurred in their twenties • Investigators hypothesized age preference will be more important in gay settings that are most youth-oriented and impersonal, such as gay bar, bath, and "tearoom" • Age, occupational level, but not gay bar attendance influence sexual age preferences (hypothesis not supported) • There is an inverse relationship between respondent's age and preferred age of partner-the relationship is strongest among those who participate in bar less and those who are of lower occupational status • Respondents of high occupational status were significantly more interested in younger than were those of lower occupational status • Socio-economic reason and sex roles may explain age preference • There is a variability in age preferences of sex partner 	<ul style="list-style-type: none"> • Investigators explained their findings in sociological perspectives, e.g. "young lower-status person may desire an older person from his presumed dominance and masculinity"
Bell & Weinberg (1980)	<ul style="list-style-type: none"> • Sexual experience 	<ul style="list-style-type: none"> • Sexual activity decreases with aging ($r=-.23$, $p<.001$) • Older age was associated with paying for sex ($r=.27$, $p<.001$) and cruising in baths ($r=.28$, $p<.001$) • Number of sexual partners decreases with aging ($r=-.015$, $p<.001$) • Sex appeal and sexual repertoire decrease with aging ($r=-.35$, $p<.001$; $r=.42$, $p<.001$ respectively) • No correlation with age and level of sexual interest • Older age was associated with problem finding a partner 	<ul style="list-style-type: none"> • A large, comprehensive study of sexual experience, social adjustment, and psychological adjustment of homosexual men and women. • Heterosexual controls were recruited from general population living in the same area of the homosexual respondents. • Sexual orientation was determined by Kinsey Rating • Analyses were stratified by sex and race
Benette &Thompson, (1980)	<ul style="list-style-type: none"> • Involvement in homosexual community • Loneliness • Happiness • Self-esteem 	<ul style="list-style-type: none"> • There was no reduction of involvement in homosexual involvement among older gay men • Older gay men (age 46+) were as likely to be in a relationship with another man as the younger gay men • Older gay men were more likely to pass as heterosexual and 	<p>Participants were recruited from a variety of sources, resulting a diverse sample with a range of socio-economic status</p>

Table 2 (Continued)

Study	Measures	Findings	Comments
		<p>worry about exposure of their sexual orientation</p> <ul style="list-style-type: none"> • Older gay men had a more stable self-concept • Authors attributed the differences not to aging per se, but to the generational effect, or cohort effect 	<p>Generally supported previous studies by Weinberg and Kelly</p>
<p>Berger, (1980)</p>	<ul style="list-style-type: none"> • Indices of psychological adaptation: self acceptance, depression, psychosomatic symptoms, life satisfaction, anxiety about homosexuality, fear of aging and death • Sexual activity and satisfaction 	<ul style="list-style-type: none"> • Inverse relationship between age and depression and psychosomatic symptoms such that older respondents were more likely to report lower levels of depression and fewer psychosomatic depressions • Lower level of depression was associated with commitment to homosexuality • Other predictors of good psychological adaptation include integration to into the gay community, low concern with concealment of sexual preference, a current exclusive relationship, and satisfactory sex life • 19% had had sex with a male partner at least three times a week, 28% twice a week, 18% two or three times a month, and 14% once a month or less • More than half of the respondents (57%) had sex with only one partner in the past six months • Almost half of the respondents described themselves as “satisfied” or “very satisfied” with their current sex life, but 27% were “unsatisfied” or “very unsatisfied” • Satisfaction with sex life predicted self-acceptance, and life satisfaction 	<p>Mixed methods-collect both quantitative and qualitative data</p>
<p>Friend (1980)</p>	<ul style="list-style-type: none"> • Coming-out • Self-acceptance • Friendship and family support system • Sex role flexibility 	<ul style="list-style-type: none"> • “Coming-out” assisted personal adjustment for older gay men, positive correlation was found between self-acceptance to levels of “coming-out”, $r=0.34$, $p<0.02$ • Respondents reported no change in traditional family support • Gay friends supplied more emotional support than family support • Respondents reported high-quality friendships and were not lonely • Respondents reported flexible sex role, they did not restrict themselves to traditional male role and saw it as an advantage 	<p>Challenge the Laner and Minnigerode findings on “accelerated aging”-39 respondents were below the age of 64 but viewed themselves as “older”</p> <p>Challenged Francher and Henkins’ finding that older gay men must rely on “family of choice” for social support. Many still have strong support from family even though most of them come out to their family</p>

Table 2 (Continued)

Study	Measures	Findings	Comments
Gray & Dressel (1985)	<ul style="list-style-type: none"> • Frequency of sex partners • Control variable: length of time engaged in homosexual activity 	<ul style="list-style-type: none"> • Both older and younger gays preferred younger partners • Older gay men were more likely than younger gay men to have paid for sex • The longer the men have engaged in homosexual activity, the more likely they would have paid for sex, regardless of their age • Older gay men reported more negative feeling about how others perceive them than the younger counterparts • Older gay men felt less positive about their appearance than the younger gays • There is no significance difference in the number of sex partners over a 12-month period among older and younger gay men • There is no significant difference in the amount of sexual activity by older and younger gay men • There is no relationship between age and discrepancy of sexual activity, defined as the difference between desire for, and incidence of sexual activity • The longer the men immerse themselves in the subculture, the more likely they will spend time with gay men only 	<p>The largest study on older gay men but selection bias cannot be discounted: those who subscribed to <i>Blueboy</i> magazine may have different socio-economic profile than those who did not</p>
Lee (1987)	<ul style="list-style-type: none"> • Life satisfaction • Self image and self description of personality • Role count • Activity • Family and friendship networks 	<ul style="list-style-type: none"> • Lee challenged the Burger’s idea that being homosexual facilitates aging • There were five clusters of ranking of current satisfaction with life and their adjustment of aging • Wealth, health, and lack of loneliness were associated with high life-satisfaction 	
Pope & Schulz (1990)	<ul style="list-style-type: none"> • Current frequency of sexual relations • Level of sexual interest 	<ul style="list-style-type: none"> • 54% of 40-49 age group reported having sexual relations more than once per week, 34% of 50-59 age group reported similarly, while only 5% of the 60 and above reported sex more than once per week. The latter group, however did report 38% having sex once per week. • 52% of the 50-59 age group reported strong sexual interest and 48% reported similarly • 69% of the respondents reported no change in their enjoyment of sex from their younger years to present, 13% an increase, 	<p>Lack of clear definition of “sexual relations”</p> <p>Thus sexual act cannot be distinguished to sex with a partner or masturbation</p>

Table 2 (Continued)

Study	Measures	Findings	Comments
		and 16% reported a decrease	
Adelman (1991)	<ul style="list-style-type: none"> • Life Satisfaction Index • Self-criticism Scale • Symptoms index 	<ul style="list-style-type: none"> • High life satisfaction was associated with <ol style="list-style-type: none"> i. high salience of homosexuality ii. low disclosure at work iii. low involvement with other gay people iv. early age of awareness v. decrease importance of homosexuality in later years • Low disclosure at work was associated with higher life satisfaction • Low disclosure to relatives was associated with lower self-criticism 	Statistical result is hard to interpret
Quam & Whitford (1992)	<ul style="list-style-type: none"> • Participation in lesbian or gay social group • Gay/lesbian social life • Life satisfaction • Aging concern 	<ul style="list-style-type: none"> • More lesbian (77%) reported participation in a lesbian/gay social group than gay men (52.5%), $p=0.02$ • Gay men (47.5%) were more likely to have visited bar than lesbians (23.1), $p=0.02$ • Lesbians (79.5%) expressed more willingness to live in a lesbian only retirement community than gay men (46.3%) in gay men only retirement community. • Respondents reported high level of life satisfaction (mean score 72%), good health, and acceptance of their aging process • Involvement in the community, participation in social organizations positively correlated to acceptance of one's aging process ($p=0.01$) • Loneliness, discrimination due to sexual orientation, income, age discrimination, and health were reported as aging-related problems • Lesbians (26%) were more likely to have problems with income than gay men (2.4%), $p<0.001$ • Lesbians (21.1%) indicated poor health was a problem as compared to only 5% of gay men, $p<0.001$ • Most respondents (68%) believed that being gay or lesbian helps them in the aging process 	Analysis was stratified by age (below or above 60) and by gender (gay men or lesbian)

Table 2 (Continued)

Study	Measures	Findings	Comments
Kooperman, (1994)	<ul style="list-style-type: none"> • Degree of concern regarding AIDS and the impact the AIDS epidemic has on sexual behavior • Sexual behavior • Sexual partners • HIV testing • Knowledge about HIV transmission 	<ul style="list-style-type: none"> • 62% of the respondents know someone living with or dead of AIDS • 66% of the respondents have a great deal of concern over the AIDS epidemic • Among 73% of the respondents report that they had engaged in some sexual activity within the past 30 days: <ul style="list-style-type: none"> 16% had unprotected anal intercourse 68% had unprotected oral sex 65% engaged in mutual masturbation 43% had more than one sex partners • 59% of those who do not use condoms believe that they and their partners are not at-risk • 72% of the respondents reported to have been tested for HIV virus • Majority of the respondents answered correctly the knowledge questions regarding HIV transmission 	<ul style="list-style-type: none"> • First published survey on AIDS related knowledge, attitude, belief and behavior in older gay/bisexual men • About 65% of the respondents live in San Francisco, a city suffered huge impact from the AIDS epidemic and primary effort has been focused • Study is done before HAART become widely available. There is a concern that MSM are abandoning safe sex because of the optimistic outcomes from HAART
Dorfman (1995)	<ul style="list-style-type: none"> • Geriatric Depression Scale • Lubben Social Network Scale 	<ul style="list-style-type: none"> • 15% of the sample, including both heterosexual and homosexual elderly were depressed, which is consistent with the prevalence in other studies on elderly sample • There was no significant difference in depression levels between heterosexual and homosexual elderly, after controlling for education, partner status, and gender • 17% of variability in depression can be accounted by social networks • There was no significant difference in level of overall social support between heterosexual and homosexual elderly • However, the types of support was significantly different by gender and sexual orientation • Heterosexual women received the most family support, followed by in rank, heterosexual men, lesbians, and gay men • Lesbian received the most friend support, followed in rank, by gay men, heterosexual women, and heterosexual men 	<ul style="list-style-type: none"> • There should be a table on the depression score stratified by gender and sexual orientation • Before running multiple regression, we do not know if depression scores differ between homosexual and heterosexual elderly. • The homosexual elderly in the sample were significantly more educated than the heterosexual counterparts and the heterosexual elderly were more likely to be partnered than homosexual elderly (data shown in table). Thus, partner status and education may explain more variability in depression than sexual orientation • It is not clear if Lubben Social Network Scale measures support from children, neighbor, volunteer work, church fellows

Table 2 (Continued)

Study	Measures	Findings	Comments
Van de Ven et al (1997)	<ul style="list-style-type: none"> • Sexual identity and disclosure • Gay community attachment • Sexual relations and practices • HIV testing 	<ul style="list-style-type: none"> • 61% of the older men identified as gay or homosexual and 28.5% as bisexual • 3% of the older men reported to be HIV positive • The older men were less likely to have disclosed their homosexual orientation and involve in gay community compared to the younger men • 48.6 % of older men had casual sex only, 21.6% of them were in monogamous relationship • 44.9% of older men had between 2-10 sex partners during the past 6 months • 37.9% of older men had had between 2-10 female partners ever • Older men were more likely to have had sex with their regular partner 1-5 times per month compared with men under 30 years. • 64.3% of 84 older men who had anal intercourse with regular partner did not always use condom • 52.4% of 189 older men who had casual partners did not engage in anal intercourse 	<ul style="list-style-type: none"> • Very detailed and comprehensive measures on sexual behavior • No racial diversity • Differences between younger and older gay men may be due to cohort effect
Murray & Adam (2001)	<ul style="list-style-type: none"> • Concerns about aging • HIV risks 	<ul style="list-style-type: none"> • Participants complained that the gay culture put too much emphasis on youth beauty and physique and felt they were not represented by the media • Participants reported mixed experiences with younger men. Some preferred younger partners, some preferred men of their own age • Many described working out intensively at the gym to “forestall the effects of aging” • Some men were isolated and lonely and yearned for intimacy and partners • Many respondents reported sex was better, more fulfilling and satisfying • Many respondents rejected the claims of “condom-fatigue”, “treatment optimism”, and “insertion invulnerability” for themselves but saw those factors as motivations for others to engage in unsafe sex • Those who reported having had unsafe sex also reported feelings of worthlessness, marginalization, and depression 	<ul style="list-style-type: none"> • Findings are descriptive, no statistical tests • Selection bias-Those who experienced unhappiness with aging may be likely to participate the study in order to get help • Volunteers may be more connected to the gay organizations

Table 2 (Continued)

Study	Measures	Findings	Comments
Grossman et al. (2001)	<ul style="list-style-type: none"> • Mental health, 5-point Likert scale • Self-esteem, 10-item scale • Loneliness, 8-item scale • Internalized homophobia • Substance use • Support network • Experience with HIV/AIDS 	<ul style="list-style-type: none"> • The investigators summed the problems faced by the older MSM as the problem of “self-esteem”—that the lack of self-esteem led to sense of worthlessness and subsequently HIV vulnerability • Most gay and bisexual males reported good mental health (M=4.18, SD=.77) • Most gay and bisexual males reported fairly high level of self-esteem (M=34.69, SD=4.50) • 27% of all participants experienced loneliness, 13% reported feeling isolated • Most participants reported low levels of internalized homophobia; age is related to internalized homophobia, older participants reported more homophobia ($r=.13$, $p<.05$) • 75% of participants reported good to excellent health • Only 9% of the participants were “problem drinker” • Participants averaged six people in their social support, and they were mostly satisfied with support from those who knew their sexual orientation • 17% reported drug abuse in the past year • 89% of the participants knew someone diagnosed with HIV/AIDS • 90% believed that they are very unlikely to be infected with HIV 	<ul style="list-style-type: none"> • ANOVA was used to compare demographic variables, health outcomes among gay men and lesbian • However, some of the descriptive statistics in the text were not reported specifically for gay men
Dolcini et al. (2003)	<ul style="list-style-type: none"> • Closetedness (5-point Likert scale, “out to all” to “out to none) • Sexual Identity • Substance use 	<ul style="list-style-type: none"> • 17% of respondents were HIV positive (19% for men in their fifties and 3% for men in their sixties) • Prevalence was high for several subgroups: • 30% for African American • 21% for MSM and IDU • 35% for moderately heavy drug users ($p<.0001$) • 21% for “less-closeted” men ($p<.001$) 	<ul style="list-style-type: none"> • A large probability sample of urban MSM • HIV prevalence is high • Only bivariate relationship was examined, no multivariable regression
Jimenez (2003)	<ul style="list-style-type: none"> • Sexual identity • Sexual behavior • Drug use • Closetedness • Stigma • HIV testing 	<ul style="list-style-type: none"> • Most men (>90%) reported sex with other men • Average number of partners during the past 3 months is 3.84 • Almost all black (except one) reported engaging in receptive anal sex during the past 3 months before the interview, with 20% without using condom • 84% of the respondents reported drinking in conjunction sex, 	<ul style="list-style-type: none"> • Only descriptive statistics reported • Formal statistical tests were not performed • There was no table

Table 2 (Continued)

Study	Measures	Findings	Comments
	<ul style="list-style-type: none"> Self-perception of risk 	<ul style="list-style-type: none"> 50% used marijuana, 23% used amyl nitrate, 20% used rock cocaine, and 20% used heroin 52% of the respondents self-identified as gay, 29% as bisexuals, and 16% as mostly or completely straight 19% of the respondents had sex mostly with men but occasionally with women 18% of the respondents had sex mostly with women but occasionally with men Only 37% reported being “out” to their friends or family members 58% and 77% ranked “being gay” and “having HIV/AIDS” in a high-stigma ranking (4 or 5 on a 5-point Likert scale) 94% of the subjects had previously been tested for HIV infection, with 17% reported to have positive result 74% perceived themselves to be at minimal risk of contracting HIV virus 	
Rawls (2004)†	<ul style="list-style-type: none"> Depression, 20-item CES-D (range 0-50) Sexual Identity Disclosure of sexual orientation 	<ul style="list-style-type: none"> Median of CES-D score is 7 21% of the respondents reported CES-D \geq 16, indicating the presence of depressive symptoms or distress 12% reported CES-D \geq 22, indicating the presence of clinical depression 86.5% of respondents are “out” to all or almost all to their friends, and 51.8% are “out” to their family members Sexual orientation disclosure declines with age, 58% of the respondents aged 50 to 59 report high levels of disclosure, compared to 40.4% of the respondents in their 60s, and only 27.8% of the respondents over 70 years ($\chi^2=17.22$, $p<.001$) Education and race were not related to CES-D score but unemployment and depression is strongly related to CESD-score ($\chi^2=15.79$, $p<.001$) 	<ul style="list-style-type: none"> Risk factor for HIV infection is not the primary research question Risky sexual behavior and other risk factors are not investigated
Kokkema & Kuyper (2007)	<ul style="list-style-type: none"> Loneliness Social Embeddedness Health (perceived and objective) Living conditions Self-esteem Socioeconomic status 	<ul style="list-style-type: none"> LGB elders were less socially embedded than their heterosexual counterparts LGB elders had significantly higher socio-economic status, measured by education and income than the older heterosexuals LGB elders were significantly lonelier than their heterosexual peers 	<ul style="list-style-type: none"> Sample include both institutionalized and independently living elders, there may be difference in levels of loneliness between these two groups A very good study in general but did not examine if loneliness influence any adverse health outcomes, for

Table 2 (Continued)

Study	Measures	Findings	Comments
		<ul style="list-style-type: none">• Higher level of loneliness experienced by older LGB respondents can be explained, in part, by weaker social embeddedness• The difference in loneliness between LGB elders and heterosexual elders persists, even after controlling for socio-economic status, health, and self-esteem• The authors called for future research to examine the quality of private relationship as well as minority stress	example suicidality

†-study was published as book chapter, MSM: Men who have Sex with Men, HAART: Highly Active Anti-Retroviral Therapy, IDU: Injection Drug User, CES-D: The Center for Epidemiologic Studies Depression Scale, ANOVA: Analysis of Variance

1.2.12 FIGURE

Contextual Stressors: Community, socioeconomic, racial or ethnic

Structural Stressors: Barriers to health care services

General stressors of aging: Decline in physical health, function, and independence; retirement; loss of spouse; fear of institutionalization; loneliness

Other stressors for older gay men: Survival guilt from AIDS epidemic, loss of friends and partners from AIDS

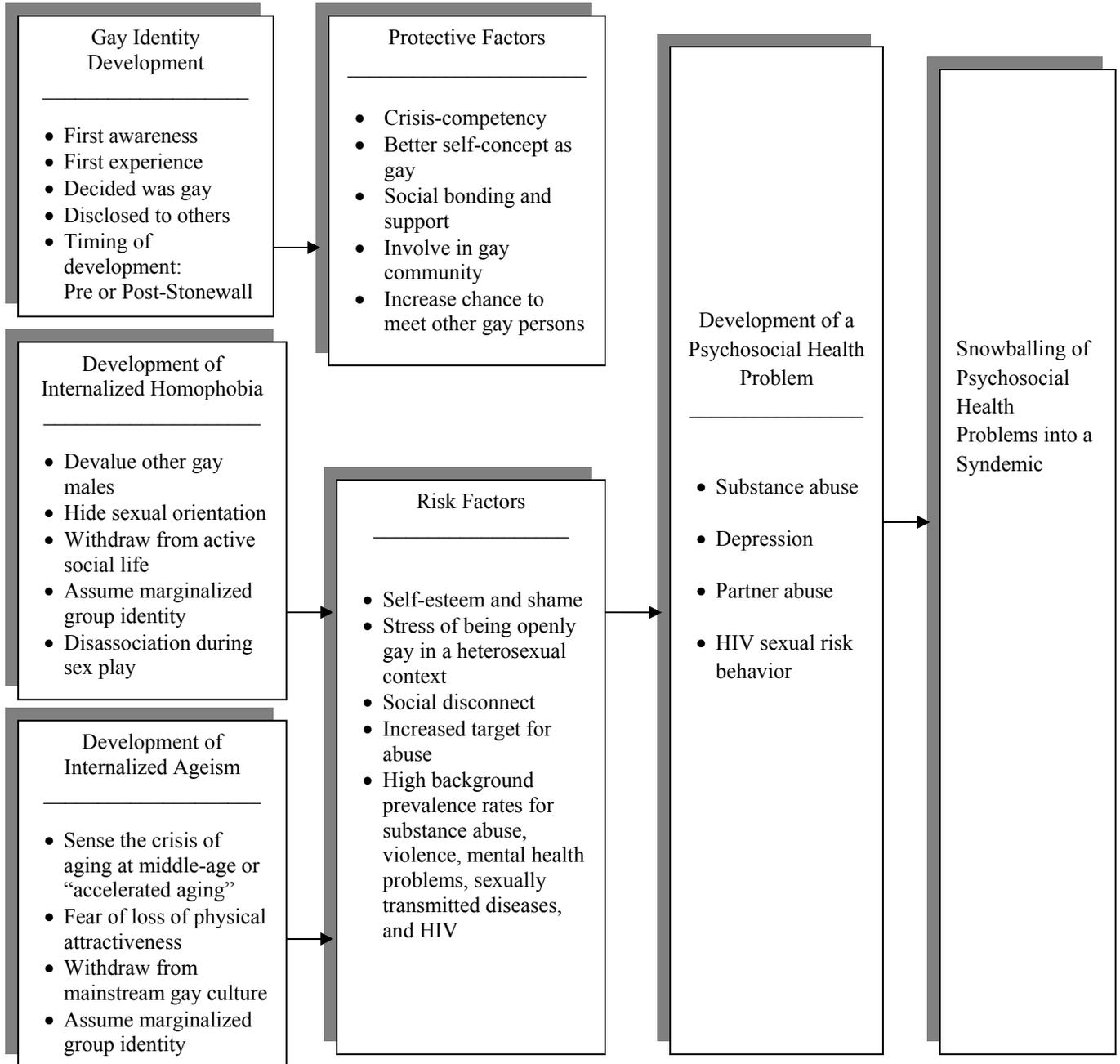


Figure 1 Syndemic production of health problems among older gay and bisexual men

**2.0 ARTICLE ONE: DIFFERING TRAJECTORIES OF HIV RISKY SEXUAL
BEHAVIOR AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO
HAVE SEX WITH MEN (MSM)**

Manuscript in Preparation

Sin How Lim¹, Nina Markovic^{1,2}, Kevin H. Kim³, Ron Stall⁴, Anthony J. Silvestre⁵

¹ Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh,
Pittsburgh, Pennsylvania

² Department of Dental Public Health, School of Dental Medicine, University of Pittsburgh,
Pittsburgh, Pennsylvania

³ Department of Psychology in Education, School of Education, University of Pittsburgh,
Pittsburgh, Pennsylvania

⁴ Department of Behavioral and Community Health Sciences, Graduate School of Public Health,
University of Pittsburgh, Pittsburgh, Pennsylvania

⁵ Department of Infectious Disease and Microbiology, Graduate School of Public Health,
University of Pittsburgh, Pittsburgh, Pennsylvania

Address correspondence to Sin How Lim, MS

Graduate School of Public Health, 213 Crabtree Hall Pittsburgh, PA 15261

2.1 ABSTRACT

Introduction: Recent studies found that MSM (men who have sex with men) over the age of 50 are engaging in risky sexual behavior and are at risk for acquiring and transmitting HIV.

However, how risky sexual behavior changes as MSM age has not been studied. The purpose of this study was to examine the trajectories of risky sexual behavior among MSM over the age of 50.

Method: Within the Pitt Men's Study (N=259), we examined the trajectories for men within the age range of 42.5 and 62 with respect to the number of unprotected anal intercourse (NUAI) partners over a 10 year period (1996-2006). A semi-parametric, group-based approach was used for this analysis.

Results: The best-fitting model yielded four distinct trajectory groups. The majority of men (48.0%) had no NUIAI partners ("low exposure group") at any age in the age range of the study, while 19.3% of men had NUIAI partners which declined from greater than one to zero ("decreasing exposure group"), 14.6% of men had a temporary increase of NUIAI partners peaking at age 55 ("midlife exposure group"), and 18.1% of men had one to two NUIAI partners across the age range of the study ("high exposure group"). Popper use and HIV-related attitudes were differentially associated with the trajectory groups.

Conclusion: The majority of men belong to the "low exposure group" and the "decreasing exposure group". Although there is no age-appropriate intervention for older MSM, these men were not engaging in risky sexual behavior. This may represent the strength in this population. Using this analytic approach, intervention may be designed to target the subgroups of men who are at heightened risk for HIV.

2.2 INTRODUCTION

Understanding the ‘age’ or ‘aging’ effects on risky sexual behavior among men who have sex with men (MSM) are extremely important to learn about the epidemiology of HIV among this population, especially since a large proportion of these men are aging. Since the emergence of AIDS epidemic, MSM have experienced disproportionate burden of HIV disease. HIV prevention efforts have focused on younger MSM because of high HIV incidence and HIV risk behavior in this population (Mansergh & Marks, 1998; Valleroy, et al., 2000). However, recent statistics from the Centers for Disease Control and Prevention (CDC) suggest that older MSM are also at risk for HIV/AIDS. It is estimated that 25 percent of Americans living with HIV at the end of 2006 were 50 and older (CDC, 2008b). A newly released report from the CDC, using a new method (STARHS) to distinguish newly-acquired infections from long-standing infections, estimates that for 2006, 10 percent of all newly acquired infections were in adults over the age of 50 (CDC, 2008a). Although a national estimate of HIV prevalence in older MSM is unavailable, HIV prevalence in older MSM could be greater than the older adults in general population. A study of HIV prevalence and risk factors of MSM living in four metropolitan cities found that 19% of MSM above the age of 50 are infected with the virus (Dolcini, Catania, Stall, & Pollack, 2003).

In addition, the burden of HIV/AIDS experienced by the older MSM appear to have increased over the past decade. CDC data shows the HIV/AIDS diagnoses in older adults increased from 2001 to 2006. The percentage of adults older than 50 among the new AIDS cases in America has increased from 11% in 1995 to 15.5% in 2006 (CDC, 2006; Mack & Bland, 1999). While data from the CDC support that older MSM are vulnerable for HIV/AIDS, social stigma due to homophobia and ageism have rendered older gay and bisexual men a marginal

population, in which HIV levels and sexual risk factors are less well known (Grossman, 1995). Contrary to general belief that older gay/bisexual men are not sexually active, a converging lines of research has found that some of these individuals are having sex that put them at risk for HIV. Cofactors likely to facilitate HIV transmission such as unprotected anal sex, having multiple sex partners, alcohol use, methamphetamine and Viagra use, meeting sexual partners on the Internet, and treatment optimism are also common in older MSM.

As early as in the 1980s, Stall and Catania (1989) observed that a significant percentage of MSM older than 50 in San Francisco could be classified as “high risk” as these individuals were having anal sex without condom and outside of monogamous relationship. In studying HIV prevalence and risk factors in older MSM in the Urban Men’s Health Study, Dolcini, Catania, et al (2003) found that prevalence of HIV was higher among African American (30%), injection drug user (21%), illicit drug users (35%), and those who were more open about their sexual orientation (21%). Other identifiable risk factors include ethnic minority status (older Latino MSM, Jimenez, 2003); multiple sex partners; unprotected receptive anal sex, drinking in conjunction with sex, recreational drug use, stigma related to being gay and having HIV, and low perception of risk contracting HIV virus.

Two recent changes in available medications may also contribute to changes in risk factors and behaviors. The advent of more effective treatments for HIV infections has resulted in more people living with HIV/AIDS. A substantial proportion of HIV-positive MSM continue to engage in high-risk sexual behavior, placing themselves at risk for contracting secondary infections and transmitting HIV virus (Crepaz & Marks, 2002; van Kesteren, Hospers, & Kok, 2007). Reduced concern due to HAART and safer sex fatigue were found to be associated with sexual risk-taking among HIV-positive MSM (D. E. Ostrow, et al., 2002). In addition, the

invention of phosphodiesterase type 5 (PDE-5) inhibitors (sildenafil, tadalafil, vardenafil) has enabled many older men to restore or enhance their sexual function. Recent work has demonstrated an association between use of PDE-5 inhibitors by itself, or with other stimulant drugs, and increased rates of high-risk sexual behavior and HIV transmission in MSM (D. G. Ostrow, Plankey, et al., 2008; Paul, Pollack, Osmond, & Catania, 2005; Swearingen & Klausner, 2005). This risk factor may be of special importance in the old MSM population (Rosen, Catania, et al, 2006; Cove and Petrak, 2004).

The population of older MSM appears to be both evolving and heterogeneous, hence the need to understand the development of sexual behavior of HIV-negative and HIV-positive MSM as they age has never been greater. It is plausible that MSM are now becoming complacent about protection with the advent of HAART (Stolte, Dukers, Geskus, Coutinho, & de Wit, 2004). In the Multicenter AIDS Cohort Study (MACS), reduced concern about becoming infected with HIV was found to be associated with sexual risk-taking among HIV-negative MSM (D. E. Ostrow, et al., 2002). Qualitative studies suggest that these individuals may also trade-off safe sex because of the perceived loss of attractiveness with aging, loneliness, marginalization within the gay community, and desire to have sexual intimacy (Murray & Adam, 2001; Wierzaliz, Barret, Pope, & Rankins, 2006).

In addition, the levels of risky sex behavior may be different among HIV-negative and HIV-positive older MSM. In a study of 624 older men who were infected or at risk for HIV, Cooperman and colleagues (2007) showed that both HIV-positive and HIV-negative men were sexually active and participated in risky sex behavior. Yet, HIV-positive men were significantly less sexually active, and had a greater prevalence of erectile dysfunction and sildenafil use. HIV-negative men reported less condoms use in the past 6 months than HIV-positive men. The

association of HIV status and risky sex behavior remained significant after controlling for daily alcohol use, frequency of sexual activity, and sildenafil use.

All in all, it is increasingly clear that older HIV-negative men are at risk for acquiring HIV while older HIV-positive MSM are likely to spread the HIV virus. These changing patterns of disease in this population require further investigation. One of the most important risk factors for HIV acquisition and transmission among MSM involve unprotected anal intercourse. Little is known about how it varies over the life course of MSM.

Heterogeneity of aging experience in older gay and bisexual men has long been recognized by previous researchers (Kimmel, Rose, Orel, & Green, 2006). However, individual differences in development of sexual behavior in this population have not been systematically examined. Specifically, no study has assessed the possibility of different trajectories of number of unprotected anal sex in aging MSM.

We hypothesize that older MSM is made up of subpopulations with different developmental trajectories of this risky sexual behavior. The goal of this study is to identify whether different trajectories for number of unprotected anal sex partners exist among older MSM. In order to inform prevention and intervention efforts, it is essential to identify factors that place older MSM at great risk of initiating unprotected anal sex and increase number of unprotected anal sex over time. To achieve the research goal, we used a longitudinal sample of aging MSM from the Pitt Men's Study, a cohort study of HIV epidemiology and disease outcomes among MSM in Pittsburgh. We used group-based modeling to identify multiple trajectories of number of unprotected anal intercourse partners.

2.3 METHODS

2.3.1 Study Sample

We obtained retrospective, longitudinal data from the Pitt Men's Study (PMS), the on-going cohort study of natural history of HIV infection and progression among men who have sex with men (MSM) in Pittsburgh. The Pitt Men's Study is one of the four sites of the Multicenter AIDS Cohort Study. Since 1983, participants in the study have been followed every 6 months with detailed questionnaire-based interview, physical examination, and medical history review. The inclusion criteria, recruitment and sampling strategies are described in greater detail elsewhere (A. Silvestre, et al., 1986; A. J. Silvestre, et al., 2006). In brief, the PMS study population is a convenience sample of men who reported having homosexual activity with another man in Pittsburgh. Subjects were recruited through personal networks with the gay community and gay-venue media advertisements. Particular effort has been devoted to recruit Black and Hispanic MSM during the latest cohort enrollment, 2001-2003. Data were selected from visit 26 to visit 46 (1 Oct 1996 to 31 March 2007) and this interval will be referred as the study period in the paper.

Individuals were included if they met all of the following criteria: (1) aged 50 and above at the last day of visit 46, which was 31 March 2007; (2) no missing data on number of unprotected anal sex partners; (3) age between 42.5 and 62 during study period; (5) participants must have had at least three visits during study period (see Table 1). Of 766 subjects who came to PMS between visit 26 to visit 46 (median number of visit for each participant = 9, range of visit is from 1 to 21), 324 (42.3%) were 50 years old and above on 31 March 2007. Among the remaining 324 participants, 312 participants had no missing data on number of unprotected anal sex partners. To ensure sufficient data points for each age interval, we limited the data to age between 42.5 to 62. This cut-off resulted in at least 30 cases at each age point and included

86.4% of the previous data (n=286). Finally, participants had to be in the study at least three times during visit 26 to visit 46, thus contributing three data points to the estimates of individual trajectories. These criteria left a final analytic sample of 259. Because the study's primary goal is to examine the age or aging effects on risky sex behavior, longitudinal data were restructured as a function of age rather than visit.

2.3.2 Measures

Dependent Variable: Number of unprotected anal intercourse partners

In every biannual visit, participants were asked comprehensive questions regarding their sexual behaviors in the past six months. Participants who reported having insertive anal intercourse and/or receptive anal intercourse were asked a different set of questions according to whether they reported having only one male sex partner or reported having multiple sex partners in interval since the previous visit. If the participant had only one male sex partner, the number of unprotected anal intercourse partner is indicated as one when he answered 'no' to "thinking of the time you put your penis in his anus/butt, did you use a condom every time, even if it broke, tore, or slipped?", or "thinking about the times he put his penis in your anus/butt, was a condom used every time, even if it broke, tore, or slipped?". For participants who had multiple insertive anal intercourse and/or receptive anal intercourse partners, the number of unprotected anal intercourse partners was calculated by total number of anal intercourse partners minus number of partners "when condom was used every time, even if it broke, tore, or slipped". The number of unprotected anal intercourse partners (NUAI) was calculated by the sum of the number of insertive anal intercourse partners and the number of receptive anal intercourse partners with whom condoms were not used. The NUAJ partners of the sample range from 0 to 1988. The

variable was heavily skewed to zero, with 68.6% of the observations (N=3034) reporting having zero unprotected anal intercourse partners in the past six months. About 14.5% answered 1 unprotected anal intercourse partner, and 9.8% answered 2 unprotected anal intercourse partners. The data for 3 or more partners were then truncated to 3, with the number of 3 or more partners making up 7.0% of the sample.

Independent variable: Age

Because participants were interviewed at six-month intervals, it was necessary to devise a consistent assignment of age, based on half-year intervals. This was done by determining the nearest half-year age (e.g., 42.0; 42.5; 43.0, etc.) at the final visit (number 46, on 31 March 2007) and then subtracting half-year increments from that age for each prior visit to calculate the age (to the nearest half-year) at each prior visit. The age calculated by this method was found to be closely matched to the age calculated by using the date of each visit minus the date of birth of participant.

Sociodemographic characteristics

Self-reported race/ethnicity was categorized as white/non white. Years of education completed at the last visit, or visit 26 was used in the study. The self-reported annual gross income in the past year was dichotomized as less than \$20,000 or not. A summary variable was created to indicate if a participant has earned less than \$20,000 at any age in the study period. Similarly, a summary variable was created to indicate if a participant has experienced financial difficulty meeting his basic expenses in the previous 6 months in any ages.

Individual Risk Behavior

Participants were considered to be current users of recreational drugs if they reported use of the following drugs even once since the previous visit: 1) marijuana, 2) poppers or nitrites inhalants, 3) crack cocaine, 4) other forms of cocaine, 5) methamphetamines (or crystals, speed, ice), and 6) other recreational drugs such as “ecstasy” or MDA/MDMA (3,4-methylenedioxy-*N*-methylamphetamine), gammahydroxybutyrate (GHB), “speedball”, ethyl chloride, hallucinogens, “downers”, or heroin/opiates. Questions about use of these drugs were asked and responses were coded individually. Stimulant drug was defined as one of the six categories of recreational drugs except for marijuana and poppers. Binge drinking was defined as 5 or more drinks per occasion occurring at least monthly.

Depressive Symptoms

At every biannual visit participants were asked to complete the 20-item CES-D, which was directly adapted from the instrument developed by Raldoff (1977). The CES-D score was examined as a binary variable using cut off at 16. CES-D score greater than 16 has been shown to be indicative of significant depressive symptoms and has been shown to predict HIV morbidity and mortality in a previous Multicenter AIDS Cohort Study (Farinpour, et al., 2003).

HIV-related Attitudes

We used the variables from the Men’s Attitudes Survey to assess HIV-related attitudes (D. G. Ostrow, Silverberg, et al., 2008). This survey consists of 20 items, with each item on a 5-point Likert scale, ranging from 1 (“Do not agree at all”) to 5 (“Strongly agree”). Five of the subscales were used in the analysis: reduced HIV concern (“I am less concerned about HIV transmission since the availability of HAART”), perception of HIV as a health threat (“HIV is less of a health threat since the advent of

HAART”), safer sex fatigue (“I find it difficult to maintain sexual safety”), viral load/transmission beliefs (“If a person has a non-detectable viral load, it is much less likely that he will transmit HIV during unprotected anal sex”), and sexual sensation seeking (“The risk of HIV infection adds to the enjoyment of sex”).

2.3.3 Statistical Analyses

A semi-parametric, group-based approach was used to identify various clusters of individual growth trajectories (D. Nagin, 1999). Trajectories were modeled as a function of age rather than visit. We analyzed all group-based models by using the SAS TRAJ macro in SAS version 9.2. Suppose $Y_i = \{y_{i1}, y_{i2}, y_{i3}, \dots, y_{iT}\}$ represents the longitudinal sequence of number of unprotected anal sex partners of an individual i over T age, and $P(Y_i)$ denotes the probabilities of Y_i . Group-based trajectory model assumes that population defined by the number of unprotected anal sex partners is composed of a mixture of J underlying trajectory groups such that

$$P(Y_i) = \sum_j \pi_j P^j(Y_i),$$

where $P(Y_i)$ is the probability of Y_i given membership in group j , and π_j is the probability of group j (D. S. Nagin, 2005). SAS TRAJ procedure estimates the group membership probabilities, π_j by a multinomial logit function (Jones, Nagin, & Roeder, 1999). A censored normal model was used to accommodate the possibility of clustering at the scale of 0 to 3. Once the optimal model and group assignment were determined, chi-square tests and analysis of variance (ANOVA) were used to test group differences in demographic, behavioral, psychosocial characteristics. Because this is an unbalanced study design, participants do not come for every possible visit and therefore the numbers of participants at each age point vary. To summarize

results of the continuous variables across ages, mean scores of these measures of interest (e.g. years of education, number of drinks, CES-D score) across the ages were calculated. For behavioral and psychological measures which are dichotomous (e.g. financial difficulty, substance use, binge drinking), a new variable was created to denote if the participant has ever reported such characteristics at any age during the study period.

2.4 RESULTS

Baseline Demographic and Behavioral Characteristics

The final sample (n=259) used in the analysis was primarily Caucasian (n=234; 90.4% of sample), with a smaller proportion of African Americans (n=22, 8.5% of sample), Hispanic white (n=3, 1.2%), and other races (n=3, 1.2%). Participants were generally well-educated, with mean of 15.5 years of education (standard deviation=2.75, range 8-21 years). The individual income of the sample was relatively high. Since there are more cases at age 51.5 than any other ages, baseline characteristics at age 51.5 is reported here. Of 135 participants who were 51.5 years old in the study period, about 18.1% (n=24) reported \$60,000 or more annual gross income. About 30.7% (n=41) reported \$50,000 or more annual gross income. About 26.3% (n=35) earned less than \$20,000 annually and 10.5% (n=14) reported experiencing major financial difficulty meeting basic expenses at the previous visit. At the age of 51.5, 31.9% of the participants (n=43) were current smokers, 7.4% (n=10) reported binge drinking in the past six months. A high proportion of participants used marijuana and poppers at age 51.5: 29.6% (n=40) reported using marijuana, and 22.2% (n=30) reported using poppers in the past 6 months. Only 2.2% (n=3) reported using crack cocaine, 3.7% (n=5) reported using other forms of cocaine, 1.5% (n=2) reported using methamphetamine or 'crystal meth' in the past six months, 5.2% (n=7) reported any of the stimulant drugs, defined by crack cocaine, other forms of cocaine, methamphetamines, or ecstasy in the past six months. For some participants, the percentages of any stimulant drug use were less than the sum of percentages of individual drugs because these individuals were using more than one drug at a time. The mean of CES-D score at the age of

51.5 is 9.45, with 22.2% (n=30) of participants reporting CES-D \geq 16 and 13.3% (n=18) reporting CES-D >21.

At the age of 51.5, 77% (n=104) of participants were sexually active, the mean of number of male sexual intercourse partner in the past six months was 5.5 (standard deviation, 11.4, range 0-75), the mean of number of unprotected anal intercourse partner in the past six months was 1 (standard deviation 0.97, range 0-33). At the end of the study period (visit 46), a total of 153 participants (61.0% of sample) were HIV-negative and 98 (39.0%) were HIV-positive. In the ten-year study period, only four new cases of HIV infection, documented by sero-conversion, occurred for an annual sero-conversion rate of 0.016.

Longitudinal Analyses

Using the SAS TRAJ procedure, we identified 4 trajectories with respect to number of anal sex partners. We compared the various nested and unnested models sequentially and systematically in order to determine the optimal number of classes (groups) and shape (e.g. linear, quadratic, and cubic) of growth trajectories of number of unprotected anal sex partners. Substantive knowledge, in combination with formal statistical criteria such as Bayesian Information Criteria (BIC), average posterior probabilities of group assignment and Odds of Correct Classification (OCC) guided the model selection. According to Nagin, the best model should be the one that has the maximum (least negative) BIC and a model is considered adequate when the average posterior probabilities of group assignment are close to 1 and OCC greater than 5.0. Table 2 displays the Bayesian Information Criteria (BIC) from a two-group model to a five-group model. Table 3 and Table 4 display the average posterior probabilities of group assignment and OCC for a four-group model and a five-group model respectively. As shown in

Table 2, BIC continued to increase as when the number of group increased in the model. However, a five-group model has yielded a prohibitively small group (see Table 4, the last group has only 18 subjects) and thus we decided upon the four-group model as the optimal model. Table 3 shows that the average posterior probabilities of group membership for the four-group model are above 0.80, the Odds of Correct Classification for each group assignment are all above 5.0. These tests support the adequacy of the model.

With respect to NUAI, we found that the subset of older men in the PMS sample could be further subdivided into 4 distinct trajectory groups based on number of unprotected anal intercourse partners (Figure 1). The low exposure group (n = 135; 48.0% of the sample, average posterior probability of group membership = 0.893) were characterized by having no unprotected anal sex partners at any age. The decreasing exposure group (n = 41; 19.3% of the sample, average posterior probability of group membership = 0.852) were characterized by having one unprotected anal sex partner at age 42.5 but declines to zero unprotected anal sex partners after age 50. The midlife exposure group (n = 36; 14.6% of the sample, average posterior probability of group membership = 0.813) were characterized by having no unprotected anal sex partners at age 42.5 but began to have one unprotected anal sex partner after age 49 and reached a peak of one or more sex partner at about age 53 but then declined to zero at age 62. Finally, the high exposure group (n = 47; 18.1% of the sample, average posterior probability of group membership = 0.909) were characterized as having one to two unprotected anal sex partners across the entire age range of the study.

The 95% confidence intervals of the trajectory curves seem to vary among four trajectory groups. The low exposure group has a narrow 95% confidence interval compared to other groups. The decreasing exposure group has a very wide 95% confidence interval at the beginning

age of the study (age 42.5) which becomes sharply narrow as age advances. The midlife exposure group has wider 95% confidence interval in the middle ages when the trajectory peaks around age 53. The high exposure group has a wider 95% confidence interval compared to other groups. The 95% confidence interval seems to diverge at the lower and upper end of the age range. The wider 95% confidence at the lower and upper ends of age range may be due to the scarcity of data points at both ends of the age range rather than heterogeneity within the groups.

Statistical parameters of the trajectory groups

Table 5 displays the sociodemographic, behavioral, and psychosocial characteristics of participants reported by each of the four trajectory groups. The trajectory groups are not statistically different in their demographic characteristics although the high exposure group appears to include more African American, younger men at the last visit. The high exposure group is made up of 97.9% of white races, as compared to only 92.7% in decreasing exposure group, 91.7% in midlife exposure group and 86.8% in low exposure group. The men in the high exposure group have the mean age of 55.5 at visit 46, compared to mean age of 56.4 for midlife exposure group, 56.9 for the low exposure group and 57.4 for the decreasing exposure group. There is higher proportion of men (15.6%) enrolled from the recruitment (2001-2003) in the low exposure group, compared to 7.3% in the decreasing exposure group, 13.9% in the midlife exposure group, and 10.6% in the high exposure group.

The trajectory groups are statistically significantly different in terms of recent popper use reported at any visits (ages) and mean of number of male sex partners in the past 6 months across ages. Participants in the high exposure group are more likely to have reported using poppers at any age during the study period as compared to other trajectory groups ($p < 0.001$). As high as

59.6% of the participants in high exposure group reported using poppers in the previous visit at any age, while much less participants in other trajectory groups reported using poppers in the past visit at any age (30.4% for low exposure group, 48.8% for decreasing exposure group and 50.0% for midlife exposure group, $p=0.002$). Participants in the “high exposure group” also reported significantly greater mean number of male sexual intercourse partners across ages (mean = 13.3) while the “low exposure group” reported a mean of 3.8 of male sexual intercourse partners, “decreasing exposure group” reported a mean of 5.9 male sexual intercourse partners and “midlife exposure group” reported a mean of 9.6 male sexual intercourse partners in the past visit ($p<0.001$).

The trajectory groups are not significantly different in their HIV status. At the end of the study period (visit 46), there is a greater proportion of HIV-positive men (43%) at in the “low exposure group” compared to 36.6% in the “decreasing exposure group” and 41.7% in the “midlife exposure group”. Interestingly, the “high exposure group” has the least proportion of HIV positive men. Only 25.5% of the men in this group were infected by HIV. The trajectories groups are not statistically different in their socio-economic characteristics such as education, income, financial difficulty, other risk behaviors such as number of drinks per week, binge drinking, other recreational drug use, as well as depressive symptoms.

With respect to HIV-related attitudes, only two of the five subscales of the HIV-related attitudes, namely safer sex fatigue and sexual sensation-seeking were differentially associated with the trajectory groups. The men in the “high-exposure group” were most likely to endorse safer sex fatigue and sexual sensation-seeking while the men in the “low exposure group” were least likely to endorse these personal attitudes. Reduced HIV concern, perception of HIV as a

health threat, and viral load/transmission beliefs were not significantly different among the trajectory groups.

2.5 DISCUSSION

The current study identified multiple trajectories of a documented HIV risk behavior, number of unprotected anal sex partners in the past 6 months, in a cohort of aging men who have sex with men (MSM). Specifically, we identified a group that has low risk which reported no unprotected anal sex partners across the ages, a group whose unprotected anal sex partner declined from more than 1 at age 43 to close to zero after age 55 (“decreasing exposure group”), a group which have near zero unprotected anal sex partner at age 43 but increased partners and peaked at age 55 and then declined after (“midlife exposure group”), and finally a group who have more than one but less than two unprotected anal intercourse partners across ages (“high exposure group”).

To our knowledge, our study is the first to examine risky sexual trajectories in the aging MSM population. Hence, there are no data from previous studies with which to compare our findings. Our study found that only popper use statistically distinguishes the four trajectory groups and can potentially be a predictor for the trajectory groups. Counter-intuitively, none of the demographic, behavioral characteristics, or depressive symptoms was found to be differentially associated with the trajectory groups.

The authors acknowledged that there are several limitations this secondary data analysis. First, the Pitt Men’s Study is not a developmental study of middle-aged MSM where all participants started in the study at the same age. Pitt Men’s Study is a cohort study where participants were recruited at different ages. To study the aging effects on risky sex behavior, we

modeled the trajectory of number of unprotected anal sex partners in terms of age of participant when he comes to the visit. The assumption is that the participants of the same age of earlier visit will have the same risk behaviors as those of the same age at later visit. One may argue that possible period effect and cohort effects such as the advent of Highly Active Anti-Retroviral Therapy (HAART) may explain the risky sex behavior rather than age itself. We conducted a subanalysis to test the association of enrollment cohort and trajectory groups by using chi-square test but no association of enrollment cohort and different trajectory groups was found.

Second, since every participant comes in every visit at different ages, number of participants in each age group varies. In fact, the data in the middle ages (50-54) are greater than the lower and higher ages. Age below 42.5 and age above 62 during the study period were eliminated because the number of this younger (below 43) and older (above 62) group is too small to make estimation of the trajectories stable. Indeed, when we tried to include this age range in our analysis, the estimated trajectories became idiosyncratically unreliable. However, we recognize that the cut-off for age did not follow biological and social standard cut off of middle and older age and the decision to use the age 42.5 to 60 in the analysis was purely a statistical decision. Last, the findings can only be generalized to MSM aged between 42.5 to 62 living in Pittsburgh.

Our study supports the hypothesis that differing trajectories of risky sexual behavior may exist in middle aged and older MSM. The men in the “high exposure group” were more likely to be white, younger at the end of the study period, and least poor than the men in other trajectory groups but the differences were not statistically significant. Not surprisingly, the men in the “high exposure group” were most likely to endorse safer sex fatigue and sexual sensation seeking than the men in other trajectory groups. This finding supports the previous study which found

that safer sex fatigue was associated with unprotected anal intercourse in the Multicenter AIDS Cohort Study (D. E. Ostrow, et al., 2002). Surprisingly, the men in the “high exposure group” have the lowest prevalence of HIV (25.5%) as compared with higher prevalence of HIV in other trajectory groups, although this difference was not statistically significant. This finding suggests that these men may have picked their sexual partners with care. An alternative hypothesis is that these participants may have employed harm reduction strategies that may work to limit their exposure to HIV, perhaps including HIV serosorting. Timing of the HIV infection may be a confounding factor in this study. In the subanalysis, we found that only 4 out of 100 HIV positive individuals seroconverted during the study period. In other words, 96% of the HIV-positive men were infected before the study period.

Previous research has shown that due to many physical and psychosocial reasons, HIV positive persons engage in less sexual activity and risky sexual behavior (Cooperman, et al., 2007). In general, the HIV-infected men have more co-morbid conditions which may reduce their sexual functions or sexual desires. These individuals have also been found to have higher prevalence of erectile dysfunction because of the side effects of antiretroviral therapy. Once informed of their HIV/AIDS diagnosis, these individuals may begin to adopt safer sex practices such as using condom for sex to prevent transmission of HIV and reinfection. In addition, the HIV-positive men may self-censor for sex because of stigma, perceived reduced desirability and fear of rejection (Siegel & Schrimshaw, 2003). The higher proportion of the HIV-positive men in the “low exposure group” may explain the low number of risky sex partners across ages as they may have already reduced their HIV risk levels prior to the time window of this study. In fact, the men in the “low exposure group” and “decreasing group” reported significantly higher proportion of any sexual inactivity across ages compared to other groups ($p < 0.001$). The other

possible explanation is that the men in this group comprise of the men who rarely engage in unprotected anal sex in their lifespan.

HIV infection, however, cannot explain fully the trajectories in “decreasing exposure group” and “midlife exposure group” because only one individual in the HIV-infected men in both groups were infected within the study period. The men in the “decreasing exposure group” may have one unprotected anal sex partner age 42 but lost his sex partner or stopped having unprotected anal sex for biomedical, socio-psychological reasons. The men in this group may stop having unprotected anal sex altogether simply because the unavailability of sexual partners or unavailability of sexual opportunities.

The men in the “midlife exposure group” may begin to engage risky sex at age 50 for many reasons. The men in this group may come out of closet at middle life and began to experiment sexually at that age. It is also possible that these men may experience some forms of midlife crisis when they reached 50 years and began to meet new sexual partners and engage in unprotected anal sex. For unknown reasons, these individuals reduced the number of unprotected anal sex partner after the age of 55.

Finally, the men in the “high exposure group” may be those for whom further public health attention may be beneficial. These men begin to have more than one unprotected anal sex partner at age 42 and continued to do at least until age 62. These individuals are more likely to have used poppers in any ages as compared to the men in other trajectory groups. There is a greater proportion of methamphetamine use in any ages compared to other trajectory groups even though the association was not statistically significant. It was also found that there was a greater proportion of Viagra use at the last visit among the men in the “high exposure group” as

compared to the men in other trajectory groups. Other possible risk factors such as binge drinking, depression, or socio-economic status could not explain the difference between the men in this group and the men in other groups. Even though the men in the “high exposure group” engaged in risky sexual behavior throughout their middle life, these individuals have the lowest prevalence of HIV. More research needs to be conducted to investigate how these individuals have avoided getting infected while engaging in risky sexual behaviors.

It is important to note that our study shows that the men in all four trajectory groups have more than one male sex partners in the previous visit across ages. Thus, the “low exposure group” and “decreasing exposure group”, as well as the men in the “midlife exposure group” after age 55 may have adopted safer sex strategies by restricting their sexual contacts to oral or protected anal intercourse with one or more men.

We acknowledge that important variables may be missing in the analysis. The information on long-term relationships is not available in the Pitt Men’s Study. It is important to distinguish long-term sexual partners, casual sexual partner, and newly acquired sexual partners where HIV risk levels could not easily be ascertained. It is possible that some men who were having unprotected anal sex partners were having this risky sex behavior with long-term partners and were engaging in “sero-sorting”. The questions on sero-status of the partners were added only after visit 40 and were not available throughout the study period. Future research will have to examine the relationship status, sero-status of the participant and that of the partner.

It is also important to note that our study examine the number of sexual partners, but not sex act per se. Frequency of risky sex behavior may be as important, if not more important than number of risky sex partners. The venues of how these individuals were meeting new sexual

partners were also missing from the analysis. The questions on venues on how these men met their new sexual partners in the previous visit were added only after visit 40, and therefore were not available for every visit in the study period.

Findings from previous qualitative studies suggest that a subgroup of MSM may be willing to trade off absolute sexually safety to combat loneliness, marginalization or simply a desire to have sexual intimacy with other men. These variables should also be considered in future research when examining trajectories of risky sexual behavior among older MSM.

Our study also supports the existence of considerable resilience among aging MSM. The majority of men in the study belong to low exposure group and decreasing exposure group. However, using this novel statistical method, we also identified a smaller group of men who consistently have one or more unprotected anal intercourse partners throughout their middle age. These individuals deserve particular HIV prevention efforts. More research is needed to better study these men, and understand how other socio-psychosocial factors, for example relational status, knowledge, attitudes, beliefs or sexual networks may influence their sexual behaviors, and how they avoid getting infected despite their relatively high sexual risk levels. Only when we can identify and understand the interactions of these risk behaviors then public health intervention can be designed so that they are appropriate and will be used by high risk older men.

2.6 TABLES

Table 3 Selection criteria of the study

Selection criteria	Subjects	Observations
Visit 26-46	766	7922
Age 50+ at visit 46 (March 31, 2007)	324	3785
No missing on NUAI partners	312	3564
Age between 42.5 and 62	288	3080
Must have had at least three visits during study period	259	3034

Footnote: NUAI indicates number of unprotected anal intercourse partners

Table 4 Bayesian Information Criteria (BIC) for two-group to seven-group models

Number of group	BIC (N=259)	BIC (N=3034)
1	-3186.97	-3191.89
2	-2597.03	-2605.65
3	-2542.39	-2558.38
4	-2502.41	-2523.33
5	-2476.60	-2501.21

Table 5 Four-group model: Group assignment based on the average posterior probabilities ($AvePP_j$) of group membership and Odds of Correct Classification

Assigned group	Number assigned	1	2	3	4	$\hat{\pi}$	OCC
1	135	0.893	0.075	0.031	0.000	0.480	9.0
2	41	0.062	0.852	0.058	0.028	0.193	24.1
3	36	0.028	0.079	0.813	0.080	0.146	25.4
4	47	0.001	0.047	0.043	0.909	0.181	45.2

OCC = Odds of Correct Classification, $OCC_j = \frac{AvePP_j/1-AvePP_j}{\hat{\pi}_j/1-\hat{\pi}_j}$, j = number of group

Table 6 Five-group model: Group assignment based on the average posterior probabilities ($AvePP_j$) of group membership and Odds of Correct Classification

Assigned group	Number assigned	1	2	3	4	5	$\hat{\pi}$	OCC
1	133	0.878	0.085	0.013	0.024	0.000	0.468	8.2
2	37	0.095	0.807	0.009	0.089	0.000	0.189	17.9
3	34	0.019	0.041	0.841	0.082	0.018	0.120	38.8
4	37	0.002	0.074	0.074	0.824	0.027	0.164	23.9
5	18	0.000	0.000	0.031	0.045	0.924	0.059	193.9

OCC = Odds of Correct Classification, $OCC_j = \frac{AvePP_j/1-AvePP_j}{\hat{\pi}_j/1-\hat{\pi}_j}$, j = number of group

Table 7 Socio-demographic, behavioral, and psychosocial characteristics of each group

	Low exposure	Decreasing exposure	Midlife exposure	High exposure	P
	(N=135)	(N=41)	(N=36)	(N=47)	
White race % (n)	86.8 (117)	92.7 (38)	91.7 (33)	97.9 (46)	0.138*
Age at visit 46 mean (sd)	56.85 (5.05)	57.40 (3.80)	56.40 (4.44)	55.49 (4.62)	0.240
Cohort enrollment 2001-2003 (late) % (n)	15.6 (21)	7.3 (3)	13.9 (5)	10.6 (5)	0.535
Education in years mean (sd)	15.29 (2.90)	16.43 (2.75)	15.11 (2.34)	15.80 (2.49)	0.088
Any less than \$20,000 income % (n)	35.6 (48)	43.9 (18)	38.9 (14)	27.7 (13)	0.445
Any financial difficulty % (n)	36.3 (49)	39.0 (16)	33.3 (12)	36.2 (17)	0.966
HIV positive at visit 46 % (n)	43.0 (58)	36.6 (15)	41.7 (15)	25.5 (12)	0.197
Any current smoke % (n)	40.0 (54)	51.2 (21)	44.4 (16)	29.8 (14)	0.218
Average no. of drinks per week mean (sd)	4.40 (6.76)	5.68 (8.17)	5.83 (8.30)	5.95 (7.98)	0.495
Any binge drinking % (n)	17.8 (24)	24.4 (10)	25.0 (9)	21.3 (10)	0.691
Any marijuana % (n)	39.3 (53)	58.5 (24)	52.8 (19)	48.9 (23)	0.117
Any poppers % (n)	30.4 (41)	48.8 (20)	50.0 (18)	59.6 (28)	0.002
Any crack cocaine % (n)	8.2 (11)	7.3 (3)	11.1 (4)	10.6 (5)	0.847*
Any other cocaine % (n)	17.0 (23)	12.2 (5)	22.2 (8)	21.3 (10)	0.614
Any methamphetamine % (n)	3.0 (4)	7.3 (3)	2.8 (1)	10.6 (5)	0.141*
Any stimulant % (n)	20.7 (28)	17.1 (7)	27.8 (10)	27.7 (13)	0.526
Viagra use at visit 46 % (n) ^a	8.0 (8)	16.1 (5)	14.8 (4)	37.5 (15)	<0.001

Table 7 (Continued)

	Low exposure (N=135)	Decreasing exposure (N=41)	Midlife exposure (N=36)	High exposure (N=47)	P
Average CES-D, mean (sd)	9.03 (8.26)	10.60 (7.85)	8.69 (8.41)	11.36 (10.28)	0.321
Any CES-D \geq 16 % (n)	47.4 (64)	68.3 (28)	52.8 (19)	55.3 (26)	0.130
Any CESD > 21 % (n)	34.8 (47)	43.9 (18)	38.9 (14)	51.1 (24)	0.242
Any sexual inactivity % (n)	54.1 (73)	56.1 (23)	33.3 (12)	14.9 (7)	<0.001
Average number of male sex partners mean (sd)	3.78 (8.29)	5.88 (12.43)	9.55 (18.84)	13.28 (19.43)	<0.001
<i>HIV-related Attitudes</i>					
(1-5)					
1=Do not agree at all,					
5=Strongly agree					
Reduced HIV concern, mean (sd)	1.21 (0.49)	1.30 (0.44)	1.36 (0.52)	1.44 (0.60)	0.065
Perception of HIV as a threat, mean (sd)	1.74 (0.86)	1.57 (0.70)	1.75 (1.07)	1.47 (0.52)	0.212
Safer sex fatigue mean (sd)	1.79 (0.87)	2.12 (0.93)	2.30 (1.00)	2.72 (0.95)	<0.001
Viral load/ transmission beliefs mean (sd)	1.51 (0.76)	1.58 (0.76)	1.57 (0.69)	1.55 (0.66)	0.936
Sexual sensation- seeking, mean (sd)	2.50 (1.18)	2.97 (1.05)	2.96 (1.19)	3.27 (1.20)	<0.001

*Fisher exact test, ^a24% of the data missing

2.7 FIGURES

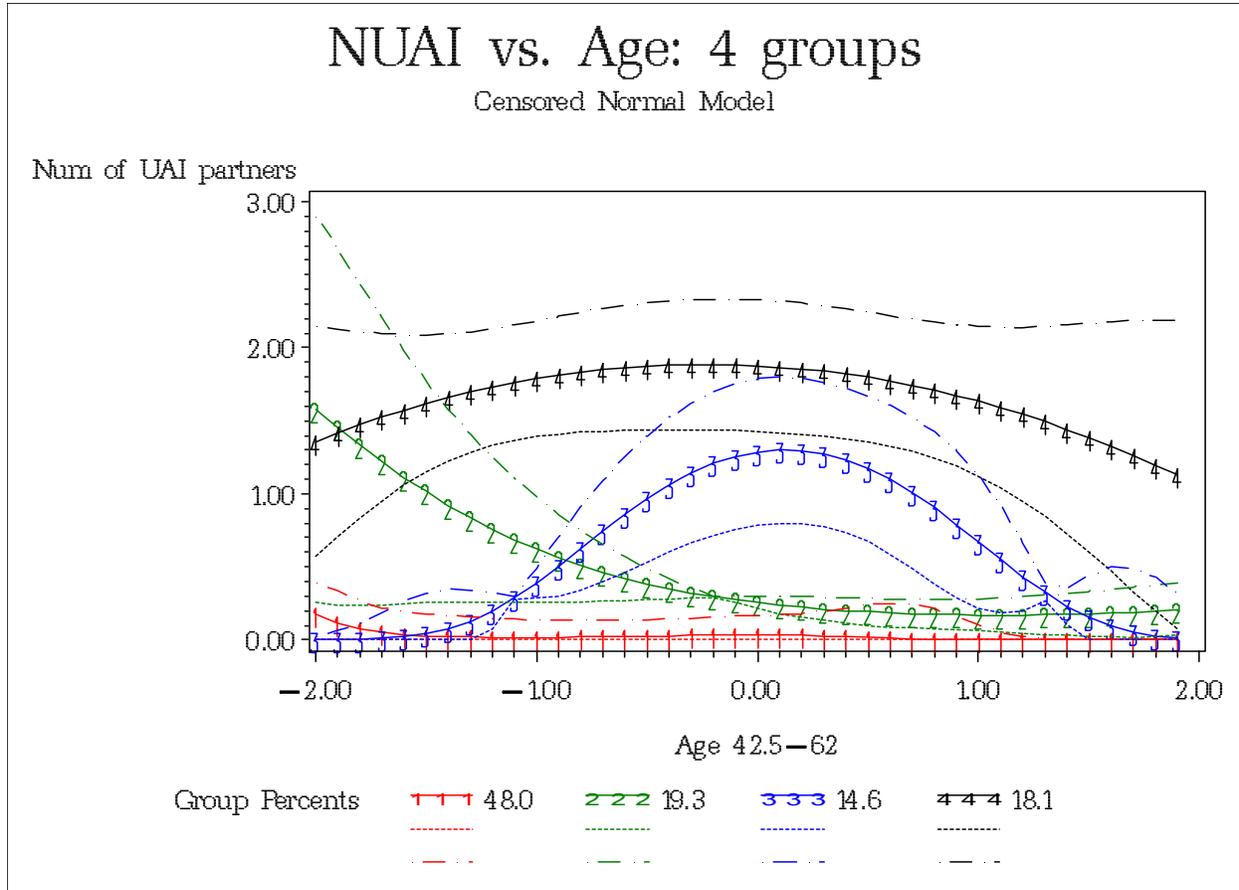


Figure 2 Estimated trajectories of number of unprotected anal intercourse (NUAI) partners from age 42.5 to 62. Group 1, low exposure group (48.0%); Group 2, decreasing exposure group (19.3%); Group 3, midlife exposure (14.6%); Group 4, high exposure group (18.1%); total n = 259. Dash lines represent the 95% confidence intervals on trajectories.

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**3.0 ARTICLE TWO: CHANGING TRAJECTORIES OF DEPRESSIVE SYMPTOMS
AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO HAVE SEX WITH
MEN (MSM)**

Manuscript in Preparation

Sin How Lim¹, S. Melinda Spencer², Kevin Kim³, Michael Marshal⁴, Ron Stall⁵, Anthony J. Silvestre⁶, Nina Markovic^{1,7}

¹ Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

² Department of Health Promotion, Education, and Behavior, University of South Carolina, South Carolina

³ Department of Psychology in Education, School of Education, University of Pittsburgh, Pittsburgh, Pennsylvania

⁴ Department of Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

⁵ Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

⁶ Department of Infectious Disease and Microbiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

⁷ Department of Dental Public Health, School of Dental Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

3.1 ABSTRACT

Introduction: MSM (men who have sex with men) have been shown to experience higher rates of depression compared with heterosexual men. The epidemiologic studies of older adults in the general population show that depressive symptoms decline with age. However, less is known about how depressive symptoms change as MSM age. The purpose of this study was to examine the trajectories of MSM over the age of 50 with respect to depressive symptomatology.

Method: Within the Pitt Men's Study (N=275), we examined the trajectories for men within the age range of 42.5 and 63.5 with respect to depressive symptoms, as measured by the Center for Epidemiologic Studies Depression Scale, over a 10 year period (1996-2006) A semiparametric, group-based approach was used for this analysis.

Results: The best-fitting model yielded three distinct trajectory groups with respect to depressive symptomatology. The majority of the participants (44.7%) reported very low depressive symptoms across the age range of the study, while 39.2% of the sample reported low symptoms which appeared to decline with age. Approximately 16% reported very high depressive symptoms throughout middle age to early old age. Racial minority status, financial difficulty, income, smoking, drinking, illicit drug use, adherence to HIV medications, and quality-of-life outcomes were differentially associated with the trajectory groups.

Conclusion: Although most of the participants showed resilience in maintaining good mental health over time, a substantial group of men experienced chronic depressive symptomatology. Using this novel longitudinal analysis, interventions can be designed and targeted to the subgroup of men who are chronically depressed in a cost-effective manner.

3.2 INTRODUCTION

Older adults are especially vulnerable to depression because of aging-related processes, chronic medical illnesses, cognitive impairment, and psychosocial adversity (Alexopoulos, 2005). The prevalence of clinically significant depressive symptoms in community samples of older adults ranges from 3%-26% (Hybels & Blazer, 2003). Lower socio-economic status, disability, negative life events, trauma, bereavement of a loved one, and social isolation have been identified as risk factors for depression (Bruce, 2002). Depression, in turn, leads to reduced quality of life, functional impairment, disability (Bruce, 2001; Penninx, Leveille, Ferrucci, van Eijk, & Guralnik, 1999), dementia (Jorm, 2000) and suicide (Conwell, Duberstein, & Caine, 2002) and death (Penninx, Geerlings, et al., 1999). In addition, depression incurs high health care costs and burdens for care-givers.

Although prevalence, risk factors and natural history for depression among older adults in the general population have been studied and reviewed (Alexopoulos, 2005; Blazer, 2003), little is known about depression and aging in gay and bisexual men. Compared to their heterosexual counterparts, older gay and bisexual men may face unique challenges upon aging (Grossman, 2008). These individuals are currently invisible in mainstream media, and they are under-represented in research studies. As a result, knowledge of the health and aging experiences of older gay and bisexual men is lacking. The need to understand the health issues and health care needs of this population is growing because of the aging of the “baby boomer” generation, which includes a segment of lesbian, gay, and bisexual persons.

A recent critical review of previous studies concluded that gay and bisexual men experience greater mental health morbidity, including depression, than do heterosexual men

(Cochran & Mays, 2008). The prevalence of major depression among urban men who have sex with men (MSM), assessed by the Center of Epidemiologic Studies of Depression (CES-D) Scale, was 17 %, which was three-fold higher than the prevalence for men in the general population (Mills, et al., 2004). There is no evidence, however, that this finding can be generalized to older gay, and/or bisexual men. Previous researchers have described some social and contextual factors that may put older gay and bisexual men at heightened risk for mental disorders. These social and contextual factors include heterosexism, ageism, homophobia (Kimmel, Rose, Orel, & Green, 2006), stigma (Adelman, 1991), fear of rejection and discrimination (Clover, 2006), victimization (D'Augelli & Grossman, 2001), bereavement due to the AIDS epidemic, loneliness (Hostetler, 2004), and lack of social support (Dorfman, et al., 1995). In addition, several large studies revealed that, unlike heterosexual men whose rates of illicit drug use decline precipitously with age, MSM report high rates of substance use in their later life (McKirnan & Peterson, 1989; Skinner & Otis, 1996; Stall & Wiley, 1988). These potentially influential factors reinforce the need for investigation on how mental health changes as gay and bisexual men age.

In addition, it is important to recognize that a segment of older gay and bisexual men who are living with HIV, may have even higher rates of depression (Heckman, et al., 2002). According to one meta-analysis, HIV-infected persons are at two-fold higher risk for major depression compared to non-infected persons (Ciesla & Roberts, 2001). Higher rates of depression were also found to be associated with progression to HIV disease, dementia, and death (Roxanna Farinpour, et al., 2003; Lyketsos, et al., 1996). The Pitt Men's Study found that HIV-positive men have a higher prevalence of depression than HIV-negative men, which could

be explained by factors such as age, employment status, support from relatives, sense of mastery and avoidance coping mechanisms (Dickey, Dew, Becker, & Kingsley, 1999).

A review of the gerontology literature on failed to provide a clear picture of the mental health of older gay and bisexual men (Wahler & Gabbay, 1997). Despite the dual stigma of being old and gay, previous studies have shown that older gay and bisexual men were well-adjusted and capable of coping with challenges of aging (Berger, 1980; Grossman, D'Augelli, & O'Connell, 2001). In fact, the resiliency exhibited by gay and bisexual men may provide researchers with insights into adaptation o aging for the general population. The favorable mental health status reported by the previous research is, however, a sharp contrast to the prevalent myth of older gay men as “sad, lonely, undesirable, and depressed” (Kelly, 1977). Furthermore, changes of depression over time have not been systematically examined in this population.

Exclusion of older MSM from large-scale epidemiologic research on depression in older adulthood is not limited to cross-sectional studies. Even less is known on how depression might change over time in this population. Beekman and colleagues (2002) found that as high as 35% of community-dwelling older adults experience chronic major depression over six years of data collection. Another recent 12-year longitudinal study of depression in a community sample of older adults in Pittsburgh identified multiple depressive trajectories and the predictors of these trajectories (Andreescu, Chang, Mulsant, & Ganguli, 2008). However, none of these studies have focused on depression trajectories of older MSM, despite the fact that certain social and contextual factors might be unique to this population.

Based on what we know from the existing literature and similar to heterosexuals, hypothesized that a subgroup of gay men do experience depression over time. In addition, due to heterogeneous aging experiences of older gay and bisexual men, we hypothesized that there may

be different trajectories of depression among aging MSM. The aims of this study were two-fold: First, we wanted to estimate prevalence of major depression in a cohort of middle-aged and older MSM. Second, we investigated the trajectories of depressive symptoms in a cohort of HIV-negative and HIV-positive MSM from middle-aged to older age. To achieve these research goals, we used a longitudinal sample of aging MSM from the Pitt Men's Study, a cohort study of HIV epidemiology and disease outcomes among MSM in Pittsburgh, Pennsylvania. We used group-based modeling to identify multiple trajectories of depressive symptomatology. After the trajectory groups were identified, we examined the socio-demographic, psychological, and behavioral characteristics that might distinguish the trajectory groups. In this way, we hope to identify factors that place a subgroup older MSM at great risk for depression over time so that prevention and intervention efforts can be targeted in a cost-effective manner.

3.3 METHODS

3.3.1 Study Sample

We analyzed longitudinal data (N=275) from the Pitt Men's Study (PMS), an on-going cohort study of the natural history of HIV infection and progression among MSM in Pittsburgh. The Pitt Men's Study is one of the four sites of the Multicenter AIDS Cohort Study. Since 1983, participants in the study have been followed every six months with a detailed questionnaire-based interview, physical examination, and medical history review. The inclusion criteria, recruitment and sampling strategies are described in greater details elsewhere (A. J. Silvestre, et al., 1986; A. J. Silvestre, et al., 2006). Briefly, the PMS study population is a convenience sample of men who reported having sexual activity with another man in the past seven years. Participants were recruited through personal networks with the gay community and gay-venue

media advertisements. A particularly concerted effort was made to recruit Black and Hispanic MSM during the latest cohort enrollment, 2001-2003. Data were selected from October 1, 1996 to March 31, 2007, referred to as the study period in the current paper.

Participants were included in the analyses if they met all of the following criteria: (1) aged 50 and above by March 31, 2007; (2) had no missing data on CES-D; (3) were between 42.5 and 62.5 years old during the study period; (4) had at least three visits during study period (see Table 1). Of 766 subjects who came to PMS during the study period (median number of visits for each participant=9, range of number of visits was from 1 to 21), 324 (42.3%) were 50 years old and above on March 31, 2007. Among the remaining 324 participants, 320 participants had no missing data on CES-D. To ensure sufficient data points for each age interval, we limited the data to age between 42.5 to 62.5 years. This cut-off resulted in at least 30 cases at each age point. Finally, participants had to be in the study at least three times during the study period, thus contributing three data points to the estimates of individual trajectories. These criteria left a final analytic sample of 275. Because the study's primary goal was to examine the age or aging effects on depressive symptoms, longitudinal data was then restructured as a function of age rather than visit.

3.3.2 Measures

Dependent Variable: CES-D score

At every biannual visit participants were asked to complete the 20-item CES-D, which was directly adapted from the instrument developed by Raldoff (1977). The participants recorded the frequency of each psychological symptom in the previous week by assigning a value as follows: 0 = "rarely or none of the time (<1 day per week)," 1 = "some of little of the time (1-2 day per

week),” 2 = “occasionally or moderate amount of the time (3-4 days per week),” or 3 = “most or all of the time per week (5-7 days per week).” A total score was summed from the 20 item, and was examined as a continuous measure in the study. A threshold of 16 or more has been shown to be indicative of significant depressive symptoms and predictive of HIV morbidity and mortality in a previous Multicenter AIDS Cohort Study (R. Farinpour, et al., 2003). A threshold of 22 has been used to approximate “major depression” in another epidemiologic study of depression among urban MSM (Mills, 2004).

Independent variable: Age

Because participants were interviewed at six-month intervals, it was necessary to devise a consistent assignment of age, based on half-year intervals. This was done by determining the nearest half-year age (e.g., 42.0; 42.5; 43.0, etc.) at the March 31, 2007 and then subtracting half-year increments from that age for each prior visit to calculate the age (to the nearest half-year) at each prior visit. The age calculated by this method was closely matched to the age calculated by using the date of each visit minus the date of birth of participant.

Sociodemographic Characteristics

Self-reported race was categorized as white/non white. Years of education completed in 2006-2007 was used in the study. The self-reported annual gross income in the past year was dichotomized as less than \$20,000 or not, and a summary variable was created to indicate if a participant had earned less than \$20,000 at any age. Similarly, a summary variable was created to indicate if a participant had experienced financial difficulty meeting his basic expenses in the previous six months at any age.

Individual Risk Behaviors

There were a total of six recreational drug outcomes. Participants were considered to be current users of recreational drugs if they reported the use of the following drugs in the previous six month: 1) marijuana, 2) poppers or nitrite inhalants, 3) crack cocaine, 4) other forms of cocaine, 5) methamphetamines (or crystals, speed, ice), and 6) other recreational drugs such as “ecstasy” or MDA/MDMA (3,4-methylenedioxy-*N*-methylamphetamine), gammahydroxybutyrate (GHB), “speedball,” ethyl chloride, hallucinogens, “downers,” or heroin/opiates. A stimulant drug was defined as any use of crack cocaine, other forms of cocaine, methamphetamines, or other recreational drugs. Binge drinking was defined as five or more drinks per occasion occurring at least monthly.

Quality of Life (QOL) Indicators

The 36-item Medical Outcome Study Short Form questionnaire (SF-36) was administered at every visit in the Pitt Men’s Study. The SF-36 is valid and reliable instrument for measuring QOL among the general population as well as in HIV infected. The SF-36 consists of 36 items and eight subscales: general health perceptions, role limitations due to physical problems, pain, social functioning, energy/fatigue, and emotional well-being, in addition to role limitation resulting from emotional problems. The raw scores for the items of each subscale were summed and transformed linearly to a range of 0-100, with higher values representing better functioning and well-being.

Other Psychosocial Variables

At each visit, the participant was asked several psychosocial screening questions regarding his general sense of well-being, such as his assessment of life satisfaction, self-esteem, sleep quality, and social support.

3.3.3 Statistical Analyses

A semi-parametric, group-based approach was used to identify various clusters of individual growth trajectories (D. Nagin, 1999). Trajectories were modeled as a function of age rather than visit. We analyzed all group-based models by using the SAS TRAJ macro in SAS version 9.2. Suppose $Y_i = \{y_{i1}, y_{i2}, y_{i3}, \dots, y_{iT}\}$ represents the longitudinal sequence of CES-D scores of an individual i over T age, and $P(Y_i)$ denotes the probabilities of Y_i . Group-based trajectory model assumes that population defined by CES-D scores is composed of a mixture of J underlying trajectory groups such that

$$P(Y_i) = \sum_j \pi_j P^j(Y_i),$$

where $P(Y_i)$ is the probability of Y_i given membership in group j , and π_j is the probability of group j (D. S. Nagin, 2005). SAS TRAJ procedure estimates the group membership probabilities, π_j by a multinomial logit function (Jones, Nagin, & Roeder, 1999). A censored normal model was used to accommodate the possibility of clustering at the scale of 0 to 3. Once the optimal model and group assignment were determined, chi-square tests and analysis of variance (ANOVA) were used to test group differences in demographic, behavioral, and psychosocial characteristics. Because this is an unbalanced study design, participants do not come for every possible visit and therefore the numbers of participants at each age point vary. To summarize

results of the continuous variables across ages, mean scores of these measures of interest (e.g. years of education, number of drinks, number of male intercourse sexual partners) across the ages were calculated. For behavioral and psychological measures which are dichotomous (e.g. financial difficulty, substance use, binge drinking), a new variable was created to denote if the participant has ever reported such characteristics at any age during the study period.

3.4 RESULTS

Sociodemographic Characteristics

The final sample (n=275) used in the analysis was primarily Caucasian (n=237; 85.1%), with a smaller proportion of African Americans (n=35, 12.7%), and other races (n=3, 1.2%). Participants were generally well-educated, with a mean of 15.4 years of education (standard deviation=2.7, range=8-21 years). The individual incomes of the sample were relatively high. Since there are more cases at age 51.5 than any other ages, baseline characteristics at age 51.5 are reported here. Of 134 participants who were 51.5 years old in the study period, 17.6% (n=23) reported \$60,000 or more annual gross income. About 26.0% (n=34) earned less than \$20,000 annually and 11.5% (n=15) reported experiencing major financial difficulty meeting basic expenses at the previous visit.

Individual Risk Behaviors

At the age of 51.5, 31.6% of the participants (n=42) were current smokers and 6.8% (n=9) reported binge drinking in the past six months. A high proportion of participants used marijuana (30.3%, n=40) and poppers (22.7%, n=30) in the past six months. Also, in the past six months, 3.0% (n=4) reported using crack cocaine, 4.6% (n=6) reported using other forms of cocaine, 1.5% (n=2) reported using methamphetamine or 'crystal meth', 1.5% (n=2) reported

using ecstasy, and 6.1% (n=8) reported use of any of the stimulant drugs. For some participants, the percentages of any stimulant drug use were less than the sum of percentages of individual drugs because these individuals were multiple drug users. The mean CES-D score at the age of 51.5 was 9.6, with 23.9% (n=32) of participants scoring CES-D \geq 16 and 14.2% (n=19) scoring CES-D \geq 22.

At the end of the study period, a total of 173 participants (62.9%) were HIV-negative and 102 (37.1%) were HIV-positive. In the ten-year study period, there were only four new cases of HIV infection, documented by sero-conversion.

Longitudinal Analyses

Using the SAS TRAJ procedure, we identified three trajectory groups based on CES-D scores. We compared the various nested and unnested models sequentially and systematically in order to determine the optimal number of classes (groups) and shape (e.g. linear, quadratic, and cubic) of growth trajectories of CES-D scores. Substantive knowledge, in combination with group size and formal statistical criteria such as Bayesian Information Criteria (BIC), average posterior probabilities of group assignment and Odds of Correct Classification (OCC) guided the model selection. According to Nagin (2005), the best model should be the one that has the maximum (least negative) BIC and a model is considered adequate when the average posterior probabilities of group assignment are close to 1 and OCC greater than 5.0. Table 2 displays the Bayesian Information Criteria (BIC) from a two-, three-, and four-group model. Table 3 and Table 4 display the average posterior probabilities of group assignment and OCC for a three-group model and a four-group model respectively. As shown in Table 2, BIC continued to increase as when the number of group increased in the model. However, a four-group model

yielded a prohibitively small group (see Table 4, the last group has only 14 subjects) and thus we decided upon the three-group model as the optimal model. Table 3 shows that the average posterior probabilities of group membership for the four-group model are above 0.90, and the OCC for each group assignment are all above 5.0. These tests support the adequacy of the model.

With respect to CES-D score, results showed that the subset of older men in the PMS sample could be subdivided into three distinct trajectory groups as shown in Figure 1. The “not depressed group” (n = 122; 44.7% of the sample) was characterized by having few depressive symptoms over the age range of the study period (CES-D mean=5.2, median=2.2). The “mildly depressed group” (n = 108; 39.2% of the sample) was characterized by having depressive symptoms that appeared to decline with age (CES-D mean=11.8, median=11.6). The “chronically depressed group” (n = 45; 16.1% of the sample) was characterized by depressed greater than 21 at age 43 that remained high throughout the 50s and began to decline after the age of 60 (CES-D mean=25.4, median=23.8).

Three trajectory curves have narrow 95% confidence intervals around the estimated trajectory for each group (see dash lines on Figure 1). The 95% confidence interval appeared to widen at the extreme ends of the age range for the mildly depressed group and chronically depressed group, which may due to the scarcity of data points at both ends of the age range.

Statistical Parameters of the Trajectory Groups

Socio-demographic Characteristics

Table 5 displays the socio-demographic, behavioral, and psychosocial characteristics of participants assigned to each trajectory groups. The trajectory groups were significantly different

with respect to race, with 26.7% of the men in the chronically depressed group being non-white, compared to 13.9% in the mildly depressed group, and 9.0% in the well-adjusted group.

Financial difficulty, annual income less than \$20,000, and disability occurred at any age in the age range of the study period were differentially associated with the trajectory groups. A higher proportion of men in the chronically depressed group reported financial difficulty, annual income less than \$20,000, and disability than in either the mildly depressed or the well-adjusted groups. Men in the not-depressed group were the least likely to report financial difficulty, an annual income less than \$20,000, and disability at any age in the age range of the study period. Unemployment during any visit did not distinguish the trajectory groups.

Parallel with the trends in CES-D trajectory groups, antidepressant use and visit to a mental health provider at any age in the age range of the study period were differentially associated with the trajectory groups. The men in the chronically depressed group had the highest proportion of participants reported using antidepressants and having visited a mental health provider, while the not-depressed group had the lowest proportion. The men who were HIV-positive in the chronically depressed group were least likely to adhere to HIV medications compared to the HIV-positive men in the mildly depressed and not-depressed groups. On the other hand, HIV-positive men in the well-adjusted group were most likely to adhere to the HIV medications ($p=0.005$).

Individual Risk Behaviors

Current smoking and binge drinking at any age in the age range of the study were differentially associated with the trajectory groups, with the men in the more depressed trajectory group being more likely to report current smoking and binge drinking. In terms of recreational

drug use, the three trajectory groups were not significantly different with respect to marijuana use, popper use, and methamphetamine use. However, the rates of crack cocaine use, other form of cocaine use, ecstasy, and stimulant drug use in any ages were significantly different among the three groups. There was a statistically higher proportion of men in the chronically depressed group who reported crack use (22.2%, n=10), other form of cocaine use (33.3%, n=15), and methamphetamine use (8.9%, n=4) while men in the well-adjusted group were least likely to report use of these drugs.

Men in the trajectory groups were not significantly different with regards to their HIV status. At the end of the study period (visit 46), there was a greater proportion of HIV-positive men (42.4%, n=19) in the chronically depressed group compared to the mildly depressed group (34.3%, n=37) and the not-depressed group (37.7%, n=46). Interestingly, HIV prevalence in the not-depressed group is slightly although not significantly higher than the prevalence in the mildly depressed group. With respect to risky sexual behavior, neither the number of male sexual intercourse partners nor the number of unprotected receptive anal intercourse partners were differentially associated with the trajectory groups.

Quality of Life (QoL) Indicators

With respect to the quality-of-life outcomes, the trajectory groups were significantly different in many SF-36 subscale scores, with the men in the not depressed group reporting the best scores in perception of general health, emotional well-being, and social functioning, while the men in the chronically depressed group reported the poorest scores in these quality-of-life measures. Similarly, other psychosocial variables were differentially associated with the

trajectory groups; men in the not depressed group having highest mean scores of self-worth and highest mean number of persons to talk to or count on.

3.5 DISCUSSION

The current study identified multiple trajectory groups based on CES-D score evaluated at 6-month interval, in a cohort of aging men who have sex with men (MSM). Specifically, we identified a “not depressed” group that has very low CES-D scores across the ages, a group of men who have some depressive symptoms which seemed to decline as age advances (“mildly depressed”). Finally a group of men who reported high depressive symptoms (mean=25.4, median=23.8) across all ages (“chronically depressed group”).

To our knowledge, this study is the first to examine depressive symptom trajectories in the aging MSM population. By using the same trajectory analysis methodology, Andreescu and colleagues (2008) found six depressive symptom trajectories in a general community sample of older adults in Pittsburgh. This study included a large (N=1260) community-based population of adults over the age of 65, and depression symptoms of the participants were assessed by a modified CES-D scale over a 12 year period. The large sample size and longer period of follow-up may have provided Andreescu and colleagues with sufficient statistical power to find the optimal number of trajectory groups. In fact, the model selection in the Andreescu’s study was based on the best Bayesian Information Criteria (BIC). In this study, BIC continued to improve when the number of groups increased. However, we decided to keep the three-group model because of the prohibitively smaller group size when we increased number of groups in the model.

Nevertheless, the results obtained in this study of MSM and Andreescu's study of a general population are strikingly similar. The majority of participants were classified in the group that exhibited little or no depressive symptoms over time. In addition, both studies found a smaller declining or "remitting depressive group", as well as a smaller yet substantial chronic or "persisting depressive symptom group".

The major methodological difference between these studies is that Andreescu and colleagues used wave (time) as the unit for trajectory analysis while our study used age of the participants as the unit of trajectory analysis. It is important to highlight the methodological challenges in using age instead of wave as the unit of analysis. Since the Pitt Men's Study is not a developmental study of middle-aged MSM where all participants started in the study at the same age, participants were recruited at different ages. To study the aging effects on depressive symptomatology, we modeled the trajectories of CES-D scores in terms of age of participant at each visit. This "cohort sequential design" is a common study design in studying development in adult lifespan (Mehta & West, 2000). It was assumed that the participants of the same age at an earlier visit will have the same psychological functioning as those of the same age at a later visit. One may argue that possible period effect and cohort effects such as the advent of Highly Active Anti Retroviral Therapy (HAART) may explain the difference in CES-D scores rather than age itself. We conducted a subanalysis to test the association of enrollment cohort and trajectory groups by using the chi-square test, but no association of enrollment cohort and different trajectory groups was found.

Second, since every participant comes to each visit at different ages, the number of participants in each age group varies. In fact, the number of participants providing the data in the middle ages (50-54) is greater than that of the lower and higher ages. Data for age below 42.5

and age above 62 during the study period were eliminated because the number in these groups (below 43 and above 62) is too small to estimate stable trajectories. Indeed, when we tried to include these age ranges in our analysis, the estimated trajectories became idiosyncratically unreliable. However, we recognize that these cut-offs for age did not follow usual biological and social standards for middle and older age. The decision to use the age 42.5 to 60 in the analysis was purely a statistical one.

Although our methodology is slightly different from Andreescu's study, similar results gained from the previous study of a general population gave us the confidence in the findings of our study of MSM. As noted before, aging MSM may have many social disadvantages that may negatively affect their mental health. Hence, there is a need to understand the life-course development of depression among gay and bisexual men. In this study, a large proportion of the research subjects belonged to the "not-depressed," or "mildly depressed" groups. A smaller, yet substantial, group of men (16% of the sample) could be classified as "chronically depressed". This prevalence is somewhat higher than in the primary care population, in which 6-10% prevalence of major depressive disorder have been documented (Blazer, 2003). The men in this group reported high levels of depression symptoms that remained high throughout the middle ages. The men in the "not depressed" group may have learned how to cope with the stigma of heterosexism and aging, exhibiting "crisis-competency" or resiliency described by previous researchers (Kimmel, 1977). However, a subgroup of men may be more susceptible to depression and are less likely to cope with the stressors or challenges of aging. Our study found these individuals have high levels of depressive symptoms that persisted over 10 years. These individuals evidently need mental health interventions.

We identified several sociodemographic, behavioral, and psychosocial variables that distinguish the three trajectory groups which can potentially be predictors for the trajectory groups. Higher rates of depression in the “chronically depressed group” may be explained by socio-economic disadvantages such as minority status, poverty, or some disability. Further research need to investigate the mediators and moderators of these socio-economic factors to depression. This finding is supported by a longitudinal study of depressive symptoms among middle-aged and older adults in the Health and Retirement Study, in which socio-economic disadvantages and physical illness were found to be associated with persistence of significant depressive symptoms at 2- and 4-year follow-up (Mojtabai & Olfson, 2004). The present study also found that men in the “chronically depressed group” were more likely to use recreational drugs, specifically crack, cocaine, and/or ecstasy, possibly to cope with depression. These individuals also reported poorer scores in many quality-of-life outcomes. Consistent with the trend of their depressive symptom scores across the middle age range, men in the “chronically depressed” group have the worst scores in many measures of psychosocial functioning (for example, poorer self worth, view on life as a whole), and they reported less social support.

Another worrisome finding from the study is that not all men in the chronically depressed group were receiving professional help for their psychological concerns. Nor they have been taking medications for depression over age range of the study. This may be related to the socioeconomic disadvantages of these men, and lack of access to health care. These individuals may be under-diagnosed or may not aware of the needs for mental health services. Consistent with previous studies, HIV-positive men in the chronically depressed were least likely to adhere to HIV medication regimens compared to HIV-positive men in the “well-adjusted” and “mildly depressed” groups. Research has shown that HIV and depression are inter-related. HIV-infected

individuals are more depressed because they are sicker, have weaker immunity, and endure stigma related to HIV, among other reasons. More integrated services and care will have to include mental health intervention for HIV-positive individuals.

Nevertheless, HIV status cannot explain the disparity of depression in this study. In fact, close to 60% of men in the chronically depressed group are HIV-negative. These individuals appear to be depressed, due to the risk factors known in the general population: minority status, poverty, disability, and lack of social support.

In summary, we used a novel longitudinal method to study changes of depressive symptomatology in a cohort of middle-aged MSM. A subgroup of men, indeed, reported very high level of depressive symptoms, but most MSM were either “not-depressed,” or experienced mild depressive symptoms which declined with age. Even though same-sex sexual behavior is a highly stigmatized behavior in the Western society, these individuals managed to adapt to the challenges of aging. This may reflect strength that remains understudied. Conservatively, the findings can only be generalized to MSM aged between 42.5 to 62 living in Pittsburgh. Future research needs to replicate this research in other sexual minority population in other communities. Hispanic and other racial minority, research subjects aged 65 and above need to be included. Future research will also need to collect data on potential predictors in the middle ages and adverse outcomes associated with depression at later ages.

To our knowledge this is the first study that examined the natural history of trajectories of depressive symptoms in a cohort of MSM in a northeastern city. Using this epidemiologic approach, we identified a subgroup of MSM who are at risk for chronic depression. Previous study on natural history of depression in general older adult population in the same city found

that high depressive symptom trajectories were associated with increased mortality. Public health prevention and intervention need to be targeted to this subpopulation of MSM. Given the strong relationship of illicit substance use, binge drinking, and smoking with depression, targeting this subgroup of men may also help reduce these risk factors, disability and adverse health outcomes of chronic depression. This epidemiologic approach to reduce mental health morbidity in a subpopulation may be a cost-effective way to prevent depression in later life among MSM.

3.6 TABLES

Table 8 Selection criteria for the study

Selection criteria	Subjects	Observations
October 1, 1996-March 31, 2007	766	7922
Age 50+ at March 31, 2007)	324	3785
No missing data on CES-D	320	3606
Age between 42.5 and 63.5 years	300	3207
Present for at least three visits during study period	275	3168

Footnote: CES-D: Center for Epidemiologic Study-Depression Scale

Table 9 Bayesian Information Criteria (BIC) for two-group to four-group models

Number of group	BIC (N=275)	BIC (N=3168)
2	-9733.74	-9741.07
3	-9465.36	-9478.80
4	-9291.18	-9308.28

Table 10 Three-group model: Group assignment based on the average posterior probabilities ($AvePP_j$) of group membership and Odds of Correct Classification

Assigned group	Number assigned	1	2	3	$\hat{\pi}$	OCC
1	122	0.961	0.039	0.000	0.447	30.5
2	108	0.052	0.942	0.007	0.392	25.2
3	45	0.000	0.033	0.967	0.161	152.7

OCC = Odds of Correct Classification, $OCC_j = \frac{AvePP_j/1-AvePP_j}{\hat{\pi}_j/1-\hat{\pi}_j}, j = \text{number of group}$

Table 11 Four-group model: Group assignment based on the average posterior probabilities ($AvePP_j$) of group membership and Odds of Correct Classification

Assigned group	Number assigned	1	2	3	4	$\hat{\pi}$	OCC
1	73	0.951	0.049	0.000	0.000	0.263	54.4
2	108	0.026	0.958	0.016	0.000	0.402	33.9
3	80	0.000	0.046	0.944	0.009	0.281	43.1
4	14	0.000	0.000	0.002	0.998	0.054	8741

OCC = Odds of Correct Classification, $OCC_j = \frac{AvePP_j/1-AvePP_j}{\hat{\pi}_j/1-\hat{\pi}_j}, j = \text{number of group}$

Table 12 Socio-demographic, behavioral, and psychosocial characteristics of each group

	Not depressed (N=122)	Mildly depressed (N=108)	Chronically depressed (N=45)	<i>P</i>
Non-white race % (n)	9.0 (11)	13.9 (15)	26.7 (12)	0.014
Education in years mean (sd)	15.53 (2.58)	15.65 (2.85)	14.67 (2.62)	0.107
Any unemployment % (n)	14.8 (18)	14.8 (16)	15.6 (7)	0.991
Any financial difficulty % (n)	22.1 (27)	44.4 (48)	68.9 (31)	<0.001
Any annual income <20K % (n)	28.7 (35)	38.0 (41)	64.4 (29)	<0.001
Any disability % (n)	9.8 (12)	25.9 (28)	44.4 (20)	<0.001
HIV prevalent at last visit % (n)	37.7 (46)	34.3 (37)	42.4 (19)	0.638
Any antidepressants % (n)	23.8 (29)	52.8 (57)	77.8 (35)	<0.001
Any mental health services % (n)	24.6 (30)	41.7 (45)	68.9 (31)	<0.001
Average adherence to HIV meds since previous visit (1-4), 1=100%,2=95-99%, 3=75-94%, 4= <75% mean (sd)	1.49 (0.45)	1.79 (0.53)	1.92 (0.56)	0.005
Any smoking % (n)	35.3 (43)	43.5 (47)	60.0 (27)	0.016
Any binge drinking % (n)	17.2 (21)	17.6 (19)	37.8 (17)	0.009
Any marijuana use % (n)	45.1 (55)	46.3 (50)	42.2 (19)	0.899
Any popper use % (n)	36.9 (45)	39.8 (43)	44.4 (20)	0.667
Any crack use % (n)	6.6 (8)	10.2 (11)	22.2 (10)	0.014
Any cocaine use % (n)	15.6 (19)	17.6 (19)	33.3 (15)	0.030
Any methamphetamine use % (n)	4.1 (5)	4.6 (5)	8.9 (4)	0.441
Any ecstasy/MDMA % (n)	4.1 (5)	7.4 (8)	17.8 (8)	0.013

Table 12 (Continued)

	Not depressed (N=122)	Mildly depressed (N=108)	Chronically depressed (N=45)	<i>P</i>
Any stimulant use % (n)	18.9 (23)	21.3 (23)	42.2 (19)	0.005
Average number of male intercourse partners mean (sd)	5.2 (12.2)	8.0 (15.9)	6.1 (9.8)	0.320
Average number of unprotected anal intercourse partners mean (sd)	0.8 (4.9)	1.5 (12.2)	0.4 (0.9)	0.739
Average general health (0-100) mean (sd) 100=excellent, 0=poor	79.0 (13.6)	64.5 (18.1)	56.1 (16.3)	<0.001
Average role limitations due to physical health (0-100) mean (sd) 100=no, 0=yes	93.7 (13.2)	76.4 (27.6)	45.5 (31.8)	<0.001
Average role limitations due to emotional health (0-100) mean (sd) 100=no, 0=yes	96.6 (7.1)	79.5 (20.4)	33.0 (26.6)	<0.001
Average energy and fatigue level (1-100), mean (sd) 100=all of the time, 0=none of the time	77.6 (10.1)	55.2 (16.4)	36.9 (15.8)	<0.001
Average pain (0-100) mean (sd) 100=none, 0=very severe	87.8 (11.8)	76.6 (19.3)	63.4 (18.9)	<0.001
Average emotional well-being (0- 100), mean (sd) 100=all of the time, 0=none of the time	88.5 (6.1)	71.6 (9.8)	48.8 (10.5)	<0.001
Average social functioning interrupted by physical and emotional health (0-100), mean (sd) 100=not at all, 0=extremely	95.7 (7.2)	81.6 (14.0)	54.0 (16.6)	<0.001
Average view on life as a whole, 1=delighted, 7=terrible	2.0 (0.6)	3.0 (0.8)	3.9 (1.0)	<0.001
Average frequency of walking up rested in the past month 1=none of the time, 6=everyday	4.7 (0.5)	3.6 (0.9)	2.7 (0.8)	<0.001
Average "running on life" 1=can run own life, 2=problems on life too big	1.0 (0.0)	1.1 (0.1)	1.3 (0.3)	<0.001
Average self worth (1-5), 1=always true, 5=never true mean (sd)	1.1 (0.2)	1.5 (0.5)	2.1 (0.7)	<0.001
Average no. of persons to talk to (1-5), mean (sd)	3.6 (1.0)	3.1 (0.9)	2.8 (1.0)	<0.001

3.7 FIGURES

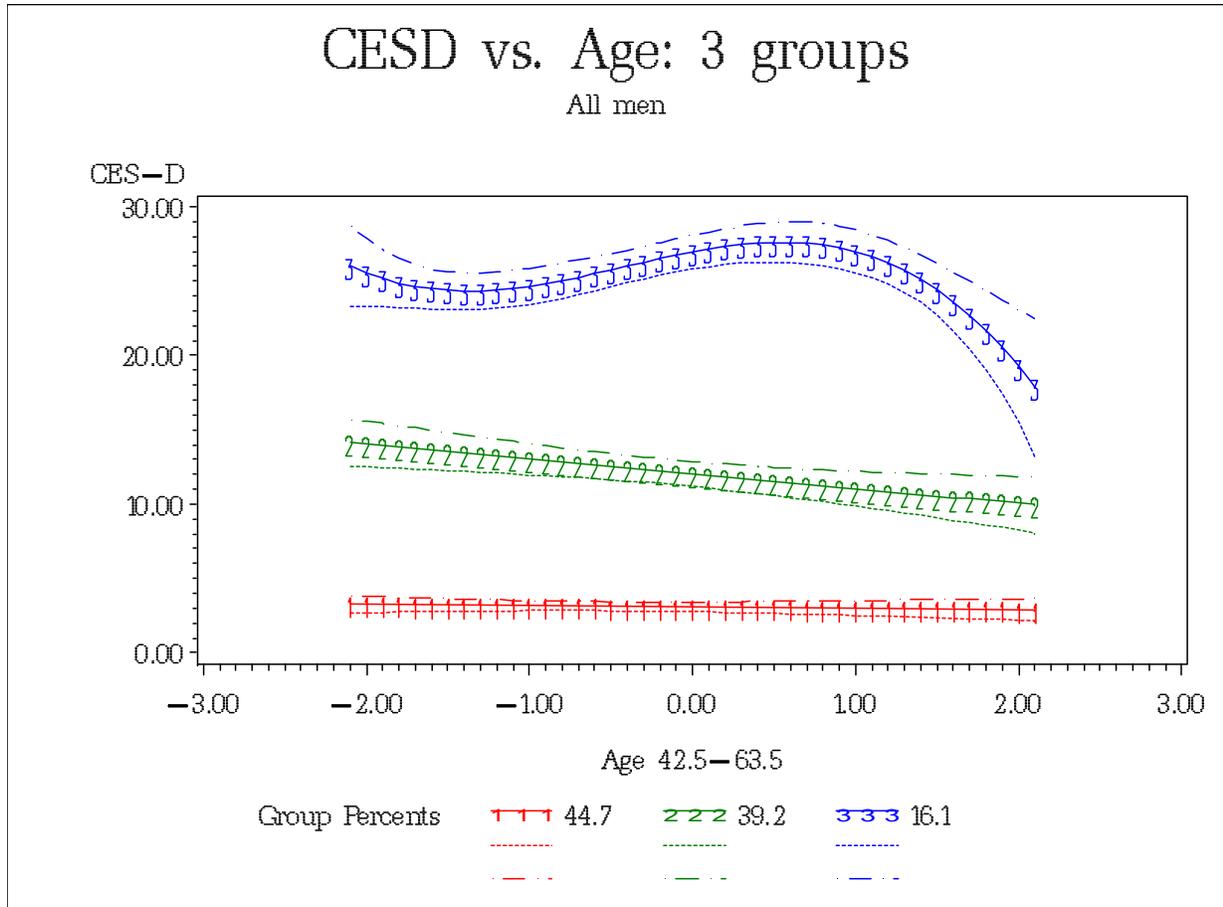


Figure 3 Trajectories of CES-D scores. Group 1, well-adjusted group (44.7%, n=122); Group 2, mildly depressed group (39.2%, n=108); Group 3, chronically depressed group (16.1%, n=45); total n = 275. Dash lines represent the 95% confidence intervals on trajectories

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4.0 ARTICLE THREE: TESTING THE CO-OCCURRENCE OF DEPRESSIVE SYMPTOMS AND MULTIPLE ILLICIT DRUG USE AMONG A COHORT OF MIDDLE-AGED AND OLDER MEN WHO HAVE SEX WITH MEN (MSM)

Manuscript in Preparation

Sin How Lim¹, Kevin H. Kim², Jessica G. Burke³, Nina Markovic^{1,4}, Michael Marshal⁵, Anthony J. Silvestre⁶, Ron Stall³

¹ Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

² Department of Psychology in Education, School of Education, University of Pittsburgh, Pittsburgh, Pennsylvania

³ Department of Behavioral and Community Health Sciences, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

⁴ Department of Dental Public Health, School of Dental Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

⁵ Department of Psychiatry, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania

⁶ Department of Infectious Disease and Microbiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania

Address correspondence to Sin How Lim, MS

Graduate School of Public Health, 213 Crabtree Hall Pittsburgh, PA 15261

4.1 ABSTRACT

Introduction: Mental disorders and substance use disorders are known to co-occur in MSM and in the general population. Older MSM reported unique challenges to aging and may be vulnerable to substance abuse and depression. Building on the dissertation project number two, this study examined the trajectories of MSM over the age of 50 with respect to substance use and tested if the trajectories of substance use and depressive symptoms co-occur.

Method: Within the Pitt Men's Study (N=273), we examined the trajectories for men within the age range of 43 and 63 with respect to multiple illicit drug use over a 10 year period (1996-2006). A semi-parametric, group-based approach was used for this analysis.

Results: The best-fitting model yielded three distinct trajectory groups with respect to multiple illicit drug use. The majority of the participants (44.5%) did not use illicit drugs at any age, while 36.7% consistently used one drug across the age range of the study. A smaller yet substantial group (18.9%) used multiple drugs at middle age and declined to using one drug by age 63. Depressive symptoms, antidepressant use, smoking, binge drinking, and risky sexual behaviors at any age were differentially associated with the trajectory groups. However, the trajectories with respect to multiple illicit drug use were not associated with trajectories with respect to depressive symptoms.

Conclusion: Although the prevalence of any illicit drug use appears to decline among MSM as they age, it is much higher than the estimate among the older adults in the general population. Future research needs to replicate the test of co-occurrence of depression and illicit drug use with consideration of potential confounders.

4.2 INTRODUCTION

Co-occurrence of mental and substance use disorders are well documented in the general population (Alaja, et al., 1998; Kessler, et al., 1996). Findings from the National Drug Use Survey, Epidemiologic Catchment Area (ECA) study, the National Comorbidity Survey, and the International Consortium in Psychiatric Epidemiology have each shown that mood disorders are strongly associated with drug use disorders (Compton, Thomas, Conway, & Colliver, 2005). Furthermore, the co-occurrence of two disorders has a significant negative impact on the course, prognosis, and outcomes of both types of disorders (Gonzales & Insel, 2004). Currently, a more integrated approach to the treatment of both disorders is generally accepted to be the most promising treatment strategy (Harris & Edlund, 2005).

The co-occurrence of mental and substance use disorders has also been documented in the populations of persons living with HIV (Bing, et al., 2001), including middle-aged and older adults living with HIV (Justice, et al., 2004). As the number of persons living with HIV are growing and aging, investigation of the interaction of HIV/AIDS, aging, mental health and substance use co-morbidities is becoming increasingly important (Stoff, 2004). In a small sample, Rabikin and colleagues (2004) reported that HIV-infected older adults did not show the decline in depression and substance use disorders that has been observed in the general population.

The co-morbid phenomenon was also observed among gay and bisexual men. A body of research has shown that gay and bisexual men have far higher rates of substance use and experience greater burden of psychiatric disorders than the men in the general population (Cochran & Mays, 2008; Ostrow & Stall, 2008). In a cross-sectional analysis of urban men who

have sex with men (MSM), Stall et al. demonstrated that multiple drug use, childhood sexual abuse, depression, and risky sexual behavior were associated with higher prevalence of HIV (R. Stall, et al., 2003). Stall and colleagues (2008) explained the co-occurrence of these psychosocial conditions using a syndemic model which places these variables in the context of homophobia (internalized, social, institutional), gay identity development, minority stress, and resilience at multiple levels (individual, social, community) and throughout the life course (childhood, adolescence, adulthood).

Compared to heterosexual men, older gay and bisexual men have unique challenges to aging (Grossman, 2008). Homophobia, loneliness, low self-esteem, feelings of alienation, and victimization may make the older gay and bisexual vulnerable to the development of substance abuse and mental health disorders (Satre, 2006). However, the mental health status and drug use patterns in this population remains understudied. Previous large studies of MSM have found that unlike their heterosexual peers, MSM carried substance use habits into later life (McKirnan & Peterson, 1989; Skinner, 1994; Skinner & Otis, 1996; R. Stall & Wiley, 1988). The lack of recognition of same-sex marriage, and of family responsibility that comes with marriage and child rearing may explain the continuing use of drugs in later life among MSM.

To our knowledge, no study has examined the relationship between substance use and depression and how it changes over the life course of middle age in older gay and bisexual. In previous research, using group-based modeling, we identified trajectory groups with respect to severity of depressive symptoms, namely the “chronically depressed” group, “mildly depressed” group, and “not depressed” group. There are two goals of this study:

(1) to use the same methodology to identify trajectory groups of multiple illicit drug use in aging MSM.

(2) to extend previous research to test the co-occurrence of 10- years history of depressive symptoms and multiple illicit drug use among aging MSM.

4.3 METHODS

4.3.1 Study Sample

We analyzed longitudinal data (N=273) from the Pitt Men's Study (PMS), an on-going cohort study of the natural history of HIV infection and progression among men who have sex with men (MSM) in Pittsburgh. The Pitt Men's Study is one of four sites of the Multicenter AIDS Cohort Study. Since 1983, participants in the study have been followed every 6 months with detailed questionnaire-based interview, physical examination, and medical history review. The inclusion criteria, recruitment and sampling strategies are described in greater detail elsewhere (A. J. Silvestre, et al., 2006; A.J. Silvestre, et al., 1986). Briefly, the PMS study population is a convenience sample of men who reported having sexual activity with another man in the past seven years in Pittsburgh. Participants were recruited through personal networks with the gay community and gay-venue media advertisements. A particularly concerted effort has been made to recruit Black and Hispanic MSM during the latest cohort enrollment, 2001-2003. We selected data from Oct. 1, 1996 to March 31, 2007, referred to as the study period in the current paper.

Participants were included in the analyses if they met all of the following criteria: (1) aged 50 and above by 31 March 2007; (2) had no missing data on CES-D; (3) had no missing

data on multiple illicit drug use (4) were between 43.0 and 63.0 years old during study period; (5) had at least three visits during the study period (see Table 1). Of 766 subjects who came to PMS during the study period (median number of visit for each participant=9, range 1 to 21), 324 (42.3%) were 50 years old and above on March 31, 2007. Among the remaining 324 participants, 319 participants had no missing data on CES-D and multiple illicit drug use. To ensure sufficient data points for each age interval, we limited the data to age between 43.0 to 63.0 years. This cut-off resulted in at least 30 cases at each age point. Finally, participants had to be in the study at least three times during the study period, thus contributing three data points to the estimates of individual trajectories. These criteria left a final analytic sample of 273 (see Table 1). Since the study's primary goal was to examine the age or aging effects on co-occurrence of depressive symptoms and multiple illicit drug use, longitudinal data was then restructured as a function of age rather than visit.

4.3.2 Measures

Dependent Variable: Multiple illicit drug use

A summary score of multiple illicit drug use in the previous visit was calculated by adding six recreational drug outcomes: 1) marijuana, 2) poppers or nitrite inhalants, 3) crack cocaine, 4) other forms of cocaine, 5) methamphetamines (or crystals, speed, ice), and 6) other recreational drugs such as "ecstasy" or MDA/MDMA (3,4-methylenedioxy-*N*-methylamphetamine), gammahydroxybutyrate (GHB), "speedball," ethyl chloride, hallucinogens, "downers," or heroin/opiates. It was found that only 3.8% of observations indicated three or more drugs in the previous visit. The variable was truncated at 3 such that the item ranges from 0 ('none') to 3 ('3 or more').

CES-D score

At every biannual visit participants were asked to complete the 20-item CES-D, which was directly adapted from the instrument developed by Raldoff (1977). The participants recorded the frequency of each psychological symptom in the previous week by assigning a value as follows: 0 = “rarely or none of the time (<1 day per week),” 1 = “some of little of the time (1-2 day per week),” 2 = “occasionally or moderate amount of the time (3-4 days per week),” or 3 = “most or all of the time per week (5-7 days per week).” A total score was summed from the 20 item, and was examined as a continuous measure in the study. A threshold of 16 or more has been shown to be indicative of significant depressive symptoms and predictive of HIV morbidity and mortality in a previous Multicenter AIDS Cohort Study (Farinpour, et al., 2003). A threshold of 22 has been used to approximate “major depression” in another epidemiologic study of depression among urban MSM (Mills, 2004).

Independent variable: Age

Because participants were interviewed at six-month intervals, it was necessary to devise a consistent assignment of age, based on half-year intervals. This was done by determining the nearest half-year age (e.g., 42.0; 42.5; 43.0, etc.) at the final visit (number 46, on 31 March 2007) and then subtracting half-year increments from that age for each prior visit to calculate the age (to the nearest half-year) at each prior visit. The age calculated by this method was found to be closely matched to the age calculated by using the date of each visit minus the date of birth of participant.

Sociodemographic characteristics

Self-reported race was categorized as white or non-white. Years of education completed in 2006-2007 was used in the study. The self-reported annual gross income in the past year was dichotomized as less than \$20,000 or not. A summary variable was created to indicate if a participant has earned less than \$20,000 in any ages. Similarly, a summary variable was created to indicate if a participant has experienced financial difficulty meeting his basic expenses in the previous 6 months in any ages.

Individual Risk Behavior

Smoking status (never, former, current), number of alcoholic beverages consumed per week were assessed at each visit. Binge drinking was defined as 5 or more drinks per occasion occurring at least monthly.

4.3.3 Statistical Analyses

A semi-parametric, group-based approach was used to identify various clusters of individual growth trajectories (D. Nagin, 1999). Trajectories were modeled as a function of age rather than visit. We analyzed all group-based models by using the SAS TRAJ macro in SAS version 9.2. Suppose $Y_i = \{y_{i1}, y_{i2}, y_{i3}, \dots, y_{iT}\}$ represents the longitudinal sequence of multiple illicit drug use of an individual i over T age, and $P(Y_i)$ denotes the probabilities of Y_i . Group-based trajectory model assumes that population defined by multiple illicit drug use is composed of a mixture of J underlying trajectory groups such that

$$P(Y_i) = \sum_j \pi_j P^j(Y_i),$$

where $P(Y_i)$ is the probability of Y_i given membership in group j , and π_j is the probability of group j (D. S. Nagin, 2005). SAS TRAJ procedure estimates the group membership probabilities, π_j by a multinomial logit function (Jones, Nagin, & Roeder, 1999). Because multiple illicit drug use is count data, the Poisson distribution is specified:

$$p^j(y_{it}) = \left(\frac{\lambda_{jt}^{y_{it}} e^{-\lambda_{jt}}}{y_{it}!} \right) (y_{it} = 0, 1, 2, \dots).$$

The linkage between the illicit drug use trajectory and age is established as,

$$\ln(\lambda_t^j) = \beta_0^j + \beta_1^j \text{age}_{it} + \beta_2^j \text{age}_{it}^2 + \beta_3^j \text{age}_{it}^3,$$

where λ_t^j is the mean rate of drug use at each age point.

Once the optimal model and group assignment were determined, chi-square tests and analysis of variance (ANOVA) were used to test group differences in demographic, behavioral, psychosocial characteristics. Because this is an unbalanced study design, participants do not come for every possible visit and therefore the numbers of participants at each age point vary. To summarize results of the continuous variables across ages, mean scores of these measures of interest (e.g. years of education, number of drinks, number of male intercourse sexual partners) across the ages were calculated. For behavioral and psychological measures which are dichotomous (e.g. financial difficulty, substance use, binge drinking), a new variable was created to denote if the participant has ever reported such characteristics at any age during the study period.

4.4 RESULTS

Basic Demographic Characteristics

The final sample (n=273) used in the analysis was primarily Caucasian (n=235; 85.1% of sample), with a smaller proportion of African Americans (n=35, 12.8% of sample), and other races (n=3, 1.2%). Participants were generally well-educated, with a mean of 15.4 years of education (standard deviation=2.7, range 8-21 years). The individual incomes of the sample were relatively high. Since there are more cases at age 50.5 than any other ages, baseline characteristics at age 50.5 is reported here. Of 134 participants who were 50.5 years old in the study period, 15.2% (n=20) reported \$60,000 or more annual gross income, 27.6% (n=35) earned less than \$20,000 annually and 13.6% (n=18) reported experiencing major financial difficulty meeting basic expenses in the previous visit. At the age of 50.5, 32.8% of the participants (n=44) were current smokers, and 8.2% (n=11) reported binge drinking in the past six months. A high proportion of participants used marijuana and poppers at age 50.5: 31.3% (n=42) reported using marijuana, and 20.9% (n=28) reported using poppers in the past 6 months. Only 3.0% (n=4) reported using crack cocaine, 6.7% (n=9) reported using other forms of cocaine, 2.2% (n=3) reported using methamphetamine or ‘crystal meth’ in the past six months, no one reported using ecstasy, MDMA, “downers”, or heroin/opiates in the past six months. Any illicit drug use, defined by any use of marijuana, poppers, crack cocaine, other forms of cocaine, methamphetamine, or ecstasy was 43.3%. About 9.0% of men reported using two illicit drugs and 5.2% reported using three or more illicit drugs at the age of 50.5. The mean of CES-D score at the age of 50.5 was 9.5, with 23.1% (n=31) of participants reporting CES-D \geq 16 and 16.2% (n=22) reporting CES-D \geq 22.4

Longitudinal Analyses

Using the SAS TRAJ procedure, we identified three trajectory groups with respect to illicit drug use. We compared the various nested and unnested models sequentially and systematically in order to determine the optimal number of classes (groups) and shape (e.g. linear, quadratic, and cubic) of growth trajectories of illicit drug use. Substantive knowledge, in combination with group size and formal statistical criteria such as Bayesian Information Criteria (BIC), average posterior probabilities of group assignment and Odds of Correct Classification (OCC) guided the model selection (Nagin 2005). Since Nagin, researchers have developed other criteria for good model fit including entropy measures, sample size adjusted BIC, and classification-based statistics (entropy, CLC [classification likelihood information criteria], ICL-BIC [integrated classification likelihood]) for mixture modeling (Henson, Reise, & Kim, 2007). The optimal model was characterized by the one that has the BIC, sample size adjusted BIC, CLC, and ICL-BIC approach to zero. The entropy summary statistics and average posterior probabilities of group assignment can be used to assess classification quality, with values ranging from 0 to 1, with values close to 1 representing good classification. The OCC greater than 5.0 also indicates adequate classification. Table 2 displays the log-likelihood, BIC, entropy, sample size adjusted BIC, CLC, and ICL-BIC from two- to six-group models. Table 3 and Table 4 display the average posterior probabilities of group assignment and OCC for a three-group model. As shown in Table 2, according to BIC, a five-group model is the best model, while according to CLC and ICL-BIC, a three-group model is the best model. Henson et al. (2007) demonstrated that when sample size is small, CLC and ICL-BIC are better fit indices. We decided upon the three-group model based on the CLC and ICL-BIC and also because the trajectories were more interpretable. Table 3 shows that the average posterior probabilities of

group membership for the three-group model are above 0.80, the OCC for each group assignment are all above 5.0. These tests support the adequacy of the model we have employed.

With respect to multiple illicit drug use, results showed that the subset of older men in the PMS sample could be subdivided into three distinct trajectory groups as shown in Figure 1. The “no use group” (n = 124; 44.5% of the sample, average posterior probability of group membership = 0.966) was characterized by not using illicit drug across all ages. The “single drug use group” (n = 102; 36.7% of the sample, average posterior probability of group membership = 0.887) was characterized by using one illicit drug consistently across all ages. The “multiple drug use group” (n = 47; 18.9% of the sample, average posterior probability of group membership = 0.882) was characterized by using about two or more illicit drugs at age 43, and number of drug use seemed to peak at age 50 and declined to using one drug at age 63. In terms of types of drug use, given that the most prevalent illicit drug use among MSM, as well as in the general population is marijuana, the men in the “single drug use group” most certainly used marijuana more than any other drugs. Similarly, the men in the “multiple drug use” are more likely to use both marijuana, poppers, in addition to one of the other illicit drugs.

The “no use group” and “single drug use group” have narrow 95% confidence intervals around the estimated trajectory for each group (see dash lines on Figure 1). However, for the “multiple drug use” group, the 95% confidence interval appeared to widen at the lower end and upper end of age range, which may due to the scarcity of data points at both ends of the age range in that group.

Correlates of the trajectory groups

Table 5 displays the socio-demographic, behavioral, and psychosocial characteristics of participants assigned to each trajectory groups. None of the socio-demographic characteristics such as race, education, unemployment, financial difficulty, annual income less than 20K was significantly associated with the trajectory groups. In addition, disability was not significantly associated with multiple drug use trajectory groups.

The trajectory groups were not significantly different with regards to their HIV status. At the end of the study period (visit 46), multiple drug use group has slightly higher proportion of HIV-positive men (44.7%, n=21) compared to the single drug use group (43.1%, n=44). The men in the no use group has the least proportion of HIV-positive men (29.8%, n=37). With respect to risky sexual behavior, both the number of unprotected insertive anal intercourse partners and unprotected anal insertive intercourse partners were differentially associated with the trajectory groups. The average number of multiple sex partners was not associated with the trajectory groups (p-value was close to significant), however the direction suggests that men in the multiple illicit drug use were more likely to report risky sexual behavior.

Consistent with previous research that found co-occurrence of alcohol and smoking with illicit drug use, current smoking since previous visit, average number of drinks per week across age, and binge drinking across age were differentially associated with the trajectory groups, with the men in the multiple drug use trajectory group more likely to be smokers and report higher average number of drinks per week, and to report binge drinking (all *p*-values were less than 0.001).

With respect to mental health, clinically significant depressive symptoms, measured by CES-D ≥ 16 and CES-D ≥ 22 , as well as by antidepressant use were differentially associated with the trajectory groups. Although the means of raw CES-D scores and any use of mental health services was not associated with the trajectory groups, participants in the multiple drug use group had higher mean CES-D scores and a greater proportion of them used mental health services compared to the men in the single drug use and no use groups. Overall, the data suggest that depression is associated with multiple drug use trajectory group.

There was no association between trajectory group membership with respect to multiple illicit drug with trajectory group membership with respect to CES-D scores (see Table 5). In other word, men who were classified in the multiple illicit drug use group were not classified simultaneously to the chronically depressed group and vice versa.

4.5 DISCUSSION

The present study found that the prevalence of illicit drug use is higher for men in the Pitt Men's Study than for men of the same age in the general population. The National Survey on Drug Use and Health found that 5.9% prevalence of any illicit drug use in the past month among adults aged 50-54 (SAMHSA, 2008). In the current study, at the age of 50.5, the prevalence of any illicit drug use in the past 6 months was 43.3%, and 5.2% reported using three or more illicit drugs in the past 6 months. When compared to the prevalence of multiple drug use in previous studies of MSM, The prevalence of drug use and multiple drug use among MSM seem to decline with age. The prevalence of multiple drug use has been reported to be 43% among young MSM (Greenwood, et al., 2001) and 18% among urban MSM aged 18-80 (R. Stall, et al., 2001).

Using group-based modeling, we identified three groups of men who shared the same trajectory of illicit drug use across ages. The majority of men (44.5% of the sample) did not use illicit drug across any age. The second largest group (36.7% of the sample) used only one drug across age range of the study. A smaller, yet substantial group (18.9% of the sample) used multiple drugs at middle age and declined to using one drug at age 63.

In contrast to current understanding of the relationship of socio-demographic factors to drug use, our study found that none of the socio-demographic variables were significantly associated with illicit drug use trajectory groups. It is possible that this lack of association was due to the lack of variations in these socio-demographic variables. About 85% of the sample were Caucasians. As noted in Table 4, participants in the study are well-educated, the means of education in years were 15.0 to 15.6 for the trajectory groups. Similarly, the percentages of

participants reporting financial difficulty or poor income were not significantly different among the trajectory groups.

Contrary to previous research that found HIV seropositivity was associated with multiple drug use, the present study found that being HIV positive at the final visit was not associated with trajectory groups characterized by multiple drug use. The p-value of the chi-square test of independence was however close to significant value of 0.05 and the dose-response relationship between drug use and HIV prevalence was observed. Men in the multiple drug use had higher proportion of HIV prevalence at the final visit, followed by single drug use. The men in the no-use group had the lowest HIV prevalence at the final visit. The higher prevalence of HIV in the multiple drug use could be partially explained by risky sexual behaviors exhibited by these men. The mean of number of unprotected receptive anal intercourse (URAI) was associated with the trajectory groups, with the men in the multiple drug use group reporting much higher mean of URAI partners compared to the men in the single drug use and no use groups. The findings supported previous literature that documented the intertwining of drug use and HIV-risk sexual behaviors among MSM (Ron Stall & Purcell, 2000).

The most surprising negative finding is that the trajectory of multiple drug use was not associated with trajectory of depressive symptoms. The lack of association may lie in difficulty in using depressive symptoms as a proxy measure of depression, which requires diagnosis by Diagnostic and Statistical Manual of Mental Disorders. Second, the level of antidepressant use among the depressed men could not be determined and it may affect the CES-D scores. It is possible that some men really had depression but were taking antidepressants, which later reduced or masked their depressive symptoms. This confounding effect may especially

significant in the present study where the number of participants classified in both the chronically depressed group and multiple drug use group is particularly small (see Table 5).

The other limitation of the study is that we could not differentiate drug use from drug abuse and/or drug dependence, the latter being more related to problematic use and have to be diagnosed by using standard diagnostic tools. It is very likely that drug abuse and/or drug dependence was more related to mental health problems such as depression, than frequency of drug use per se. Furthermore, in this study, we were not able to ascertain the outcomes of drug use, or treatment of drug abuse in this population. Lastly, we did not assess the Viagra use in the present analysis. The variable was added in the Pitt Men's Study in the middle of the study period and inclusion of the variable would render many missing data. The use of Viagra to treat erectile dysfunction, and/or conjunction with other illicit drugs for sex may be more relevant to this population (Ostrow, et al., 2008).

In recent years, using novel statistical models, such as mixture modeling, previous researchers have shown co-occurrence of depression and substance abuse in adolescence (Dekker, et al., 2007; Measelle, Stice, & Hogansen, 2006). Adverse mental health outcome were found to be associated with a high substance use trajectory group (Chassin, Pitts, & Prost, 2002; Chi & Weisner, 2008). While drug use and mental health has been extensively studied in the adolescent population, trajectory of drug use and relationship of drug use and depression in the population of aging sexual minorities has never been investigated.

Using the novel longitudinal method, the current study identified and described the trajectories of multiple drug use in a cohort of middle aged and older MSM. The authors acknowledge the possible existence of other trajectories of drug use in other aging high-risk

populations. For example, late-onset of crack cocaine use has been reported (Johnson & Sterk, 2003). It is also likely that a subpopulation of middle-aged or older MSM may increase their use of poppers for anal sex.

The current study may add to the life-course perspective on drug use in MSM. Future research needs to investigate the contribution, as well as the interactions, of other biological, psychosocial, and contextual factors to the trajectories of drug use. Such comprehensive models are imperative since drug use is a complex interaction of individual characteristics with social, cultural environments. Future research needs to include other developmental factors such as childhood sexual abuse, social factors such as family support, relationship status, belief about drug use, etc in the model as well. Previous researchers have suggested that the lack of recognition of the same-sex couple family, and lack of social responsibility and conforming to the social norms as gay and bisexual men age are the main reasons why gay and bisexual continue to use drugs at the later age. Causal explanations as to how these contextual factors influence drug use in later life need to be future investigated.

In summary, by using this epidemiologic approach, we identified a subgroup of MSM who used multiple illicit drugs from midlife to early old age. The current study shows that multiple drug use was strongly associated with smoking, drinking, and binge drinking. Targeting public health intervention to this subgroup of men may also help reduce these risk factors. This epidemiologic approach to reduce illicit drug use in a subpopulation and may be a cost-effective way to prevent drug-use related problems such as HIV infection among MSM.

4.6 TABLES

Table 13 Selection criteria for the study

Selection criteria	Subjects	Observations
Visit 26-46	766	7922
Age 50+ at visit 46 (March 31, 2007)	324	3785
No missing data on CES-D	320	3606
No missing data on multiple illicit drug use	319	3563
Age between 43 and 63years	297	3114
Present for at least three visits during study period	273	3078

Note: ¹CES-D: Center for Epidemiologic Studies Depression Scale

Table 14 Bayesian Information Criteria for two-group to six-group models

	L	Free parameters	BIC	entropy	ssBIC	CLC	ICL-BIC
2	-2403.01	11	-2436.67	0.923	4832.846	4835.054	4896.759
3	-2319.88	15	-2367.56	0.862	4676.341	4722.512	4806.654
4	-2286.38	19	-2348.08	0.783	4619.096	4737.315	4843.895
5	-2269.10	23	-2344.83	0.725	4594.290	4780.063	4909.081
6	-2266.57	27	-2356.32	0.679	4577.037	4847.566	4948.536

Note: ssBIC: sample size adjusted BIC

Table 15 Group assignment based on the average posterior probabilities (*AvePP_j*) of group membership and Odds of Correct Classification

Assigned group	Number assigned	1	2	3	$\hat{\pi}$	OCC
1	124	0.966	0.033	0.001	0.445	35.4
2	102	0.016	0.887	0.097	0.367	13.5
3	47	0.000	0.118	0.882	0.189	32.1

OCC = Odds of Correct Classification, $OCC_j = \frac{AvePP_j/1-AvePP_j}{\hat{\pi}_j/1-\hat{\pi}_j}$, j = number of group

Table 16 Socio-demographic, behavioral, and psychosocial characteristics of multiple illicit drug use trajectory group

	No use (N=124)	Single drug use (N=102)	Multiple drug use (N=47)	<i>P</i>
Non-white race % (n)	14.5 (18)	8.8 (9)	23.4 (11)	0.056
Education in years mean (sd)	15.6 (2.9)	15.4 (2.5)	15.0 (2.8)	0.423
Any unemployment % (n)	13.7 (17)	13.7 (14)	17.0 (8)	0.841
Any financial difficulty % (n)	32.3 (40)	44.1 (45)	42.6 (20)	0.155
Any annual income <20K % (n)	34.7 (43)	42.2 (43)	38.3 (18)	0.515
Any disability % (n)	16.1 (20)	24.5 (25)	29.8 (14)	0.102
HIV positive at final visit % (n)	29.8 (37)	43.1 (44)	44.7 (21)	0.063
Average CES-D mean (sd)	8.9 (8.6)	10.0 (8.4)	12.4 (10.0)	0.073
Any CES-D ≥ 16 % (n)	45.2 (56)	57.8 (59)	68.1 (32)	0.016
Any CES-D ≥ 22 % (n)	34.7 (43)	43.1 (44)	57.5 (27)	0.025
Any antidepressants % (n)	37.1 (46)	45.1 (46)	59.6 (28)	0.029
Any mental health services % (n)	34.7 (43)	39.2 (40)	48.9 (23)	0.231
Any currently smoking % (n)	33.1 (41)	43.1 (44)	66.0 (31)	<0.001
Average number of drinks per week mean (sd)	3.0 (5.5)	6.4 (8.6)	7.3 (8.0)	<0.001
Any binge drinking % (n)	10.5 (13)	27.5 (28)	34.0 (16)	<0.001
Average number of male sexual intercourse partners mean (sd)	4.9 (12.8)	6.7 (13.7)	10.1 (14.6)	0.089
Average number of unprotected insertive anal intercourse partners mean (sd)	0.3 (1.0)	0.4 (1.0)	3.4 (18.6)	0.059

Table 16 (Continued)

Average number of unprotected receptive anal intercourse partners mean (sd)	0.2 (0.4)	0.3 (0.8)	4.6 (20.0)	0.006
Average general health (0-100) mean (sd) 100=excellent, 0=poor	70.7 (16.8)	69.9 (19.0)	67.2 (19.7)	0.521

Table 17 Cross-tabulation of group membership of trajectory of multiple illicit drug use with group membership of trajectory of CES-D scores

		Group membership of trajectory of multiple illicit drug use			Total
		No drug use	Single drug use	Multiple drug use	
Group membership of trajectory of CES-D scores	Not depressed	62	44	16	122
	Mildly depressed	45	40	21	106
	Chronically depressed	17	18	10	45
Total		124	102	47	273

Pearson chi-square test of independence, $p(3.972, 4) = 0.410$

4.7 FIGURES

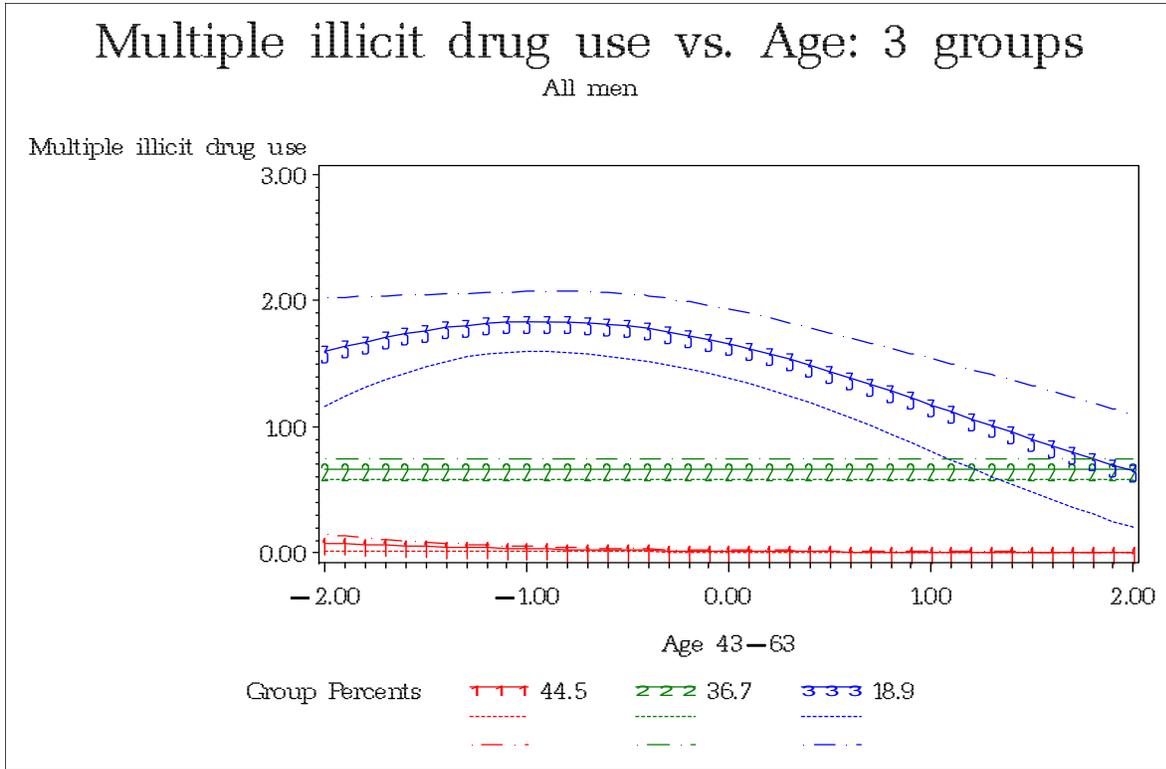


Figure 4 Trajectory of multiple illicit drug use. Group 1, “No use group” (44.5%, n=124); Group 2, “Single drug group” (36.7%, n=102); Group 3, “multiple drug group” (18.9%, n=47); total n = 273. Dash lines represent the 95% confidence intervals on trajectories

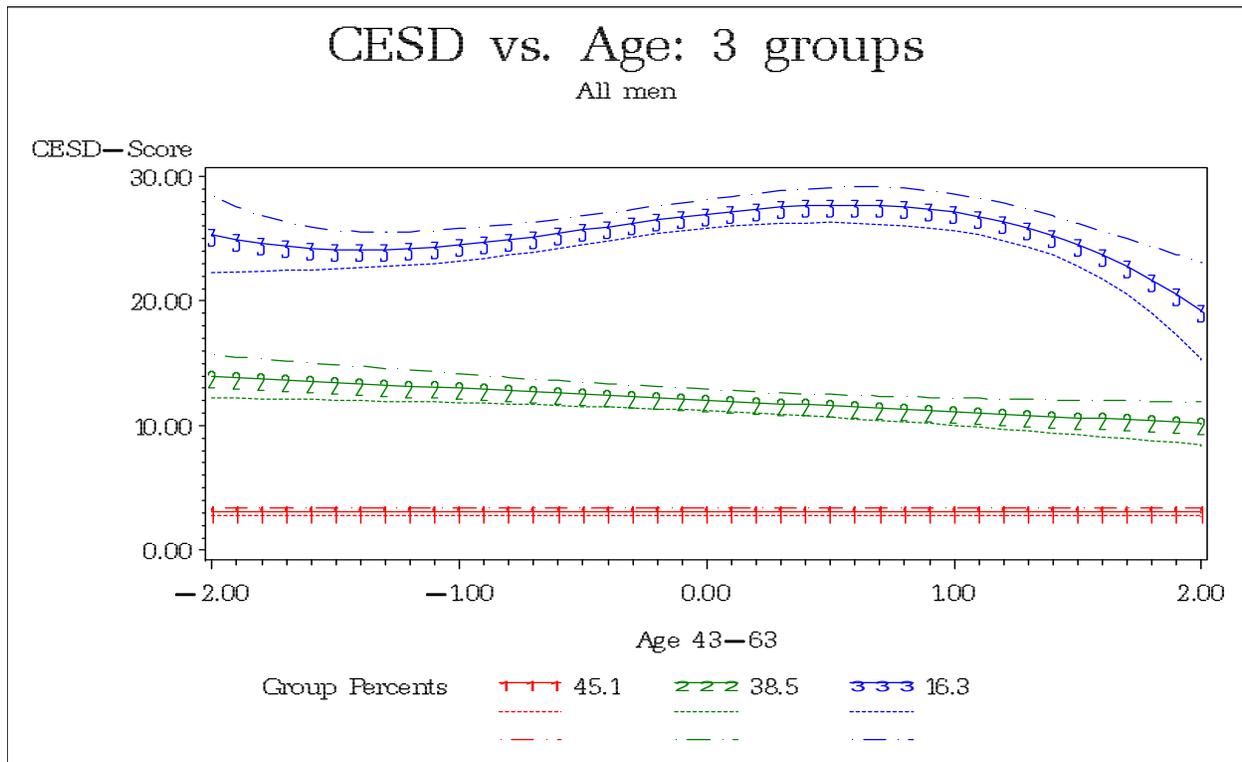


Figure 5 Trajectory of CES-D scores. Group 1, “Not depressed group” (45.1%, n=122); Group 2, “Mildly depressed group” (38.5%, n=106); Group 3, “Chronically depressed group” (16.3%, n=45); total n = 273. Dash lines represent the 95% confidence intervals on trajectories

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5.0 GENERAL DISCUSSION

5.1 SUMMARY OF FINDINGS

Current knowledge of HIV risk behaviors among older MSM is scarce. The variation of sexual behavior, drug use, and mental health over the life course of MSM is understudied. Such investigation is important as disparities in risky sexual behavior, depression, and substance abuse have been reported in studies of younger MSM. Since wide diversity and heterogeneity in aging experiences of older gay and bisexual men have been observed, the trajectories of sexual behavior, mental health, and substance use among these individuals may differ. Through the group-based statistical approach and 10-year segment of data in the Pitt Men's Study, we were able to examine the trajectories of risky sexual behavior, depressive symptoms, and multiple illicit drug use among MSM from middle-aged to early old age.

The first project identified four trajectories with respect to the number of unprotected anal sex partners in the past 6 months. The majority of men (48.0%) had no NUIAI partners ("low exposure group") at any age in the age range of the study, while 19.3% of men had NUIAI partners which declined from greater than one to zero ("decreasing exposure group"), 14.6% of men had a temporary increase of NUIAI partners peaking at age 55 ("midlife exposure group"), and 18.1% of men had one to two NUIAI partners across the age range of the study ("high exposure group"). Popper use and HIV-related attitudes were differentially associated with the trajectory groups.

The second project identified three distinct trajectory groups with respect to depressive symptomatology. The majority of the participants (44.7%) reported very low depressive symptoms across the age range of the study, while 39.2% of men reported low symptoms which

appeared to decline with age. Approximately 16% of men reported very high depressive symptoms throughout middle age to early old age. Racial minority status, financial difficulty, income, smoking, drinking, illicit drug use, adherence to HIV medications, and quality-of-life outcomes were differentially associated with the trajectory groups.

The third project identified three distinct trajectory groups with respect to multiple illicit drug use. The majority of the participants (44.5%) did not use illicit drugs at any age, while 36.7% consistently used one drug across the age range of the study. A smaller yet substantial group (18.9%) used multiple drugs at middle age and declined to using one drug by age 63. Depressive symptoms, antidepressant use, smoking, binge drinking, and risky sexual behaviors at any age were differentially associated with the trajectory groups. However, the trajectories with respect to multiple illicit drug use were not associated with trajectories with respect to depressive symptoms.

One of the most surprising findings is that analysis shows that trajectories of risky sexual behavior among older MSM are not as simple or stable as generally believed. Specifically, there was a midlife exposure group who put themselves at risk at midlife and a high exposure group who always had one to two unprotected anal intercourse partners from the middle age to early old age. Our analysis also showed that while the majority of the participants had few or mild depressive symptoms, or use any illicit drug, a group of men reported depressive symptoms indicative of major depressive disorder (16%) and a group of men used multiple drug (18.9%) over the age range of the study. The rates of major depressive disorder and multiple drug use are both higher than the rates in the older adults in the general population. Public health prevention and intervention need to be targeted to these individuals.

The dissertation also found that smoking and binge drinking are differentially associated with trajectories based on depressive symptoms and trajectories based on multiple illicit drug use. Smoking and binge drinking at any age in the age range of the study was prevalent. Even among the not-depressed group and the no drug-use group, more than 30% of men in both groups reported smoking and more than 10% reported binge drinking.

Lastly, although the trajectories of multiple drug use were not associated with trajectories of depressive symptoms, our analysis also showed that the illicit drug use at any age was associated with depressive symptom trajectory groups and clinically significant depressive symptoms at any age were associated with multiple illicit drug use trajectory groups. Future research needs to disentangle the relationships of multiple drug use and depressive symptoms, which may be confounded by antidepressants use.

5.2 PUBLIC HEALTH SIGNIFICANCE

Currently, there is a general misconception that older adults are not sexually active. These individuals are generally believed to have stopped using illicit drugs or engaging in risky sexual behavior and therefore no longer at risk for HIV. Physicians rarely discuss issues surrounding sexuality and sexual behavior with their older patients (Hillman, 2000). Depression and drug abuse disorders are often under-diagnosed among older adults, who are also less likely to seek treatment for depression and drug abuse disorders. With the aging of the “baby boomer” generation, the prevalences of drug abuse are predicted to increase and more substance abuse treatment services will be needed (Gfroerer, Penne, Pemberton, & Folsom, 2003). In addition, older adults infected with HIV are often diagnosed at later ages, and have less favorable outcomes and faster progression to AIDS as compared to younger counterparts (Mack & Ory, 2003).

Older gay and bisexual men, a segment of older adults, may be at even higher risk for HIV acquisition and transmission. These individuals often are not willing to disclose their sexual orientation to their physicians for fear of discrimination (Grossman, 2008). Most geriatricians, on the other hand, are ignorant about the challenges faced by the older sexual minorities and the potential health disparities that exist in this population. For example, older men have lowered immunity due to aging-related processes and therefore they may be more vulnerable to HIV infection.

Depression, substance use, and risky sexual behavior are established risk factors for HIV infection. Understanding the life-course development of these behaviors and mental health is important because it offers the researchers the clues to the etiology of these behaviors and

depression and therefore provides opportunities for interventions. Using a group-based approach, the dissertation shows that trajectories exist for a cohort of aging MSM living Pittsburgh, Pennsylvania. Future research will investigate the risk factors specific to the differing trajectories. Physicians can then use this information to identify patients who may experience chronic depression, use multiple illicit drugs, or have multiple unprotected anal intercourse partners over an extended period of time. In addition, public health resources can be targeted to the smaller group of men who have particularly unfavorable trajectories with respect to HIV risk in a cost-effective way.

With the aging of the “baby boomer” generation and growing population of the HIV-infected adults over the age of 50, investigations of trajectories of HIV risk behaviors in MSM may provide insights on the etiology of depression, substance abuse, and risky sexual behavior in other aging populations. Currently, there is no age-appropriate HIV or mental health prevention and intervention designed for older MSM. Future research will have direct implications for development of such prevention or intervention for older MSM.

5.3 FUTURE RESEARCH

To my knowledge, this dissertation is the first to study the trajectories of risky sexual behavior, substance use, and depression among aging MSM. Further research is needed to confirm that these trajectories exist. The methodology should be replicated by including data from other sites of the Multicenter AIDS Cohort Study, namely Chicago, Baltimore, and Los Angeles. Such inclusion will increase the sample size, statistical power, and racial and socioeconomic diversity in the study participants. The expansion of inclusion of MSM from other urban areas will increase the generalizability of the findings of the study. However, future research will also need to include older MSM who live in the rural areas, for which the risk factors and behaviors are less well-known.

Future research needs to include more MSM who were born in the 1940s or earlier (or currently above the age of 60). These individuals came of age before 1969, when the Stonewall Revolution occurred. Previous researchers have noted that the pre-Stonewall generation individuals experienced greater stigma and discrimination (Morrow, 2001). These individuals were more likely to hide their sexual orientation and experience internalized homophobia vis-a-vis the post-Stonewall generation who may be more open about their sexual orientation. The generational divide may have implications related to the development of depression in later life (Kimmel, et al., 2006). Due to the limited number of participants older than 60 years in the current study we limited our analysis to early old age (62 to 63 years). Future research needs to stratify the trajectories with respect to depression, risky sexual behavior, and substance use by pre- and post-Stonewall generation in order to examine such cohort effect.

In addition, the age when an individual first had same-sex experience, or the age where he first embraced his sexual orientation (often noted as “gay age”) may be more important in the development of mental health and risky behaviors than the biological age. Friedman and colleagues (2008) have shown for gay adolescents, those who developed their gay identity at an earlier age were more likely to be infected with HIV, to experience more gay-related victimization, sexual abuse and depression at adulthood. Future research will need to collect the data of “gay age” in addition to biological age.

In order to examine sero-conversion effects, we will need more participants who have sero-converted within the study period. Besides HIV infection, future research will also need to examine other health outcomes of the depression and substance use. For example, quality-of-life outcomes, problems related to illicit drug use, disability, or even mortality.

Future research will have to examine the development of the interacting psychosocial health problems among the older MSM based on the syndemics model. Furthermore, researchers will have to consider upstream social variables such as childhood sexual abuse, other contextual factors such as stigma and discrimination, marginalization within gay community, as well as social support and coping mechanism in relation to the trajectories of risky sexual behavior, depression, and substance use. Investigations into social support and coping mechanism may reveal resiliency of the older gay men, and will have direct implications for strength-based interventions.

5.4 CONCLUSION

Using a novel statistical approach, we identified different trajectories based on risky sexual behavior, depressive symptoms, and substance abuse among a cohort of MSM from their middle-age to early old age. The majority of participants belonged to the group who had low exposure to risky sexual behavior, the group who reported few or mild depressive symptoms, the group who used zero or one illicit drug over the age range of the study. However, we also identified a smaller, yet substantial group that had high exposure to risky behavior, chronically depressed, and were using multiple illicit drugs from the middle-age to early old age.

These results demonstrate that negative stereotypes of older gay and bisexual men as “sad, undesirable, depressed” are incorrect. Future research needs to investigate the risk factors related to these trajectories so that public health prevention and intervention can be targeted to a particular subgroup of men who are at risk for HIV, substance abuse, and depression in a cost-effective manner.

Current knowledge on the health of older gay and bisexual men is lacking. This dissertation hopes to generate interests among researchers to study this marginalized and underserved population. Epidemiologic studies specific to older MSM are needed. These studies should include MSM above the age of 60, older MSM who live in the rural area, and older MSM of color, and consider other constructs of sexual orientation (attraction and identity). In addition to studying the risk factors related to the trajectories based on risky sexual behavior, depression, and substance abuse among older MSM, future research will also need study the protective factors such as social support and coping mechanism which will have direct implications for strength-based interventions.

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